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The use of exploratory software testing in SCRUM

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ABSTRACT

Exploratory testing is a very common, yet under researched, software testing technique [2]. Research has shown how this technique can provide a better insight about the system under test than other techniques [9], that it can find defects more efficiently than other testing approaches [1, 5] and even aid the design of other techniques [3].

This research aims at increasing the understanding of exploratory testing and the way it is used within industries utilising SCRUM. Another aim is to identify and understand the factors that enable the tester to use this technique successfully. The decision to set the study in SCRUM comes from the fact that this Agile management framework is the most popular in industry [12] and from the suggestion to focus on the relationship between Agile and exploratory testing [9]. Also, the choice of a specific context adds significance to the findings [11].

This research will be conducted in a Sheffield based company, which produces data analytics software. The methodology will consist of three phases. During Phase 1 (Identification), SCRUM practitioners will be interviewed about the use of exploratory testing in SCRUM and the success factors of this technique. The aim of Phase 2 (Confirmation) will be to confirm the findings from Phase 1. This will be accomplished with focus groups and widely-distributed online survey. Finally, during Phase 3 (Verification), practitioners will take part to experiments to verify that the success factors identified during the first two phases enable efficient and effective exploratory testing.

The purpose of this research is to enrich the academic field of software verification and validation, but also to provide industries utilising SCRUM with useful guidance.

CCS CONCEPTS

• **Software and its engineering → Formal software verification**; **Empirical software validation**.

KEYWORDS

software testing, exploratory testing, SCRUM

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1 INTRODUCTION

There is no universally accepted expansive definition of exploratory software testing. Because of its exploratory, context-driven nature and inherent openness to adaptation, most definitions are minimalist but reference its extensibility.

In exploratory testing, the tests to run on a system or application may not be written in advance, although the tester may make a few annotations beforehand. As opposed to other testing approaches, which require the practitioner to execute predefined tests, exploratory testing utilizes the creativity, experience and knowledge of the tester "to steer the process dynamically" [3]. Exploratory testing may even combine all the testing activities-from planning to closure- into one. It is a common testing approach in industrial software engineering [1], which has been in the testers' "toolbox" for a long time [2] and can be used at any stage of the software development process [10]. The term exploratory testing was coined by Cem Kaner in 1988 [9]. More clarity on the nature and the uses of exploratory testing in industry is needed.

A systematic literature review was conducted with a twofold aim: to clarify how exploratory testing is used in industry, and to identify the factors that enable successful exploratory testing. While the literature confirmed that techniques with different levels of structure (i.e., predefined instructions) share the denomination of exploratory testing, it was pointed out that what distinguishes this technique from the others is the will of the tester to explore, rather than confirm/check [6]. Eight success factors have been identified by the literature: experience, domain knowledge, system knowledge, software engineering knowledge, personality, use of tools and right level of exploration.

2 RESEARCH QUESTIONS

This research will focus on exploratory testing as described by Itokonen, Mantyla and Lassenius [6]: a technique that aims at finding defects in unexpected places and learning about the system, as opposed to confirmatory testing, which checks that the system behaves according to expected outcomes.

This research will be conducted in a SCRUM environment for the following reasons:

(1) It was suggested that the choice of a specific context adds significance to the findings [11]. The way software is tested depends on the characteristics of the life cycle (i.e., the software development context). As opposed to sequential models, like Waterfall, in which testing occurs at the end of the development, in Agile, testing may be performed at different levels over the entire cycle, to provide constant feedback to the developers. Also, it is reasonable to assume that SCRUM,

as an Agile framework, has an influence on way the testing activities, that may include exploratory testing, are carried out.

(2) According to Mårtensson et al. [9] the relationship between exploratory testing and Agile needs attention. No research has ever been published about exploratory testing in SCRUM, Agile's most popular framework in industry [12].

Therefore, Research Question 1 (RQ1) shall be:

- How can efficient and effective exploratory testing be performed in SCRUM?

The 15 studies considered in the systematic literature review have identified a total of eight factors that enable efficient and effective exploratory testing in industry: experience, domain knowledge, system knowledge, software engineering knowledge, personality, use of tools and right level of exploration. This research will aim at identifying these factors in a SCRUM environment.

