Engaging Stakeholders in Scenario-Based Requirements Engineering with Gamification

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Abstract. The purpose of this paper is to evaluate the effectiveness of gamification in requirements engineering in order to improve stakeholder engagement. We developed an online digital platform for scenario-based RE supported with gamification. Derived from an in-depth literature study, we selected user stories complemented with scenarios from behavior-driven development (BDD) as a method to express stakeholder requirements. Points, badges and leaderboards (PBL) are very common game elements in terms of gamification and are used as a starting point for the gamified platform. In total, the RE eliciation system consists of 17 different game mechanics and elements, which intension is to positively affect intrinsic and extrinsic stakeholder motivation. Subsequently, the gamified platform is tested in a controlled experiment. The findings demonstrate that it is possible to effectively change stakeholder's behavior with gamification. Stakeholders who are influenced by gamification produce more requirements, with better quality and more creativity. The majority of their user stories consist of attractive requirements that enhance customer satisfaction. Derived from the results we agree that competitive game elements are advantageous for RE elicitation to mitigate collaboration and therefore, prevent production blocking. In sharp contrast, social game elements are favorable for RE analysis, specification and validation where cooperation is demanded.

Keywords: Gamification, Scenarios, User Stories, Engagement, Experiment, Motivation, Performance, Requirements Engineering

1 Introduction

Although requirements engineering (RE) can be seen as an insurance for software development [33], many IT projects nowadays still fail to deliver on time, within cost or expected scope [4]. Reasons for project failures are wrong, unsatisfied or unmet requirements, often caused by poor collaboration and communication. The lack of stakeholder participation in RE workshops and review meetings are further considerable reasons why software projects are never completed [21]. The aim of this paper is to improve quality and increase creativity of requirements by enhancing active participation of stakeholders in requirements

elicitation workshops. A possible mean to achieve this objective is with the support of gamification. Gamification is "the use of game mechanics and experience design to digitally engage and motivate people to achieve their goals" [3]. It has the potential to increase customer loyalty, enhance employee engagement, and reinforce stakeholder participation.

In our research gamification is used for scenario-based RE to allow stakeholders express their goals. Scenarios are narrative descriptions of how actors will interact with the system [15]. While stakeholders frequently have problems expressing their needs, scenarios are comfortable to tell stories with real life examples rather than abstract concepts. To measure the effectiveness of gamification in scenario-based RE an online digital platform for requirements elicitation was developed together with a conceptual framework. The gamified platform was then tested in a controlled experiment with two equal balanced groups of stakeholders. Finally, the results between the two experimental groups are quantitatively and qualitatively analyzed and thoroughly discussed.

2 Related Work

First, we explain the concept of scenario-based RE, followed by an introduction of gamification. Furthermore, we illustrate two research projects where gamification has been successfully applied to requirements engineering.

2.1 Scenario-Based RE

In requirements engineering scenarios are described as "an ordered set of interactions between partners, usually between a system and a set of actors external to the system" [15]. Scenarios can take many forms and provide various types of information on different abstraction levels. The specification spectrum can vary between informal descriptions to more formal representation. They can be expressed in natural language, diagrams, pictures, wireframes, mockups, storyboards, prototypes, customer journeys, and many other formats [38]. The selection of the appropriate scenario technique is influenced by factors such as *acceptance*, *notation skills*, *specification level*, *type of system*, *complexity*, *consistency*, and *unambiguity* [33].

User Stories. After weighting different techniques, we decided to select user stories as a documentation technique, because of their simplicity and comprehensibility. They are easy to learn and can be also applied by stakeholders without any notation oder modelling skills. Furthermore, user stories stimulate collaboration and facilitate planning, estimation and prioritization. Cohn [6] suggested to use the following tripartite structure when documenting user stories:

As a [**role**] I want to [**goal**] so that I can [**benefit**] [11]

Goal defines a feature to be implemented, *benefit* is the value that will be returned, and *role* defines a person who will directly benefit from the feature.

