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iThink : A game-based approach towards improving collaboration and participation in requirement elicitation

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

[a]*INESC-ID, Lisbon, Portugal*
[b]*Instituto Superior Técnico, Lisbon, Portugal*

Abstract

Requirements are the heart of Information Systems development because they determine how the system will operate. Therefore, requirements elicitation is a critical activity of the information systems development life cycle. 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. In this article we present a game-based collaborative tool called iThink that aims at improving the participation in a requirement elicitation process. iThink takes advantage of the association between "gamification" concepts and the six hats of thinking method for collecting both new requirements and feedback about existing ones and for presenting the requirement elicitation process in a form of a collaborative game. Two case-studies, involving several stakeholders, are also presented with the purpose of evaluating the effectiveness and acceptance of this tool.

Keywords: Requirements Elicitation; Gamification; Colaboration; Serious Games

1. Introduction

It is unanimously acknowledged that we are living in the information age, taking part in the information society [1, 2]. What makes these two emerging concepts possible is technology that most of the times is delivered to us in a form of Information Systems. Developing such systems is often complex and difficult requiring a significant effort on planning and managing their development process [3].

Therefore, the information system "life cycle" has been broken into a number of so called "phases" of which requirements elicitation is the earliest phase. This phase aims on understanding and defining how the system will operate, taking into account the feedback provided by different stakeholders. This is only possible with an intense communication between stakeholders, being cooperation and collaboration vital in this process [4].

Requirement elicitation is in fact a wide research area, where several studies have been conducted with the goal of edifying common limitations in this process, mainly aiming at understanding the role of communication and

*Corresponding author. Tel.: +351-969-172-196.
E-mail address: joao.costa.fernandes@inesc-id.pt.

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cooperation between stakeholders. Nevertheless, despite of the research efforts, is still not clear how to overcome limitations such as: how to avoid requirments errors that are normally discovered in an implementation stage, how to enhance the generation of new requirements and how to improve the stakeholder involvement [5].

Since communication is a critical factor, requirement elicitation tools must take this into account allowing stakeholders to articulate their needs collaboratively and overcoming the limitations of gathering stakeholders at the same 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 [6, 7, 8].

Recent research as proved the benefits of adding game mechanics to common tasks outside the traditional video games environments [9], essentially increasing of user motivation and engagement. This approach as commonly referred in the literature 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 [10].

This paper presents a requirement elicitation tool in a form of a game called iThink. This tool propose the integration of the ”gamification” concept with a creative thinking method called the Six Thinking Hats with the goal of enhancing the collaboration in the requirement elicitation both aiming at the creation of new requirements and on gathering feedback about the existing ones. iThink was developed in a form of a web-based game allowing the asynchronous collaboration between different stakeholder in several projects. This tool was evaluated using Action Research [11, 12] through two field studies.

The paper is structured as follows: Section II presents a review about the existing requirement elicitation tools, including problems and limitations. Section III describes the concept of ”gamification” and how it can be applied to this domain. Section IV described iThink game design and implementation. Section V described the protocol used in the two field studies. Section VI and VII present the results and discussion. And finally section VIII exposes conclusions and future work.

2. Requirement elicitation common practices and challenges

Requirements are the heart of Information Systems development [13] because they determine how the system will operate [14, 15]. Therefore, requirements elicitation is a critical activity of the information systems development life cycle [15].

Despite many years of investigations, errors on the requirements elicitation activity still represent major causes for the failure of information system projects [14, 15]. The literature identifies several problems of this activity, including lack of users involvement and the complex communication between stakeholders and analysts. 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, leading to low quality requirements [13].

Based on communication, the social nature of the Requirements Elicitation activity is undeniable [3]. As such, recent trends of investigation have been using methods derived from social sciences in order to increase chances of success of requirements elicitation [15]. Such methods include ethnography, interviews and group work.

Ethnography focuses the observation of people in their natural environment, translating stakeholders activities and interactions [16, 17, 15]. Although some researchers claim that ethnography may have satisfactory results eliciting [17], several limitations are recognized. These limitations include risk of incorrect interpretations, impossibility of identifying new requirements or difficulty of generalizing results [16].

