Entertainment Computing 5 (2014) 335–345

Contents lists available at ScienceDirect

Entertainment Computing

journal homepage: ees.elsevier.com/entcom

Gamifying requirement elicitation: Practical implications and outcomes in improving stakeholders collaboration ☆

Claudia Ribeiro [a,*], Carla Farinha [b], João Pereira [a], Miguel Mira da Silva [a]

[a] INESC-ID, Department of Information Systems and Computer Science, Technical University of Lisbon, Rua Alves Redol 9, Lisbon, Portugal
[b] Opensoft, Lisbon, Portugal

ARTICLE INFO

Article history:
Received 30 May 2013
Revised 11 February 2014
Accepted 1 April 2014
Available online 11 July 2014

Keywords:
Requirements elicitation
Cooperation
Collaboration
Communication
Six Thinking Hats
Gamification

ABSTRACT

The requirements engineering process is a key phase of the Information System development since it determines its functionalities and its operation. Before requirements can be analyzed, modeled, or specified they must be gathered through an elicitation process. Requirements elicitation is non-trivial because you can never be sure you get all requirements from the user or stakeholder by just asking them what the system should do. Requirements elicitation practices include interviews, questionnaires, user observation, workshops, brainstorming, use cases, role playing and prototyping. However, these common procedures are still prone to be ambiguous or incorrect which can lead the Information Systems to failure. It is consensual that one of the major problem of this activity relates to the communication and collaboration between different and distant stakeholders. Thus, recent studies have been proposing web collaborative tools to gather these stakeholders in order to elicit requirements. The paper aims to evaluate the effectiveness and acceptance of such a collaborative tool which was developed by using a gamification approach and the Six Thinking Hats method. The document also makes a discussion of the implication and outcomes of improving stakeholders collaboration.

1. Introduction

Today we live in an Information Age where people rely on computers and technology to work, socialize or live [1,2]. This technology quite often comes to us through Information Systems. Building such systems is usually a complex and difficult task, demanding a significant effort on planning and managing their development process. Therefore, system designers and developers use the System Development Life Cycle (SDLC) framework which breaks down the development process into a pipeline of activities. Several SDLC models have been created (waterfall, fountain, rapid prototyping, incremental, etc.) but all of them have the requirements elicitation activity as the earliest stage in the pipeline. Before requirements can be analyzed, modeled, or specified they must be gathered through an elicitation process. The aim here is to understand and define how the system will operate [4]. Requirements elicitation is based on an intense communication between stakeholders and between stakeholders and analysts. Therefore, cooperation and collaboration are vital in this process [5]. Requirements elicitation is non-trivial because you can never be sure you get all requirements from the user or stakeholder by just asking them what the system should do. Several studies have been conducted with the goal of edifying common limitations in this process, mainly aiming at understanding the role of communication, collaboration and cooperation between stakeholders. Nevertheless, despite of the research efforts, it still remains unclear how to overcome limitations that can account for 60–70% of projects that fail to deliver on time, on cost and with the scope originally promised [3], costing around 80–100 times more if discovered at the implementation stage and are very hard to fix [4].

Since communication is critical, requirement elicitation tools must ease this communication between stakeholders in order to articulate their needs collaboratively, allowing their meetings even at a different time and place to discuss those needs. In this context, game-based tools can bring numerous benefits to this process since they typically provide immediate feedback, active participation and the high motivation promoted by the competitive environment [5–7].

Recent research as proved the benefits of adding game mechanics to common tasks outside the traditional video games environments [8], including motivational benefits to participate in online communities. This approach is commonly referred in the literature

☆ This paper has been recommended for acceptance by Matthias Rauterberg.

* Corresponding author.
E-mail address: claudia.sofia.ribeiro@gmail.com (C. Ribeiro).

http://dx.doi.org/10.1016/j.entcom.2014.04.002
1875-9521/

as "gamification", a concept that is already used in numerous applications ranging across productivity, finance, health, education, sustainability, as well as news and entertainment media [9].

The paper aims to evaluate the effectiveness and acceptance of iThink system [13], a RE tool, which was developed by using a gamification approach and the Six Thinking Hats method. The document also makes a discussion of the implication and outcomes of improving stakeholders collaboration. The evaluation was based on Action Research in real world organizations: Action Research allowed us contributing with practical actions on the organization and generating knowledge about its context on the real world situations. We performed two Action Research cycles: we studied the problematic situation of the first environment, applied an action, evaluated the results and extracted lessons learnt. In the second cycle we also studied the situation taking into account the lessons learnt from the first cycle, applied an action with iThink, evaluated the results and extracted other lessons [10,11].

2. Requirements elicitation

As stated by Avison and Fitzgerald [4], "the definition of requirements can be problematic, but in relation to information systems, it can be said to be everything that the set of relevant stakeholders want from a system". Requirements are, indeed, the key information in Information Systems Development: they translate stakeholders' needs, determining what and how the Information System will operate [12,13].

Despite many years of computing and research efforts in the requirements elicitation field, this activity is still not well understood. Errors still happen on the requirements elicitation activity and still represent major causes for the failure or even the suspension of the entire information system project [12,13].

2.1. Ineffectiveness

Many authors have been studying the reasons of the ineffectiveness of requirements elicitation activity. For example, Avison and Fitzgerald [4] stated that analysts may not identify all the relevant stakeholders and just capture requirements from a small set of users, raising costly fixes when the time comes to identify forgotten requirements. They also state that stakeholders' time constraints to participate in the elicitation activity promote missed requirements. Finally, they refer that analysts misinterpret requirements because of the culture "gap" or may miss requirements leaving the specification incomplete.

