The Gamification of Software Testing

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***Abstract*—Software testing is a task that is prominent in the world of technology, at times this task can be very tedious and repetitive. This is where gamification comes into play, establishing game-like features to help motivate software testers to perform at a higher standard and accomplish more tasks. Just like any video game, a gamified system has mechanics, aesthetics, and dynamics to allow for smoother gameplay for the participant. It is human nature to want to achieve greatness, having a gamified system that shows the progress of a participant is one of the best ways to motivate an individual. This idea of creating a gamified system revolving around software testing has infiltrated the software development lifecycle due to the increase in productivity. Many gamification applications exist but it is hard to capture all components equally to allow for a perfect gamification application, this is something that was kept in mind when creating a gamification application prototype which is talked about in later sections. Overall gamification has changed the world of software testing for the better, but like anything, it can still be abused. This report will open the eyes of the reader, explaining all the important aspects of gamification.**

***Index Terms*—Software testing, Test Case Generation, Software development life cycle (SDLC), Verification, System under test (SUT), Gamification, Gamified System, Gamification Platform**

I. Introduction

Simply put gamification takes many of the elements and concepts of games and applies them to something else [1]. In this context, we are talking about how gamification can be used in software testing, and since gamification is about how to approach a problem rather than a specific solution it can be used in a multitude of ways. This process is typically best for repetitive tasks to motivate and incentivize the workers but to be successful it needs to be easy to use and maintain. The idea of gamification has grown exponentially over the last few years and can be seen every day on a small scale such as ratings. However, the gamification system in the workplace has not come without concern. Fictional rewards like points and badges need to also be paired with typical rewards for good work and still allow employees to work on tasks that they find value in along with transparency with the company to ensure that the employees understand what they are participating in [2]. Without some safeguards, in place, employers can use the gamification system to manipulate and control their employees at a whole new level and it is important companies understand some of the risks if the system is abused. [2]. At the end of the day, software testing is very dependent on human interaction and intuition to build, understand intended behavior, and maintain the system. Sometimes a gap in education about software testing can be seen and the repetitive nature is a very good candidate for a gamified system.

II. Case Studies Involving Gamification of Software Testing

A. Gamification System Design

One of the first things that can be seen throughout many articles about gamification is the importance of the design of the system. There are 6 main game elements that are commonly found in a gamification system; feedback, goals, badges, point system, leaderboard, and user levels [1]. These components give important information to the user about the progress they are making and what still needs to be achieved. Along the way awarding points and badges for completing each of the tasks that reflect the level of challenge; harder tasks gain more rewards than simpler tasks. These are only the building blocks of the system, to control how the system feels to the user there are 3 frameworks: mechanics, dynamics, and aesthetics [1]. The mechanics deal with the data and algorithms for point/badge distribution. Where dynamics focus on how the player interacts (input/output) with the system over time such as what is considered a completed task and the choice the player would have over what task(s) they can work on next. Last is the aesthetics and this is all about how the system feels to the user, such as the feeling of challenge.

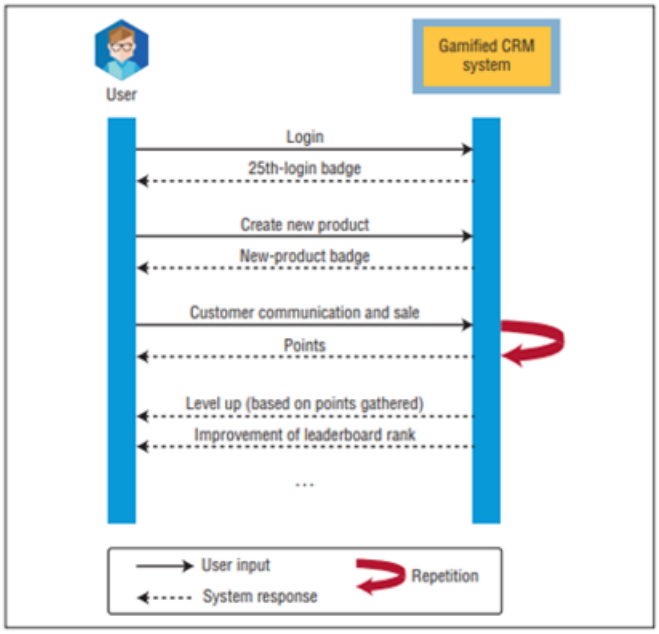

FIGURE 2. Interaction between a user and a gamified customer relationship management (CRM) system. The interplay of mechanics and dynamics during system use is meant to evoke the desired aesthetics.

