Evaluating the Students' Experience with a requirements elicitation and communication game

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Abstract. Context: Group dynamics and games are used to provide practical support to theoretical concepts. Many of them are proposed in the literature, however, they do not receive an evaluation of their efficiency in teaching. Objective: to present an evaluation of the game "Translation Loss" whose goal is to be an immersible educational game to teach requirements elicitation and communication abilities. Method: we evaluated the students' experience in two classes from two different universities. In the first execution, we planned and executed the game with the participation of 40 students. Then, the students evaluated the game, considering the Model for the Evaluation of Educational GAmes (MEEGA). In the second execution, we relied on the participation of 27 students. Results: All aspects covered by the MEEGA model were approved by the students, concluding that the game had a good acceptance. Conclusions: We obtained empirical evidence that the Translation Loss contributes to improving requirements elicitation and communication skills in the students, and it could be a great educational material to simulate real tasks during the RE process.

Keywords: Requirements Engineering Education · Requirements Communication · Requirements Elicitation · Software Quality.

1 Introduction

Failures in software development projects are mainly caused by problems in the Requirements Engineering process [15][16]. Regardless of the process model adopted, the focus of every software project should be on quality at every step. The exit condition for every process activity, action, and task should focus on the quality of the work product that has been produced [7].

Fernandes et al. [5] state that 85% of software problems originate from the requirement elicitation activity. Projects fail because important information falls into the cracks and/or stakeholders fail to coordinate their efforts to create a successful product [7].

Effective communication (among technical peers, with the customer and other stakeholders, and with project managers, for example) is among the most challenging activities faced in the software development process [19][7]. The communication of requirements among stakeholders is critical for system quality [19]. The critically derives from the fact that requirements should be understood in the same way by different roles in the development.

Communication problems in software development were investigated by some authors such as Brady et al. [1], Pernstal [10], Rasmussen and Lundell [11], Wang et al. [18] and Vilela et al. [19][17]. RE focuses on good specification practices but has yet to find working solutions for effective requirements communication [19] considering its potential in supporting the improvement of software processes and the quality of the final product.

One of the main causes of the failures and deficiencies of software systems is the lack of appropriate skills and knowledge of those engaged in RE activities. Requirements related problems, as well as communication and coordination, is an essential undertaking in software engineering education if the field is to have professionals who are capable of accomplishing software projects.

In this context, educational games can bring benefits to the teaching and learning processes, and several games have already been developed and are used in different levels of teaching and disciplines [12]. However, there is a surprising lack of empirical evidence on its utility. Moreover, simulating real scenarios of projects in the classroom and providing experiences in decision making and problem-solving for the students is a challenge activity. Another important fact is that in many areas of technology games are used as a teaching tool, but this is rare in the field of Requirements Engineering.

This paper presents an experience report of the application of a game called "Translation Loss" [2] in two undergraduate classes of different universities. The first class was composed of 40 students from the second semester of the Software Engineering course at Universidade Federal do Ceará (UFC) - Campus Quixadá. The second class consisted of 27 students from the first semester of the Information Systems course at Universidade Federal de Pernambuco (UFPE). The game aims to support the requirements engineering teaching, focusing on the activities of requirements elicitation and communication with the client. The target audience is undergraduate students of courses in the area of computing, which have in their grid, disciplines that involve requirements engineering.

In this game, the participants must carry out the requirements elicitation from a client. To perform such task, participants must collect information about the system and separate system and user requirements [14] in two stages with the absence/presence of the client to simulate a traditional software process and an agile one.

This study is indicated to requirements engineering professors who want to make their classes more dynamic and fun, using a game that was empirically assessed in relation to students learning and experience through the MEEGA model for educational games [12]. In overall, the students positively evaluated the game since all MEEGA model aspects were well scored by the students.

Therefore, we conclude that the game can be considered as an effective learning approach that allows practical experience on requirements communication.

This article is structured as follows: in the Second section, we define the theoretical foundation, and discuss related works; in the Third, we explain the rules of Translation Loss game; In Fourth section, we describe the methodology used; in Fifth section, we report the results, and finally, in Sixth section, we present conclusions and future work.

