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Gamify: Gamification in Software Development, Verification, and Validation

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ABSTRACT

In this paper we report the outcomes of the 1st and 2nd edition of the International Workshop on Gamification in Software Development, Verification, and Validation (Gamify 2022 and Gamify 2023) which were held as part of the 30th and 31st ACM Joint European Software Engineering Conference and Symposium on the Foundations of Software Engineering (ESEC/FSE 2022, in Singapore, November 17, 2022 and ESEC/FSE 2023, online workshop, December 4, 2023).

1. INTRODUCTION

Gamification is the practice of applying game-like mechanics to increase the engagement and fun in non-ludic activities. Gamification usually involves elements such as leaderboards, achievements, missions, and competitions between players. Evidence in Software Engineering literature demonstrates that gamification can improve software quality when applied to most phases of the software process. The Gamify workshop aims at investigating the current trends in the development of source code, and in the generation of test scenarios that leverage Gamified mechanics.

The workshop aims at bringing together researchers, practitioners and tool developers working on topics related to the application of such gamified mechanics to software development, verification and validation. The workshop will aim including both academic and empirical research, as well as presentations of gamified tools and industrial case studies.

Topics of interest for the Gamify workshops series include the following:

- Gamified software development;
- Gamified definition of test cases/suites;
- Gamified end-2-end, capture & replay or exploratory testing;
- Gamified integrated development environments;
- Theoretical gamification frameworks;
- Metric frameworks to evaluate the performance of software developers and testers;
- Gamification applied to software development and software testing education;
- Applied games for software development and software testing education.

1.1 Workshop Chairs

The 2022 [CAML22] and 2023 [CAFL23] editions of the Gamify workshop has been organized by:

- Riccardo Coppola - Politecnico di Torino, Turin (Italy)
- Luca Ardito - Politecnico di Torino, Turin (Italy)
- Maurizio Leotta - University of Genova, Genova (Italy)

with the help of:

- Mirna Muñoz - Centro de Investigación en Matemáticas A.C. Zacatecas Unit, Zacatecas (Mexico) for the 2022 edition
- Gordon Fraser - University of Passau, Passau (Germany) for the 2023 edition

2. SUMMARY OF 1ST EDITION OF THE GAMIFY WORKSHOP

In its first edition the Gamify workshop received 8 paper submissions: 2 full, 5 short and one tool demo. Each submitted paper was reviewed by three members of the Program Committee and the selection of the accepted papers was decided based on the quality (novelty, relevance, clarity of presentation, correctness) and contribution to the workshop. At the end of the review process, three papers were accepted (37.5% acceptance rate): one full paper, one short paper, one tool demo.

The workshop was opened by an invited keynote by Gordon Fraser, titled “Gamifying Software Testing” [Fra22]. The abstract of the keynote talk follows.

Writing good software tests is difficult and not every developer’s favourite occupation. If an activity is so difficult, boring, or otherwise unattractive that people do not want to engage with it, then gamification offers a solution: By turning the activity into a fun and competitive task, participants engage, compete, and excel. In this talk, I will explore how this idea can be integrated into software testing tools (e.g. IDEs), processes (e.g. continuous integration), and education. Our experiences with gamified testing illustrate the potential of using gamification to address some of the many problems that we are facing today in software testing. There are, however, many challenges ahead, and I will outline some of the challenges and research opportunities related to gamifying software testing.

In the following we report the presenter and abstract of each accepted paper.

- Giacomo Garaccione presented the paper “GERRY: a gamified browser tool for GUI testing” [GFT22]. Graphical User Interface (GUI) testing is a relevant step of the software development process which is not often performed thoroughly due to its unappealing nature, to the inherent fragility of test cases, and to the fact that test cases – composed of long and complicated sequences of operations – have to be manually written by testers. We propose GERRY, a Capture & Replay GUI testing tool which implements an approach based on Gamification, i.e., the application of gaming elements to non-ludic activities. The purpose of the tool is to increase the engagement of the testers when performing GUI test case definition tasks. The tool makes use of mechanics typical of games such as progress indicators, leaderboards, and unlockable rewards, to increase user interest and involvement. GERRY also generates reports (i.e., traces of all actions and milestones reached during a session), written logs of the performed testing sessions, and scripts compatible with existing GUI testing tools (SikuliX and Selenium) for replay purposes.
- Casimer DeCusatis presented the paper “Gamification of Cybersecurity training” [DAD22]. A large fraction of cybercrimes could be prevented with improved cybersecurity awareness training. We have developed a virtual cybersecurity escape room based on the three-dimensional Unity game development platform. This application is based on the proven Octalysis gamification framework, which has been shown to improve user engagement and knowledge retention. Following a discussion of the application design, this position paper presents playtesting results, work in progress, and experimental quantification based on eight gamification metrics.
- Savas Ozturk presented the paper “Gamification of exploratory testing process” [Ozt22]. Exploratory testing is an experience-based testing technique often used in addition to formal ones. However, it can be used as a replacement for formal techniques when time is limited and/or documentation is poor. Conducting test charters and maximizing efficiency are seen as tough works due to their informal nature. Dividing test load to testers, scoring the severity level, consolidating the results, and reporting the issues are some challenges of this process. In this experience study, efforts of gamifying exploratory testing process are told. A public institution in Turkiye demanded software testing for their software for a limited timeframe and employed testers were motivated by gamification efforts. It was seen that gamification helped us detecting more critical faults quickly. Failure cases such as test contest organization attempts are told as well.

