CS/IT Honours
Final Paper 2021

Title: Exploring Gamification as a Critical Success Factor in Online Learning

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Project Abbreviation: OnlineSuccess

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Category	*Min*	*Max*	Chosen
Requirement Analysis and Design	*0*	*20*	10
Theoretical Analysis	*0*	*25*	10
Experiment Design and Execution	*0*	*20*	5
System Development and Implementation	*0*	*20*	10
Results, Findings and Conclusions	*10*	*20*	15
Aim Formulation and Background Work	*10*	*15*	10
Quality of Paper Writing and Presentation	*10*		10
Quality of Deliverables	*10*		10
Overall General Project Evaluation (*this section allowed only with motivation letter from supervisor*)	*0*	*10*	
Total Marks		**80**	

Exploring Gamification as a Critical Success Factor in Online Learning

Gamified Learning

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ABSTRACT

Covid-19 has brought about monumental shifts and changes throughout the world. Very few fields have gone untouched, and that includes the discipline of Computer Science Education (CSEd). The recent trend in increasing technological access affords institutions new means by which to deliver content - Online Distance Learning (ODL). However, the introduction of ODL has come with many complexities, particularly with regard to issues such as poor engagement with course materials. This is where Critical Success Factors (CSFs) come in, as they help alleviate these issues. Although studies have identified many CSFs, the focus of this paper will be directed towards the CSF of gamification. There is a global demand for new learning environments and cyber-classrooms. This means that new methods, technologies, and ways of teaching must be created or used in order to increase the probability of success in such environments. This research topic is specific to an introductory programming course that will be presented online for the first time at the University of Cape Town (UCT) in 2022. It is thus the duty of this paper to make use of gamification as a means by which to enhance students' likelihood of successfully completing this course. When determining success, pass-rate could be used as the core-success factor, as this is what the university is aiming to maintain in its transition to an online learning medium. However, due to the time constraints, pass-rate will not be applicable to this paper.

It was not possible to identify CSFs which guarantee certain success in the current context at UCT but the chosen factor of gamification has been proven to increase the probability of course completion in the context of an online learning environment.

This paper explores the potential of a gamified Learning Management System (LMS) which, when implemented, could help embed the CSF into first year Computer Science Courses (CS1). Insight into the procedures and methods that went into the development and assessment of these tools is provided. However, due to the broadness of the CSF, the adoption of these tools would also be beneficial to online courses in general, and not just CS1.

CCS CONCEPTS

• Critical Success Factors (CSFs) • Gamification • Computer Science Education (CSEd) • Self-Regulated Learning (SRL) • Learning Management System (LMS) • Electronic Learning (E-Learning) • Gamified Learning (GL) • Computer Science 1 (CS1) • Online Distance Learning (ODL)

KEYWORDS

Computer Science Education, Gamified Learning, Critical Success Factors, Online Distance Learning, Learning Management System

1 INTRODUCTION

Online Distance Learning is now more necessary and widespread than ever before in history and it is becoming more sought after at an ever increasing rate [2]. There are many issues pertaining to online learning and these include that the performance of students who are participating in online learning is not satisfactory, and that their persistence and efficiency are also poor [1]. Introductory programming courses at a varsity level can be difficult to master, especially without any prior exposure to programming. Online programming courses tend to lack 'sufficient' and effective interactions, which can have a negative impact on the learning outcomes [3]. Gamification has been proven to increase course interaction and results from a study showed significant improvements in terms of attention to reference materials, online participation and proactivity when gamification was added to their students' learning experience [4].

Gamification is defined in the Cambridge Dictionary as the practice of making activities more like games in order to make them more interesting or enjoyable. In this context it refers to the incorporation of game-like elements into UCT's LMS, namely Vula, in order to encourage student engagement with the course. Unfortunately, for security reasons, this research project was not given access to the necessary utilities in order to integrate the designed system, so a proof of concept was developed instead.