Therefore RQ2 shall be:

- Which are the factors that enable effective and efficient exploratory testing in SCRUM?

The following RQ will focus on the balance among the success factors. Ghazi et al.[4], for example, suggested that less experienced testers may need to choose a more structured exploratory testing approach to ensure its success, which suggests that the lack of one of the success factors may be compensated by the presence of another. RQ3 will focus on how this balance can be achieved and maintained in SCRUM. Because of time constraints and other practical reasons, RQ3 will likely focus of a subsect of the factors identified during Phases 1 and 2.

- In a SCRUM environment, how can the presence of each success factor be utilised to compensate for the absence (or lower availability) of other success factors, to enable efficient and effective exploratory testing?

The possible outcome of this research will be enriching the field of software verification and validation with a better understanding of how exploratory testing is used in SCRUM, but also providing industries with guidance on best practices in the use of this technique. This will not only involve the way exploratory testing is performed, but it will also inform management decisions with regards to the most suitable set of skills a tester should possess for a certain job or project that requires exploratory testing. Finally, the results of these studies might shed some light on the kind of training exploratory testing performers should undergo and what qualifications they should achieve.

3 METHODOLOGY

3.1 Overview

This research will be divided in three major phases: Identification, Confirmation and Verification. During Phase 1 (Identification), the participants will be asked open-ended questions (in person or via video conference), about exploratory testing in SCRUM and the success factors of this technique. Such participants will be recruited from a local company which produces and sells data analytics software to other companies. This firm currently employs 45 developers/testers, all working in SCRUM teams. The purpose of this phase will be to understand how the participants see and use exploratory testing, and to identify the factors that enable an efficient and effective use of this technique. Thematic coding and analysis will, then, be carried out as recommended by Robson and McCartan [11] Phase 1, along with the following Phase 2, will attempt to answer RQs 1 and 2. During Phase 2 (Confirmation), the participants will attend focus groups, during which they will discuss the findings from Phase 1. An online survey will also be disseminated outside of the company. The purpose of this phase will be to "amplify and understand the findings of the survey" conducted during Phase 1 [11]. Phase 2, along with the previous Phase 1, will attempt to answer RQs 1 and 2. Finally, Phase 3 (Verification) will consist of experiments. Their design will depend on the findings from Phase 1 and 2. Several success factors (the independent variables) can be anticipated and thus a factorial experimental design between-subjects will be used. Phase 3 will focus on answering RQ2 and RQ3.

Each of the three phases will be divided into the following sub phases: Research Design, Research Ethics Approval Process, Recruitment, Data Collection and Data Analysis. Although there are dependencies between each phase and the following, Recruitment and data Collection might take place during the same period of time.

3.2 Phase 1 - Identification

Phase 1 will begin in October 2022 and end in March 2023. The purpose of Phase 1 will be to understand how exploratory testing can be successfully used in SCRUM (RQ1),and to identify the factors that enable an effective and efficient use of this technique (RQ2). This will be accomplished through face-to-face, fully structured, interviews.

The participants to Phase 1 will be familiar with SCRUM and exploratory testing. Professionals who have hands-on experience of this technique in SCRUM and/or manage/coach people who do (i.e., SCRUM masters) would be good candidates. The participants will be the employees of a Sheffield based company that produces data analytics software.

In Mårtensson et al.[9] 20 interviewees were recruited for the first part of the study about the success factors in exploratory testing. Recruiting five extra interviewees will maintain an appropriate sample, in case some of the participants withdraw their availability. Therefore, 25 participants will be recruited for the face-to-face interviews.

Emails will be sent from the researcher's University of Sheffield account to her acquaintances who work within a SCRUM team. These professionals will, then, forward the email to their colleagues. There will, therefore, be an exponential non-discriminative snowball sampling. The interviews will take place in person or online (i.e., via Google Hangouts), depending on the proximity and availability of the participants.