Fig. 1. Relationship between the user and the gamification system [1].

It is important that the system is designed in a way that allows the user to tackle challenges that they see as productive and useful. Of course, like with any job, there will be tasks that are necessary, but it is important to see a variety of takes with respective rewards.

B. Challenges

The next most common topic discussed is the challenges that are faced with the system including ethical concerns. One of the main ethical concerns is using the system in a workplace where the high-level managers control the tasks, rewards, and general flow of the gamification system. If the right safeguards are not in place the workers can be manipulated and overworked, receiving fewer real rewards for their efforts. The points/badge reward system is fantastic

when also paired with real rewards such as vacation time, gift cards, cash, promotions, etc. that reflect the work needed to complete a task with an elevated level of completion. Another challenge is creating a system that allows users to be creative in their tasks and explore alternative ways of making progress that could be superior to the system in place through the gamification system. In this case, a fully gamified solution would not work the best for the environment but could be part of a flexible solution where repetitive tasks are managed by the gamification system and creative tasks have looser goals but are still rewarded for quality completion of the work. In terms of software testing, this could look like this: learning the testing suite, creating basic test cases, and running the testing suite can all be handled with the gamification system with thorough instructions and step-by-step goals. Where tasks such as debugging and creating complex test cases can have more flexibility and the work would still be rewarded but have fewer specific instructions and promote quality results rather than following a strict list of instructions. There is a multitude of different challenges that a team will face when first implementing a gamification system, but the best part is that it's a flexible system that can change and adapt to the needs of the user/team.

C. A Framework for gamification in software Engineering (Article 7) – Section 4: Application of GOAL in a Software Company

Background: A small/medium-sized company located in Spain founded in 2004 that works on a national and international level with 25 people, 19 of that are in IT. They produce off-the-shelf and custom software development packages. The company had a previous solution for quality management and improvement before implementing the gamification system. The company aims to maintain a variety of standards and the new system needs to continue the same level of support.

Gamification System: The company is using custom-built software that was developed in-house with the main functionality of real-time information about the status of any of the current projects and being able to see historic data. Additionally, the tool also has requirement management that allows the team to know the status of the task set by the project manager with version controlling for any changes made to the requirements. There are some supporting tools used with the custom software that includes Redmine (issue/change management) and JUnit (unit testing). The GOAL framework that is explained in detail in the article is used to gamify three primary areas of the organization with the hopes of better understanding if the GOAL framework can be used to gamify processes on a large scale. The biggest challenge was working on getting all the different components working together with the tasks needed from the previous workflow into the new system. The implementation of the gamification system understands the need for a centralized location for the gamification rules and the users' actions. In figure 2.2 you can see how everything leads back to the gamification engine as the central unit of all the different components.

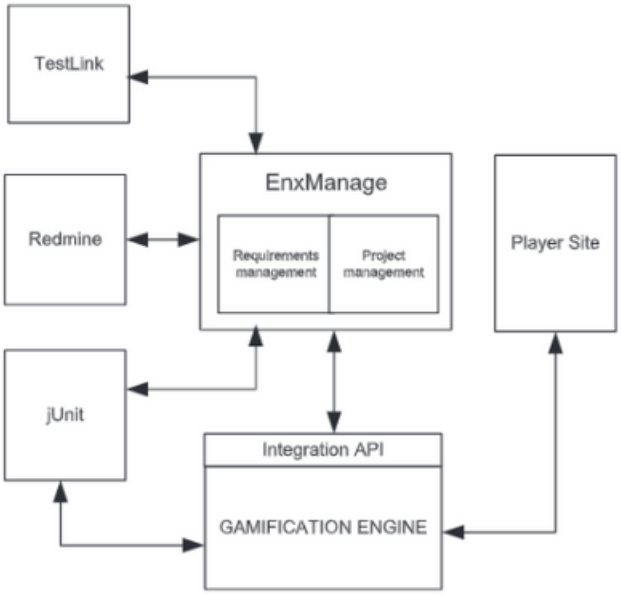

Fig. 10. Software architecture of the gamified environment.