Online courses are defined as having at least 80% of the course content delivered online [9]. ODL includes benefits such as 24-hour access to information, up-to-date content materials, self-paced learning, customised courses, and cost effectiveness [12].

According to Mishra et al. [6] some students reported a lack of interest and attention during the online classes as they were not accustomed to learning with smartphones and computers and this turned into a major setback for them. Gamification can be used to alleviate this short-coming and to encourage students to have a higher course interaction and engagement. An increase in student engagement results in improvements such as: an increase in student satisfaction; improved student performance and growth in student motivation. Students' sense of isolation is inversely proportional to student engagement so this is reduced as engagement is increased [7].

Student engagement and interaction play an important role in course completion. Although Vula provides platforms for interaction, such as chat-rooms and forums, this paper makes an attempt to find new methods that improve overall course engagement.

Research Question 1: What are some proven CSFs that one can use to enhance the offering of an online course?

Research Question 2: What is the perceived effect of additional gamification elements to a LMS? Does it increase the system's effectiveness, or does it create additional complexities in the learning environment?

1.1 Project Aims

The importance of this research is to enable universities and other academic institutions to better equip their students and instructors for successful online programmes. The aim is to improve the current methods in which students can engage with course materials, through the addition of gamification.

The general issue that this research aims to address is the fact that institutions have seen a higher dropout rate in online learning courses than from regular face-to face courses [5]. This paper has the objective to reverse/lessen this trend and to enhance the students' learning environment in such a way that will enable and empower them to successfully complete their online courses.

2 RELATED WORK

This section discusses the work that has been done that is closely related to this research interest.

This research is unique, and better focused than other studies. There are many papers that highlight critical success factors (CSFs) in an online learning environment [5, 8, 9]. However, few directly resemble the implementation of the tools that this research aims to develop, in response to the research question. Instead we have a discussion of some of the work which is currently being used in an attempt to tackle the issues that have been identified.

The literature review found that due to the wide variety of CSFs identified, it was not possible to decide on the single most important or critical factor for success in an online course. It is not even possible to develop a ranking for the importance of factors. However, it is possible to create a comprehensive list of multiple factors that will increase the probability of a successful course outcome. Gamification is one of these factors.

Common shortcomings of the reviewed literature were that most of the studies were not conducted within the South African context.

2.1 Proven CSFs to Enhance Online Learning

A closely related CSF for online learning is the Learning environment (LE) and its core element is the learning management system (LMS) such as Vula. The LMS is an environment that provides an instructor with a set of tools and a framework that allows the simple and efficient creation and teaching of online course content.

Instructor technical competence relates to the instructor's ability to use and promote the internet technology (LMS) effectively. Classroom interaction shows that the instructor's ability to encourage students to interact and participate in class is significant [13].

To mitigate the high rates of unsuccessful course completion associated with online learning, Campbell et al. [5] aimed to find methods and factors that could enable success in an online environment. It found an important factor for online success to be self-efficacy and another study by Cho and Shen [16] showed that having a strong teaching presence, as well as encouraging students to set attainable goals, would encourage self-efficacy success. Campbell et al. [5] found that test anxiety was a negative factor in terms of exam success for online students. They found that online students must complete exercises analogous to exam questions to avoid this hindrance. A study by Bergin et al. [17] found that self-regulated learning (SRL) such as stronger metacognitive skills and better management of resources were associated with higher grades on introductory programming performance.

Volery and Lord [13] identified that there are 6 CSFs for online education. The first factor is ease of access and navigation. This comprises the variables which relate to the ease with which students can access the site and the usability of the software in general. Flexibility in terms of times (24-hour access) was also notable. The second factor is interface. This relates to the visual structure and design of the course. An important aspect was having an

appealing and well-structured web page design. The third factor was interaction. This relates to the interactive abilities of an online course between instructors and students. A true virtual classroom was found to be an important aspect of the interaction factor. There is a strong relationship between instructor characteristics and teaching effectiveness. The fourth factor relates to attitudes towards students. The instructor's personal approach and teaching manner are important and the instructor must show empathy towards students. Factor five is instructor technical competence. This relates to the instructor's ability to use and promote the internet technology (LMS) effectively. The final factor has to do with classroom interaction. The instructor's ability to encourage students to interact and participate in class is significant.