Personas also play an important role in the discovery of new user stories. A persona is a fictional character that represents roles and characteristics of product end-users [8]. While user stories tell what user do, personas tell who the users are.

Scenarios. Acceptance criteria complement user stories and determine when a story is complete. They are a set of statements that specify how the system should behave to meet user expectations [6]. An approach used in behavior-driven development (BDD) to write plausible acceptance criteria was introduced by Dan North in form of scenarios [5]. He provided a template to define the scope of a user story by determining which conditions must be satisfied. The syntax for writing scenarios is structured as follow:

Given [**context**], when [**event**], then [**outcome**] [5]

Quality of User Stories. INVEST is an acronym with six attributes to evaluate the quality of a user story [39]. The model identifies how well the characteristics *Independent*, *Negotiable*, *Valuable*, *Estimable*, *Small*, and *Testable* are satisfied in a user story.

The perceived product quality from a customer perspective can be identified with the Kano model. Kano is useful in RE to determine how satisfied or dissatisfied end-users will be with the presence or absence of a system feature [20]. Although initially developed for marketing, Kano can be utilized in agile methodologies for product backlog prioritization. The priority is determined by answering *functional* and *dysfunctional* questions [7].

2.2 Gamification

The principles behind gamification have existed for decades, but the term itself became mainstream only since 2010 with its initial definition of "the application of game-design elements in non-gaming contexts" [13]. The reason why gamification has become so popular in recent years is due to the fact that games have a strong pull factor [23]. Games affect positive emotions, relieve stress, create stronger social relationships, give a sense of accomplishment, and improve cognitive skills [16]. With gamification the advantages of games are applied to existing business contexts in order to increase success metrics [43].

Game Elements. The classic triad of elements in gamification includes *points*, *badges*, and *leaderboards* (PBL). Many platforms use these components because of their operational effectiveness and implementability [41]. Points are tangible and measurable evidence of accomplishment. Badges are a visual representation of achievements; and leaderboards allow players to compare themselves on a

highscore list. Next to PBL, a great variety of other game elements and mechanics exist, for instance, *levels*, *storytelling*, *chance*, *goals*, *feedback*, *rewards*, *progress*, *challenge*, *avatar*, and *status* [17]. These dynamics, mechanics and components allow for a compelling user experience and leverage motivation. [12]. To better understand the effects of gamification on player's behavior, a closer look at motivation and engagement is required.

Motivation. Motivation and engagment are two closely intertwined concepts that are much debated in literature. People have needs that motivate them to take action in order to satisfy their desires. The Maslow pyramid is one of the earliest theories describing people's needs [24]. Based on various research studies, Steven Reiss identified 16 basic desires that guide human behavior [31]. Self-Determination Theory (SDT) is concerned with people's inherent tendencies to be self-determined and self-motivated, without the external interference [11]. Furthermore, SDT distinguishes between intrinsic and extrinsic motivation [34]. People are intrinsically motivated when they do something because they like to do it or find it interesting, whereas extrinsically motivated people do something for external rewards or to avoid negative consequences. Flow is also considered to be a motivating force for excellence. Individuals experiencing flow are more motivated to carry out further activities [9]. Optimal flow is obtained with progression stairs, whereas engagement loops are responsible to keep players motivated by providing constant feedback [41].

Engagement. Engagement has the potential to leverage performance by motivating people to take certain actions. User engagement in information science covers the study of people's experience with technology [27]. The term is an abstract concept and closely related to theories of *flow*, *aesthetic* and *play*. In literature user engagement is defined as "the emotional, cognitive and behavioral connection that exists, at any point in time and possibly over time, between a user and a resource" [2]. Therefore, engaged people not only better accomplish their personal goals, but are also physically, cognitively and emotionally closer connected to their endeavors [19].