The script (see Appendix A) is divided in three sections. It is important to maintain the order of the questions because the participants should not be asked their opinions about the success factors in exploratory testing identified by the literature before they have had the chance to express their own opinion. In fact, providing them with "prefab" ideas would be leading. Questions 1 and 2 should be asked first, as they are about exploratory testing in SCRUM in general, while the following seven questions contain personal

questions about the participant's work experience and education. "Zooming in" from general to personal will work as an icebreaker. The remaining questions will seek the participants' opinion about the success factors identified by the literature.

The expected outcomes of Phase 1 are:

- An understanding of how exploratory testing is used in SCRUM (i.e., how the session is organized and conducted, in which circumstances and for what purposes is exploratory testing used).
- An understanding of the factors which make exploratory testing efficient and effective in SCRUM and of the impact of each factor on the others.
- Patterns between different opinions/statements and work experience/educational background.

3.3 Phase 2 - Confirmation

Phase 2 will begin in April 2023 and end in July 2023. The purpose of this phase will be to confirm the findings from Phase 1 and, therefore, the focus will be on RQs 1 and 2. A confirmatory phase will have the purpose to ascertain the correctness of the researcher's interpretation and to look for negative cases [9]. Data will be collected via focus groups and via a widely distributed (i.e., outside of the company) online survey.

During the focus groups the participants will be asked to discuss the outcomes of Phase 1. Focus groups are a good way to "amplify and understand the findings from a survey", and "a very valuable means of guarding against researcher bias" [11]. Cross-company workshops (i.e. focus groups) were successfully utilised by Mårtensson et al. [9] to confirm the findings from the previously conducted interviews about the success factors in exploratory testing. The focus groups will take place online, via a video conferencing software (Google Hangouts) or in person, depending on the proximity and/or availability of the participants.

The participants to the focus groups of Phase 2 will have the same characteristics as Phase 1. The recruitment will take place in the same company, therefore some of the participants might have been interviewed during Phase 1. There are different opinions about the optimal size of a focus group, but the participants should be no more than 12 [11]. In Mårtensson et al. [9] a focus group was conducted with 14 participants. The recruitment will be conducted in a similar way to Phase 1.

The agenda of the focus groups will likely reflect the outcomes of Phase 1. The moderator (the researcher) will allow a certain time interval to each item on the agenda and, probably, use visual aids (e.g., a chart displaying the ratings of the success factors in exploratory testing).

For the purpose of data triangulation and to guarantee external validity, an online survey will be disseminated outside of the company. The questions will be similar to the ones of Phase 1's interview script (see Appendix A), but slightly modified to be more suitable for an online survey (e.g., Likert scales instead of open ended questions).

The aim of Phase 2 will be to confirm the findings from Phase 1. Therefore, the expected outcomes are a better understanding of how exploratory testing is used in SCRUM, and more clarity on the success factors.

Should many inconsistencies and/or an unexpected number of negative cases arise during the focus groups or from the online survey, the research team will investigate the causes of the discrepancies, then decide whether to proceed to Phase 3 or redesign Phase 1.

3.4 Phase 3 - Verification

Phase 3 will begin in August 2023 and end in march 2024. The purpose of Phase 3 will be to verify that the success factors identified and confirmed during Phases 1 and 2 enable efficient and effective exploratory testing, from the perspective of the researcher, in the context of practitioners in software engineering testing a piece of software. This phase will also analyse the performance of the participants with regards to the balance among the success factors. Therefore, the focus of this phase will be on RQs 2 and 3. The participants to Phase 3 will be professionals recruited in the same company as Phases 1 and 2. Therefore, an individual recruited for Phase 3 might have already taken part to Phase 1 and/or Phase 2.

Phases 1 and 2 will have shed light on how effective and efficient exploratory testing can be achieved in SCRUM, and on the success factors which can facilitate the use of this. The participants of Phases 1 and 2 will also have provided useful information on how, when and why exploratory testing should be utilised. Since several success factors (i.e., independent variables) are anticipated, and this research is also concerned with the interactions among these independent variables, experiments with factorial design will be conducted, as recommended by Robson and McCartan [11]. The dependent variables will be the effectiveness and the efficiency of exploratory testing. These will be measured respectively in terms of number of defects identified and number of defects identified per unit of time. The defects will be sorted in four levels of severity: critical, major, minor and trivial. Test coverage will also be a dependent variable.

