

Gamification for Teaching Java

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ABSTRACT

The term ‘gamification’ refers to the use of game elements in non-game environments like education, business, sales and marketing. The method of ‘gamifying’ has been applied in many different contexts and for many different reasons; for instance, in order to improve productivity, to increase sales, to motivate employees and customers, et al. In recent years, educators began to investigate the effects of different gamification elements within the context of education. There has been a considerable debate regarding the actual effects of gamification on the intrinsic motivation of students towards learning, and many research have been conducted in order to discover the results of ‘gamifying’ any specific course curriculum. Each research study has revealed another impediment, supported by multiple review studies that revealed significant problems with some of the methods of majority of studies in the research area now known as the ‘gamification of education’. This paper explains the design, analysis and implementation process of an open-source gamification platform, which is aimed at providing a gamification platform for education, while also explaining a preliminary survey conducted on an Introduction to Java course. The platform was developed using multiple technologies and frameworks related to the Java programming language while the survey was conducted at third level education students through a quantitative questionnaire.

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SIMUTOOLS '17, September 11–13, 2017, Hong Kong, China
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ACM ISBN 978-1-4503-6388-4/17/09.
<https://doi.org/10.1145/3173519.3173538>

CCS CONCEPTS

• **Social and professional topics** → **Computer science education**; • **Applied computing** → **Education**; • **General and reference** → *General conference proceedings*; • **Information systems** → Open source software;

KEYWORDS

Gamification, Software Engineering, Education, Gamifying Education, Java Education

ACM Reference format:

Çağrı Çubukçu, Bo Wang, Lizbeth Goodman, and Eleni Mangina. 2017. Gamification for Teaching Java. In *Proceedings of 10th EAI International Conference on Simulation Tools and Techniques, Hong Kong, China, September 11–13, 2017 (SIMUTOOLS '17)*, 11 pages.
<https://doi.org/10.1145/3173519.3173538>

1 INTRODUCTION

Salen and Zimmerman describe games as “systems in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” [1]. There are two mechanics in every game: rules and elements [2]. In digital games, these elements can be identified as points, badges, achievements, quests, and all the other components that make a game. Rules on the other hand define the means of acquiring or achieving these elements. Rules are basic how-to’s of the game which define ways of unlocking badges, completing achievements, earning titles, or even progression in the game. In every game, there are tasks that the player needs to complete in order to achieve some form of recognition through a feedback mechanism while also motivating players towards completing even more tasks, guaranteeing a loop that will drive them even further. Video games have been taking advantage of these loops to motivate players to spend more time in the game; therefore, it comes as no surprise when game elements started to be used in businesses for commercial purposes. As of today, game elements are being used for a variety of purposes in the private sector; increasing engagement, promoting brand loyalty, or even increasing employee dedication.

There are many applications and businesses that use gamification today, such as; healthy living [3], greener energy

consumption on cars [4], and life improvement [5]. Essentially, brand loyalty programs are gamified systems as they take advantage of points, reward mechanisms and membership levels. In an educational application, instructors try and use these elements to improve a student's intrinsic motivation towards learning. Researchers have been trying to discover ways for integrating different game elements into their courses to motivate students without facing any adverse effects but it has been a troublesome process nonetheless.

On academic grounds, a comprehensive review study that was published on 2014 by Hamari *et al.* [6] found that majority of the literature was subpar. Authors scanned through 8 different databases and found 8050 papers about gamification in total. The amount of peer-reviewed papers, however, was only 809. Then the peer-reviewed papers were divided into following four categories:

- Conceptual papers;
- Engineering papers that are describing a system without evaluation;
- The term was mentioned in the text but the paper was irrelevant;
- Short Paper/Extended Abstract/In-Progress.

The papers that fit into these categories were deemed subpar while the remaining were considered tangible studies. The result was a mere number of 24 tangible studies, out of which education was the most studied context with 9 papers. Authors point out to multiple issues that are inherent in many studies which are; small sample sizes, improper psychometric measurements, absence of control groups, durations, lack of clarity, and lack of multilevel measurement models. This claim was supported by a later study by Seaborn and Fels [7] while another paper by Iosup and Epema [8] sheds some light into the reasoning behind the state of the current literature. They explain that they have faced approval and support limitations when they were trying to get the software developed for their research. They also express the need for a computerized support for gamifying courses as calculating points, achievements, and every other item by hand imposes a huge workload on the instructors themselves.

Aim of this study and GeNIE is to address the issue of shortage of computer-assisted solutions for conducting research on gamification of education while also running a survey to investigate the initial perceptions of students about the gamification aspects of a course. Multiple technologies and frameworks are employed in order to create the software that can run on many different environments with little to no modification. Another aspect of the project is providing a modular solution which can be modified according to the specific needs of the instructor; even though, adding or removing certain features would require an intervention from an experienced software developer, it will still be much less resource consuming than creating a completely new software suite.