2.3 Gamification in Requirements Engineering

During our literature review we encountered two studies examining the impact of gamification in RE [14][35]. Both research studies developed a tool to increase stakeholder engagement and evaluated it in a case study format. The former study, called *iThink*, uses the *six thinking hats* [10] to stimulate parallel thinking and increase group discussion. The latter study, called RE*fine* was developed for crowd-centric RE (CCRE) [36] where internal and external stakeholders can participate. In both case studies stakeholders felt more motivated and participation rate in the requirements elicitation process was increased.

Despite the novelty of these two studies, there are still some limitations. First, the researchers only evaluated their tool in the context of a case study, making

it difficult to generalize the results [42]. Furthermore, the impact of alternative causes, such as usability, design, and stakeholders' background were omitted in both studies.

3 Conceptual Framework

Derived from the theory of gamification, engagement and performance, a conceptual framework was constructed for requirements engineering. The relationships between these three concepts are depicted in a conceptual model visualized in Fig. 1. The model consists of three main abstract variables with two relationships. Furthermore, two control variables were introduced to mitigate threats to internal validity. These two are stakeholder expertise and motivation. For user engagement three sub-dimensions were defined emotions, cognition and behavior [2]. Performance was further sub-divided into productivity, quality and creativity [22].

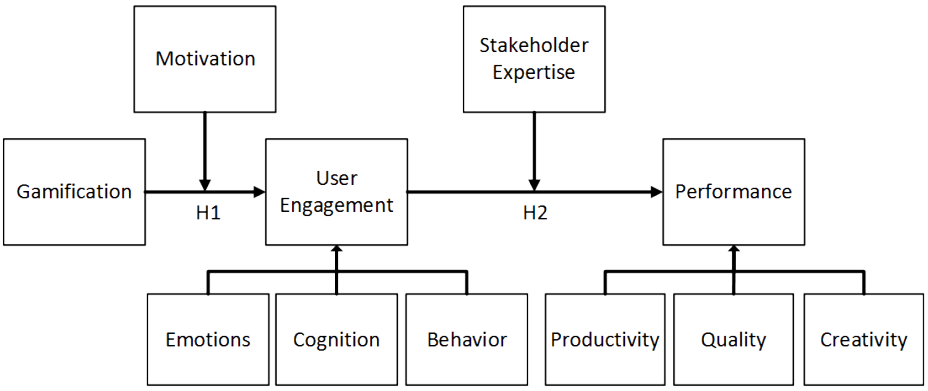

Fig. 1. Conceptual Model

The gamified RE platform consists of 17 game elements and is measured with a dichotomous variable by dividing a sample size into two equal balanced groups. Stakeholder expertise is measured with a pretest questionnaire, and motivation with the Reiss profile test [30]. Emotions are reported with the Positive and Negative Affect Schedule (PANAS) [40]. Since gamification is expected to provoke positive emotions, we only consider Positive Affect (PA). The Flow Short Scale (FSS) [32] is responsible to report cognition, and behavior is measured with background analytics provided by the content management system (CMS).

Productivity is calculated with the number of produced requirements over time. Quality of requirements is evaluated with the INVEST [39] and Kano model [20]. Finally, creativity of user stories is determined with expert opinions on a 5-point Likert scale (1 = definitely not novel, 5 = definitely novel).

Based on this conceptual model the following two hypotheses are defined:

H1. If a diversified gamification RE platform is deployed in alignment with stakeholder motivation, then user engagement is significantly increased.

H2. If stakeholders are more engaged in requirements engineering with respect to their expertise, then the overall performance of the process and outcomes is significantly increased.

4 Artifact Design

To ensure that stakeholder engagement is caused by gamification, an online platform for RE was developed. Wordpress was used as a CMS because of the large number of plug-ins released by independent developers [28]. The blogging feature from Wordpress was adapted to the user story template, and scenarios from BDD can be submitted via the comment field. Furthermore, the platform includes personas from which perspectives stakeholders have to identify requirements. Furthermore, a chat is included to facilitate stakeholder collaboration.