Zowghi and Coulin [13] categorized issues and pitfalls in the requirements elicitation activity based on their revision of the literature and their empirical experience. Their categories of issues were particularity and uniqueness of process and project; complex communication between stakeholders and analysts; quality of identified requirements; conflicts of interests; and experience of the analyst.

Davey and Cope [12] enumerated quite a few problems with requirements, including incomplete, ambiguous, incorrect, excessive and inconsistent requirements. Also, they suggested other problems such as poor users' collaboration, unnecessary design considerations, different views of different users or continuous acceptance of additional requirements.

Resuming, practitioners consider requirements as main reasons for project failures. Within this field of study, there are numerous authors that believe that problems begin with the complex and intense communication between disparate communities involved in the requirements elicitation activity [14,15]. On the one hand, stakeholders do not always know what they want or how to articulate their needs. On the other hand, analysts may not entirely understand business concepts, misinterpreting required needs [4].

2.2. Trends from social sciences

Requirements elicitation is based on communication. As such, the social nature of this activity is undeniable [16]. Previous works, have tried to address the ineffectiveness of requirements elicitation activity that result form this social nature as described in the previous section. Namely, recent trends have been studying and using a range of methods derived from social sciences in order to increase chances of success of requirements elicitation. These methods include: ethnography, interviews and domain group work [13]. Ethnography focuses the observation of people in their natural environment, translating stakeholders' activities and interactions. Some researchers claim that ethnography may have satisfactory results eliciting requirements [17]. Nevertheless, several limitations were also recognized, such as risk of incorrect interpretations, impossibility of identifying new requirements or difficulty of generalizing results [18,17,13]. Interviewing is an informal interaction where analysts explore needs asking stakeholders about the system in use and the system to be [13]. Well-known limitations of interviewing are the limited stimulus–response interaction and the need of participants to share basic concepts and methods [16].

Group work gathers stakeholders to collaborate reaching solutions about an identified problematic situation. Groups are particularly effective because they involve and commit the stakeholders directly and promote cooperation [13]. Examples of such methods are JAD, Creativity workshops or Focus Groups. JAD (Joint Application Development) aims to quickly determine system requirements for an Information System. Stakeholders elicit these requirements through structured and focused discussion sessions about business needs [19]. Nevertheless, Coughlan [15] presented two studies about the practical usage of JAD and criticized the need for a user–analyst interaction that is excessively rigid or the important role of the moderator to keep the session focused on the final product solution. Creativity workshops, based on the Creative Problem Solving of Alex Osborn and Sidney Parnes, encourage creative thinking to discover and invent system requirements [20]. Pennell and Maiden [21] report results and lessons learned from two experiences with creativity workshops. They concluded that this creative thinking must be prepared and incubated in order to truly succeeded. Focus Group is a group-based discussion to obtain feedback from participants on a particular topic. In order to be effective on the discussion, the group has special characteristics: homogeneous regarding key topics, focused on key topics but open to communicate freely [22]. Farinha and Mira da Silva [23,24] applied regular and web-based Focus Groups on real environments to evaluate the success of this method eliciting requirements for the development of Information Systems' projects. The results confirmed that stakeholders effectively discussed different perspectives about the desired system and cooperated in order to formalize requirements. However, some limitations were also pointed out such as the dominance of particular users, or the complexity of analysis or time-consuming on the regular Focus Groups, or the lack of stakeholders' participation on the web-based Focus Groups.

In sum, methods derived from social sciences have address some of inefficiencies inherent to requirement elicitation activity. Nevertheless, every method has its own strengths and weakness, as described previously. Typical weaknesses include dominant participants, biased opinions, high logistic costs and difficulties on gathering stakeholders at the same time and place [13]. Collaboration tools have tried to address these weaknesses as explained next.

2.3. Collaboration tools

Recognizing the importance of collaborative work and the huge difficulty of gathering stakeholders at the same time and place, researches have been proposing web collaborative tools to elicit requirements [25]. Such tools include variations of the WinWin spiral model, Athena, variations of wikis, iRequire, AnnotatePro or Stakesource [26]. For example, the CoREA method (Collaborative Requirements Elicitation and Analysis), based on the win–win spiral model, is a geographically distributed environment. It includes decision support for analysing and selecting requirements. Athena is a collaborative approach supported by a tool to elicit requirements based on group storytelling. The stories are merged in a single story, transformed into scenarios and translated into use cases. Wikis were also widely studied to deal with distributed stakeholders, easing communication and increasing the participation of all stakeholders. This collaborative tool allows spatially distributed stakeholders to add, remove, and amend content on a common platform. There are several proposals based on wikis, such as WikiWinWin [27], SoftWiki [28], SmartWiki [29] or ShyWiki [30]. AnnotatePro [31] obtains requirements by drawing annotations directly on the users screen and using snapshots in combination with ordinary picture editing functionality. The snapshots may easily be sent to the software engineers by email. iRequire [32] is a tool for mobile phones and enables users to blog their requirements whenever their need is triggered. The main features of iRequire are the possibility to take a picture of the environment, document a user need, describe the main task and provide a rationale, and check the summary of a need. Stakesource 2.0 [26] is a web application using standard technologies that uses social networks and collaborative filtering, a crowd sourcing approach, to identify and prioritize stakeholders and their requirements. Stakeholders can invite other stakeholders to participate, suggest and rate requirements.

In Table 1 the weaknesses of the previously listed collaboration tools are summarized. Although several research efforts have been made towards methods and tools to better support requirements elicitation this activity still generates 55% of computer systems' troubles, leading to 82% of the efforts devoted to correcting mistakes [14]. Therefore, eliciting requirements is still complex, critical and leads to low quality requirements that compromise the success of Information System projects.