3. SUMMARY OF 2ND EDITION OF THE GAMIFY WORKSHOP

In its second edition the Gamify workshop received 10 paper submissions. Each submitted paper was reviewed by three members of the Program Committee and the selection of the accepted papers was decided based on the quality (novelty, relevance, clarity of presentation, correctness) and contribution to the workshop. At the end of the review process, seven papers were accepted (70% acceptance rate): five full papers, and two short papers.

The workshop was opened by an invited keynote by Beatriz Marín, titled “Gamification to Ignite Learning in Modern Times” [Mar23]. The abstract of the keynote talk follows.

Modern times reflect an interconnected world thanks to globaliza-

tion and technology, which provide higher economic and societal integration, and stimulate technology transfer and knowledge sharing. This challenges the educational landscape demanding new teaching and learning approaches. Teaching complex concepts, such as computer science topics, requires engaging students with the practice of the contents for successful learning. Gamification and serious games have demonstrated their importance to deal with the lack of self-motivation in students when learning. In this keynote, different approaches that we have used to improve the motivation and learning effectiveness of software engineering students will be presented. After that, the keynote will focus on lessons learned and future research directions that deserve attention from the community.

In the following we report the presenter and abstract of each accepted paper.

- Giacomo Garaccione presented the paper “A Gamified Learning Tool for Conceptual Modeling with UML Class Diagrams” [CGC⁺23]. Conceptual modeling is a fundamental skill for analysts and software engineers, as it is necessary for abstracting concepts and expressing them in a meaningful way that can then be translated into effective software design. Conceptual modeling is taught in different Software Engineering university curricula, with Unified Modeling Language (UML) class diagram being one of the most commonly used notations for this purpose. This paper presents a proposal for the Gamification of conceptual modeling education in a university environment. We describe a tool prototype with common gamified mechanics such as experience points, levels, and customizable avatars, together with an underlying evaluation system for assessing the correctness of the diagrams modeled by the students. A preliminary assessment on existing lab assignments was performed to gauge the ability of detecting errors. We discuss the tool capability and the potential benefits that such a tool could bring, as well as envision future plans for an empirical evaluation of those benefits.
- Naomi Unkelos-Shpigel presented the paper “Revise That Again: Are You Motivated?” [USBK23]. Requirements engineering (RE) presents several challenges stemming from the required collaboration and knowledge transfer between analysts, developers, and customers. Motivation theories have been used occasionally to analyze and encourage motivation and engagement of stakeholders in RE tasks. In recent years, gamification techniques have been used in software engineering tasks, and specifically, in RE tasks in order to promote stakeholder engagement. However, existing research works seldom offer a rigorous method for designing gamification environments for RE tasks. This paper describes a socio-technical environment, which was built for requirements elicitation and specification. This environment allows researchers and team managers to decide on different mechanisms to gamify the current RE task in practice. The environment was evaluated by experts and was further tested with the participation of students in two proof of concept studies for demonstrating its functionality, yielding some anecdotic results.
- Lorenzo Gerini presented the paper “Virtual Reality for Computational Thinking” [GDG⁺23]. In Computer Science Education, coding activities are extremely important to teach younger students the basics of programming and computational thinking. To provide an immersive experience, in this paper, we propose VRCoding, a Virtual Reality (VR)-based

block coding system. VRCoding can teach computational thinking in an immersive Virtual Reality environment, exploiting passive haptics to improve interaction and give tactile feedback to the users. Passive haptics is obtained using simple physics placeholders, i.e., textured parallelepipeds, that are tracked in real-time, and aligned with the coding blocks in VR. The system is tested on a group of secondary school users, performing simple coding exercises with a standard monitor-based block coding environment and with the proposed VRCoding block language. Results show positive feedback concerning the sense of presence and the user experience.