A core plugin implemented is the gamification API from 'Captain Up' [1]. This engagement system was selected because it comes out of the box with a variety of game elements with a reasonable price. Captain Up is a web interface that turns any website into a game like experience. Basic game elements that come out of the box include PBL, levels, challenges and activity feeds. Actions on the website can be individually defined and rewarded with points and badges. For instance, submitting a user story is rewarded with *30 points* and adding a scenario with *10 points*. After writing 3 user stories a '*User Story Writer*' badge plus *90 bonus points* are credited to the user's account. Based on collected points, players can level up and compare their rank on a highscore list. The primary goal of the gamification API is to allow players to seek for mastery with a progression stair and keep them actively engaged with a positive reinforcement cycle [41]. A front-end screenshot of the graphical user interface is shown in Fig. 2

Additional game elements were added to the gamified platform to enhance user experience. A complete list of elements is captured in Table 1. The purpose of this broad selection is to affect several human needs. While leaderboards satisfy people with desire for status and power, storytelling is more suitable for people with a demand for curiosity [29]. In total, the intervention given to the control group consists of 17 game elements, which were omitted in the platform used by the control group.

5 Experiment

After completion of the RE platform, we investigated the effect of gamification on user engagement and performance in an offline laboratory setting. The aim of the experiment is to measure the response of the intervention that was given to the treatment group by means fo an ex-post test. The experiment was conducted

Table 1. Game elements implemented for the gamified platform

Game Element	**Description**	**Affected Motivation [30][29]**
Points	Basis to reward users for their activities.	Order, Status, Saving
Badges	Visualizations of achievements to give a certain surprise effect.	Power, Order, Saving
Leaderboard	A ranking that shows all players in an order from top-down.	Power, Order, Status
Levels	Different phases of difficulty in a game to enable linear progression.	Order, Independence, Status
Challenges	Steps towards a goal, which are rewarded with badges and points.	Curiosity, Independence, Power
Activity feed	A stream of recent actions in the community.	Power, Order, Status
Avatar	A graphical representation of the player that can be selected.	Power, Independence, Status
Onboarding	The process of getting familiar with the platform	Curiosity, Independence, Tranquility
Game master	A moderator to interact with players and answer questions.	Curiosity, Social Contact, Status
Storytelling	A background narrative to arouse positive emotions.	Curiosity, Independence, Tranquility
Video	A visual and audio media to user stories and the business case.	Curiosity, Order, Tranquility
Facial animation	Motion and audio-driven characters to present personas.	Curiosity, Order, Tranquility
Progress bar	A status bar to show a current state of the player in a process.	Order, Tranquility
Quiz	A test to let players check their new acquired knowledge.	Curiosity, Independence, Order
Timer	A clock to show remaining time and to generate a sense of pressure.	Order, Tranquility
Liking	A feature where users can support certain content.	Power, Status, Vengeance
Prize	A physical award given to the winner of the game	Power, Independence, Status

at an IT consultancy company in Munich and included 12 potential stakeholders. Participants were divided into two equal balanced groups with consideration to motivation and expertise. Before the experiment, all test persons were simultaneously briefed and provided with a real business case. The company is currently lacking an efficient *video conferencing system* (VCS) for corporate team meetings. This problem was selected to have stakeholders gather user requirements that serve as a check list to compare existing VCS solutions. Both groups were given a time range of two hours to fill an initial VCS backlog with user stories together as a team.

To avoid interferences between the experimental groups, participants were told that they are working on two separate and independent cases. Furthermore, the impression was given that the intention behind the experiment was to test online requirements engineering and that communication is only allowed within the team via the chat feature. The investigation of gamification was never mentioned.