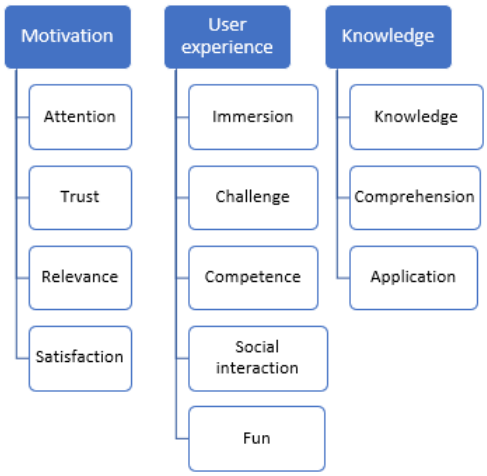
2 Background and Related Work

In this section, we describe the main concepts involved in this work, and we discuss related works.

2.1 Evaluation Model for educational games quality (MEEGA)

The MEEGA model was proposed by Savi et al. [12] to assess the quality of educational games. The model aims to evaluate if a game: i) can motivate students to use it as learning material; (ii) provides good user experience (e.g., if it is fun); and (iii) it generates a perception of educational utility among its users (i.e., whether students think they are learning the topic). The MEEGA model defines three components: motivation, user experience, and learning that are evaluated by attributes as illustrated in Figure 1.

Fig. 1. The MEEGA model (adapted from [12]).



Motivation is divided into attention, trust, relevance and satisfaction [12]. Attention refers to students' cognitive responses to instructional stimuli, and Trust

is related to creating positive expectations in the students. Relevance evaluates whether the game allows the student to connect the content of learning with their professional or academic future. Satisfaction is concerned with providing positive feelings in the students about the experience of learning.

User experience is divided into immersion, challenge, competence, social interaction, and fun [12]. Immersion distorts the notion of time, leading the player to have an experience of deep involvement in the game. Challenge evaluates whether the level of difficulty changes and gradually increases to maintain the player's interest as he develops his skills. Competence assesses the perception of skills, control, and use of these skills to explore the game and progress. Social interaction is related to the feeling of sharing an environment with other people and of having an active role in it. Finally, fun is concerned with the game providing feelings of fun, pleasure, relaxation, distraction, and satisfaction.

Knowledge is divided into learning questions [12]. Knowledge is the ability to remember information about facts, dates, words, theories, methods, classifications, places, rules, criteria, procedures, etc. Comprehension is to understand the information or the fact, grasping its meaning, using it in different contexts. Furthermore, Application is to apply knowledge in concrete situations.

2.2 Related Works

In the literature, some games and dynamics contribute to teaching requirements engineering. For instance, we found games to teach agile methodologies [8][9], Requirements Elicitation [13], Requirements modeling [3].

The Scrum Card Game [8] allows players to experience the execution of agile software development project activities and dealing with different issues that occur in day-to-day agile teams working with Scrum. Another approach to student teams learn the Scrum roles, events, and concepts in practice is by simulating several development Sprints incrementally planning and building a product of LEGO blocks [9].

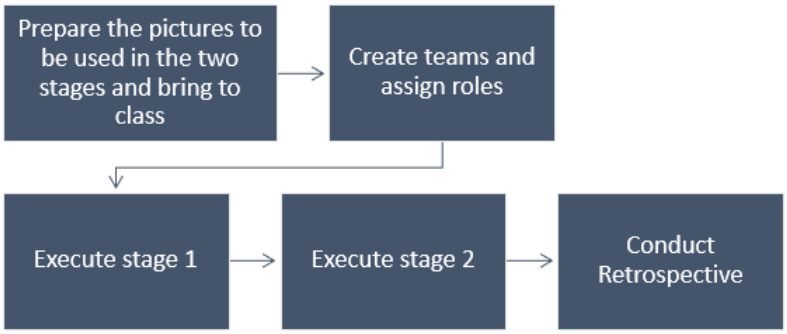
Silva et al. [13] present an experiment with the game ELEMENT, which is a software solution that allows elicitation techniques teaching. The game provides support for a variety of problems and training scenarios in some key elicitation techniques, i.e., brainstorming and interviewing.

The Modeling game [3] aims to provide support for teaching engineering requirements. Its objective refers to the elaboration of a conceptual model of software development based on a given scenario. During the game, participants perform a series of activities called "Plays", sequentially arranged: (1) the Start Play, (2) the Play of Actions (which is a set of activities), and (3) the Validation Play. Nevertheless, the management effort and the amount of assumptions this game requires makes the complexity of its application higher compared to the ELEMENT game. We explain the Translation Loss game in the next section.