Alqahtani and Rajkhan [8] is a recent paper that was created specifically with Covid-19 as the basis for finding its impact on CSFs for E-learning during this crisis. The paper concluded with the following CSFs that it found to be the most important factors in a successful E-Learning environment: knowledge management; support from management; student characteristics; and a high level of information technology from instructors. Knowledge management focuses on the management knowledge within the educational institution for faculty members and administration. Support focuses on supporting both the instructors and the students to enhance their experiences. Student characteristics focuses on the students' environment while learning. Information technology focuses on the information technology system which delivers learning materials and objectives.

Quille and Bergin [18] is a literature review based on over a decade worth of papers from 2005-2018. The paper sets out to describe the evolution of a prediction model named PreSS. This model was created to predict student success rates in introductory first year Computer Science (CS) courses with an accuracy of 71%. The research showed that two CSFs for struggling students include running a Scratch course alongside CS1, as well as promoting a growth mindset.

The addition of a Scratch course for students who have never coded before could be very beneficial for them. It is a very simple and practical CSF which can teach CS concepts quickly and graphically. This may appeal to students as they get to experience the results of coding expeditiously. It may not be necessary for the Scratch course to be run concurrently with the CS course, however, the benefits of offering it as a workshop/bridging course, should be considered before the semester begins.

2.2 **Gamification**

Vula already has a statistical graph that shows the distribution of marks for a specific assignment. This can be incorporated as part of gamification in such a way that it resembles an anonymous leaderboard. Gamification concepts have been found to motivate people to engage with the content of a video or a course to build a vibrant community of participation [10]. The data collected in a study suggested that the introduction of the gamification aspect of awarding virtual badges for obtaining full points in their quizzes, seemed to motivate students to learn [11].

This paper explores gamification as a tool in online learning so as to utilise its possible benefit in an online introductory course to programming.

Gamification is one of the educational approaches and techniques that increases motivation and engagement of learners [14]. It has been chosen as it is currently not being exploited enough and it has the potential to have good outcomes, based on the research and findings relating to it's implementation.

Another reason for choosing gamification is that E-learning is suitable for easy and effective integration of gamification which can make positive changes in students' behaviour and attitudes towards learning and improve their motivation and engagement [14].

Another study found that their results consistently showed that a positive correlation is always present between individuals in the Gamified Learning (GL) group and better academic achievement [15]. These students attained better grades and had a better probability of success in the final exams, were much less prone to quit the course, and provided more frequent contributions and information to the forums. They were usually higher quality students and better critical thinkers.

These two studies above demonstrate the efficacy of gamified learning in an educational environment [14, 15].

3 **EXPERIMENT DESIGN AND EXECUTION**

When determining success, the ideal core-success factor would have been the pass-rate, as this is what the university is aiming to maintain in its transition to an online learning medium. Since one cannot know the outcomes of the course for next year by the time this project is due, feedback from questionnaires was used to aid the experiment design. The facilities made available from UCT were used. Feedback from students in the various undergraduate years was utilised and their ideas and beliefs of how to deliver better online courses was ascertained. Questionnaires were provided to identify their suggestions for improved ODL teaching models and find out what they would like to see incorporated into the presentation of their courses, so as to optimise the learning and teaching experience of the students.

3.1 **Requirements Gathering**

Regular Microsoft Teams meetings were held with the project supervisor and there were constant updates through emails and WhatsApps. Meetings were also held with Vula support staff and emails were exchanged with

them as well. Unfortunately access to the Vula database was denied due to privacy restrictions and a lack of access privileges, so a prototype program was developed in place of a fully-fledged Vula supported plugin.

