GeNIE: A PORTAL FOR GAMIFICATION OF HIGHER EDUCATION
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Abstract
Gamification is the usage of game elements in non-game environments like education, business, sales and marketing. In the last decade, educators began to investigate the effects of different gamification elements within the context of education. Existing research revealed the errors in the methods of majority of studies in the area of gamification of education. The actual reason behind the issues in the existing literature is quite simple; the shortage of computerized support. This project aims to provide a solution to this shortage by creating a modular and platform-independent system for gamifying university-level education through Java-related technologies.

Introduction
Salen and Zimmerman describe a game as a “system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome” (2003, p. 11). There are two mechanics in every game: rules and elements (Ibanez, Di-Serio, & Delgado-Kloos, 2014). 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 that define ways of unlocking badges, completing achievements, earning titles, or even progression in the game. In every game, there is a task 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.

There are many applications and businesses that gamification is applied to from healthy living (“Fitocracy”, n.d.) to promoting literacy (“Mindbloom”, n.d.). Even brand loyalty programs can be considered gamified systems as they take advantage of points and reward mechanisms. In an educational application, instructors try and use these elements to improve a student’s intrinsic motivation towards learning. Current literature on applying game elements to education contains a great deal of opposing studies and there seems to be no convergence of an opinion on any of the elements or the way they are applied to a course. The aim of this project is to address the shortage of a computer-assisted software for conducting research on gamification in education. This project employs multiple technologies and frameworks to create 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 a software developer experienced with this kind of software, it will still be much easier than creating a software from scratch.
Background
Gamification aspect of the portal targets a subset of game elements, which is the most widely implemented set of elements by researchers so far; Points, Leaderboards, Badges, and Achievements (Hamari & Koivisto, 2013; Ibanez et al., 2014; Iosup & Epema, 2014). These elements were chosen so that future improvements and research could focus on other elements of gamification that might prove to be more advantageous on education. Another key approach taken with this project is improving the modularity of the gamification elements. This modularity is achieved by providing an option to researchers to toggle each individual element, as well as the master switch that toggles gamification on a course basis. This switch is also given to the students to improve their autonomy by enabling them to opt-out of elements they don’t wish to participate.

Iosup and Epema (2014) presented one of the longest running studies on gamification. They taught two courses, an undergraduate course that was taught for 3 consecutive years, and a graduate course 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 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 authors identified were badges as a way to show off achievements, tutorials, social engagement loops, and unlockable content. After the gamification of these courses, they have observed an increase in attendance and in completion rates that was accounted to gamification elements by the students’ responses. The bonus grades collected have increased over the years but it especially saw a rise after the social interactions were introduced. Lastly, Iosup and Epema express the need for a computer-assisted software for managing gamification and they explain that approval and support limitations were faced in order to get the approval for their software project.

A review study that was published on 2014 by Hamari, Koivisto, and Sarsa (2014) 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 papers 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 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.

Analysis & Design
The motivation and the aim of this project, as well as the gamification elements and technical specifications that are used will be explained in this section. For this project, after careful consideration it was decided to develop a basic Learning Management System (LMS) and implement a subset of gamification elements using this newly
developed LMS. Even though using an already existent open source LMS could be modified to provide the gamification functionalities, effort required for understanding the infrastructure of an already mature LMS would be a vigorous task that would hinder the ultimate goal of this project, which is to provide an easily expandable and modular system.

Goals
GeNIE essentially has one main purpose, which is to provide an easily expandable and modular gamified system for further use by researchers. Achieving modularity within the software itself is a matter of designing the system accordingly; however, this system is also designed to be able to run on different kinds of servers, which is a matter of choosing the right tools for the development. By providing researchers a base system in which the most studied gamification elements are already functional, we hope that future studies can focus on implementing other elements and the resource expenditure on similar specifications can be avoided in the research area of gamification of education.

Another aspect of this project was the target audience, which we decided as the university students. University students are currently the main target audience of the gamification studies and since GeNIE is aimed at overcoming some burdens of future researchers, it was the suitable choice. It doesn’t mean that it cannot be used for other student demographics either; as mentioned earlier, the system is built with modularity in mind but it would require more customization work.

