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Gamification in software engineering – A systematic mapping

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ABSTRACT

Context: Gamification seeks for improvement of the user's engagement, motivation, and performance when carrying out a certain task, by means of incorporating game mechanics and elements, thus making that task more attractive. Much research work has studied the application of gamification in software engineering for increasing the engagement and results of developers.
Objective: The objective of this paper is to carry out a systematic mapping of the field of gamification in software engineering in an attempt to characterize the state of the art of this field identifying gaps and opportunities for further research.
Method: We carried out a systematic mapping with a view to finding the primary studies in the existing literature, which were later classified and analyzed according to four criteria: the software process area addressed, the gamification elements used, the type of research method followed, and the type of forum in which they were published. A subjective evaluation of the studies was also carried out to evaluate them in terms of methodology, empirical evidence, integration with the organization, and replicability.
Results: As a result of the systematic mapping we found 29 primary studies, published between January 2011 and June 2014. Most of them focus on software development, and to a lesser extent, requirements, project management, and other support areas. In the main, they consider very simple gamification mechanics such as points and badges, and few provide empirical evidence of the impact of gamification.
Conclusions: Existing research in the field is quite preliminary, and more research effort analyzing the impact of gamification in SE would be needed. Future research work should look at other game mechanics in addition to the basic ones and should tackle software process areas that have not been fully studied, such as requirements, project management, maintenance, or testing. Most studies share a lack of methodological support that would make their proposals replicable in other settings. The integration of gamification with an organization's existing tools is also an important challenge that needs to be taken up in this field.
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1. Introduction

The field of gamification has experienced significant growth and popularity in the last few years [1–4]. Although many definitions can be found in the literature, gamification has been defined in [1] as "the use of game design elements in non-game contexts". Gamification uses the philosophy, elements, and mechanics of game design in non-game environments to induce certain behavior in people, as well as to improve their motivation and engagement in a particular task. That is to say, gamification takes those features that make real games fun and attractive (and even addictive), and uses them to improve the player experience in a non-game environment, such as the workplace, the school, a software application, or customer-oriented web site.

Gamification has been applied in many different domains in the last years. One of those domains is education and training [5], where game elements are used to increase the motivation, engagement and performance of the students. Gamification has also been a central part of the design of many mobile applications for smartphones and tablets, in the quest to achieve stronger user engagement and diffusion of the applications. Corporate websites oriented toward customers have also been the object of gamification as they seek to improve the customer experience on the website [6]. Gamification has also been applied in corporate environments in an attempt to improve the results of employees in the development of their daily tasks and work [7].

This paper focuses on the potential benefits gamification can bring to the Software Engineering (SE) field; its application here deserves special attention, given the human-intensive nature of software processes. This turns gamification into a promising field which can help to improve the daily engagement and motivation of software engineers in their tasks. As a matter of fact, some existing commercial tools which support SE processes are starting to incorporate basic gamification mechanisms; see, for instance, JIRA Hero [8], RedCritter [9], PropsToYou [10], ScrumKnowsy [11], MasterBranch [12] or Visual Studio Achievements [13]. In the SE field, therefore, researchers and practitioners are not unaware of the potential benefits of gamification in the workplace. A number of proposals have been published in recent years, some of them focused on teaching and training, others on real SE contexts.

Bearing in mind the aforementioned ideas, the focus of this work is to analyze the application of gamification in Software Engineering (SE); a systematic mapping has been carried out to that end. The aim is to provide a more structured view of the state of the art in the field and to identify existing gaps and weaknesses. The scope of this systematic mapping is the software development context; it does not include those pieces of work focusing on teaching or training. The rest of the paper is structured as follows: Section 2 presents the related work. Section 3 describes how systematic mapping was planned. In Section 4 we present the results we obtained during the study, providing answers for the stated research questions. The discussion of the results obtained in the study is set out in Section 5 and finally, Section 6 summarizes the conclusions of the paper and outlines challenges that may lead to future research.

2. Related work

To the best of our knowledge, in the relevant literature there are no systematic literature reviews (SLR) or systematic mapping studies which tackle the application of gamification in SE. It is true, however, that we can find some work whose aim is to provide the state of art in the field of gamification. In this line, Hamari et al. [14] analyze the empirical studies on gamification by means of a literature review of peer-reviewed papers, the aim of whose main research question is to evaluate the usefulness of gamification. The results are classified according to a framework which considers: (1) motivational affordances, (2) psychological outcomes, and (3) further behavioral outcomes. As a result of the review, authors conclude that gamification does work, "but some caveats exist". Most papers report positive results from gamification, with some empirical evidence. However, some underlying confounding factors exist in the empirical results; these consist mainly of the role of the context being gamified and the qualities of the users. Methodological improvement is proposed for future research and suggestions are given for avoiding the pitfalls of current studies. Xu [15] conducts a literature review about gamification in web applications. The author concludes that the current state of gamification focuses on the relatively superficial game mechanics (point, level, leaderboard and badges). As a future direction for research to consider he highlights: social interaction; mobility, by supporting the ubiquitousness of mobile devices and; analytics which must be enhanced, although most of the commercial tools already include some engagement metrics and behavior analytics.

On the other hand, we can find some systematic literature reviews (SLR) in the related area of serious games. In particular, Connolly et al. [16] analyze the potential positive impacts of serious games and computer games on gaming users from 14 years old, with respect to learning, skill enhancement and engagement. The study selected 129 papers out of 7392, which include some empirical evidence. In addition, a multidimensional approach was developed to categorize the games. The main conclusions from this study were the reported diversity found in the research on the impact of playing digital games, and the difficulties of classifying learning outcomes. Some evidence about the effectiveness of games-based learning was also collected, although it is suggested that more rigorous research is needed. Another significant observation is that to incorporate games in learning environments it is essential to develop a better understanding of the tasks, activities, skills and operations that different kinds of games can offer and examine how these might match desired learning outcomes. Steinkuehler [17] describes the qualitative results obtained about the analysis of massively multiplayer online games applied for learning. The results are obtained from a two and a half year cognitive ethnography of the MMO Lineage and demonstrate the core practices that constitute gameplay in virtual worlds. They focus on the development of educational activities for after-school clubs that capitalize on those capacities. Other reviews look at the application of games in other domains. Graafland et al. [18], for instance, tackle the application of digital games for training medical professionals. 25

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