

Gamifying Information System Testing– Qualitative Validation through Focus Group Discussion

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Abstract

This paper presents the evaluation of a developed gamified Information System Testing platform through results obtained from focus group sessions with software developers and testers. The purpose of this study is to understand if the developed tool and platform can help Information System Testing to be interesting while increasing the engagement of software testers in a rewarding testing environment. Findings suggest that choosing suitable game elements to design a gamified environment for performing serious tasks is very important. Moreover, findings suggest that the developed tool and gamification may be a solution to increase testers' engagement and testing experience. Furthermore, participants suggested that game elements such as feedback and comparison may increase testing motivation, engagement and experience of software testers. The majority of participants rated the feedback element as a vital element in a gamified Information System Testing environment.

Keywords: Gamification, information system, HCI, design elements, engagement, motivation.

1. Introduction

Software testing is an important phase in the software development lifecycle. Even with decades of research and practices by researchers and practitioners on various software quality assurance techniques, testing activity is still one of the most studied and practiced methods for improving the quality of software [32]. The main goal of software testing is to discover the existence of faults in the software product and to verify it meets the stated requirements. Software is of high quality, if it is fault free, user friendly and provides satisfaction to its client [40].

Software testing can be performed either manually or automatically and one-way to reduce the number of software failures is through robust testing. Recently, there has been a trend in the automation of software testing activities. However, the importance of testing for human software engineers will never disappear [16]. For example, Ciupa et al. [8] conducted a research and compared different testing strategies. Findings of stated research study suggest that, the automated tool helps to find a high number of errors in shorter time. However, humans identified faults that automation missed. Lack of testing may cause various issues and most recent software issues are due to rushed testing activities. Software testing is an expensive activity in the software development process, which can consume up to 50 % of the total cost

of software development projects[5]. The scientific literature confirms that continuous testing during the development can reduce project cost. For example, Maximilien and Williams [28] stated that minimizing the number of defects is one of the most effective ways to reduce the development cost. They also suggested that revealing errors after the release of the final product is up to 30 times more expensive than finding the defect during design or architectural development phase.

Many research papers and texts today have concerns about the area of testing [4], [42], [44]. For instance, Torkar et al. [42] stated that today it is important to have a more integrated testing methodology combined with the old configuration management method in order to increase the quality and efficiency of software testing. Software engineering requires sophisticated methods and tools to facilitate developers in building fault free software.

Black box, white box and grey box testing methods are deployed to detect various faults like design error, statement error, input or test error and specification error to name few. Although testing is an important part of software development, this activity cannot guarantee the absence of errors even with well-designed tests [31].

It is important to keep developers and testers motivated. In the last decade, gamification has been adopted by researchers and practitioners as a means to enable active participation and engagement during formal tasks including the software development community [22]. Gamification has mostly been studied in the context of education and learning and the results indicate an increase in motivation, learning and enjoyment in the desired gamified activities [20]. Gamification has become a field of interest in many domains such as Software Testing [7], Education [23], Language Translation [43] and others. Recently, there has been many studies and practices in the usage of gamification in the area of software applications with the aim to increase engagement and motivation of the developers [9], [15]. For example, Seixas et al. [9], evaluated the effectiveness of gamification platforms as a method to identify the level of students' engagement. Findings of that study showed that, students with more rewards got significantly better average performances. Gamification is a new trend, which is offering a possible solution to this issue by transforming routine or difficult exercises into a more engaging, fun and competitive activities. Thus, gamification of software testing tends to resolve issues ranging from tester engagement, industry issues and limitation of testing.

This paper focuses on the evaluation of a gamified software testing tool. The main aim is to study and investigate the impact gamification has on software testing by applying the chosen and verified game elements proposed in the previous research study [29], next step is to evaluate the developed platform to improve software-testing experience with the aim of providing an engaging and rewarding environment for software testers.