Fig. 2. Software architecture of the gamified environment

Methodology: The main difference that makes the approach of the gamification system different in this case study than what is typically seen is the GOAL framework, part of that being the methodology. It is one of the most valued components of the team as it guides the process by giving an iterative approach to making the gamification system. It gives the development team direction, the next step in the process is always known along with what needs to happen at that step. The first two activities of the methodology are the most valued: Alignment with the business objectives and player analysis [7]. With the dev team reacting so positively to the methodology it can be concluded that the GOAL methodology is a solid way to guide a team to incorporate gamification into their software lifecycle.

Benefits: All the benefits discussed in theory throughout different research papers hold true in practice but are highly dependent on the quality of the gamified environment. There were a few benefits that stood out more than others such as adding an element of fun to everyday tasks, having a clear understanding of tasks and the status both individually and within the team, and in general, was highly informative to the management team. An example of where a direct improvement in activities for the company is the use of EnxManage for collaborative efforts. A 20 percent growth was seen in registered requirements and comments than what was seen on similar projects before gamification was integrated [7]. Getting further accurate quantitative results is tricky as there are many working parts and it would be difficult to have a perfect comparison of a system with and without gamification so having a measure of improvement is highly encouraging.

Conclusion: This paper has been able to make a significant

contribution to gamification in software engineering with the ability to create and follow a methodology that has yet to be seen in other case studies on a similar topic. This methodology and technical support through GOAL provides the developers with something to follow and directs the development of the software rather than looking at gamification on a theoretical basis. Using this process, the developer is left with only needing to decide what areas of the process will be involved in the gamification process and then follow the methodology. It is important to keep in mind that gamification is not limited to the development process but other processes in the company as well. In the future, this process could work very well for an organization that uses a DevOps approach and would be implemented in an environment that would allow for quality quantitative information to be gathered.

III. Experimental Setup, Methodology, and Findings

When researching the gamification of the software testing life cycle it was evident that having a fully functioning and enticing gamification platform was one of the most principal factors. In the initial stages of our research, many different gamification platforms were reviewed and compared based on their functionality and overall appeal. When speaking on the functionality side of the gamification platforms we reviewed, there were certain functions that were mandatory to have. These functions included project creation, milestone creation, ability to edit projects and milestones, point system, and achievements [1]. When referring to the overall appeal of a gamification platform, it needed a user-friendly GUI, a stunning color palette, and a project-wide leaderboard. After comparing many different platforms, one stood out, gametize.com. This gamification platform checked all our boxes and became the model for our gamification platform prototype. The two most notable features of gametize.com can be viewed below in figures 3.1, 3.2, and 3.3. The figures show the main functions which determined why gametize.com was the gamification platform we modeled our prototype after