Analysis
Majority of the researchers tested a subset of elements of gamification called pointsification (Seaborn & Fels, 2015; Hamari et al., 2014) and it is likely that more researchers will come up with software solutions for these elements. So, the subset of elements to be implemented was chosen as the subset of elements also known as pointsification that mainly consists of Points, Leaderboards, Badges, and Achievements. This can potentially allow future researchers to focus on other elements and direct their resources accordingly.

Points are used for two main purposes in games, indicating progression and performance. Points that indicate progression are generally named experience points. In games, experience points are often linked to a level system, which isn’t implemented in GeNIE. However, the system uses points as an indicator of a student’s performance. GeNIE would allow instructors to give custom names to their point system so that it can be tailored for the specific theme that will be applied to the course. The other feature is the point-to-grade conversion that is handled by the system according to the weight given to the point system. It is important to provide a conversion scheme from points to actual grades as it can act as a motivator in that case. Points are also be used as the ranking criterion within the Leaderboards. Currently, the point system cannot be turned off like the other elements as it is directly linked with the point-to-grade conversion scheme, but it can be neglected. However, with further work, it can be modified to be as independent as other elements.

After examining the current literature, certain issues regarding the modularity of many of the developed systems were discovered. Understandably, researchers got a system designed and developed according to their needs at that time (Iosup & Epema, 2014;
Sheth, Bell, & Kaiser, 2012) but issues would arise if they needed modifications for
these systems as it would require further resources to do so. On the other hand, putting a
switch for each of the elements, and for the general gamification could provide great
flexibility to researchers by moving this aspect from a static implementation to a
dynamic one. This switch however, works on a course basis and not on a system-level
so researchers can experiment with different settings of gamification using the same
system, as well as having control groups within the same system. With such options and
this software, only introducing new features would need resources without having any
effect on the already developed elements or on the system in its totality. Also, this
switch for toggling each element is given to students as well; so, they can individually
opt-out of any element they don’t wish to participate, which could increase a student’s
feeling of autonomy.

Leaderboards have the option to toggle anonymity of student names, which when
toggled, hides the names of other students from the leaderboard. This can help reduce
social pressure that is caused by this element. Also, instructors have the option to hide
or show certain parts of the leaderboard if they wished to do so. For example, they can
show the top five students in the Leaderboard or both the top five and bottom five
students. This is also left to the instructor’s choice. Currently only viable criterion for
Leaderboards within this system is points but it can be extended to account for other
criteria as well.

Badges provide another means for rewarding students through different tasks, using
Achievements in this project; that will be showcased on a student’s profile once they
unlock that badge. Badges should have a unique and appealing visual aspect to them, as
they are the main social recognition objects that are not based on a competitive element,
like Leaderboards. Hamari and Eranti (2011) defined three components of an
achievement as follows: Signifier, Description, and Completion Criteria. 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.
Ideally, an achievement would have a fourth component, a reward. There are multiple
tracking criteria already defined within the system including attendances and
assignment submission dates. The flexibility of achievements allows creation of
achievements, not only with positive criteria but also with negative criteria if it’s
required. For example, there can be an achievement for submitting an assignment after
the deadline has passed or getting below a certain grade.

**Design and Software**

As previously mentioned, one of the main objectives of this project is modularity and
platform independence. For achieving such a platform, an architectural pattern called
*Model-View-Controller* (MVC) is used. This pattern splits a platform into three
components; *Model*, representing the data; *View*, representing the user interface; and
*Controller*, which contains all the logic of the platform. Using this structure allows
future developers to freely change a component without having any effect on the rest of
them. Multiple frameworks and small components are used to achieve this structure and
a better platform independence.

This project uses the programming-language called Java; which is an object-oriented
platform-independent and class-based programming language ("Java SE — Oracle
Technology Network — Oracle”, n.d.). GeNIE is designed as more of an enterprise-level software solution rather than a simple web page and there are many underlying software frameworks being used to enrich the functionality of the system.