3. Gamification

Serious games and virtual-based environments are an important response from the technologist to the "digital natives" [36,37], a generation who were raised on interactive games and expect the same kind of interactive experiences in every information system. Indeed, it may not be entirely correct to call the use of serious games a novelty, since by nature young children begin to gain interest in several topics through games during their earlier years [38].

The field of business is not an exception in the permeation of these kind of approaches. A great number of different business games and game-based tools have been developed [39] and used in management training by different business schools, faculties and enterprises all over the world [40–42]. Most of these games seek to engage and delight players through their content, but the development and design of such content is costly and this imposes several restrictions on their use and development. Due to this, there has been an increasing interest in the "gamification" concept, through which is proposed that the main appeal of video-games are the game mechanics behind it and not necessarily its content [8]. Some of these mechanics, such as points and levels can be used outside the traditional video games environments and applied in common tasks leading to an increase of motivation and engagement and allowing the development of gamified tools at a lower cost when comparing to the development of traditional video-games [43].

Table 1
Collaborative tools weaknesses.

Collaboration tool	Weaknesses
CoREA	Lacks evaluation in real-world projects [33]
Athena	Has usability issues; time consumed when compared to interviews or a group dynamics approach [34]
Wikis	Lacks the means to discuss conflicts among stakeholders [35]
AnnotatePro	Lacks a method following a well-structured plan, does not provides a formal notation language and does not allow tracking own submitted requirements [31]
iRequire	Lacks support for brainstorming, does not document well-defined requirements and the authors recognize that utility and usability studies are needed to improve the tool [32]
Stakesource	Lacks evaluation in real-world projects [26]

3.1. Origins and definitions

Gamification connects to a sizeable body of existing concepts and research in human–computer interaction and game studies, such as serious games, pervasive games, alternate reality games, or playful design [9]. Gamification as a term originated in the digital media industry. The first documented use of the "gamification concept" dates back to 2008 [44], but its widespread adoption only started around the second half of 2010. Parallel terms continue being used and new ones are still being introduced, such as "productivity games" [45], "surveillance entertainment" [46], "funware" [47], "playful design" [48], "behavioural game" [49] or "game layer" [50].

According to Brian Burke [51], gamification describes the broad trend of employing game mechanics to non-game environments such as innovation, marketing, training, employee performance, health and social change. Other vendors and/or consultants have described gamification practically and in terms of client benefits, such as: the adoption of game technology and game design methods outside of the games industry [52] and the process of using game thinking and game mechanics to solve problems and engage users [53]. Finally, Deterding et al. [9] have defined gamification as the use of game design elements in non-game contexts.

It has been reported that the goals of gamification are to achieve higher levels of engagement, change behaviors and stimulate innovation. Gartner [51] identified four principal means of driving engagement using gamification:

- Accelerated feedback cycles. In the real world, feedback loops are slow (e.g., annual performance appraisals) with long periods between milestones. Gamification increases the velocity of feedback loops to maintain engagement.
- Clear goals and rules of play. In the real world, where goals are fuzzy and rules selectively applied, gamification provides clear goals and well-defined rules of play to ensure players feel empowered to achieve goals.
- A compelling narrative. While real-world activities are rarely compelling, gamification builds a narrative that engages players to participate and achieve the goals of the activity.
- Tasks that are challenging but achievable. While there is no shortage of challenges in the real world, they tend to be large and long-term. Gamification provides many short-term, achievable goals to maintain engagement.

Its believed that this can be achieved by careful though out game mechanics. Game mechanics lie at the heart of gamification. For example, achievement levels, point tracking and bonuses are ways for desired activities to be recognized and rewarded. Leader boards and progression indicators can steer individuals to reach the next tier of performance. Quests and countdowns can help shape behavior the former as a way to structure long combinations of tasks for a larger goal; the latter to motivate a flurry of activity within a finite, specified time frame.

3.2. Gamification applications

"Gamification", as a concept is already used in numerous applications ranging across productivity, finance, health, education, sustainability, as well as news and entertainment media [9]. There has also been an increase in research covering various domains, where the combination of pervasive technology and game design has been explored as a means to motivate people in different aspects of their life [54]. Thom et al. discussed the introduction of points and rankings within a company-internal social network, concluding that removing such elements resulted in a drop of contributions and participations [55]. Lander et al. discussed the use of similar mechanisms for encouraging student to take non-mandatory quizzes concluding that these mechanisms increased substantially the student participation [56]. Some other authors have tried to identify design patterns that might afford joy of use under the term "funology", explicitly drawing inspiration from game design [57], this includes work detailing specific design features that afford player enjoyment [58].

In persuasive technology [59], video games and game aspects such as "gamification" have been studied as potential means to shape user behavior in directions intended by the system designer, or to instil embedded values. Social psychological studies on contributions to on-line communities or the motivational uses of recommender systems arrived at the conclusion that accords with core design properties of video games. Likewise, it suggests itself to model the reward and reputation systems of gamified applications with economically inspired approaches such as incentive centred design.

3.3. Benefits of gamifying requirements elicitation

As described previously, requirements elicitation is a complex process. This complexity occurs because of several factors that inhibit effective requirements elicitation, including contextual, human, economic, and educational factors [13]. These factors promote several difficulties, such as poor users' collaboration, incomplete domain knowledge, ambiguous requirements and incomplete understanding of needs to name only a few [12,60]. Also, requirements elicitation involves an intense communication between analysts and stakeholders of the system [61], demanding a high level of cooperation and collaboration [25]. Considering communication as an important factor for successful requirements elicitation implies that tools must also take this aspect into account by allowing stakeholders to express their needs collaboratively. In this context, gamification concepts may provide a potential solution to this process, by increasing collaboration and communication through engagement and motivation promoted by the competitive environment. Gamification has already been studied and proved effective improving user experience and engagement in several domains as described in previous sections. Therefore, gamification concepts, such as rewards, progress indicators and rankings, were use to develop an online game (iThink) in order to enhance and improve stakeholders collaboration and communication. The subsequence sections describe how gamification concepts were used to develop iThink.