Interviewing is an informal interaction where analysts explore needs asking stakeholders about the system in use and the system to be[15]. Several researchers have been studying the nature of conversations and interviews to progress their efficiency [14, 3]. Despite the improvements that their research results demonstrated, they admit that more research is needed [14]. Moreover, well known limitations are advanced, such as the limited stimulus-response interaction and the need of participants to share basic concepts and methods [3].

Group work gathers stakeholders to collaborate reaching solutions about an identified problematic situation [15]. Although practice with methods such as JAD [18, 19], focus groups [20, 21] or creativity workshops has proven pleasing results, several limitations are known. Typical limitations include dominant participants, biased opinions, high logistic costs and difficulties on gathering stakeholders at the same time and place [15].

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 [22]. Such

tools include variations of the WinWin spiral model [23], Athena, variations of wikis, iRequire, AnnotatePro or Stakesource [24].

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 analyzing and selecting requirements. Nevertheless, this method was not empirically evaluated although their authors have initially planned it [25].

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. Although Athena eased the asynchronous interactions between participants, it has several limitations. These limitations include a difficult usability; an inaccurate view since stakeholders do not construct a single view together; or time consumed when compared to interviews or a group dynamics approach [26].

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]. Although wikis proved to ease distributed collaboration, they lack the means to discuss conflicts among stakeholders. This limitation may origin misunderstandings about requirements elicited by stakeholders with different work practices and responsibilities [31].

AnnotatePro [32] 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. Although easing involvement of stakeholders, this tool does not contain a method following a well-structured plan, does not provides a formal notation language and does not allow tracking own submitted requirements.

iRequire [33] 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. However, it does not support brainstorming of needs; does not document well-defined requirements; and the authors recognize that utility and usability studies are needed to improve the tool.

Stakesource 2.0 [24] is a web application using standard technologies that uses social networks and collaborative filtering, a crowdsourcing approach, to identify and prioritize stakeholders and their requirements. Stakeholders can invite other stakeholders to participate, suggest and rate requirements. However, this tool was not completely evaluated in real-world projects.

Summarizing, problems in this activity generate 55% of computer systems' troubles, leading to 82% of the efforts devoted to correcting mistakes [34]. Although several research efforts have been made towards methods and tools to better support requirements elicitation, all of them recognize that much more work is needed. In fact, eliciting requirements is still complex, critical and leads to low quality requirements that compromise the success of Information System projects.

3. Gamification

Serious game and virtual-based environments are an important response from the technologist to the "digital natives" [35], a generation who were raised on interactive games and expect the same kind of interactive experiences in every information system. Indeed, it may possibly be wrong to call the use of serious games a novelty, since by nature young children begin to gain interest in several topics through games at their earliest years [36].

The field of business is not an exception in the permeation to this kind of approaches, a great number of different business games and game-based tools have been developed [37] and used in management training by different business schools, faculties and enterprises all over the world [38, 39, 40]. Nowadays these games are seen as a useful tool to learn how to manage firms and to explore new strategic opportunities [41], promoting organizational learning, namely: (i) to orient and train new employees; (ii) to select current managers or future managers; and (iii) for ongoing management training [42]. Several authors referred that the most important advantages of applying games and game-based tools in a business context, are the immediate feedback, active participation, learning from the experience and the high motivation promoted by the competitive environment [6, 7, 8].

Most of these games seek to engage and delight players through their content, nevertheless the development and design of such content has a high cost, imposing 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 [9]. 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 gamifed tools with a lower cost when comparing to the development of traditional video-games [43].

”Gamification”, as concept is already used in numerous applications ranging across productivity, finance, health, education, sustainability, as well as news and entertainment media [10]. 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 [44]. 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 [45]. Lander et al. discussed the use similar mechanisms for encouraging student to take non-mandatory quizzes concluding that these mechanisms increased substantially the student participation [46]. 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 [47], this includes work detailing specific design features that afford player enjoyment [48].

In persuasive technology [49], 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 instill embedded values. Social psychological studies on contributions in online 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 centered design.