5.1 Results

The operation of the experiment went smoothly with some issues facing the treatment group. There was a participant drop-out after 10 minutes, leaving the group with only 5 stakeholders. The data from this participant was omitted for the analysis. Moreover, the average page load time of 2.15 seconds slightly exceeded the tolerable value of 2 seconds [26]. The control group experienced an average waiting time of .46 seconds. The lagging was presumably caused by the gamification API.

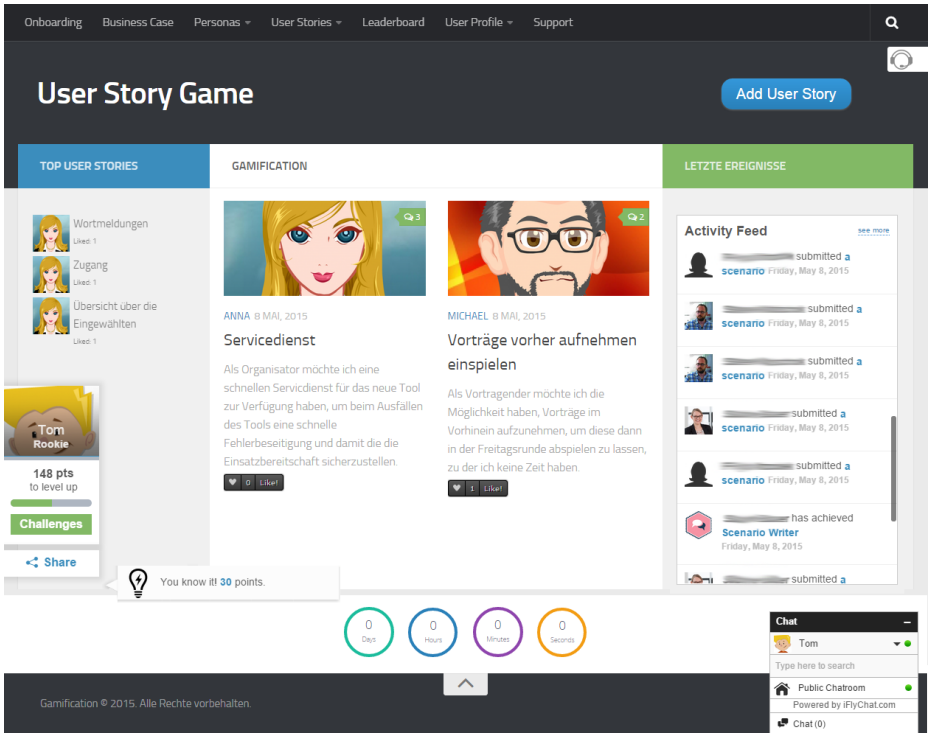

Fig. 2. A screenshot of the graphical user interface with two user stories

The following sections present the aggregated findings from the experiment, which were statistically analyzed in SPSS. Data to assess quality and creativity were further evaluated with Scrum experts and potential end-users.

User Engagement

Emotions. Users interacting with the gamified platform did not report higher positive emotions (PA) (M = 36.8, SD = 4.025) than did the control group (M = 37.0, SD = 4.0), $t(9)$ = -.082, $p < .05$. The average PA score in percentage per participant is shown in Fig. 3.

Cognition. The treatment group experienced slightly more flow (M = 50.4, SD = 7.635) compared to the control group (M = 43.333, SD = 5.645). However, this difference was not statistical significant ($t(9)$ = 1.767, $p > .05$). The mean differences between the groups are illustrated in percentage in Fig. 3

Behavior. Participants interacting with the gamification platform caused more page visits (M = 161.0, SD = 40.367) than did the control group (M = 88.833,