4. Requirements elicitation with visualization techniques

Before our game-based studies, our previous web-based Focus Groups [23,24] were successful on eliciting requirements from distant stakeholders. Those Focus Groups promoted discussion towards relevant issues in order to formalize requirements for an outdated Information System. Moreover, all stakeholders could participate in this discussion and not only key stakeholders, which allowed being more confident on the results. Nevertheless, the participation rate was not satisfactory. Therefore, we evaluated the integration of visualization techniques in the requirements elicitation activity.

4.1. Foundation

Following the literature, visualization techniques have been proposed to overcome several problems related to these collaboration tools, including the perception of requirements and the discouragement to participate in these on-line communities. Visualization is defined as "the act of forming a mental vision, image, or picture of something (not visible or present to the sight, or of an abstraction) to make visible to the mind or imagination". Visualization is also a form of computing through the transformation of data into graphical representations to arouse consciousness and easier assimilation by an individual's sense of sigh [64].

Requirements engineering collects a great amount of information from different sources, both formal and informal, and among a variety of stakeholders. Visualization techniques can serve this rich environment of information to enhance communication and understanding relative to the essential properties from which software systems will be developed [65].

In the requirements field, visualizations are mainly focusing the analysis and specification phases of the requirements engineering process. For example, UML has been widely used to specify the elicited requirements. The requirements elicitation activity has received very few proposals, suggesting the use of tabular visualizations, quantitative visualizations of risks through charts, or modeling requirements through business processes. Requirements still tend to be written in a textual and narrative format [64].

Regarding collaboration, a community is useful and interesting only if many people are participating and contributing. The social comparison theory says that people tend to compare their achievements and actions with people who they think are similar to them in some way. Moreover, people are willing to make an effort to gain social reputation. As a result, visualization has been used to represent social aspects in on-line communities to stimulate participation and is called social visualization. This social visualization creates awareness of what is going on in the community by, for example, showing a representation of the contributions of the community members along these activities. Size is generally an intuitive representation of participation. They also suggest showing all users instead of just those on-line [35].

4.2. Visualization supported platform

We performed a web-based Focus Group supported by visualizations in order to overcome the low participation rate with both social visualizations and requirements visualizations. A custom platform had to be developed to integrate our desired features: possibility of asynchronous discussion, anonymity, written participation, voting system, requirements' visualizations, social visualizations. The requirements visualizations were charts to present

elicited requirements and top requirements (a bar chart with the most voted requirements; a bar chart with the most commented requirements; a bar chart with the last commented requirements; a treemap with the 2-level hierarchy of categories; a 3D tag cloud with all elicited requirements, distinguishing the most popular with a larger size and a motion chart illustrating the evolution of the number of votes and comments on requirements throughout time). The social visualization were based on charts to compare participants' activities and stimulate participation through competition: a bar chart to illustrate the most active participants and a bubble chart to provide social comparison according to the number of given comments and votes.

Stakeholders were asked to provide new requirements which included the title of the requirement, the description of the requirement to explain its purpose, the category to define its scope and username (optional). The elicited requirements could be regarded as a textual list; as a treemap that represented the categories as larger as the number of included requirements; as a 3D tag cloud that presented is a motion chart displaying all elicited requirements by their titles (the size and color of these titles are determined by the number of votes and comments); as a motion chart, exposing the growth of comments on requirements thorough time.

The platform included the social visualizations in the dashboard: a bubble chart that included a bubble per stakeholder (the size of every bubble represents the sum of the number of contributions, including new requirements, comments or votes). The field study was planned to discuss requirements for an incomplete Information System of a sports betting forum. This Information System did not support a registry of bets and was not able to extract results' reports. Seventeen moderators of the sports betting forum that were young IT savvy individuals were invited to participate and to enumerate desires or needs.

The Focus Group took place in the custom platform, configured following the previously enumerated features. Scheduling the Focus Group was easy since stakeholders did not have to meet on a specific time or space. During that time slot, they could express their ideas, discuss others' ideas or vote.

A report with the ordered list of elicited requirements was elaborated and delivered to the administrator so that he could evaluate those requirements and plan how to integrate them in an improved Information System. The stakeholders were finally asked to give some feedback about their participation.

4.3. Discussion

The discussion of perspectives was not intense: only seven from the seventeen invited stakeholders actually contributed in the discussion which was also short. As a result, the number of elicited requirements was low (3 new requirements, 4 votes, 2 comments).

The feedback from stakeholders showed that they enjoyed the requirements' visualizations. However, when asked about several features that would motivate their contribution, stakeholders diverged in their opinion. Social visualization and providing the collaboration tool as a game were almost consensual factors that would stimulate the participation of stakeholders. Surprisingly, rewards were not stimulating enough to encourage participation.

This web-based Focus Group introduced visualizations to ease perception of requirements and to stimulate stakeholders' participation. These problems were not overcame. Based on the results of this study, stakeholders' feedback claimed that their motivation could be increased with social visualizations or a discussion provided as a game, besides their natural interest in the project. Therefore, we intended to perform other studies with a game-based collaboration tool, maintaining the social visualization in order to encourage participation.

5. iThink

iThink is a web-based gamified environment designed for supporting collaborative requirement elicitation. By combining several game mechanics with the use of a creative thinking technique, called "The Six Thinking Hats" [62], it attempts to tackle the collaboration and user involvement problems previously described. iThink presents to the user, the requirement elicitation process as a game, through which the player is rewarded not only by the generations of new requirements, but also by the analysis of existing requirements using several perspectives. Therefore, iThink core goal is to create requirements by fostering user collaboration and not intended to encourage or stimulate creativity.