4. iThink

iThink is a web-based gamified environment design for supporting collaborative requirement elicitation. By combining several game mechanics with the use of a creative thinking technique, called ”The Six Thinking Hats” [50], 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.

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.

4.1. The Six Thinking Hats

The western thinking method was heavily influenced Greek tradition of argument, proposed by Socrates Plato and Aristoteles, and builds upon understanding the question ”What is what?”, which is determined by analysis, judgment and discussion. Although this approach is useful there are a wide range of thinking methods that are often neglected such as constructive thinking and creative thinking, that builds upon understanding the question ”What may be?”.

Answering this question is essential in many aspects of our life, since many processes depend on creativity and on the ability to generate new ideas. Aiming at this, De Bono [50] proposed the concept of parallel thinking, as a possible solution to overcome some of the limitations of western thinking. In western thinking, two persons disagree, emerging a discussion in which each person tries to prove the other is wrong. Using parallel thinking, both perspectives, although may be contradictory, are placed in parallel.

The six thinking hats method has been developed by De Bono [51] 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 modelled as six different thinking hats represented by colors.

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 justifications 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 some ”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 the six thinking hats method, aiming at increasing user participation, engagement and collaboration in the requirement elicitation process.

4.2. 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 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 point, since the project manager is not considered a player. The green hat is used by players, to create and propose new requirements being this activity rewarded with points.

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 obtain to preserve the game fairness, a player cannot express opinions about their own requirements.

4.2.1. Scoring Scheme

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. Table 1 summarizes the scoring scheme.

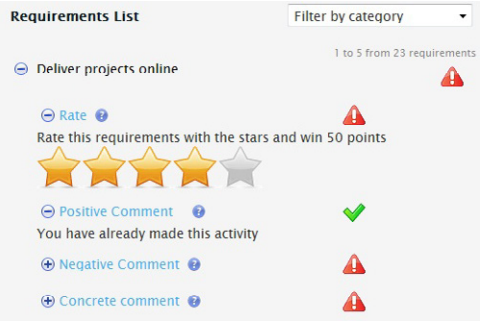

Fig. 1. Rating a requirement with stars

Table 1. Game scoring scheme

Activities	Points
New requirement	500
Star Rating	50
Positive comment	100
Negative comment	100
Concrete comment	50
Bonus	100

4.3. Implementation

A prototype to support the game has been built using the Outsystems agile platform [**?**]. This platform has been chosen due to its simplicity, short learning curve, and also for its capabilities of version control and easy deployment. The developed prototype supports the activities that were introduced previously like the submission of a new requirement, discussion through different kinds of comments and a way to rate the requirements based on stars.

The 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 (see Figure2).

After choosing a project the user is taken to gaming screen (see Figure3). On the left side the project name, logo and description and available again. A progress bar that displays the amount of points that the player has gained in comparison with the total points that are available to be won is also visible.

On the right side of the page is the list of requirements that have been submitted by the other players. The player can choose a requirement and open a requirement to perform the proposed activities (see Figure1). A warning sign is displayed when there are activities related to a requirement that are available to be done. The question marks in front of each activity display a help message associated to each task 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 also 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.

5. Case-studies

iThink has been used in two case-studies, the first aiming at evaluating the game mechanics and the proposed methodology and the second aiming at evaluating the prototype, the following sections systematize the protocol used in both case-studies.

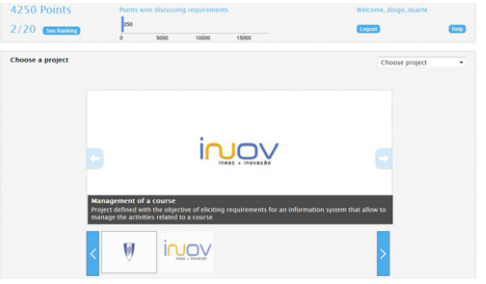

Fig. 2. Screen to choose a project

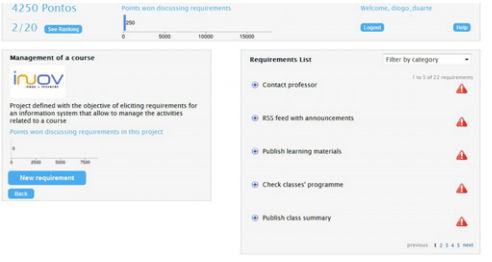

Fig. 3. Gaming screen after choosing a project

5.1. *First Case Study - "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. The project manager defined six initial requirements and three categories that were also used to group the requirements, public area that mainly consisted in the company website, extranet that is accessible to the children and their parents and intranet that is accessible to the workers of that organization. Seven persons with different roles in the organization participated in this experiment: two from management, two teachers, one educator, one secretary and one transportation manager.