2 BACKGROUND

Iosup and Epema [8] presented one of the longest running studies on gamification. They taught two gamified courses; an undergraduate course on Computer Organization that was taught for 3 consecutive years, and a graduate course on Cloud Computing that was taught for 1 year during the writing of their paper. Their main challenge was to make technically and conceptually challenging courses interesting. Authors have identified 3 core mechanics and 4 core dynamics for gamification. The 3 core mechanics were points, leaderboards, and levels. Levels consisted of user levels and access levels where user levels indicated a student's level while access levels controlled what a student can see, which only consisted of additional material and nothing mandatory for the course. The 4 core dynamics that authors identified were badges, tutorials, social engagement loops, and unlockable content. After the gamification of these courses, they have observed an increase in attendance and in course completion rates, which was accounted to gamification elements by the students. The bonus grades collected have increased over the years but it especially saw a rise after the social interactions were introduced. They also saw a rise in the ratio of failed students returning to take the resit exam but it couldn't be determined if any or all parts of this change can also be attributed to gamification or not.

More recently, a survey paper was published by Seaborn and Fels [7] that supported findings of Hamari *et al.* [6]. Existing literature was surveyed with three goals in mind; exploring whether gamification had a consensus on the term and concept or not, providing a multidisciplinary review of the current literature, and figuring out if there are any links between theoretical work and the practical implications. Authors queried 8 databases on July 30, 2013 for gamification papers and found only 769 papers in total. They filtered down these in relation with multiple criteria and found 31 papers in total that could be deemed tangible.

Seaborn and Fels criticize many researchers who try to pass an implementation of points, badges, and leaderboards as gamification while in truth that subset of elements is called "pointsification" and these are not essential elements of gamification. As the term "Gamification" is a little broad, there are many different voices and multiple definitions for the term. Authors argue that systems that are defined as gamified or gameful can easily be categorized as the other due to this confusion around the definition of the term. They found that many studies suffer from the points made by Hamari *et al.*; like the absence of control groups and statistical data. In the end, authors concluded that there are four major issues with the field; lack of a standard definition for the term, theoretical foundations are inconsistently referenced and interpreted, there is a gap between theory and practice of the platforms, and more empirical studies are needed to understand the actual effects of gamification.

One of the papers that were shaped by the work of Hamari *et al.* [6] is a paper by Hanus and Fox [9], which focuses

on the competitive elements of gamification. Six hypotheses about social comparison, motivation, satisfaction, effort, and empowerment were tested through a system that implemented coins, badges, and leaderboards that used coins as the ranking criteria. The results of the study suggested that gamification might be harming the very motivation it was supposed to improve. Students in the gamified course compared themselves more with other students, had lower intrinsic motivations and lower class satisfaction and they have shown to spend more effort while feeling less empowered. The negative effects might arise due to the fact that students in the gamified course didn't have a choice and it was mandatory for all of them to participate. Rewards in mandatory situations have been shown to be harmful if the student is already motivated towards that given task [10, 11]; so, forcing rewards and other elements on the students might be one of the reasons that the study produced such negative results.

Hanus and Fox [9] mention that further studies should take advantage of the current technology to produce better solutions and also admit that potentially the most competitive elements of gamification were used in their study and they encourage further studies to be conducted on more positive elements. Furthermore, authors suggest that studies should also be conducted on individual elements to better understand their effects and their effectiveness. A study conducted using an individual element was published by Hamari [12] that focused on badges, which was conducted on a relatively large sample size of 2989 people who were split into two groups. The first group was a pre-implementation group of 1410 people and the second group was a post-implementation group of 1579 people to assess the effects of a badge system. Badges were implemented on an existing system called Sharetribe. This paper also refers and supports the previous claim made by Hamari *et al.* [6] and suggests combining experimental setups with surveys for gathering more accurate links between different mechanics of gamification and their effects. For this study Hamari determined four dependent variables: page views, trade offers, comments, and accepted transactions. They used these variables to determine the differences between research groups. At the end of the study, the post-implementation group showed a positive graph; they had significantly higher numbers on all four of the dependent variables, which suggests that users were motivated by the badges themselves.

A study that attempted to investigate the effects of gamification on Computer Science education was published by Ibanez *et al.* [2]. They attempted to gamify a part of their course that focused on teaching basic concepts of C-programming language to undergraduate computer science students. In this study, there were three research objectives;

- Exploring the impact of gamification on student engagement;
- Gain understanding of the perceived engagement;
- Measure the actual academic impact.