The following sections will present in detailed the iThink gamified environment, staring by describing the creative thinking technique following by the game design and its implementation.

5.1. The Six Thinking Hats

The Six Thinking Hats method has been developed by De Bono [63,62] as a way of supporting parallel thinking in different contexts such as: meetings, lectures, discussions and brainstorming sessions. This method structure the act of thinking into six different perspectives modeled as six different metaphorical hats represented by colors. During a meeting or a discussion, for example, each thinker can put or take of one of these hats to indicate the type of thinking that is being used.

The white hat focuses on facts and numbers and requests their exposure in a neutral and objective way. The main objective is to get facts without any additional opinions or the arguments that support those facts. The red hat worries about emotions and feelings opposing to focus on neutral information given by the white hat. Opinions given with the red hat do not need to be supported with justification or illustrate the reasons behind that opinion.

The black hat is related to negative judgements and why something may not work. Imperfections of design, risks and dangers related to a topic should also be identified with this hat. Positive thoughts are related to the yellow hat. It asks for optimism and the positive benefits of an idea opposing the black hat.

The green hat introduces creative thinking, focusing on new ideas and more alternatives. The finding of alternatives is a fundamental aspect of this hat that asks people to go beyond the well-known. Finally, the blue hat focuses on a global vision and on the problem definition. Conclusions are also taken while wearing the blue hat.

The several hats allows a detailed analysis over each topic separating the logic of the emotion or the creativity from the information. The guidelines and concepts provided by this thinking method can be easily related with "gamification" concepts previously discussed, allowing the creation of a game-based environment in which the use of the hats is related with the player score. Taking into account the current limitations of the requirement elicitation tools, we proposed to associate "gamification" with the Six Thinking Hats method, aiming at increasing user participation, engagement and collaboration in the requirement elicitation process.

5.2. Game design

Since we consider that elicitation consists not only in the discovery of new requirements but also in the discussion of the existent ones, we consider that the Six Thinking Hats method can be used in requirements elicitation process, being the basis for the definition of the several game mechanics.

The adaptation of the Six Thinking Hats method into the game mechanics requires some adjustments over the traditional method, taking into account the given context. Therefore each thinking hat was mapped into an activity in a elicitation process, carrying out these activities will contribute to obtain points generating new requirements and discussion. The main adjustments proposed over the Six Thinking Hats method falls into the blue and green hat. In iThink, the blue hat is used by the project manager when a project is set up and the categories to group requirements are defined, this activity is not rewarded with points, since the project manager is not considered a player. The green hat is used by players, to create and propose new requirements.

The other hats are matched to activities that are related with the collaborative discussion over existing requirements. The players can express their opinion on a requirement in four different ways, rating the requirement with stars (red hat), a positive comment (yellow hat), a negative comment (black hat), a concrete or statistical comment (white hat). In order to preserve the game fairness, a player cannot express opinions about their own requirements.

5.3. Scoring scheme

iThink is a points-based system where the goal of the incentive scheme was to encourage the creation of new requirements, and also to promote discussion about the existing ones. By providing a new requirement a user wins 500 points. Since this is one of the main objectives of the game and probably the most difficult task, this activity is the one that is rewarded with more points.

Rating a requirement with stars is a pretty straight-forward action so by rating one requirement 50 points are given to the player. Concrete or statistical comments may not be very easy to give but since they are not that much relevant for the elicitation activity, we decided to assign 50 points to this activity. On the other hand positive and negative comments are more important to this process and may be easier to express, so we decided to assign 100 points to this activity. If a user completes the discussion of a requirement in the four available ways a bonus of 100 points is given.

5.4. Requirement elicitation in iThink

The requirements that led to the development of iThink were based on the activities of the requirement elicitation process. Which in its turn derived how the Six Thinking Hat method was transformed into game mechanics as explained in the previous section.

The web-based digital prototype supports the elicitation of requirements for multiple projects at the same time and the player can choose in what project he/she will participate. The different projects are displayed in a slideshow that displays the title, description and an icon that are associated to each project. A drop-down list can also be used to choose a project in an alternative way (Fig. 1). After choosing a project the user is taken to the gaming screen, which includes the project name, a logo, a description and a progress bar that displays the current score of the player. On the right side of the page is the list of requirements that have been submitted by the other players. The player can add a new requirement or choose an existing requirement and perform the proposed activities. A warning sign is displayed when there are activities related to a requirement that are available to be done. A drop-down list can be used to filter the requirements by the category that they are grouped in.

At the top of each screen the user can find the information related to the scores and rankings. A progress bar displays the amount of points that the player has obtained and the total of points that can be obtained. There is also a button that displays the help page.

6. Case studies

iThink is a web-based gamified environment designed for supporting collaborative requirement elicitation. By combining several game mechanics with the use of a creative thinking technique, called "The Six Thinking Hats" [62], it attempts to tackle the collaboration and user involvement problems previously described. iThink presents to the user, the requirement elicitation process as a game, through which the player is rewarded not only by the generations of new requirements, but also by the analysis of existing requirements using several perspectives. Therefore, iThink core goal is to create requirements by fostering user collaboration and not intended to encourage or stimulate creativity.

Following the studies of Farinha and Mira da Silva that applied Focus Groups as regular discussion sessions and web-based discussion sessions, we also decided to compare these two kinds of discussions. Therefore, iThink has been used in two case-studies: the first, a face-to-face discussion, aiming at evaluating the game mechanics and the proposed methodology; and the second, a web-based discussion, aiming at evaluating the web-based digital prototype.