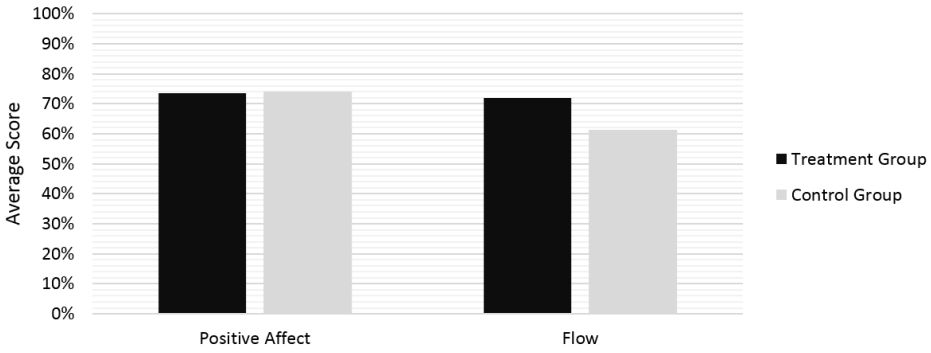

Fig. 3. Mean emotions and cognition in %

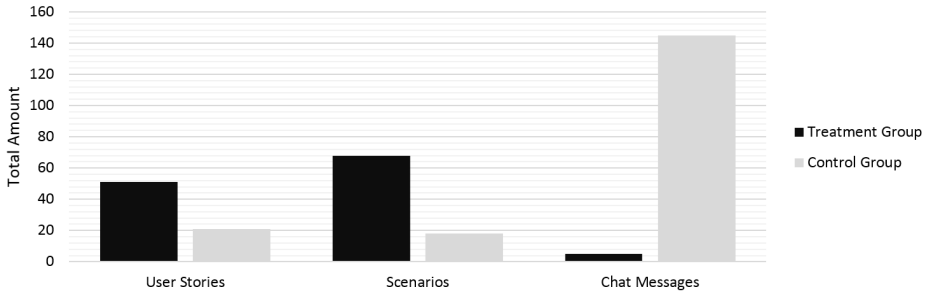

Fig. 4. Total number of user stories, scenarios and chat messages produced over time

$SD = 38.338$), $t(9) = 3.036$, $p < .05$. In sharp contrast, the control group wrote more text messages ($M = 24.167$, $SD = 1.732$) compared to the treatment group ($M = 1.0$, $SD = 1.732$), $t(9) = -2.65$, $p < .05$). The total amount of written messages is shown in Fig. 4.

Performance

Productivity. The average amount of provided user stories within the treatment group ($M = 10.0$, $SD = 2.345$) was much higher than those of the control group ($M = 3.5$, $SD = 2.258$), $t(9) = 4.673$, $p < .05$. A significant difference was also identified in the total number of submitted scenarios between the treatment group ($M = 13.4$, $SD = 5.727$) and the control group ($M = 3.0$, $SD = 3.847$), $t(9) = 3.597$, $p < .05$. The total amount of produced user stories and scenarios per group can be found in Fig. 4.

Quality. For the quality aspect, the requirements were categorically sampled and evaluated by five qualified Scrum experts (between 1 to 9 years of experience)