Authors tested three hypotheses in this paper; students will work more than the actual requirements of the course, students will change their learning strategy once they achieve the requirements of the course and that students would gain knowledge of the C-programming language. They introduced a system where students would achieve the maximum grade when they reached 100 points but they were still able to acquire more points through the course activities, which was intended to test if students would change their behaviour after reaching the maximum grade points. These activities were split into three groups that featured direct work activities as well as social recognition activities. The participants consisted of 22 students, 17 males and 5 females; all of who were playing video games and were already familiar with the concepts. The results showed that students performed extra work to explore uncovered areas of the language after they have achieved the maximum grade, which suggests that students have shown cognitive engagement towards the material. Some students expressed that they continued the work to get all the badges or to place higher in the leaderboards while some of them just wanted to learn more. Also, some students just wanted to help others reach 100 points, which supports the positive effects of cooperative based social encounters on the platform. Students reported shortage of time and reaching the limits of the platform as the main reasons for stopping the usage of the system. Authors also found strong evidence to support that those students, in fact, changed their activity levels after reaching 100 points; their activity levels dropped significantly even if they continued to use the platform. It is not clear if the reason students participated in further activities is gamification, intrinsic motivation or another effect. This uncertainty is due to multiple shortcomings, like some of the aforementioned studies, such as a really small sample group of 22 students who were engaged with the gamified platform for 3 lectures, and the absence of a control group. This absence of control group prevented them from drawing a clearer conclusion.

Li *et al.* [13] decided to take a different approach towards gamifying a course by developing a portal called PeerSpace that focused on social collaboration to improve engagement of computer science students. This portal facilitated a peer support network among students to improve their learning. PeerSpace implemented an ecosystem of gamification elements; project submission, course preparation, peer review, wiki, user profiles, friends, blogs, groups, forum and chat. An unusual addition to the system was the implementation of four turn-based games to improve social interactions of the students. These games were multiplayer games like a modified version of "Guess Who?" that used faces of students and faculty members so they would get acquainted with each other easily. Leaderboards were facilitated for these games and other information such as the rate of participation. They received very positive comments from the students and seen an overall greater number of activities than previous data. However, there were not many activities used in this observation or they did not report them because there is only

mention of posts and game plays in the analysis section. This study, like some of the previous studies, suffers from a short duration and a small sample size.

3 CONCEPTUAL GAMIFICATION FRAMEWORK

3.1 Points

Points are used for two main purposes in games: Indicating progression and performance. Points that indicate progression are generally named experience points; and in games, experience points are gained in multiple ways including completing quests/tasks or defeating opponents [14]. In education, there are no opponents. So, the experience points will have to come from accomplishing different tasks and quests. Progression points often indicate how far a user is in a gamified system and a higher amount of progression points (Experience points or levels that are gained by progression points) imply a deeper knowledge of the system in question and the user's progression through the content as well.

Second use for points is, as an indicator of performance. When points are used for this purpose, best course of action would be to make points real performance indicators and provide a conversion chart from points earned within the framework to actual grades. Performance points can be named according to the context in which they are being used. A game might name performance points as minerals, coins, points or even thunderbolts. In gamified courses, this can be named in line with the coursework, i.e. network components for a gamified grid-computing course. Performance points often indicate the performance of a user within the system, how good of a user they are. In gamified systems like loyalty point programs, a customer often earns points through purchases, and they are rewarded with points as a show of gratitude for being such good customers. In education, on the other hand, performance points can be used to obtain items from virtual shops; items that provide deadline extensions, decrease questions in quizzes or allow a student to skip a class without penalties.

3.2 Achievements

Achievements open up another stream to indicate progress and they act as a rewarding mechanism. Achievements, despite being a common element to games, are not implemented in gamified systems as often as one might think [7].

An achievement consists of three elements; signifier, description, and completion criteria [15]. Generally, there are two types of achievements in both games and gamification applications. First is the quantitative, or incremental, achievements. These are managed by the application itself, as there is generally a numeric condition that a user needs to achieve in order to be awarded with the achievement. In games, these achievements can be about defeating an amount of enemies, reaching a level, or acquiring a certain amount of currency. Quantitative achievements are often progressive, starting with an easily achievable number and advancing to really

high numbers in multiple steps with scaling rewards, generally with a huge reward at the end. This progressive approach should help keep the student in a flow channel and allow them to master their skills before moving on to a greater challenge that should be presented in the next step of the progression chain [16]. In an educational gamification portal, quantitative achievements can be tracked by the system itself and rewarded accordingly. Some examples to these can be as follows:

- Score # points in a quiz/assignment/exam;
- Attend # classes;
- Submit # assignments at least 24 hours earlier than the due date;
- Accumulate # points;
- Collect # badges;
- Rank #th on Points Leaderboard;
- Submit an assignment # days earlier;
- Get an overall rating of # on # different review questions;

As it can be seen from these examples, quantitative achievements while numerous, is restricted to numeric values. Second kind of achievements is the qualitative type. These generally do not, or cannot, feature a progression bar as they are rewarded for accomplishing a single unquantifiable task. Arguably, these do not exist in games as everything is tracked and achievements are rewarded automatically, so one way or another, it is quantifiable. These can, however exist in a gamification setting. Qualitative achievements give more freedom to the instructor but they cannot be tracked by the system; the instructor can award these through an approval mechanism. A student can fill in a reward request for a specific achievement and if the instructor is convinced or is already informed that the completion criteria has been met, then they can award this achievement to the student. A picture or some description can be provided while submitting this request as proof. There can be countless examples for this type of achievement; entirely up to the creativity of the instructor. Some examples can be given as follows:

- Bring extra material that can be useful to the class;
- Do a voluntary presentation about the week's subject;
- Take your study material to a road trip;
- Cover a person or a pet with printouts;
- Wear a costume to class;
- Study for the exam as a group of at least # people;
- Make no grammatical errors in a paper.

