

Abstract

Software testing plays a crucial role in the software development lifecycle. End-to-End (E2E) testing is essential to verify the correct functionality and availability of modern software by interacting as a real user would do. Such activity faces challenges such as limited user participation and significant costs. The application of gamification - i.e., the incorporation of game design elements in non-game contexts - has the potential to enhance user engagement, thereby facilitating a more effective testing process.

The work conducted during the PhD reported in this thesis addresses five main goals: (i) mapping the current landscape of gamification usage within the software testing field; (ii) designing and creating tools aimed at enhancing testing methodologies; (iii) investigating how gamification influences the effectiveness and efficiency of testing; (iv) examining the effects of gamification on the quality of tests; and (v) analyzing how gamification techniques impact the user experience of testers.

To accomplish the defined objectives, several studies were conducted. The first goal was pursued by conducting a Multivocal Literature Review to determine the existing gaps to be filled. The other goals were accomplished by developing new gamified tools to support testing process not yet covered, and evaluating them first with preliminary assessments and then with empirical studies.

The first part of the thesis focused on the development of a gamification tool for Web GUI testing, particularly addressing the augmented testing technique. These studies allowed the initial implementation of a gamification plugin for Scout, an existing tool in the literature, and its subsequent enhancement to enable a crowd-testing approach. An additional tool was developed to provide gamification for augmented testing in the form of a browser extension. An empirical experiment aimed at evaluating the gamification plugin for Scout was conducted with students, measuring the effectiveness, efficiency, quality, and user experience of the resulting test suites.

The second part of the thesis aims to study the replicability of an existing study by extending the capability of IntelliGame, an IDE plugin for unit testing in Java, to a new programming language, i.e. JavaScript. The extension of the plugin was subjected to empirical experimentation with graduate students, evaluating the same test properties mentioned above. Based on the idea of IntelliGame, a new gamified IDE plugin was developed to support scripted GUI testing in Selenium.

The results indicate that the application of gamification can improve both the motivation and performance of testers, leading to quantifiable advancements in test effectiveness, in terms of test coverage. However, the experiments did not prove higher efficiency within the context of augmented testing; rather, enhancements were observed in gamified scripted testing. The quality measure of the test yielded contrasting results. Conversely, user experience resulted markedly enriched, as a considerable majority of participants indicated a positive experience.

Gamification has significant potential to overcome persistent challenges in end-to-end software testing. This thesis provides practical implementations for incorporating game elements into testing environments, paving the way for more engaging, efficient, and sustainable software validation practices.