2. Background

2.1 Gamification

Gamification is the use of game elements: mechanics, aesthetics, and game thinking outside the context of computer games with a purpose to provide a more engaging, motivating environment for learning and problem solving for individuals and teams [10], [33], [37]. Deterding et al. [12] suggested that the term itself invented within the digital media industry in 2008, but the use of the actual term itself did not become popular until around 2010. Other studies suggest that the term was created by Nick Peilling in 2002 [27]. Thus, it is safe to say that the term originated in the 2000s and became popular around the year 2010. It is important to note that serious games are actual games while gamified platforms are not [14]. A serious game is considered as a category of a game which has a specific intention rather than entertainment value [13]. For example, Pex4Fun is a serious game introduced by Microsoft Research, which enables an environment for training computer science development skills to attendees. This web-based environment, allows students to edit code in different browsers, which can be executed and analysed in a cloud. It helps students to identify the program process and procedure. Additionally, it detects the differences between the specification and student's program [41]. The intention of gamification designers is to provide a game full of user experience with the

use of game design elements [20], [22]. As an example, Arnarsson and Jóhannesson [3] used gamification method to increase the motivation of developers to generate effective and efficient unit tests. The developers were rewarded after reviewing their performance. The developers suggested that the gamified tool had encouraged them to create better unit tests. During recent years, video games have become popular among people and has been drawing the interest of researchers and practitioners in a variety of fields [20], [36]. Undoubtedly, video games naturally supply a great level of motivational potential [17], [21], [35]. Moreover, gamification of testing activities, based upon video game principles, has become a testing strategy in both academia and industry [20]. The aim of using this method is mainly to increase users motivation towards tasks being given or using the technology to increase the quantity and quality of the output of given tasks [19]. Studies suggest that there are significant interest levels for organisations to use this method as part of their training and operating processes [30]. Any task that might affect an employee's performance could be gamified to increase engagement; from recruitment to training and experience [6].

2.2 Gamification and Information System Testing

Gamification has been used as a tool for software systems and applications in different fields and the results in many cases were positive [20], [24]. Moreover, studies suggest that gamification can be very useful in different fields and aims [34]. The notion of gamification can be injected into software testing as testing is often tedious, monotonous and boring practice [38] and is also considered time-consuming and difficult activity to focus [1].

Software testing activities are extremely important in software engineering which takes 40 to 50% of the development effort [26]. Insufficient testing may be harmful, and many issues with recent software failures have been due to the lack of effective testing strategies being employed in practice. Because of inadequate testing, Apps would crash and require constant upgrades, lives are also being put to risk [16]. Lately, there has been a trend in innovating technologies and growth in creating simple products with more complexity in the backend, which carry with them failures [25]. For example in 2016, HSBC reported that a complex technical issue caused a major IT outage in their organisation [18]. On a similar note, (in 2015), HSBC was unable to process 275,000 payments due to an issue in their electronic payment system [18]. With the large role these technologies play in our lives, comes "an even greater opportunity for them to cause harm" [25]. This has created a need within the industry to recruit and retain professional testers that has in the past struggled to hire good quality professional testers [11]. Besides offering training and professional development opportunities for their testers, companies are not seeking innovative solutions to meet this challenge.

Gamification can be employed as an effective method to help remedy the high level of repetitive tasks during testing and can lead to increased testing engagement during the testing process. There have been various attempts in the field of software testing at using gamification to increase motivation, engagement and performance of participants in software engineering tasks [33], [39] used gamification method to encourage computer science students to deploy more frequent commits to version control. Also, [2] proposed gamification as a method to motivate developers to remove warnings of bug pattern tools and results suggested that developers were successful in removing 150% warnings with the proposed tool (compared to the case where they did not use the suggested tool).