Achievements; on the other hand, do not have to be just reward and progress mechanisms. They also possess enough information to pose as a supportive tutorial element. Achievements can contain subtle bits of information for informing the user of the possible actions that they can perform within the application. One might learn that they can create quizzes for their peers as a study material through achievement descriptions or that there is a store in which they can spend their coins. GeNIE doesn't implement qualitative achievements at this point but this should be a point of consideration for

further developers that are interested in participating in the project.

3.3 Leaderboards

While being one of the most implemented elements of gamification [7], current literature suggests that Leaderboards actually do more harm than good and they are inherently a competitive element that is reported as harmful in education [9, 17, 18]. Providing an option of student anonymity to the instructor that will control whether student names will be displayed or not in the leaderboards might decrease competitiveness and promote a better social comparison. Also, giving the students to opt-in or opt-out of leaderboards might be a good approach if they do not want anything to do with leaderboards, which will in turn give the students more autonomy that would potentially improve their intrinsic motivation [17].

An approach where instructors will be given multiple options towards the leaderboard, including a master switch that can be employed to further empower this element might help better the situation. Multiple options towards the visibility of leaderboards might also help reduce competitive feelings that might be generated because of them. Presenting leaderboards from the very start beginning might not be as beneficial as one might think. In any given game, an experienced player will always progress faster from a person that is newly introduced to video games. This gap might never really tighten but at least, in many games, the new player would get a chance to improve their skills before getting thrown into the same arena as the experienced player. In Battlefield 4 [19], Leaderboards are split into divisions so players would compete with their peers, from around the world, in terms of skill and in Clash Royale [20], only the top players can participate in the Leaderboards. The same thinking can apply to gamification. If students are made to compete from day one, already experienced students will get an unfair advantage; especially when you consider that women do not enjoy competition as much as men do [21], this competition might become one-sided. Another setting that would help reduce competitiveness might be providing a warm-up period before Leaderboards become available to give the inexperienced students a chance to learn the system.

Leaderboards, like quantitative achievements, require an integer-based indicator to track and rank students. Numeric values that are used for these achievements can also be used in leaderboards as well. It should be noted that having a leaderboard for a rare occurrence is generally a useless feature. If there is a leaderboard for assignment submissions, then it is likely that most of the participants will have the same amount of submissions and will be ranked the same.

3.4 Badges

Badges are currently one of the most used reward elements in gamification [6, 7]. They possess a powerful element as they contain both a visual and a textual element that provide a unique identification for accomplishments. Students should

be able to show their badges on their profiles; or on a more general medium like forums or wiki pages; or on social media to receive recognition from their whole social circles. Badges, while simple, have an important aspect that should be taken into account and that is the significance of the visual aspect. If the badge given for a simple task looks rather similar, without any signifiers, to a badge that is given for a really tough task, it wouldn't be too hard to imagine the latter badge to lose its significance.

4 GENIE

GeNIE [22] was developed in order to address the lack of computerized support for gamification of education and it involves a simplified Learning Management System (LMS), with basic user and course-related functionalities such as assignment submissions and course enrollment while also implementing a more advanced mechanism through Quizzes and a recommender system that evaluates a student's knowledge level and creates a quiz according to the determined level. The gamification aspect of the portal focuses on a subset of elements also called pointsification [6, 7], set of most implemented elements of gamification. This subset was chosen on the basis that a lot of researchers had to get their own systems developed and spent many resources on such tasks while essentially, resources were being spent on developing the same technology that was already developed and it is likely that many researchers will have to continue doing so. GeNIE aims to address this issue by providing an open source project and to direct these resources into improving a shared system and make way for development of less-tested elements of gamification.

Since GeNIE is aimed at a wide group of researchers, most essential aspects are modularity and platform independence. Modular aspect of the platform is the ability given to instructors for easily toggling an element; e.g. the badge system of a course within a specific semester can be turned off individually. Platform independence is achieved by the use of Java programming language [23] and related technologies that further improve this ability, along with other capabilities, of the language itself such as Spring Framework [24], Maven [25], Hibernate [26], MySQL [27], PrimeFaces [28] and multiple Apache libraries and tools [29, 30].

4.1 Gamification in GeNIE

GeNIE includes Points, Leaderboards, Badges and Achievements as its gamification element subset. As modularity is a key component, instructors are given switches that they can use to enable or disable each of these elements for a course and the functionality works on a semester basis so that the retrospective implementations of the settings would be kept within the system, and this switch is also provided for the gamification aspect in its totality. Once any of these switches are turned off, students lose their access to the given element. However, these switches are not only given to instructors, they are also given to students with which they can control their own settings. Students are given the option to enable or

disable individual elements of gamification for a given course in a specific semester, which might in turn increase their feeling of autonomy and competence by not forcing anything on the students.