- Tommaso Fulcini presented the paper “Is ChatGPT Capable of Crafting Gamification Strategies for Software Engineering Tasks?” [FT23]. Gamification has gained significant attention in the last decade for its potential to enhance engagement and motivation in various domains. During the last year ChatGPT, a state-of-the-art large language model has received even more attention both in the field of scientific research and in common use by individuals or companies. In this study, we investigate the possibility of adopting ChatGPT as a tool for designing gamification platforms in the Software Engineering domain. Leveraging the capabilities of ChatGPT, we assess how good is it at generating effective suggestions and ideas for designers or developers. To evaluate ChatGPT’s potential as a gamification platform creator we narrowed the context to one particular Software Engineering activity, asking for possible aspects of the activity to be gamified. Each proposed aspect was subsequently unraveled by ChatGPT both asking in a shared and separate context, first following the conversational nature of the model, then applying a validated design framework. The study assesses ChatGPT’s ability to select and integrate game elements to build a thriving gamification environment by framing the design of the platform to a state-of-the-art conceptual framework. To evaluate the goodness of the design choices made we relied both on the Octalysis framework and on personal experience. The findings of the papers show that ChatGPT can only create simple playful experiences not very effective. Although, by instructing the model with more specific desired mechanics and dynamics, it is possible to guide it toward the application of the ideas suggested. We argue that ChatGPT is not capable of building a gamified environment on its own, but it could still be used to build the foundation of a gamification platform as long as the designers refine and rough out the advice gained from a user-centered solution.
- Enrico Russo presented the paper “Cyber Range and Cyber Defense Exercises: Gamification Meets University Students” [RRO⁺23]. In the last decade, gamification has emerged as a valid alternative to more traditional learning processes both in academia and for professional training. Gamification has been successfully implemented in various disciplines to enhance the enjoyment and engagement of learning. This result can be achieved by providing challenges and quests, incentivizing task completion, and using role-playing games where learners assume different roles and perform tasks within a story format. In the case of cybersecurity, gamification can be introduced thanks to Capture The Flag (CTF) competitions or within virtual environments known as Cyber Ranges, where participants can test their skills on simulated networks, ICT systems, and other critical infrastructures. In this paper, we describe our experience with a cyber defender training activity proposed to computer science and computer engineering students. We organized lectures on cybersecurity,

oriented towards developing problem-solving and practical skills. Then, we introduced gamification by running two on-site competitions: a Jeopardy CTF and a Cyber Defense Exercise.

- Wei Ren presented the paper “Gamification in Test-Driven Development Practice” [Ren23]. The challenge of effectively developing and sustaining high-performance professional development practices in software engineering education is one that must be addressed. Test-driven development (TDD), an example of a key professional practical activity, is strongly linked to these high-performance practices. To examine the effects of gamification - the use of game design elements in a non-game context - on motivating students to develop and sustain TDD practice, an experiment was conducted and utilized ordinary least squares (OLS) regression to analyze the data. This experiment showed that gamification motivates students to do high-performing TDD practice. More specifically, gamification changes the individual’s TDD behavior, increases engagement in the development activity, and the effect continues for a longer period even after gamification has ceased. Furthermore, a positive association between gamification and the maintainability of the team codebase was supported by the data.
- Patrick Feldmeier presented the paper “PlayTest: A Gamified Test Generator for Games [FSF23]. Games are usually created incrementally, requiring repeated testing of the same scenarios, which is a tedious and error-prone task for game developers. Therefore, we aim to alleviate this game testing process by encapsulating it into a game called Playtest, which transforms the tiring testing process into a competitive game with a purpose. Playtest automates the generation of valuable test cases based on player actions, without the players even realising it. We envision the use of Playtest to crowdsource the task of testing games by giving players access to the respective games through our tool in the playtesting phases during the development process

4. REMARKS AND FUTURE WORK

These two editions of the Gamify workshop successfully bring the community interesting presentations of research papers and two inspiring keynotes. All the accepted papers were invited for a special issue of the Software Quality Journal (SQJ) [LCA].

During the first two editions of the Gamify workshop we witnessed an increasing interest towards the application of gamified constructs to the practice of software development, verification and validation. The discussions held during the workshops highlighted a special interest in the definition of testing approaches including gamification mechanics. In the second edition the need to explore the possibilities offered by large language models (e.g., OpenAI) was shared among most of the authors.

Our goal is to continue in proposing new editions of the Gamify workshop trying to attract contributions from academia and industry, pushing further on emerging contributions from young researchers, developers and experts alike to inspire new gamification ideas for the future.

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