The main framework that is being used is called The Spring Framework ("Spring Framework", n.d.). Spring, provides multitudes of different modules to help build a system and enhance every aspect of it. Multiple components of the Spring Framework are being used in this project including Spring Web Flow ("Spring Web Flow", n.d.) and Spring Security ("Spring Security", n.d.), which respectively provide functionality for creating a flow within the pages, and the authorization and security aspects. Along with Spring Framework, multiple small components that are overseen by the Apache Software Foundation (ASF) are used (“Welcome to The Apache Software Foundation!”, n.d.), including Maven ("Maven - Welcome to Apache Maven", n.d.). These are used for achieving a better platform independence and are included with further enhancements in mind. All these components can be considered the Controller part of the MVC structure, along with all the custom functionality of GeNIE.

View of the MVC is developed using PrimeFaces ("PrimeFaces", n.d.), which provides many rich components that could be used when creating a user interface for a web page. This can be easily changed with another technology or another design as other components of the whole system are designed with such a change in mind. Model, the last component of the MVC, represents the data of a system. An Open Source database system called MySQL ("MySQL :: The world’s most popular open source database", n.d.) is used for providing database functionality. However, another framework called Hibernate ("Hibernate. Everything data", n.d.) is used to facilitate a connection between the database and the rest of the system. Main reason for using such a component for this communication is providing an easily changeable database. It is only a matter of changing a couple lines of properties to completely change the underlying database system of GeNIE, and it would work seamlessly. It is a really powerful tool that greatly improves the functionality of the system, as well as easing future improvements to it.

There are multiple servers that can run a Java-based application but for this project a server called VMware vFabric tc Server ("Pivotal tc Server Overview", n.d.) was used for hosting the application, which is actually an enterprise version of the ASF’s Apache Tomcat ("Apache Tomcat - Welcome!", n.d.) server.

**Implementation of a Course**

As the development details of GeNIE would be overly technical for the purposes of this paper, the implementation of a sample course into the system will be explained in this section instead. Dr. Yavuz Samur provided a sample course and related content to be implemented with GeNIE, which he also presented in a paper (Samur, 2015). This course uses a point-to-grade conversion schema to calculate the final grades of students. The maximum amount of points a student needs to get an A is 1000 while the maximum attainable amount of points is higher than that amount.
Initially an Administrator needs to create relevant academic year and semester information within the system before an instructor can create courses and assign those courses to a semester. Course creation happens in multiple steps, which is done by an instructor, first a course has to be created and then it has to be assigned to a relevant semester. After a course is created, the grading criteria should be set, which is done on a semester-based manner rather than course-based to provide a possibility for accurate retrospective data. The next step then is creating the Course Plans from the relevant page within GeNIE. Once all Course Plans are created, instructors can add materials and assignments to that specific plan.

After the course is properly created and everything is set, students can enroll in the course through the enroll button in the Course List page. There is a page called Grading & Attendance for entering data for students’ assignment, exam, or project grades as well as their attendances. This page will also list the final grades calculated accordingly from the grading criteria that was set during course creation.

Gamification page, as the name suggests, is where all the settings related to gamification, Leaderboards, Badges, Points, and Achievements, lie. This is where an instructor can toggle a certain element, set the maximum points required to earn the assignment grade point and an alias for points to be used throughout the system. All related options could be found in their related tabs within the Gamification page, it is all designed to be self-explanatory. Achievement and Badge creation, and settings related to Points and Leaderboards are all found on a single page called Gamification. Figure 2 shows this page for the sample course created.
Evaluation

In order to evaluate and collect user experience reports after the creation of the sample course, users were asked to fill out a survey. In total, 37 responses were collected through this survey, which focused on the respondents’ first expressions on GeNIE and asked them for reviews. As it can be seen from Table 1, the system was rated as being technically reliable and fast as no one encountered any issues during their usage. The user interface of GeNIE was rated consistent, which means the wording, colors, dialogs, and functionality felt consistent across the whole system. The respondents rated the interface of GeNIE as being simple and easy to use but they noted that the system didn’t favor discoverability and they felt lost at times, especially at the very beginning of their usage. Further developments on this system should work on improving the interface as well as introducing a simple tutorial for getting users started with the system.