First of the four implemented elements is Leaderboards, which often receives negative feedback due to the competitive environment it creates [9, 17, 18]. Multiple options to address this issue have been implemented in the platform; first of them, as mentioned before, is student control over their Leaderboard participation. Apart from that, there are two options regarding a student's visibility on the Leaderboard:

- Visibility;
 - Top Students: Only a certain amount of top ranking students will be visible;
 - Top and Bottom Students: Only a certain amount of top and bottom ranking students will be visible;
 - All Visible: All students will be visible on the leaderboard.
- Name Visibility:
 - Anonymous: All students except the student that is viewing the Leaderboard will be listed as anonymous.
 - Username Visible: Usernames of students will be visible on the Leaderboard

Points are currently the only ranking criteria that can be used in the Leaderboards and they can be earned through a couple different means, Achievements and course-work. Points are used as a performance indicator within the system but they currently do not feed into a level system; so, the amount of points a student has indicates their performance as a student through the coursework. Points are not solely used for the purpose of ranking students on the Leaderboards, it can provide a tangible outcome for the student through the option given to the instructors, Maximum Convertible Points (as it can be seen on Figure 1), that can be used to calculate a grade outcome from the points a student has earned during the semester. For this purpose, an instructor sets a grade weight for gamification aspect and then sets the Maximum Convertible Points option and when semester finishes, a grade is awarded to students proportional to the amount of points they earned in relation to the Maximum Convertible Points setting.

Badges, like Points, are earned through Achievements and they provide a visual reward for the tasks they accomplish that can be showcased on a student's profile. As Badges are mainly a visual element that can promote motivation through social recognition, visual aspect should reflect the importance of the Badge itself [16]. Badges are hidden and their images are replaced with a default image until the student unlocks the given Badge, at which point it is also displayed in their profile pages.

Achievements, within GeNIE, are made up of four components: Signifier, Description, Completion Criteria, and Rewards. Three of these components, except rewards, are defined by Hamari and Eranti [15]. Signifier is the part of an Achievement that is presented to the students; it can consist of a visual element and a textual element. Description

lists the details of the Achievement and explains it while completion criteria are the set of rules for unlocking that Achievement. Lastly, rewards; as the name suggests, will define the rewards of that specific Achievement. There are predefined completion criteria in the system, enabling them to be tracked by the system automatically. Flexibility of the Achievements mechanism allows not only good feats to be rewarded but also negative ones as well to allow for testing of these mechanisms. For example, there can be an achievement for submitting an assignment after the deadline has passed or getting below a certain grade, which might help mitigate the effects of such unwanted situation. The criteria that can currently be used for Achievements are total or consecutive attendances, total or early assignment submissions, getting a certain grade on a grading item, and three criteria regarding the multiple choice question module (Quiz Completion, Questions Answered and Correct Answers).

Achievement rewards are flexible to give more control to the instructor. Rewards are made up of four options: attendance, grades, badges, and points. Rewards section has the possibility of rewarding the student multiple items. First reward is the points; where the instructor will enter an amount of points that will be rewarded when this achievement is completed. Second reward consists of a selection from already created Badges that will be rewarded. Instructors are also able to give rewards related to any assessment criteria in the form of grades or attendances. For this kind of reward, instructor will have to choose an assessment criterion first and according to their selection one of the three drop-down menus will appear; an assignment list for the assignment grade rewards, a week list for attendance rewards, and for the remaining assessment criteria, the relevant items will be displayed. Instructor will also have to enter the grade amount that will be rewarded in order to properly setup this reward.

5 IMPLEMENTING JAVA COURSE GAMIFICATION

The course that is implemented in GeNIE for this study was COMP20250 Introduction to Java that is being taught at University College Dublin by Eleni Mangina. Once the course is created on the system, it was then assigned to a semester and the assessment criteria was set to being completely through Gamification with the assessment item name GameScore.

Once the initial setup was complete and the course was created, the next step was creating the course details. First step is creating the course plan; in this case it is a weekly course plan but the system allows for wider time period plans to be created as well. After adding all the documentation to these newly created course plans, assignments were added to each week to complete the course plan creation process.

At this point, course is ready to be served to the students but as mentioned before, there is an additional functionality added for providing Multiple Choice Questions (MCQs). In the MCQ page, the instructor would choose a course in order to display the topics and the MCQs. The topics section has