3. Methodology

This section describes the chosen method for the evaluation of a gamified software testing platform. To realise this purpose, a number of activities were performed which can be categorised into following sections. A) Conducting a literature review to ascertain the broad elements and categories used in serious games followed by applying the findings into the initial prototype. B) Conducting focus group sessions with software testers and developers to validate both initial prototype and chosen game elements. C) Implementing the final product with

previous findings and validating the final product by organising focus group sessions with software developers and testers. In our previous study [29] we have conducted a literature review to identify the existing problems and to identify the game elements used to design serious games. It is important to note that lack of testing may cause issues, and many of the recent software issues are due to not well-planned software testing activities. Moreover, as discussed in previous section, while software testing is a difficult and time-consuming practice, it is often a boring and repetitive tasks [1], [38]. Furthermore, in our previous study, conducting various focus group sessions with developers and testers helped the researcher to validate the key factors to develop a system, which gamifies the software testing process with the aim to increase the engagement and experience of software testers. The next step is to validate the final gamified platform by conducting focus group sessions with software developers and testers to ascertain the usefulness of this tool to increase testers' motivation and provide them with an engaging and rewarding environment.

3.1 Conducting a literature review to ascertain the broad elements and categories used in serious games followed by applying the findings into the development of the initial prototype

Literature review helped the researcher to study and understand which game elements suit the needs of this study. In the previous study [29], detailed description on why and how initial game elements were selected was discussed. The main reason for choosing the right game elements is to increase the engagement and satisfaction of the software testers, which can lead to improved experience with the testing activities. The literature review helped the researcher to adopt core principles of serious game design suggested by Whyte et al. [45] listed in below to identify game elements required to design the gamified platform:

- A. A story line that helps increase the level of motivation, engagement and quality.
- B. Goal directed learning around targeted skills, which provide challenges and progress.
- C. Feedback and awards, which play an important role in shaping behaviour in serious games and players, intend to work continuously to achieve certain goals.
- D. Badges and levels, which help in endeavouring to attain a challenging, but achievable level of difficulty for testers.
- E. Provision of choice, allowing individuals to have choice over some aspects of the game environment.

3.2 Prototype and game elements validation

Senior level Computing undergraduate students were invited to help with validating key factors to optimize a system, which gamifies the software testing process. Written questionnaires and recorded discussions were used in capturing the evaluation results. In our previous research, we discussed the method used in gathering and analysing the findings, which helped us to identify vital game elements to design final version of the software testing platform [29]. Furthermore, results suggested that gamification can be used as an effective method to encourage software testers. Moreover, vital information required for performing software testing were identified such as requirement and design documentations, tools, time as well as knowledge are the key factors to consider [29]. Figure 1 shows the results of the survey with the participants. Moreover, while conducting various focus group sessions, essential game elements and motivational factors were also identified. Results of that study indicated that points, levels, real gifts, character development, provision of choice, and feedback were the other main factors which has been linked to the 5 core design principles suggested by Whyte et al. [45]. Figure 2 presents essential game elements for designing a gamified software testing platform.

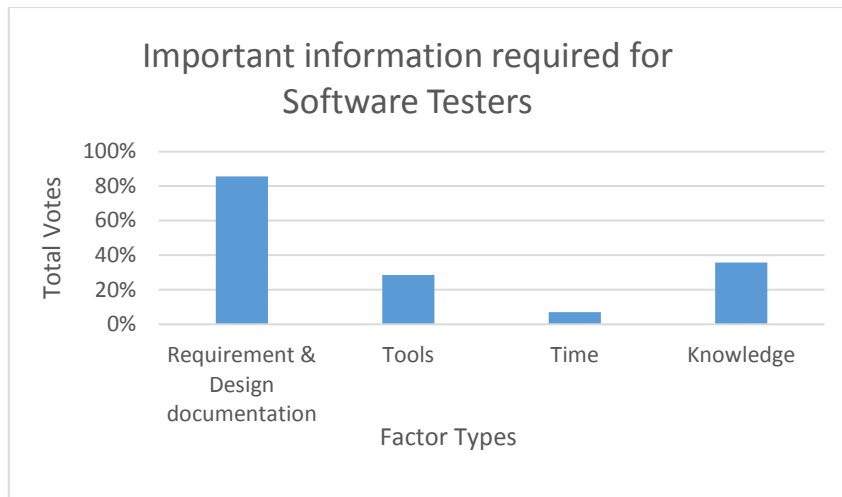


Fig. 1. Factors required for software testers [29].