This data was gathered through virtual questionnaires. The Likert scale format is a simple and efficient method for data collection. This scale also enabled one to see common likes and dislikes of ideas. The ones which trended well, were then extrapolated upon and the ones that did not were discarded or adapted accordingly. The research is data driven to avoid bias.

As this project is mostly research-based as opposed to software development, the success of the components will be determined by the project assessors.

3.2 **Approach**

Architecture: For the prototype, which is a combination of two tools - namely the “progression tool” and the “achievements tool", a web stack consisting of PHP, JavaScript, CSS and HTML was utilised.

Methodology: The style of development was Agile. The prototype went through many changes and evolutionary designs. The system changed dramatically from version to version. The development was of the two most sought after game-like features as requested by the students. This allowed the development of the tools to be user-based.

Development Technology: Visual Studio Code was used for all the coding and a localhost was created to run the application.

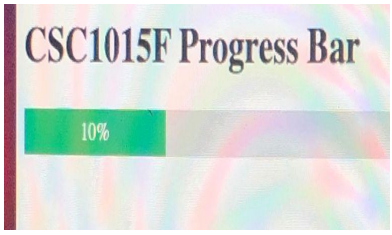
Adaptations to Software Design: There was continual change to the prototype due to the agile nature by which it was developed.

Code Base: Please feel free to check the code out on github:
https://github.com/roscoekerby/gamificationProofOfConcept

The following is with reference to adaptations in the progression tool.

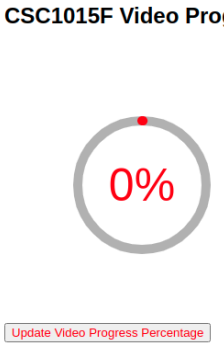
The progression tool started as a static bar that the lecturer would update using a popup. For example, if the lecturer felt like the class was 30% of the way through the course, then they would type 30 into the popup box to update the course progress percentage shown to the students. The progression tool started as a single progress bar to show the total course completion at a specified point. This evolved into 3 different progress displays. One to display video progress, one to display assignment progress and one to display total course progress. The original progress bar started as a simple line/linear display but evolved into a circular one.

Version 1 (line bar)

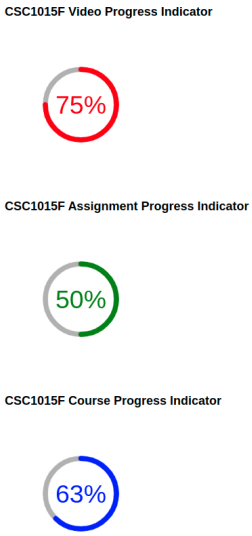


Version 2 (circular bar with onclick popup)

Version 3 (automated update onclick)



Version 4 (fully-automated dynamic update)



Originally, requirements from the supervisor included updating the video bar automatically after the student watched 90% of the video, but allowing the students to check a video once they watched it allows them more freedom and control over the system. This also played into self-regulation as a CSF. So the bar became dynamic (i.e. it checked the video automatically after watch time was 90% or more) and it could be changed based on the students' own accord. The tool was restarted as CSS was originally solely used. CSS proved too difficult to use to integrate and manipulate data.

The following is with reference to adaptations in the achievements tool.

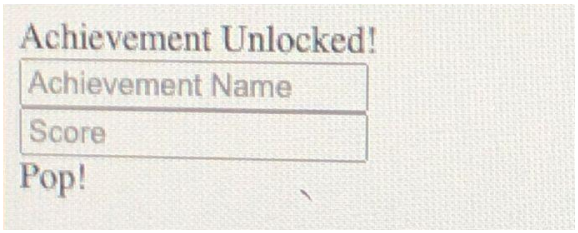
It originated as too X-Box like, as the goal was trying to make it as game-like as possible. This proved too on-the-nose and it was decided that it was too informal for a classroom setting.