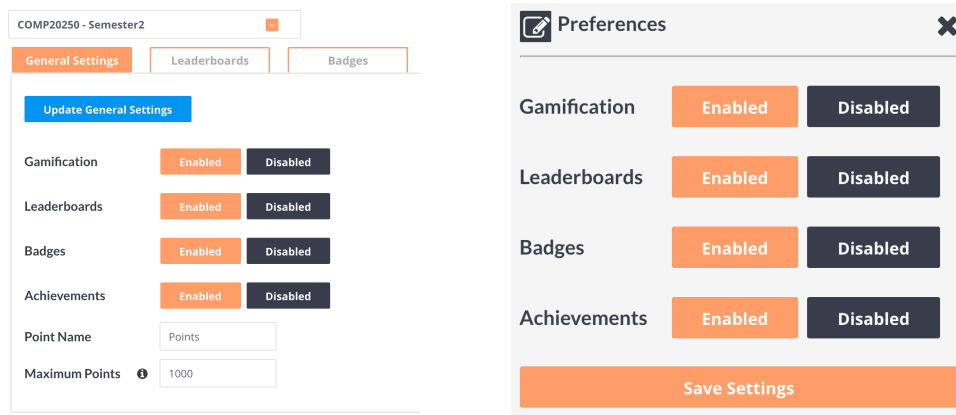


Figure 1: Gamification toggles for instructor (left) and student (right)

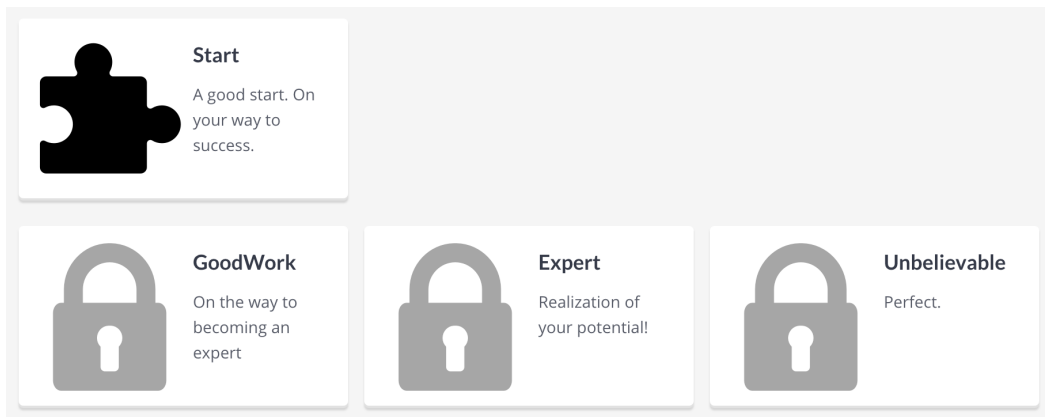


Figure 2: Badge display page of a course for a student

the functionality to disable a topic without deleting it in case it is needed during modification of questions. It also displays the total amount of times it was answered by students and the ratio of times it was answered correctly in a cumulative manner. The 'Import File' button becomes enabled after a topic is chosen from the table and allows for batch creation of questions for that topic if the imported file is structured in a specific manner. For this course, 14 different topics were added to the MCQ page with Difficulty Border Percent and Degrade Border Percent being set to 60 and 40 respectively for each topic, which is used by the recommender to create the quizzes with higher difficulty or lower difficulty questions. MCQs were uploaded through the Import File button using the already existing RTF files that included from about 80 to more than 120 questions for each topic with varying difficulty levels. It is also possible to individually add questions through the interface.

Student side of things is rather straightforward and it only requires them to enter an enrollment key to sign up to a course. However, for the Quiz section, when a student wants to take a practice quiz from the MCQs in the system, they

would be facing a randomized set of questions. The MCQ module chooses questions at random with a random order including the order of the answers. When a student answers all questions, they would go the results page by clicking the Go To Result button where their results would be shown with correct and wrong answer details. This also updates the overall ratios of topics that the instructor can view.

There are in essence, two different recommenders at play in this system. The main recommender is the one that creates quizzes and the second recommender is the one that suggests topics to students. Once a student passes a Hard difficulty level quiz, they will see an otherwise hidden button in the results page that displays all the other topics in the course ordered by the recommendation level when clicked. These are ranked by the correct ratio of each topic and the overall correct ratio is calculated depending on all the answers submitted by all the students.

All elements of gamification that are developed in GENIE are used in this study, which are; Points, Leaderboards, Badges, and Achievements. The leaderboards are set to only show the top 10 students and their usernames were displayed