Although using principles from the Six Thinking Hats method to integrate gamification, this field study was conducted as a Focus Group: the questions of the method were focused, participants could freely and openly communicate without inhibitions or fears, and the discussion was moved towards intended research questions.

With these studies, we planned to compare the benefits from a face-to-face discussion with a web-based discussion where people do not have to meet at the same time and place. In order to validate the results of our qualitative research, we used triangulation, which is a technique that eases validation with cross verification from two or more sources of studies of the same phenomenon. The following sections describe the procedures used in both case studies.

6.1. First case study – physical board game

This case study took place at a childcare center that was restructuring its information system. The game was used to elicit requirements for that system.

Since this was a face-to-face discussion, the number of participants had to be limited. Therefore, only seven stakeholders with different roles in the organization were invited to participate. These stakeholders included two managers, two teachers, one educator, one secretary and one transportation manager.

The blue hat activity was performed by the project manager that defined six initial requirements and the following three categories to group new requirements:

- Public area category, concerning the company website.
- Extranet category, regarding the children and parents' area.
- Intranet category, regarding the employees' area.

At the beginning of the discussion, stakeholders were explained about its purpose and rules. The discussion was introduced as a board game with rounds in which each stakeholder played one round. At each round the stakeholder (player) was asked to review the existing requirements and rate them with stars. Additionally,

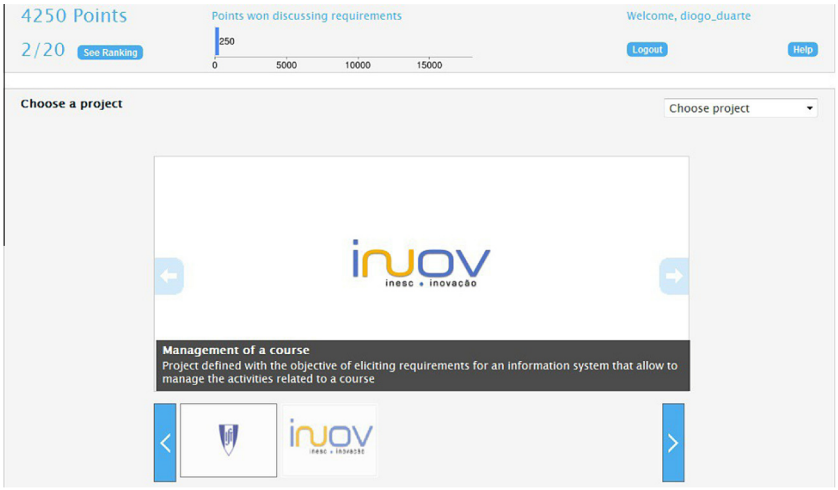

Fig. 1. Screen to choose a project.

the player could make any comments that felt appropriate to each requirement and was invited to suggest other requirements.

Since the game had specific rules according to the hat that the player was using, the moderator had no trouble guiding the discussion while players were following the rules. This case study led to the elicitation of ten new requirements, six positive comments, six negative and three of the comments were factual or statistic. The results are summarized in Table 2.

6.2. Second case study – web-based digital prototype

The second case study took place at a classroom from a course of the last year from a MSc in Information Systems and Computer Engineering. The students were asked to use the web-based digital prototype to elicit requirements for an information system that would be used for the management of a course. Since this was made in this classroom, only the seventeen present students were involved and the teacher that was the project manager.

The blue hat activity was performed by the teacher that defined eight initial requirements and the following three categories to group new requirements:

- Teacher activities category.
- Student activities category.
- Other activities category.

At the beginning of the discussion, stakeholders were explained about its purpose and rules. The stakeholders were then asked to use iThink in their computers to elicit requirements. Students rated and commented the initial requirements but also elicited new requirements.

Since the game was performed in a on-line collaboration tool and had specific rules according to the hat that the player was using, the moderator was not required to have high skills to handle unexpected situations. This experiment led to the elicitation of ten new requirements, six positive comments, six negative and three of the comments were factual or statistic. The results are summarized in Table 3.

7. Results

In order to obtain some feedback on the game and on the information that resulted from the game two different questionnaires were made, the first was directed to the players and the second was aimed at the project manager.

7.1. Player questionnaire

After playing each player was asked to answer a questionnaire to have some feedback on the game. The main goal of the questionnaire was to evaluate if the game motivated the players to participate in requirements and if it was easy to play and understand. The questions were:

- Q1 – Do you consider that the game is easy to understand?
- Q2 – Do you consider that the game is easy to play?
- Q3 – Rate the amusement rate of the game
- Q4 – The game motivates you to participate in requirements elicitation?
- Q5 – Do you consider that the game is a useful tool for requirements elicitation?

The answers to these questions were based on a six points Likert scale with 0 meaning "No" and 5 meaning "Yes". Two additional questions were made, they were related to additional factors that could increase the player motivation and what were the main difficulties to participate. These were multiple choice questions with "Teams", "Bonus Rounds", "Rewards" and "Other" as the options for the question related to motivation. For the question related with difficulties to participate the possibilities were "Lack of ideas", "Did not understood the game's objective" and "Other". More than one possibility could be chosen in both questions.

7.2. Project manager questionnaire

After each experiment a list with requirements and their respective comments was produced, this list was also ordered by

Table 2
Results from first case study.

Contributions			
New requirements	Positive	Negative	Concrete
10	6	6	3

Table 3
Results from second case study.

Contributions			
New requirements	Positive	Negative	Concrete
22	48	32	36

the average ratings of each requirement and the results were sent to the project manager. Afterwards the project manager to answer a questionnaire that featured three questions based on six points Likert scale with 0 meaning "No" and 5 meaning "Yes". These questions were:

- Q1 – Are you satisfied with the number of the contributions obtained with the game?
- Q2 – The relevance of each requirement is well represented by its rating?
- Q3 – The requirements obtained with the game have helped to better define the project scope?