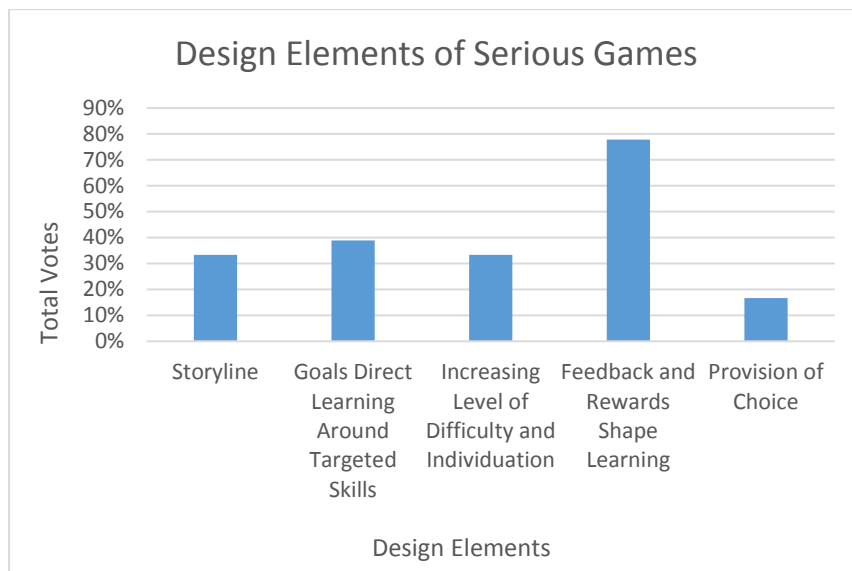


Fig. 2. Design elements and motivation factors [29].

3.3 Final product implementation and validation

In our previous study, the proposed idea of how gamification could encourage software testers and motivational factors were also discussed and identified. The next step to that study is to design the finalised gamified information system testing platform based on the verified game elements for software testers. Figure 3 represents the tester's home page. In order to increase the motivation and engagement levels of software testers, identified game elements such as points, badges (difficulty in levels), real gifts, feedback, comparison and provision of choice have been added into the system. In order to unlock each badge, testers need to obtain certain points by the review team. Furthermore, comparison is the next element included in the platform for testers to boost their performance after reviewing other testers' performances. Moreover, provision of choice helps the testers to have a control over requests to accept or decline any assigned testing tasks after reviewing each request. Real gift is another motivational factor

identified in the previous study [29], and has been included for those testers who receive enough points to unlock the final badge.

Following the implementation of the finalised gamified information system testing platform, several focus group sessions were conducted to evaluate the developed gamified platform. The focus group discussions were conducted to ascertain the usefulness of this method to increase testers' motivation and provide them with an engaging and rewarding environment. Recorded focus-group discussions and written questionnaires were used in gathering this information. This information and a number of similar responses were then matched with identified key factors and were converted into graphs to represent the results. In the next section, these findings will be presented and explained in details.