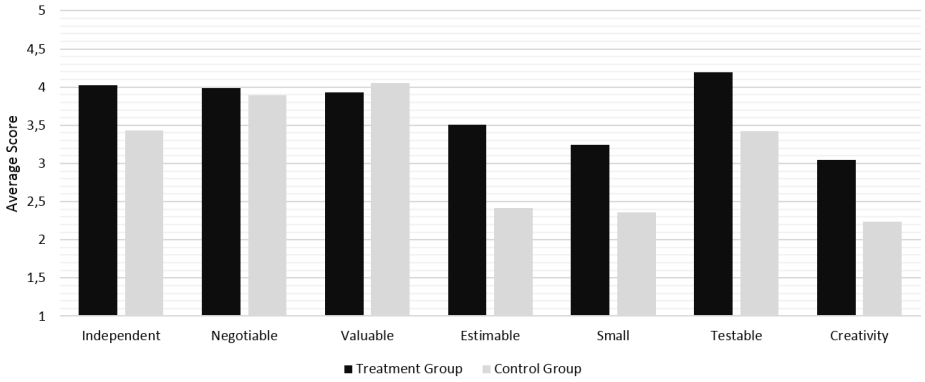

Fig. 5. INVEST and creativity scores that were rated by Scrum experts

with the INVEST model [39]. User stories of the treatment group (M = 4,022, SD = .95) were more independent (I) than those of the control group (M = 3.436, SD = 1.302), $t(78.481) = 3.025$, $p < .05$. User stories gathered by the treatment group (M = 3.504, SD = 1.177) enabled for better estimations (E) compared to those of the control group (M = 2.418, SD = 1.213), $t(188) = 5.714$, $p < .001$. In addition, user stories of the treatment group (M = 3.244, SD = 1.187) were smaller (S) than those of the control group (M = 2.364, SD = 1.007), $t(188)$ = 4.837, p < .001. Finally, user stories written by the treatment group ()*(M* = 4.193, SD = 1.04) were better testable (T) than those of the control group (M = 3.418, SD = 1.37), $t(80.546) = 3.772$, $p < .001$. Negotiable (N) and valuable (V) did not report any significant differences. The average quality score for each characteristic is presented in Fig. 5.

To determine customer satisfaction and dissatisfaction, the Kano questionnaire [20] was answered by 13 internal employees. The results from Fig. 6 indicate that nearly half of the requirements within the treatment group were categorized as attractive requirements. Must-be requirements account for one third, and indifferent requirements for approximately a quarter of all user stories. On the other hand, most of the requirements in the control group were prioritized as must-be requirements, followed by a few attractive and indifferent requirements. Performance requirements were absent in both backlogs.

Creativity. Creativity was also rated by the Scrum experts and was higher as well for the treatment group (M = 3.044, SD = 1.085) than the control group (M = 2.236, SD = .922), $t(188) = 4.853$, $p < .001$. The average creativity score per group is shown in Fig. 5. Furthermore, creativity strongly correlated with the Kano categories, $r(11) = .654$, $p < .001$. Higher creative requirements were more likely to be classified as attractive or indifferent, whereas requirements with low creativity score were classified as must-be.

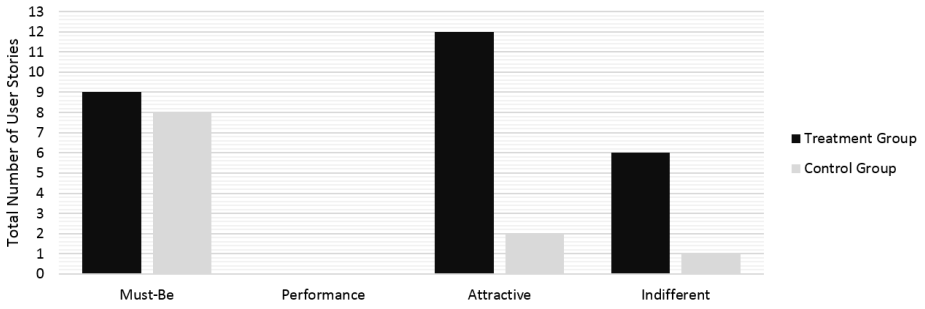

Fig. 6. Total number of user stories per Kano category

5.2 Hypothesis Evaluation

Emotions and cognition did not exhibit any statistical differences between the two experimental conditions, whereas behavior apparently did. While stakeholders exposed to gamification were active with requirements production, the comparison group was primarily communicating together during the operational phase. Therefore, it is not possible to reject the null hypothesis for H1, because user engagement rate was high in both groups during the requirements elicitation process.

The statistical results that were used to measure our second hypothesis support our theory derived from literature. Findings from both experimental groups reported significant variations in all sub-dimensions of the performance concept. Not only did the treatment group gather more user stories, but their quality and creativity was higher too. Performance was indirectly impacted by gamification, which caused a change in the behavioral dimension. Consequently, our second hypothesis provides evidence to be true and therefore, we rejected the null hypothesis for H2.