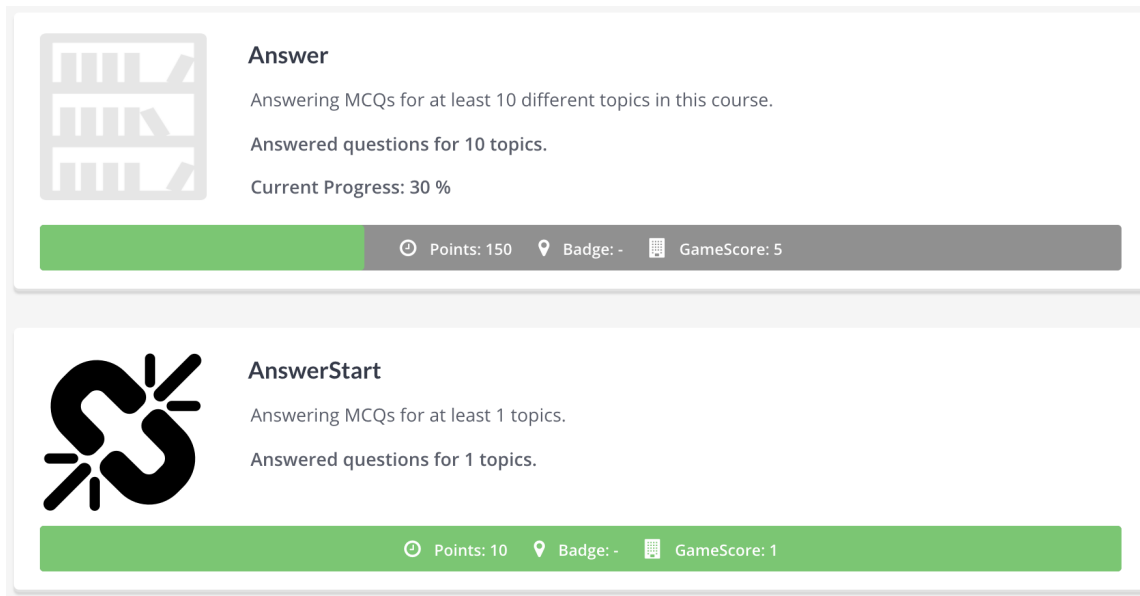


Figure 3: Achievement details page for a student on their course page

on the leaderboards. Four badges were added signifying their knowledge level. Achievements were also created to fit in this segmented approach where they were divided into different stages of their studies. This was done in order to provide more rewards at the beginning and increase the scarcity later on in order to motivate the students at first and create a sense of challenge for the remaining achievements.

6 EVALUATION

A short questionnaire was created in order to collect user experience reports from students after a short usage of the portal. They were asked to log in to the system and consume the content there before being asked to fill in the questionnaire, of which the results can be found on Table 1.

Students have reported Leaderboards as the top motivator yet the literature seems to be contradicting this self-reported inclination [9, 17, 18]. However, the fact that students do not want other students to see their progress can mean, in the long run, Leaderboards would indeed have a negative impact in this implementation, as they would earn grades completely from the gamification elements; thus, a direct display of one's progress. This raises awareness for further research that it should be a focus to investigate both the perceived and actual benefits of gamification as even at this stage, students reports on Leaderboards are contradictory within themselves. They also reported that achievements would be the second most important motivator for them in this platform yet they were not as inclined towards working towards unlocking an achievement. This suggests that achievements should be implemented with a purpose and not swarm students with many tasks to complete, especially if the rewards are directly related to their grades, it might be beneficial to provide

multiple means of acquiring those rewards to give them alternatives. It would not be too hard to see a student get demotivated if they are struggling to receive the hardest achievement in order to get an A and continuously failing to do so. It should be extra content rather than core requirement.

Even though students expressed that they would spend more time and effort to achieve a Badge, they also rated badges as the lowest-ranking reason to keep using the system, which suggests that they saw badges as an additional aspect that they would work towards but would not be a direct reason for them to continue using the system. Another aspect worth considering is that the students ranked points as the second lowest reason to continue using the system; this does not constitute a milestone point on its own, yet the responses should be considered along with the fact that points were their only grading criteria and them still ranking it so low opens a path for further studies that would look into the effects of points on intrinsic motivation in a single element study.

7 CONCLUSION

Gamification is a relatively new area when compared with many other research areas and there are not many efficacious studies in this field/area. There are no standards or guidelines that would help researchers or instructors on gamifying their courses but this is not a surprise as the term Gamification itself doesn't have a standardized definition. During the development process and this study, it became clearer that this research area suffered from the shortage of software support that it needs in order to be applied in a proper manner. Overall, even though this study was rather limited in terms of providing solid results, respondents were

Table 1
Survey results

Question	n	Mean	Std dev	Std err	Mode
Does the system help you understand the concepts that are being taught better?	27	4.19	0.74	0.14	4
Can you relate the activities to the subject matter?	27	4.19	0.88	0.17	5
Would you put in more time and effort to achieve a Badge?	27	4.19	0.74	0.14	4
Would you put in more effort and time to see your name on the Leaderboards?	27	4.56	0.58	0.11	5
Do you want other users to be able to see your progress?	27	3.52	1.12	0.22	4
Would you put in more effort and time to unlock an Achievement?	27	4.07	0.92	0.18	5
Does the points system have any effect on your usage behaviour?	27	4.11	0.97	0.19	5
What is your opinion about using achievements as overall progression indicator?	27	4.04	0.76	0.15	4
Why would you continue to use the system?					
The system is more fun	27	3.81	0.79	0.15	4
I get motivated by my achievements	25	3.92	0.86	0.17	4
I want badges	24	3.63	0.77	0.16	3
I want to level up	24	3.83	0.76	0.16	4
I want to see my name on the leaderboard	24	4.00	0.93	0.19	5
I want to gain points	24	3.71	0.81	0.17	4
I learn something useful each time I use the system	24	3.83	0.82	0.17	4