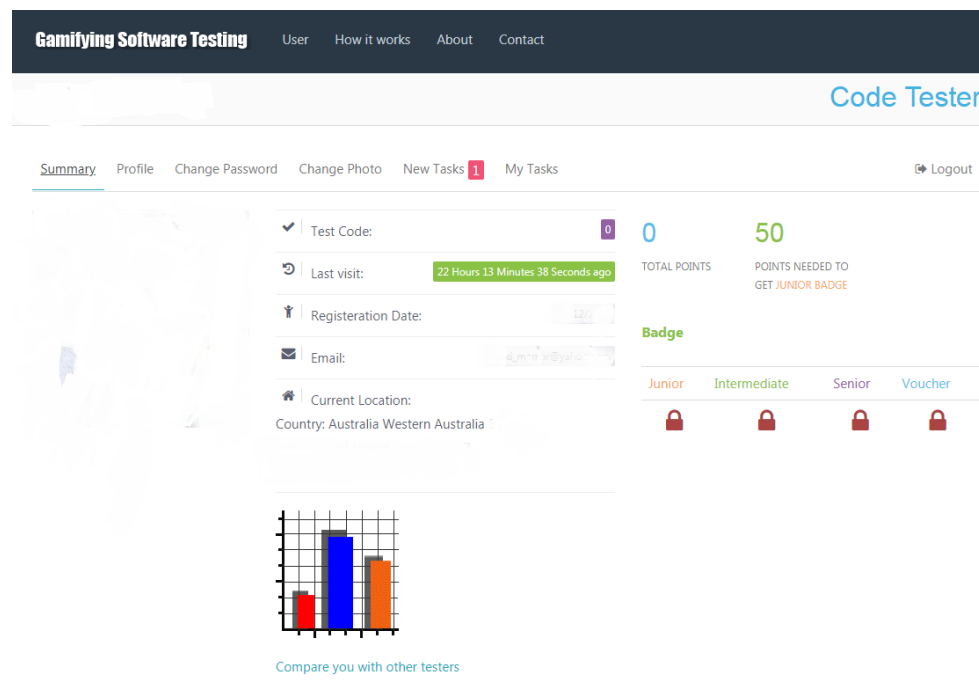


Fig. 3. Game elements used in the gamified software testing platform.

4. Results and Analysis

In this evaluation, a total number of 20 senior level Computing students (17 male and 3 female) who had experience of working on real-time industry projects and practices as part of their learning process, attended the sessions and out of them 80% had both Software Development and Software Testing background, 10% had Software Development background and rest 10% had Software Testing background. All 20 students had learned and had exposure to unit testing techniques (mainly expert users of JUnit framework). During the focus group sessions, we allowed participants to work with the platform and experience the gamified environment. In the questionnaire, participants were given the following question to answer: "How likely is it that you would recommend other testers to use this software testing platform for their testing task?". Results suggested that majority of participants were satisfied with the platform and they would like to recommend to other testers as well. Figure 4 represents the level of satisfaction after evaluating the final platform.

In addition, results suggest that participants felt that this application is interesting and motivating. Arnarsson and Jóhannesson [3] also applied gamification method to increase the motivation of developers to generate high quality unit tests. Their findings also suggest that

developers were satisfied and agreed that gamified platform encouraged them to participate actively and provide useful tests.

Another question was asked on how likely is that participants would recommend other testers to use the current software testing platform and results suggest that majority of participants (15 out of 20) would recommend this platform to other software testers for their testings activities. Some of the responses are listed below as ready reference:

- “I enjoyed the fact that there is a reward system to completing testing and that there is a certificate for completing a certain amount of testing. I do feel like once a certificate is achieved there is less of a motivation to continue with the testing so perhaps further rewards are needed. I do like the idea of the progression system however.”
- “The competitive aspect of it could be quite entertaining in a workplace environment, especially with highly competitive/social co-workers”
- “This will create a competition environment for testers.”

Some also argued that gamification may not be a method to motivate all software testers. The following statement is an example to support this idea:

- “Gamification could appeal to certain people as a motivation for software testing, however it may do little to nothing for some people. Some people may even find it patronising, though I imagine this is a small minority of people.”



Fig. 4. Participants' level of satisfaction.

Furthermore, participants were given the following question to answer: “How did the gamification experience (i.e points, storyline, feedback, levels, badges, progression, comparison, certificate and provision of choice) encouraged you to participate and complete the provided software testing task?”. The responses indicate that majority of participants agreed that the final gamified platform was encouraging. Some of the responses are listed below as ready reference:

- “The levels, almost ladder-like structure appeals to a competitive drive within me, on top of the addition of physical rewards, it creates a want to find something important such as design breaking bug in order to reach the top of the standings.”
- “Knowing that there was a reward for testing the software helped motivate me. In addition, the competitive aspect also motivated me to try to better than my peers.”
- “I felt slightly more compelled to do well due to the competitive nature of seeing other people's points. It reminds me of when I did language perfect where you could see the

people that were ahead of you on points. It kind of pushed you to beat and 'one-up' them and get ahead.”