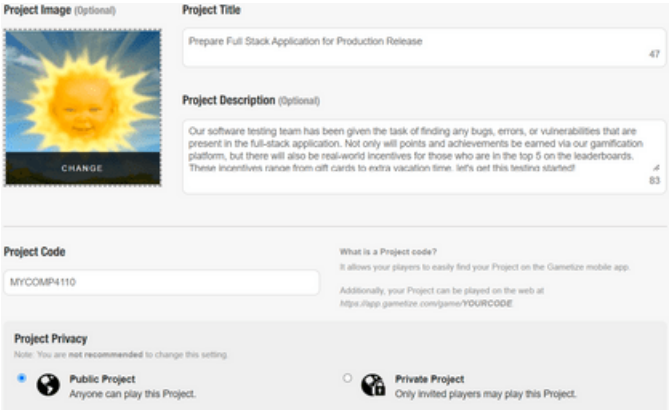

Fig. 3. Gametize.com Project Creation Page

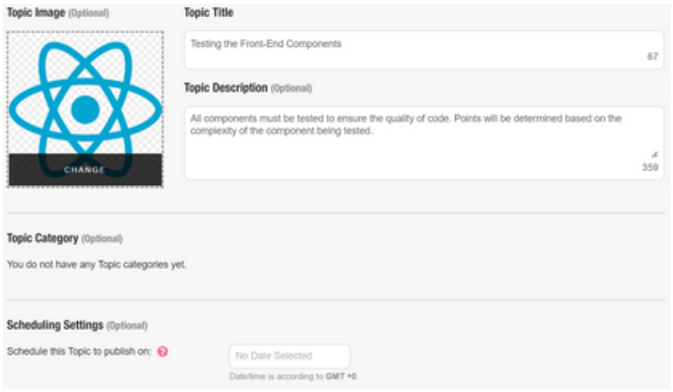

Fig. 4. Gametize.com Topic Creation Page

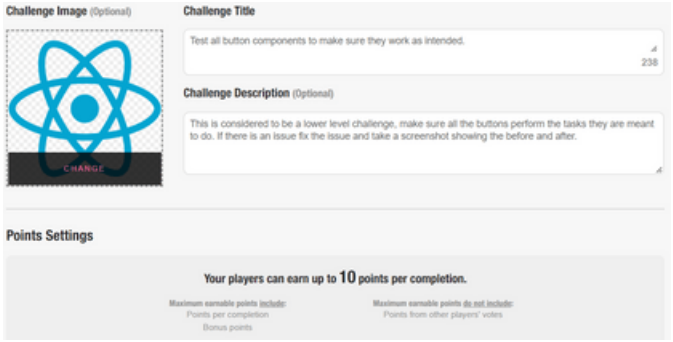

Fig. 5. Gametize.com Challenge Creation Page

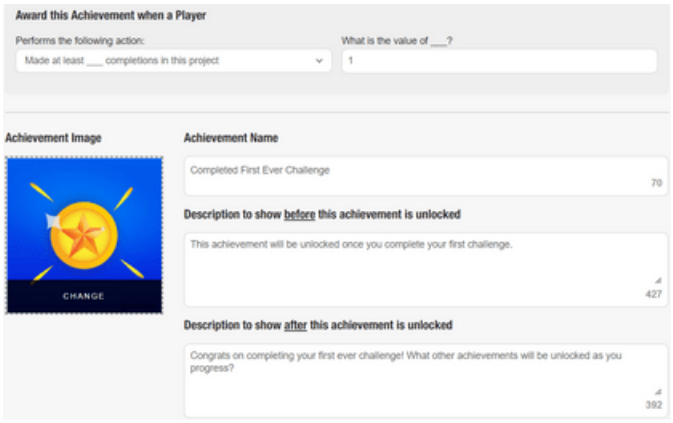

Fig. 6. Gametize.com Achievement Creation Page

A. Developed Prototype

The prototype that was created during our research was barebones, only containing premade projects and milestones, a point system, and a leaderboard. The project and milestones were hardcoded as well with the information pertaining to the milestones. The reason for this is that we were able to test how our gamification platform worked in terms of a point/achievement system and how the leaderboard would function. Since we were researching gamification from a software testing life cycle point of view, the project and milestones revolved around specific topics in that field. Our prototype was

equipped with a simple GUI, although not visually appealing it still showed the achievements the participants have obtained and provided a leaderboard for a sense of competitiveness. The reason it was a priority to have these functions in our prototype was due to a certain factor that allows gamification to be effective. The factor that is being referred to is aesthetics, even without a visually appealing graphical user interface, the prototype is still able to display the achievements and overall points for each participant that is on the project leaderboard. The figure below is the main page that is present in our gamification prototype, as this is the first iteration prototype it will only have enough functionality to give the reader a general idea of how it will work. As time progresses the prototype will have added functionality based on factors that will allow for the creation of a fully immersive gamification platform. The factors mechanics, dynamics, and aesthetics will be considered until the prototype is able to be released for production or used for experimental purposes.