The tool started out not being customisable - it evolved to being customisable. For example: lecturers can pick any picture to use as an icon for the achievements - using an image URL.

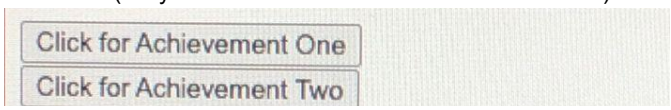
Originally there was only a set number of predefined achievements - this was altered so that achievements could be added and removed.

The achievements started as fixed elements in code i.e. one could only edit them if you knew how to access the code.
Now the lecturer can dynamically add elements and remove elements on the fly.

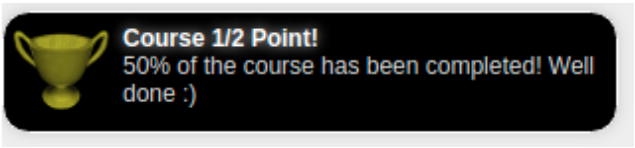
Version 0 (Basic scaffold)

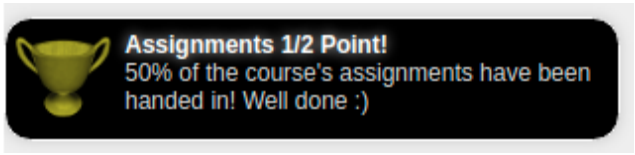


Version 1 (Only two achievements that were hard-coded)

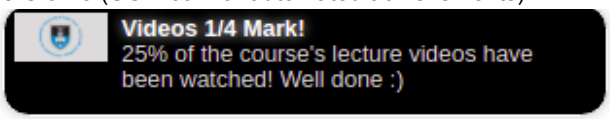


Version 2 (Automated addition of achievements)





Version 3 (UCT icon for automated achievements)

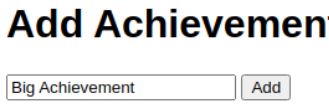


Version 4 (UCT icon as the default icon but the lecturer can change to any image with url address and the lecturer can add any achievement manually)

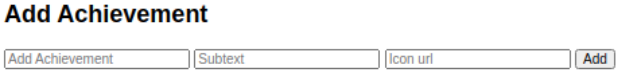
4 FEATURES

Features for achievements tool:

1. All the achievements can be shown (i.e. locked and unlocked achievements are displayed)
2. All of the achievements can be locked at once.
3. All of the achievements can be unlocked at once.
4. Achievements can be added or removed.
5. The total number of achievable achievements (i.e. locked achievements can be displayed).
6. The total number of achieved achievements (i.e. unlocked achievements can be displayed).
7. All the achievements can be reset (i.e. all of the achievements are removed/deleted)



Old Version (above)



Updated Version shown above to allow for any image with a url to be used as an icon

There would be a difference in what is displayed depending on whether the user is a student of a lecturer. The lecturer would be able to edit the data such as adding or removing achievements. The lecturer would also be able to change the displayed icon on the achievements. The students would only be able to see their own achievements and progress bars. The student would not be able to add or remove achievements nor lock or unlock them - those features would only be applicable to the lecturer. The counting features would be available to the students so that they could compare the number of achievements they had in comparison to each other, so as to create a competitive environment.

5 TEST DESIGN/METHODS

A Questionnaire with approximately 40 responses from UCT CS students was used to determine which tools to develop. The finding was that the students most wanted an achievements tool and a progression tool.

Acceptance Test - Supervisors will determine whether the application meets their requirements, whether the game-like elements are going to improve the course or hinder the learning experience for the students.

Usability - lecturers shall be asked to use the system to test after reading the supporting documentation. Students shall also test the system. This is on the provision that the system is ever developed into a fully-fledged system.

Scalability - the tool should become integratable with any Tsugi-based system and should then be added to Vula similarly to any other Tsugi tool. However, since access was denied - the proof of concept program will be run locally for demonstration purposes.