- “The strongest points in my experience are the comparison, certificate and feedback. Receiving physical and real world rewards both as a certificate and as comparing myself to others is a strong motivator in doing more, better tests.”

Arnarsson and Jóhannesson [3] also reported that the leader board and point system were the most effective elements identified in their study to influence developers to generate more effective unit tests. This leads to providing a competitive environment which increases the motivation and engagement levels of developers to perform testing task.

Furthermore, findings suggest that participants agreed to the fact that gamification can be used as a tool to increase quality of the software testing activities. From the responses, 85% of the participants supported this fact. Figure 5 represent participants’ response on this question. Some the responses are listed below:

- “As listed above, I think it would exponentially increase the amount of work people would put in, knowing they would be compensated for it either via digital standing or actually.”
- “I believe that if the tester feels some sort of accomplishment in their testing, they'd certainly feel more motivated, and hence an improvement in quality.”
- “Physical or virtual rewards are very important for everyone. To achieve the points compared to the other will make the software tester more focus on the quality because the points are related to what they did.”

Some also had different responses as listed below:

- “Yes and No because if rather the software tester is looking more at the code and less at the actual gamified software testing application then the link between reward and tested software is weaker. However if the depth of the software testing is short and it allows users to test more with more rewards given in a shorter time then I would assume people would have a higher level of quality for the testing.”
- “I don't think it would necessarily improve the quality of the software testing, as I didn't feel that it helped my skills or process of testing while I was doing it.”

Moreover, following question was given to participants to answer: “From your experience, do you think that gamification of software testing would increase the engagement of software testers?”, Results suggest that 85% of the participants agreed that gamification is a method used to increase the engagement of software testers. Figure 6 supports responses obtained from the participants. Some participants stated that testers would like to gain incentives when they are given tasks to work on.

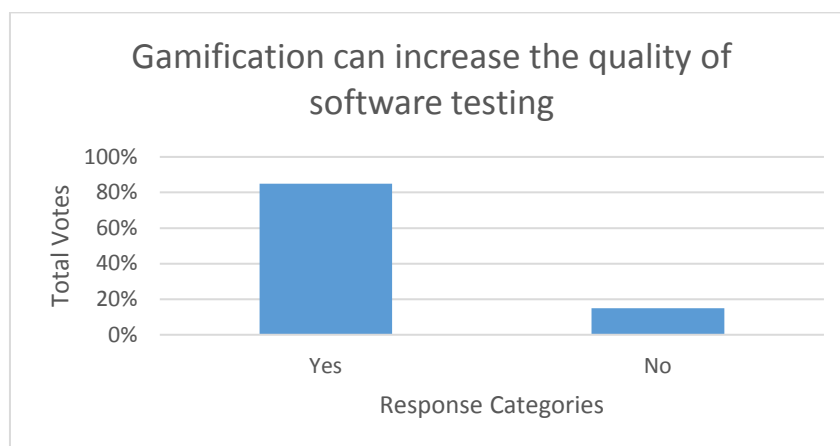


Fig. 5. Gamification may increases the quality of testing activities.

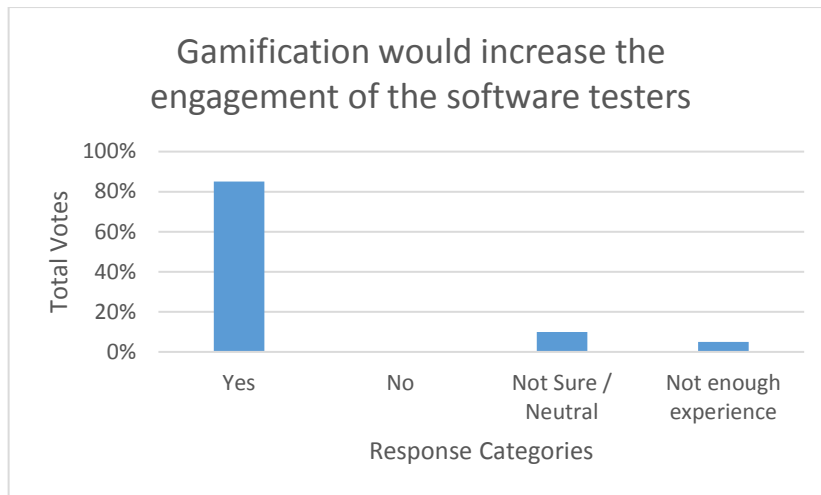


Fig. 6. Gamification increases the engagement level of software testers.