Additional questions included the evaluation of the quality and the relevance of the contributions that were obtained with the game.

7.3. First case study feedback

The answers were based on a six points Likert scale with 0 meaning "No" and 5 meaning "Yes" and are presented in Table 4.

Two persons indicated that the existence of teams would motivate them more, two other persons mentioned bonus rounds and one referred to the existence of rewards. One player mentioned lack of ideas as an obstacle to participation. Table 5 shows the results of the questionnaire that was made to the project manager and project owner.

Both the respondents considered that all the obtained requirements were relevant to the project and that the least valuable contributions were the concrete comments. On the other hand, the project manager considered the new requirements has the more significant contribution but the project owner considered that the negative comments were the most important information.

7.4. Second case study feedback

After participating, each player was asked to answer the questionnaire, however only 12 from the 17 participants agreed to do that (see Table 6).

Six respondents of the respondents indicated that rewards would motivate them; the same number mentioned that playing in teams would make the game more interesting, finally one respondent stated that bonus rounds would also have a positive impact on the motivation to play. Two players stated that they did not understand the game's objective. Lack of ideas was identified as a difficulty to participate by six of the twelve respondents to the questionnaire. The results from the questionnaire made to the project manager after the elicitation activity are now displayed (see Table 7).

The project manager also identified the negative comments as the least relevant contribution and positive comments as the most important. 85 percent of the requirements were relevant for the project.

Table 4
Players' questionnaire results.

Question	Max.	Min.	Avg.	Std. Deviation
Q1	5	3	4.57	0.79
Q2	5	4	4.71	0.49
Q3	4	1	3.29	1.11
Q4	5	3	4.14	0.90
Q5	5	4	4.57	0.53

Table 5
Project manager and project owner's questionnaire.

Respondent	Q1	Q2	Q3
Project owner	5	4	4
Project manager	5	5	5

Table 6
Players' questionnaire results.

Question	Max.	Min.	Avg.	Std. Deviation
Q1	5	2	3.92	1.08
Q2	5	3	4.33	0.65
Q3	4	0	2.50	1.17
Q4	5	1	3.16	1.02
Q5	5	1	3.58	1.16

Table 7
Project manager's questionnaire results.

Respondent	Q1	Q2	Q3
Project manager	5	4	5

8. Discussion

iThink emerged from our previous studies [66,67]. These studies advanced with requirements elicitation challenges, namely stakeholders' difficulties articulating and recognizing own needs; stakeholders' conflicts of interests; and analysts' misinterpretations. Beginning with a regular Focus Group to better elicit requirements, we then moved to web based Focus Groups. With these studies, we identified a number of techniques and features that should be part of the discussion to ease communication and promote the elicitation of high quality requirements. Such features included, for example, the asynchronous discussion in the web-based discussion to allow controlling dominant talkers since time would not be consumed; the voting system through ratings to allow providing votes over others' ideas; rewards to stimulate participation or requirements categories to focus participants' requirements towards relevant issues, avoiding dispersion of ideas. Therefore, the purpose of the described case-studies was to evaluate the impact and acceptance of iThink as a requirement elicitation tool, focusing on the analysis over the collaboration and generation of new requirements.

The use of the Six Thinking Hats as a game mechanic was mainly chosen because it promotes stakeholders' discussion, which is needed in the requirements elicitation process. This game engages participants discussing different perspectives of each idea in order to evaluate the importance and relevance of that idea. Therefore, disagreeing opinions is not penalized. In fact, is encouraged when using the black hat. By providing a manner of expressing negative ideas regarding a certain requirement, without the influence of peer pressure, the requirement more relevant and useful emerge. Therefore, the Six Thinking Hats game was chosen because it guided stakeholders' discussion towards relevant perspectives of each elicited requirement. Instead of thinking only in a way (agreement or disagreement of a certain requirement), participants expressed their opinions in several different ways (positive and negative aspects, ratings or concrete comments). This discussion promoted new ideas, as we could observe in these studies.

Analysing the results of these game-based field studies, we consider them a success because they promoted discussion of stakeholders towards requirements and allowed eliciting several requirements. Therefore, new requirements were generated with

the collaboration of participants using iThink. Moreover, participants also evaluated others' opinions by giving arguments that support and refute those requirements and by rating them. At the end of the discussion, it was possible to extract a list of requirements ordered by priorities according to participants' ratings.

Participants' feedback shows that iThink is fun, interesting and potentially more motivating than traditional approaches of requirements elicitation. This means that iThink was appealing and accepted as a requirement elicitation tool to those participants. Nevertheless, they felt that the elicitation process was still much dependent on the ability to generate new ideas, which may be an obstacle to participants that have difficulties on thinking out of the box.

In both field studies, project managers reported a high degree of satisfaction regarding the number and quality of generated requirements. This means that project managers were pleased to gather such number of requirements and that those requirements were considered relevant and pertinent. They also expressed that the number of valid requirements and the requirements feedback was similar or better when compared to traditional tools that they recurrently use on their projects. That is, traditional approaches of requirements elicitation do not elicit more requirements than this approach, according to the feedback we collected from our participants.

Several empirical conclusions can also be drawn from both case-studies. The first case-study allowed us to gather essential feedback regarding the effectiveness of the game mechanics and to highlight the need for a web-based tool. That is, it showed that the game of the Six Thinking Hats could be used to effectively elicit requirements and that a web-based tool would ease the participation of distributed people. The second case-study tolerates a higher number of participants and a high participation was actually verified. That is, not only more people could contribute in the elicitation of requirements using the web-based tool but also participants were more stimulated to contribute in a web based tool. Nevertheless, their feedback also reported that the game would benefit from a more immersive environment, such as a 3D virtual world. Moreover, the interface is still limited and unappealing, which may affect the acceptance of this tool and limit its use.