6 OUTCOMES

This research and the tools that were built, have the objective to enhance the learning performance of learners at UCT who will be enrolled in first-year programming courses that will be offered entirely online for the first time in 2022.

The goal is to ensure that the tools and findings impact positively on the course pass-rate and the results will help the case for implementing CSFs in online learning. The findings may directly impact the course structure and add value to it. This will be indicated by a decreased drop-out rate. The expectations would be to see better course evaluations and more engaged learners who are better equipped to complete their courses. This would be due to an increase in their motivation which could be brought about by better self-regulated learning (SRL) (another CSF).

These interactions from game-like elements are often linked with high satisfaction levels of the course by students.

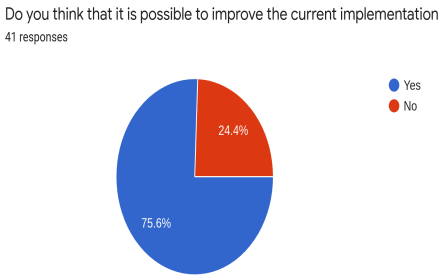
Students are expected to enjoy the gamification features as they will hopefully be user-friendly and they will add a fun atmosphere to the otherwise bland learning environment. Everyone might not enjoy the game-like tools so the suggestion would be that the lecturer makes them optional with an opt-in/out button.

6.1 **Gamification Tools**

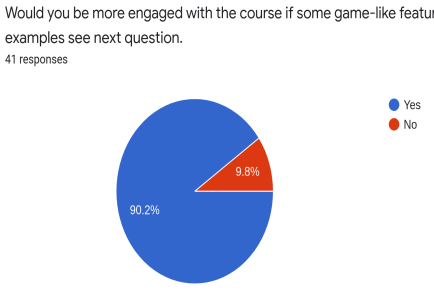
For a positive outcome, the game-tools need to be fun, easy-to-use and user-friendly so as to add some variety to the learning process. They will be deemed successful if the learners use them frequently and if they increase the student's engagement with the course.

7 **RESULTS AND DISCUSSIONS**

The following charts depict results from questionnaires sent to Computer Science (CS) students who are currently studying CS at UCT. Most of the respondents (34/41) are currently enrolled in the CS1 course. The remaining 7 respondents are past pupils of the CS1 course.



As depicted above, over 75% of students who participated in the questionnaire believe that it is possible to improve the current CS1 course at UCT.



Over 90% of students feel that they would be more engaged with course material if gamification was added to the Vula LMS.

See **Appendix A** for the bar chart.

The two most wanted game-like features, as requested by the students, were an "Achievements feature" that over 60% of students would like to have added and a "Progress feature" that was requested by over 55% of the students.
Since these two features were the most wanted by the students - they were developed in a simple prototype that will be used as a proof of concept and may hopefully be developed further and implemented in the future. The tools are called "Achievements tool" and "Progression tool" respectively and have been integrated into a gamification proof of concept prototype called the "Gamification Proof of Concept Prototype".

Unfortunately given the pandemic circumstances and a general lack of enthusiasm from students to partake in research (understandably) only 40 students answered the questionnaire and a dismal 2 lecturers answered their one. Hopefully further research can be done with larger numbers of participants. This proved true for the testing of the system as well. Luckily since it is only a proof of concept system and not a fully integrated system the testing could be a lot less strict and it will be up to the future developers of the gamified system to adapt and create a fully tested system before implementing it.

8 **CONCLUSIONS**

In summary, this project explores gamification as a specific CSF related to improving a first-year introductory course in programming. It has the potential to have its findings extended to other courses presented in an ODL environment.

This project explored gamification as the means by which to improve the quality of CS Education.
Overall, the tools worked as intended as a prototype/proof of concept system. Whether it is going to be implemented/extended/disregarded is still to be determined by the Vula team.