To identify the importance of another key element used in the software testing platform for software testers, participants were given the following question: “How do you rate the importance of the feedback element?”. Responses suggest that feedback is a vital element in designing serious games in software testing environment. Figure 7 represents participants’ responses to this question. Following to that question, participants were asked the following question: “Do you feel encouraged to participate more after reviewing your performance against the performance of others in the software testing platform?”. Their responses suggest that majority agreed on the fact that comparison is very important to encourage testers to perform better. Some of the responses are shown below as ready reference:

- “I am competitive, I don’t like not winning, and I’d participate more in order to reach the top.”
- “The competitive aspect gives a novel gimmick to encourage engagement.”
- “having people to compare gives context to my skill level, which helps motivate me to improve”

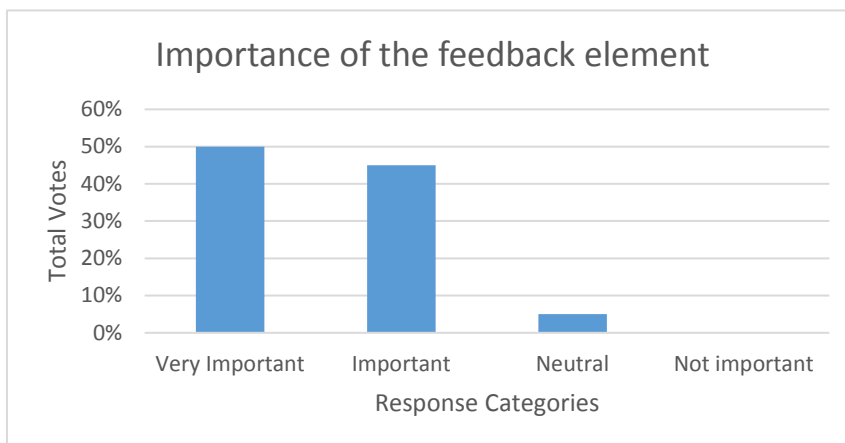


Fig.7. Importance of the feedback element.

5. Conclusion and Future Work

In this paper, a brief background of gamification and software testing was explained. Furthermore, findings are presented after conducting focus group sessions for the evaluation of final gamified platform. Participants invited to participate in the focus group sessions in this study are senior level Computing students who have experience of working on real-time industry projects as part of their learning process. The results obtained in the study might impact the outcome of the study as there might be higher expectations or different view in relation to design validation by a larger group of professional software testers. In this study, researchers have tried to choose participants who have both software development and software testing background and experience to obtain better results on the final gamified platform validation. Results suggested that the developed gamified platform may be a solution to increase the level of satisfaction and engagement of software testers in practice. In addition, majority of participants agreed that game elements such as feedback and comparison may help to increase testing motivation, engagement and experience of software testers. Furthermore, they rated the feedback element as a vital element in gamified software testing environment. Additionally, majority of participants agreed that gamification can be used as a method to increase the quality of software testing activities. However, this requires further investigation. The next step of this research is to evaluate if gamification can be used as a method to increase the quality of the written test codes. In addition, the evaluation of the final platform with time pressure can help to check if the line number of test code written by the tester can be a factor, which affects or increases the quality of results. Moreover, in the future work, researchers' plan to investigate if time restriction can be a factor to motivate the testers in order to increase their productivity.

Note: This study was conducted after obtaining ethics approval from the Office of Research and Development (ORD), Curtin University, Australia with Ethics approval number: **RDSE-76-15**. Participants gave informed consent before participating in the focus group sessions.

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