Analysing the results, we believe that this game is good for both ranking and criticizing requirements but also for requirement creation. This is true since group discussions encourage collaboration, commitment, deep exploration of key topics, and resolution of conflicts and data collection. Therefore, group discussions obtain participants' knowledge and perspectives, promoting a group synergy that brings unexpected and new results. These results are generally unforeseen ideas that could not be elicited otherwise. Comparing the results from the two field studies, the physical board game and the web-based digital prototype, we can say that both were meaningful. On the one hand, both results illustrate that participants considered the game easy to play, easy to understand, motivating and useful to elicit requirements. On the other hand, both studies demonstrate that project managers were pleased with the number of gathered contributions, their relevance and even with the aid of the game to understand real needs. Therefore, quantitative results do not seem to be very different with iThink. Comparing qualitative results, we observed that a face-to-face discussion allowed stakeholders to create a bond and communicate with language and facial expressions. Therefore, face-to-face discussion benefited from human relationships that may ease the communication. However, the web-based digital prototype has also its advantages: when the time comes to meet, busy or distant stakeholders prefer to contribute through a web-based collaboration tool such as the prototype of iThink rather through a face-to-face discussion. And, as we could see, both gather good results.

The evaluation of our qualitative studies was performed by triangulation, that is, cross-verifying conclusions with different data (participants and research topics) and different environments (locations, settings and factors). We begun with previous field studies and moved to these game based discussions. Therefore, with triangulation, we were able to validate our research with several sources of studies of the same phenomenon. The quality of requirements and, therefore, of this qualitative research, is addressed by validity and reliability. Regarding validity, we recognize that we may have a threat to construct validity and external validity, as discussed in the limitation section. However, we believe that there is internal validity since we have already performed other studies [66,67,23,24] that manipulated other factors (in both physical and digital group discussions). Therefore, we believe that the effects observed in these studies were due to the manipulation of the environments of the physical and digital group discussions presented in this paper.

9. Limitations

Our research is a qualitative research and, therefore, it lacks statistical significance, hypotheses, a control group, of systematic choice of subjects, experts and projects. Actually, we followed triangulation to validate our qualitative research. Therefore, we used two sources of studies of the same phenomenon to evaluate different data and environments. The different data concern different stakeholders and different research topics. The different environment concern different locations of the studies, different settings (one is based on a physical group discussion while the other is based on a digital group discussion) and different factors (one is performed with a collaboration tool).

Regarding collaboration tools, the use of such systems may change the nature of group work from being largely face to face to largely on-line. The face to face contact is lost and several changes can happen, including roles, responsibilities or interactions. Finally, there are privacy and security implications as well as individuals' concerns about sharing their knowledge with others. Therefore, it is very important to be careful in the way such systems are introduced and used to achieve a better teamwork. Moreover, our research does not intend to address all the challenges of the requirements elicitation activity. Instead, it was focused on easing the communication and, therefore, collaboration of different stakeholders who have different perspectives of their needs.

It was also not intention of this research to enhance communication and collaboration in all Information Systems projects. In fact, we focused on two case-studies where the results seem promising but we do not intend, so far, to extend our results. We only evaluated the usage of the physical board game in an outdated Information System that needed progress and the usage of the web-based digital prototype on a project for a new Information System. Therefore, the case-study of the physical board game was easy to discuss because participants had a base Information System to criticize and compare different needs while the second case-study was not so easy because there was no Information System to take as reference. Another limitation is the fact that our studies were only performed with a small or medium target, that is, a restricted number of stakeholders concerning a few individuals. A higher number of involved stakeholders may raise several unexpected difficulties that turn this research complex to apply in practice. Finally, in order to ensure success, we are assuming that stakeholders have interest in the address topic (Information Systems in our case) and are genuinely willing to contribute and cooperate with other stakeholders to reach a consensual solution. However, this may not always be the case.

10. Conclusion

This paper presents two case studies aimed at evaluating a requirement elicitation tool based on gamification concepts and the Six Thinking Hats method. These case studies were successful in promoting discussion of stakeholders towards requirements. Consequently, several requirements were orderly elicited as well as arguments that support and refute those requirements. Moreover, the results demonstrate a good number of contributions and that this approach may enhance the user involvement in requirements elicitation. According to the questionnaires, the iThink is easy to understand and play. The participants in the case studies also feel that this approach is useful and motivates them to participate in requirements elicitation.

The use of the Six Thinking Hats method aided guiding stakeholders' discussion towards relevant perspectives of each elicited requirements (positive and negative aspects, ratings or concrete comments). In both field studies, project managers reported a high degree of satisfaction regarding the amount and quality of generated requirements. Moreover they pointed out that the amount of valid requirements and requirements feedback was similar or better when comparing to traditional tools that they recurrently use on their projects.

Several empirical conclusions can also be drawn from these field studies. The physical board game allowed gathering essential feedback regarding the effectiveness of the game mechanics as well as highlighting the need for a web-based collaboration tool to ease participation. The web-based digital prototype observed a higher participation rate, although participants reported that the game would benefit from a more immersive environment, such as a 3D virtual world.

Acknowledgments

This work was supported by the Portuguese Fundação para a Ciência e a Tecnologia (INESC-ID multiannual funding) under the project PEst-OE/EEI/LA0021/2013. The authors also would like to acknowledge to the European funded Project Games and Learning Alliance (FP7 258169) the Network of Excellence (NoE) on Serious Games.

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