Depending on time and resources, the scope of the experiments might be reduced to a subsect of the success factors, which is likely to include the most popular factors identified during Phases 1 and 2.

The characteristics and number of the participants will depend on the independent variables considered in the experiment. However, it is safe to assume that they will have similar characteristics to the ones described for the previous phases. The recruitment will be conducted in a similar way to Phase 1 and Phase 2 (focus groups).

It is impossible to outline the procedure of the experiments of Phase 3 before knowing their independent variables. However, it is reasonable to expect that the participants will perform exploratory testing on application/software to find defects and/or familiarize themselves with the system under test.

Phase 3 is expected to verify that the factors identified and confirmed in Phases 1 and 2 enable efficient and effective software testing. Phase 3 will also bring more clarity on the balance among the success factors.

4 CONCLUSIONS

Exploratory testing is a widely used software testing technique [2, 8, 9], yet its very definition and success factors are unclear. Studies [1, 3, 5, 7, 9] have described exploratory testing as an effective

and efficient technique. It has been suggested that the relationship between Agile and exploratory testing needs attention [9], and that this technique should be studied from a social science perspective [6]. A systematic literature review was conducted with a twofold aim: to clarify how exploratory testing is used in industry, and to identify the factors that enable successful exploratory testing. While the literature confirmed that techniques with different levels of structure (i.e., predefined instructions) share the denomination of exploratory testing, it was pointed out that what distinguishes this technique from the others is the will of the tester to explore, rather than confirm/check [6]. Eight success factors have been identified by the literature: experience, domain knowledge, system knowledge, software engineering knowledge, personality, use of tools and right level of exploration.

A three stage methodology (1- Identification, 2 - Confirmation and 3 - Validation) has been developed that will allow the researcher to clearly identify how exploratory testing is used in a SCRUM environment.

This research may enrich the research field of software verification and validation, but also provide industries utilising SCRUM with guidance on how to perform exploratory testing successfully. Also, a clearer understanding of the success factors may be useful to inform industrial management decisions about what characteristics the testers should have, within a certain context/for a specific project. Finally, this research may identify ways to train and support testers.

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A INTERVIEW SCRIPT - PHASE 1

(1) What are your views on the use of exploratory testing in SCRUM?
(2) In your opinion, what are the key factors that enable efficient and effective exploratory testing in SCRUM?
(3) What is your educational background?
(4) Have you gained any software testing qualification (e.g., ISTQB)? If so, which ones?
(5) How many years of industry experience do you have of working within a software development lifecycle?
(6) How would you describe your individual role and responsibilities?
(7) How is/was exploratory testing used in your company (if applicable)?
(8) How do you approach an exploratory testing session (if applicable)?
(9) How often do you use exploratory testing (if applicable)?
(10) For which purposes do you use exploratory testing (if applicable)?
(11) What are your views on the years of experience in software development as a success factor in exploratory testing?
(12) What are your views on knowledge of subject matter as a success factor in exploratory testing? By that I mean a specific/specialized knowledge in the specific field of the software/application (i.e., a chef has good subject matter knowledge of a cooking app).
(13) What are your views on user perspective knowledge as a success factor in exploratory testing?
(14) What are your views on the knowledge of the features of the system under test, as a success factor in exploratory testing?
(15) What are your views on the knowledge of technical details of the system under test, as a success factor in exploratory testing?
(16) What are your views on general software engineering knowledge as a success factor in exploratory testing?
(17) How can a company facilitate successful exploratory testing?
(18) How can a tester's curiosity be conducive to successful exploratory testing?
(19) How can a tester's creativity be conducive to successful exploratory testing?
(20) How can a tester's eagerness to learn about the system be conducive to successful exploratory testing?
(21) How can the use of tools facilitate successful exploratory testing?
(22) What influences the level of detail in your charter in an exploratory testing session?
(23) When, if ever, do you use freestyle (i.e., completely unscripted) testing?
(24) How can the choice of the right level of exploration enable successful exploratory testing?
(25) Have you got any questions or comments?