9 **LIMITATIONS AND FUTURE WORK**

A limitation to this research was the time frame - since this was an honours research project, only several months were allocated to do everything. A longer time allocation and more researchers on this topic would be beneficial to future studies.

Money is another limitation as the budget for this project was zero. This study would have been more comprehensive if we could have paid for more willing participants for studies in-person. Workshops and other such activities could have greatly improved the findings.

Unfortunately due to the Covid Pandemic we were unable to host in-person workshops as well as interviews.

This research needs to be continued over time and assessed periodically. As times change, so will some of the results gathered here - such as the most wanted gamification elements which were voted upon by students. As gamification becomes more commonplace, more advanced game elements may be required/requested by students and lecturers alike.

A limitation was needing access to UCT's Vula LMS and the Tsugi test tool, in order to integrate the coding deliverables. Access was denied.

Future work could include extending the system; adding features; intensive testing and testing with an actual class. If the class participation improves then the system could be regarded as a success.

ACKNOWLEDGMENTS

This research was a group effort and thanks must be attributed to Corné Oosthuizen and the research supervisor Aslam Safla.

Special thanks to my partner Moses Netshitangani for his help and consistent support throughout the research project.

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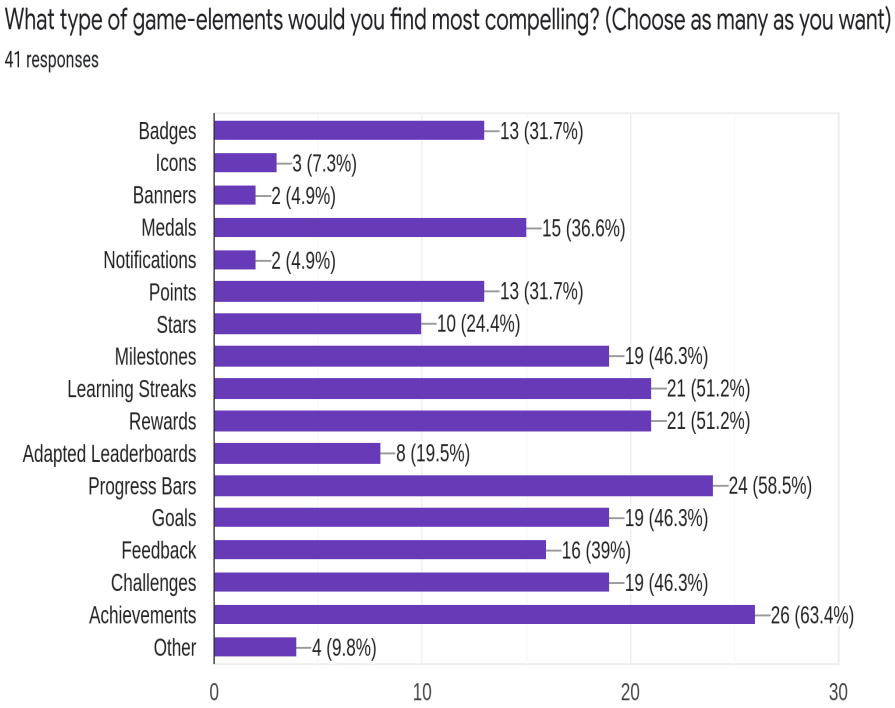
Appendix A:


What type of game-elements would you find most compelling? (Choose as many as you want)
41 responses
Badges
13 (31.7%)
Icons
3 (7.3%)
Banners
2 (4.9%)
Medals
15 (36.6%)
Notifications
2 (4.9%)
Points
13 (31.7%)
Stars
10 (24.4%)
Milestones
19 (46.3%)
Learning Streaks
21 (51.2%)
Rewards
21 (51.2%)
Adapted Leaderboards
8 (19.5%)
Progress Bars
24 (58.5%)
Goals
19 (46.3%)
Feedback
16 (39%)
Challenges
19 (46.3%)
Achievements
26 (63.4%)
Other
4 (9.8%)
0
10
20
30