9. Why would you continue to use the system? (The following answers are related to question 9. You can answer 1 or more)

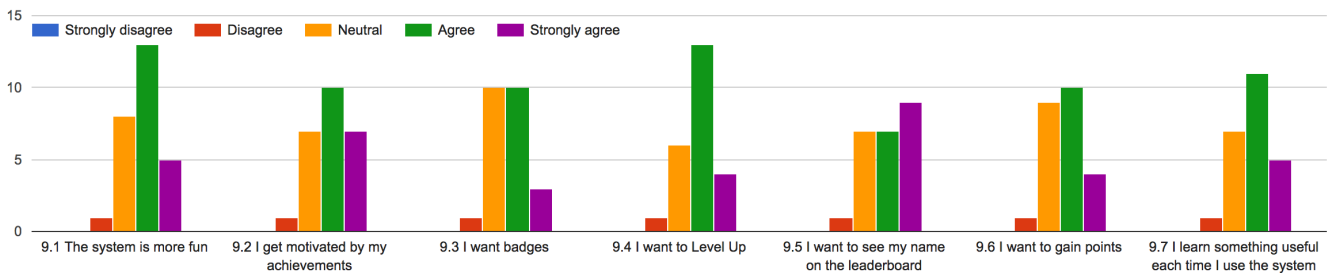


Figure 4: Visual representation of the answers given for Question 9

enthusiastic about the system and the idea of gamification. This further emphasizes the need for single element studies and the importance of differences between perceived and actual benefits of gamification with a strong emphasis on psychometric evaluation.

7.1 Further Research

Gamification elements haven't been examined in full detail to this day, and it is still unclear if certain elements would do more harm than good, even for the Leaderboards. Furthermore, all gamification elements should be examined in their simplest form as well as a combination of elements, or even an ecosystem of elements. The scarcity of single element studies is appalling which is also mentioned in a single element study focusing on Badges conducted in a non-educative context [12]. Another neglected approach is the perspective of a student's peers on their accomplishments. Studies that are focusing on a single element should take advantage of that opportunity and ask students about their perspective and feelings on

their classmates' accomplishments; e.g. a question regarding feelings if one of their friends completed an extremely hard achievement before them.

Even though there are many studies and while the majority of them are in education, some key research wasn't conducted on education. Future studies should focus on providing a deeper understanding of these mechanisms and their resonances within the educational context. More studies should be conducted on demographic differences, different gamification elements with different scopes, novelty effect, and perceived benefits and harmful sides of gamification. These studies should exercise great caution to avoid the pitfalls that affected past studies as shown and detailed by Hamari *et al.* [6].

Apart from the aforementioned areas that require research in the field of gamification of education, there are new technologies and methodologies that gamification is bound to integrate with that will require in depth research in the near future. One of the new methodologies that is already being

applied in the educational field is adaptive learning. Adaptive learning is a technique that utilizes computers to adapt the educational material according to a student's specific needs. These needs are derived from their analysis that is conducted by the system according to a student's actions while using the system. A system that utilizes gamification and adaptive learning can improve the effectiveness of both methods. Each gamification element takes advantage of a different part of a student's personality. Some elements promote competitiveness while some require the students to be helpful. A student's interactions with a specific element can shed more light into their personality and help draw better conclusions on their learner profiles. Inferring a better profile for a given student would result in providing much more suitable content to that student. This system can also be incorporated with recommender systems to improve its capabilities even further. Recommender systems try to predict a user's preferences by finding similar users to the current user or similar items to the current user's items and then these systems suggest the current user a list of items according to these calculated preferences [31]. When this is incorporated with a gamified system that features adaptive learning techniques, a recommender system can accurately predict a student's course preferences and provide suggestions accordingly. A student could then know which courses would best fit their learning style and their approach towards courses. This can improve a student's overall outcome from their education and greatly improve their motivation towards learning. However, neither of these approaches has been studied before and researchers should start shifting their focus towards these techniques, as they possess more potential together to provide a much better educational approach than they do on a singular level.

7.2 Further Development

Further development on the GeNIE platform should focus on improving student and instructor experience by creating clearer flows within the user pages. Another important point of improvement is improving the modularity between gamification elements. Badges and points are given through achievements in the current version and one might think what would happen when achievements are turned off but badges and points are left functional. Since this disabling mechanism is a cosmetic difference rather than a functional one, students will still receive their badges and points that result from completing achievements. However, students would have no way of knowing where their rewards would be coming from or track their progress. This scenario is currently not handled and it should be a priority for further development if GeNIE is going to be used in such a setting.

Furthermore, addition of more gamification elements that follow the same principles of the platform is essential in order to create a comprehensive platform for gamification research. The last important development point on this open source platform is a reporting section. Currently, GeNIE doesn't implement a reporting mechanism to instructors where they

can track their students' actions and their progresses through the system, yet it a necessary addition.

ACKNOWLEDGMENTS

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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