Some users commented that they would be highly motivated by badges while others said they would be motivated most by achievements but they wouldn’t bother trying to unlock every single achievement. Even though respondents rated Leaderboards as the second biggest source of motivation, this controverts the current research that suggests otherwise. A comment is right on track with the literature which states that they would be hesitant about the leaderboard and they would be terrified to be at the bottom; they also stated that they would actually feel bad for whoever was at the bottom and worry about their standing there.
Table 1

Survey Results for GeNIE

<table>
<thead>
<tr>
<th>Question</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Std. Err.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simplicity of the user interface</td>
<td>7.92</td>
<td>1.52</td>
<td>0.25</td>
</tr>
<tr>
<td>Ease of use</td>
<td>7.65</td>
<td>1.46</td>
<td>0.24</td>
</tr>
<tr>
<td>Organization of information on the screen</td>
<td>7.51</td>
<td>1.69</td>
<td>0.28</td>
</tr>
<tr>
<td>System speed</td>
<td>8.08</td>
<td>1.80</td>
<td>0.30</td>
</tr>
<tr>
<td>System reliability</td>
<td>8.43</td>
<td>1.46</td>
<td>0.24</td>
</tr>
<tr>
<td>System consistency</td>
<td>8.08</td>
<td>1.53</td>
<td>0.25</td>
</tr>
<tr>
<td>Do you think if everything can be done by trial and error? (Discoverability)</td>
<td>6.84</td>
<td>2.05</td>
<td>0.34</td>
</tr>
<tr>
<td>Did the system provide enough information and feedback?</td>
<td>7.03</td>
<td>2.15</td>
<td>0.35</td>
</tr>
<tr>
<td>Do you think GeNIE would’ve helped during your education?</td>
<td>7.76</td>
<td>1.77</td>
<td>0.29</td>
</tr>
<tr>
<td>Do you think if leaderboards would motivate you towards studying more?</td>
<td>7.38</td>
<td>2.25</td>
<td>0.37</td>
</tr>
<tr>
<td>Would you compete for the top places in the leaderboards?</td>
<td>6.84</td>
<td>2.19</td>
<td>0.36</td>
</tr>
<tr>
<td>Do you think if badges would motivate you towards studying more?</td>
<td>7.16</td>
<td>2.36</td>
<td>0.39</td>
</tr>
<tr>
<td>Would you spend time to collect all badges?</td>
<td>6.76</td>
<td>2.34</td>
<td>0.38</td>
</tr>
<tr>
<td>Do you think if achievement would motivate you towards studying more?</td>
<td>7.65</td>
<td>2.10</td>
<td>0.34</td>
</tr>
<tr>
<td>Would you invest effort to unlock all achievements?</td>
<td>6.92</td>
<td>2.15</td>
<td>0.35</td>
</tr>
<tr>
<td>Would you try to collect more points even after you reach the maximum required points?</td>
<td>6.81</td>
<td>2.16</td>
<td>0.35</td>
</tr>
<tr>
<td>How much time did you spend on GeNIE? (Minutes)</td>
<td>22.11</td>
<td>27.53</td>
<td>4.53</td>
</tr>
<tr>
<td>Your Overall Score of GeNIE</td>
<td>6.92</td>
<td>1.80</td>
<td>0.30</td>
</tr>
</tbody>
</table>

Conclusions and Future Work

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 lifetime of this project, it became clear that this research area suffered from the shortage of software support that it needs to be properly applied. GeNIE targeted this void and hopefully addressed it up to some extent. However, it needs improvements in multiple areas, which will be discussed below.

Future Research

Gamification elements haven’t been examined in full detail yet, and it is still unclear if certain elements would do more harm than good, even for the Leaderboards. All
gamification elements, including the ones that aren’t mentioned in this paper should be implemented and examined in order to find a definitive answer regarding their effects on students. Furthermore, these 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 on a non-educative context (Hamari, 2015-in press). 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. However, all future research should exercise great caution to avoid the pitfalls that affected past studies as shown and detailed by Hamari et al. (2014).

Future Developments

Main points that were criticized by the respondents were the lack of tutorials for getting a new user informed and ready to use the system and the shortcomings of the user interface. More gamification elements should be added to the GeNIE; however, they should be in compliance with the rest of the system on toggle-able elements. There can be future improvements made to the current elements as well; such as, opening up new paths for gaining points apart from achievements. There are many possibilities and paths that can be taken for improving GeNIE as it is an open source project and can be found online (ccubukcu/GeNIE, 2015).

References


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