6 Conclusion

The results from the experiment show that the two groups exhibited completely different behaviors while interacting with the platform. Despite the same instructions given at the beginning to all subjects, this behavioral difference had a substantial impact on the outcome and quality of the trial. The group who was exposed to various game elements not only gathered more user stories and scenarios, but the quality of their proposed requirements was higher too. Most user stories of this group were categorized as attractive requirements, which have great impact on customer satisfaction. Moreover, this group undisputedly outperformed the control group in the creativity dimension as well. While this group identified many attractive requirements, it was a logical sense that these were also more novel.

This research project was able to demonstrate that gamification has the ability to influence human behavior to achieve a desired output. The success however, highly depends on the choice of game mechanics and game elements, as they can affect different psychological needs. The experimental findings show that an individual leaderboard incentivizes competition and turns team players into rivals in a positive manner. A competitive environment led to increased requirements production with higher quality and more creative ideas.

Based on the results from our experiment we conclude that simulating competition with gamification can be supportive to gather basic and novel requirements. In requirements elicitation workshops less communication might be an advantage, most notably when the process requires creative thinking. We have seen that too much verbal communication can cause production blocking and therefore, inhibit creativity. The intensive discussion in the control group probably absorbed people's attention. We support this statement with the cognitive theory of idea generation [37].

However, individual leaderboards or activity feeds might not always be the right choice. They should be avoided in other RE phases where success relies on team work. In later stages of the development process, it might be beneficial to apply more cooperative game elements for the analysis, specification and validation of requirements. Hereby, social game mechanics and elements, such as team leaderboards or team challenges are possible means to stimulate cooperation and collaboration between stakeholders. [41]. This statement is based on assumptions and not supported with empirical evidence.

In summary, we conclude that the setup of gamification for RE highly depends on the engineering activities and desired performance results. Based on our initial goal, we were able to demonstrate that stakeholder engagement can be enhanced with competitive game elements at an initial phase of RE where creative thinking is demanded. In later stages of the RE process, it might be wise to implement a more social gamification environment to facilitate team work.

6.1 Limitations

The small sample size and lack of probability sampling prevented us from making generalizations about the population we studied. The feedback from the pilot phase had shown that it can get confusing to keep track of user stories when too many people are involved. This prompted us to keep the group sizes rather small. Moreover, because the research project was conducted within a software engineering company, we were bound to the available resources. Interested employees that were willing to invest their time on voluntary basis were asked to take part in the experiment.

Next, the total game time of two hours in the experiment inhibited us to draw conclusion about the long-term effect of gamification. Extrinsic rewards have shown to be effective in the short-term, but their long-term consequences remain unknown. Aside from that, the composition of our gamified system was evaluated as a holistic framework, making it impossible to predict the impact size of the individual game elements on players' behavior.

Finally, we were aware that many of the participants Reiss profile results had mean values around the center. This means that the basic desires depend upon the context of a particular situation and would have required an in-depth analysis in a face-to-face meeting with the participants [31].

6.2 Future Research

In the context of our work, we recommend future research to run several more experiments to better generalize the results to the requirements engineering discipline. First of all, the experiment should be executed again, but with the removal of the chat function. This would prevent the control group from being socially engaged and presumably decrease production blocking [37].

Next, it would be valuable to conduct trials with different sample sizes and game elements. Game mechanics and elements should be tested in isolation and in partial combinations to measure their influential impacts on motivation and behavior. Mekler et al. [25] have already opened a door in this direction by conducting experiments with points, levels and leaderboards.

Furthermore, we propose to test the gamification platform in a software engineering project over several days or weeks to detect long-term trends with respect to user engagement.

Emotions and cognition should also be measured at different stages in the experiment. For instance, the FSS and PANAS questionnaires should be answered after the onboarding program, then at half time and once again at the end of the experiment. This would allow to show a trend line of how players are emotionally and cognitively engaged over time.

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