Fig. 7. Prototype Main Page

B. Research Findings

Gamification revolving around the software testing lifecycle has many different areas of study. The area that was researched for this paper included the underlying factors that caused gamification to become prominent in the software testing lifecycle. In this section, the findings for each individual factor will be discussed and compared to real-life situations involving software testing. Due to software testing being a tedious task at times, it was the main point of our research to uncover what caused software testers to want to uncover and fix bugs, errors, and vulnerabilities. The factors tied closely to our findings are as follows, aesthetics, dynamics, and mechanics [1]. Each of these factors contributed information that solidified our findings, we shall break down each factor and explain what information was gathered from each. Starting with aesthetics, as mentioned in the earlier sections aesthetics refers to the visual aspect of the gamification platform. During our research, it was shown that when achievements were available to be collected in the gamified system and if a leaderboard was present this had a direct impact on the productivity of the software testers. This was a positive impact on increasing the productivity of the software testers, it is evident that the aspect of competition/achievement hunting is the driving motive [3]. Aesthetics have a significant impact on the success of a gamification platform, as aesthetics become more engaging it will increase the productivity of the software testers. This is until a certain point, eventually, a plateau is reached where no matter how engaging the aesthetic portion of the gamification system is the productivity will no longer increase [3]. Speaking on the dynamics factor of a gamification platform, this is referring to the evaluation of the participant. This factor is the functionality side of the achievements, how the participant's points are gathered, and what determines their position on the leaderboards [3]. This goes hand and hand with aesthetics, software testers are more willing to tackle harder to resolve issues for the sole reason of being able to obtain a sought-after achievement. This is caused by human nature, wanting to achieve something that is a perplexing task [8]. Lastly speaking on the mechanics of a gamification platform, the evaluable actions. What must be done to obtain the possible achievements, speaking from a software testing standpoint, would refer to testing a specific component or something of that nature [1]. All the three factors mentioned need to work together to allow for a perfect gamification platform [7]. Mechanics are particularly important because this is how the achievements/points are determined, which is the motivation of the gamification platform. Since the mechanics lay down the path the participants must follow to achieve a milestone, this increases productivity by mitigating the time the software testers need to determine what actions must be taken when testing an application [2]. Our findings were quite surprising, after uncovering what each factor brings to a gamification platform in the software development lifecycle. It was determined that with these three factors working together in perfect unison the productivity of testing a software application was increased by a significant margin until a plateau was reached [6]. With software testing being a tedious task, it was intriguing to see how much gamifying the software testing lifecycle could affect the productivity of all the participants involved [6].

IV. Future Work

During our research, substantial amounts of data have been analyzed which led us to a firm understanding of gamification and its role in the software testing lifecycle. There are many avenues that can be explored when referring to gamification. Our future work would begin with more detailed research being done with references from a software testing standpoint and human psychology standpoint. The art of software testing can be grueling, we would want to uncover why something that seems almost childish can motivate software testers to want to find errors with an application. As we start to gather more information on the human psychology aspect of gamification, we will begin to add more features to our prototype. These features would include a graphical user interface, project creation, milestone creation, and more features pertaining to the human psychology side (specific color palettes, sounds, etc.). Once we have created an application that is fully operational, we will then perform an experiment using a university software testing course that volunteered to participate. The experiment will involve the students utilizing our application in parallel with their semester-long project. At the end of the semester, the students will submit a report explaining their overall opinion about using a gamification platform and what milestones they

achieved. As well the students can opt to participate in a series of psychological tests. The tests performed on the students would be a personality test, achievement test, attitude test, and aptitude test. With the data obtained from this experiment, a more concise research paper will be formulated and if accepted, published. This would conclude our future work.

V. Conclusion

Over the course of our research, many different factors had to be considered when comparing and choosing a gamification platform to model our prototype after. Using the three major factors, mechanics, aesthetics, and dynamics it was determined gametize.com would be the gamification application to model the prototype after. After reviewing countless research articles, it was seen that having a proper gamification platform did truly increase the productivity of software testers [6]. It was present in specific articles that the productivity of a software tester will eventually hit a plateau this is to be expected since productivity can't increase infinitely [4]. Using the research obtained and our model to base our prototype, a simple gamification application was created, although being very barebones it is still able to show off important features of a gamification application. This paved the way for further development which would directly lead our team into performing our own experiments. Overall, the gamification of software testing has helped motivate software testers around the world and indirectly helped to create more reliable and secure software for the public.

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