The game was presented in a form of board game and was played by rounds, each person played one round. At each round the player was asked to review the existing requirements and rate them with the stars. Additionally, the player could make any comments that felt appropriate to each requirement and was invited to suggest other requirements. 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.

Table 2. Results from first case study

Contributions			
New requirements	Positive	Negative	Concrete
10	6	6	3

5.2. *Second Case Study - 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 prototype to elicit requirements for an information system that would be used for the management of a course. Seventeen students participated in this case study with new requirements, ratings and comments to the initial requirements. Three initial categories were defined by the project manager, teacher activities, student activities a third one named "other" to group requirements that did not fit in the previous two. Eight initial requirements were defined.

This experiment led to the elicitation of twenty-two new requirements, forty-eight positive comments, thirty-six negative and thirty-two of the comments were factual or statistic. The results are summarized in Table 3.

Table 3. Results from second case study

Contributions			
New requirements	Positive	Negative	Concrete
22	48	32	36

6. 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.

6.1. 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.

6.2. Project Manager Questionnaire

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

6.3. 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.

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

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. The project owner also manifested availability to answer this questionnaire.

Table 5. Project manager and project owner's questionnaire

Respondent	Q1	Q2	Q3
Project Owner	5	4	4
Project Manager	5	5	5

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.

6.4. 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.

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

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 project made to the project manager after the elicitation activity are now displayed.

Table 7. Project manager's questionnaire results

Respondent	Q1	Q2	Q3
Project Manager	5	4	5

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.

7. Discussion

The purpose of the described case-studies was to evaluate impact and acceptance of iThink as a requirement elicitation tool, focusing on the analysis over the collaboration and generation of new requirements.

In general all participants agreed that using iThink as a way to elicit requirements, was fun, interesting and potentially more motivating than traditional approaches. Nevertheless participants also reported that the elicitation process was still much dependent on the ability to generate new ideas. The use of the the six hats of thinking

method seemed to increased collaborative participation, however the test sample was too limited in order to draw further conclusions.

In both case-studies, project managers reported an 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 both case-studies. The first case-study allowed us to gather essential feedback regarding the effectiveness of the game mechanics as well as helped to highlight the need for a web-based tool as a way of facilitating the participation and access to the platform.

In the second case-study we record an increase in participation, nevertheless participants reported that the game would benefit from a more immersive environment, such as a 3D virtual world. The interface is still limited and unappealing, which may affect the acceptance of this tool and limit its use, this likely is expressed by the relatively low rate of amusement (question Q3 asked to participants in both pilots).

8. Conclusion

This paper presents iThink a game-based tool for collaborative requirements elicitation. This tool aims at increasing the collaboration and stakeholder involvement in this activity, by associating ”gamification” with the six hats of thinking method. Two case studies have been made in order to evaluate this proposal. The first was made as a board game and the second was supported with the developed prototype.

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 feedback from the project owner and project managers assured the quality of the requirements and the contributions that were obtained in the case studies.

The weakest point of this proposal seems to be the amusement factor, which may be related with the developed interface that was seen as unappealing by several users. Some of the questionnaires' results are sparse demonstrating that further studies are needed, the number of participants in the case studies should also be increased.

Regarding future work, more case studies with different stakeholders and technological environments should be performed in order to obtain more results. According to players' feedback, iThink can be played in teams or enhanced with bonus rounds. The project manager can also have a more active role by controlling some aspects of the game, like which requirements need more discussion, the points that are assigned to each activity or to simply remove some requirements from the discussion.

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