3 The "Translation Loss" Game

The goal of the game is to understand the difficulties related to verbal communication between clients and the development team. Another objective is to understand the advantages of client presence practice and prototyping in requirements development. The estimated duration time to execute the game is 2 hours (but it can be reduced according to the time available for the class), and the material needed is pens, papers, stopwatch, and a picture collection. Figure 2 presents the flow followed during the game execution. This process was designed from the steps produced by Carvalho [2].

Fig. 2. Steps to execute the translation loss game.



The class is divided into groups of 4 (minimum) and 6 (maximum) people. The groups nominate one customer, one requirements analyst, and the other members play the role of developer. The game is divided into two stages. Each stage has 4 distinct phases that are: (1) analysis, (2) interview, (3) development, and (4) delivery.

In stage 1, in the analysis phase (1):

- The client of each group leaves the room and receives a picture from the instructor.
- He analyzes the picture for 5 minutes and returns it to the instructor.

The Translation Loss is a non-digital game. Hence, we can use pictures such as Figure 3 and Figure 4, whose requirements should be elicited by the teams from the client.

After the analysis of the picture by the client, he returns to the room to start the interview phase (2).

- The developers leave the room.

Fig. 3. Example of a picture to be developed by the team in the first stage [2].

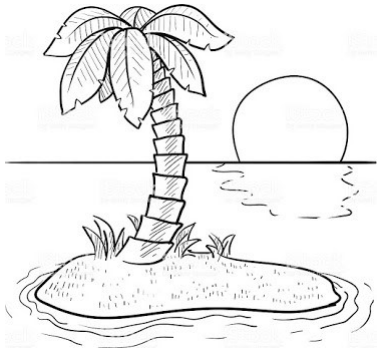


Fig. 4. Example of a picture to be developed by the team in the second stage [2].

- The requirements analyst interviews the client in a predefined time (we adopted 7 minutes) to elicit the requirements.
- The client describes the figure to the analyst (without drawing).
- The analyst takes note of "requirements", and he can ask whatever he wants to the client in the time available.
- Another rule is that the analyst cannot draw, only write the requirements in natural language.

In the development phase (3):

- The developers return, and the client leaves the room.
- The analyst provides the written specifications to developers.
- Analyst can talk freely with developers that are the only ones allowed to draw the picture on a predefined time (we adopted 10 minutes). improved.

In the delivery phase:

- The client returns to the room.
- He analyzes what was designed by the team.
- He compares with the picture given to him at the beginning.
- At this point, feedback is provided in 10 minutes on what went right or wrong, as well as what could be improved.

In stage 2, the same procedure of the four stages is conducted but with a different picture, for example Figure 4. However, in this stage:

- The analysis lasts 3 minutes, and the client is interviewed by the team (not only the requirements analyst) by 15 minutes.
- The client participates actively in the development, and he explains at any moment how he wants the final product.

At the end of the game, a retrospective (around 10 minutes) is conducted to discuss questions like [2]:

1) What problems occurred in Stage 1, how do they relate to traditional methods of development?

2) What elicitation technique was used in Stage 2, what benefits did it bring to development?

3) Indicate at least two fundamental competencies that can be related to the challenges experienced in the game;

4) Explain why competency would facilitate or enable the execution of requirements engineering activities?

We define the research methodology adopted in this work in the following section.

4 Methodology

In this paper, we intend to answer the following research questions:

RQ1: What was the students' reactions to the Translation Loss game?

RQ2: Did the students consider that they improve their requirements communication and elicitation skills by participating in the game?

The methodology used in this work to assess the learning results from teaching the importance of requirements elicitation and communication using the Translation Loss game consisted of two steps: (1) game planning and application; (2) game evaluation by the students.

4.1 Step 1: game planning and application

In Step 1, we executed the game following its rules described in Section 3. The game was applied in two undergraduate classes. The first class was composed of 40 students from the second semester of the Software Engineering course at Universidade Federal do Ceará (UFC) - Campus Quixadá. The second class consisted of 27 students from the first semester of the Information Systems course at Universidade Federal de Pernambuco (UFPE). During the activity, the game facilitator could answer questions from the students about the game itself.

4.2 Step 2: game evaluation by the students

We used a mixed-method approach combining qualitative and quantitative methods in Step 2. The assessment is based on the student's opinion about the game considering the model developed by Savi et al. [12] that proposes a model for the evaluation of educational game quality. The model defines three components: motivation, user experience, and knowledge, as described in Section 2.1.

The evaluation was performed considering students' perceptions measured by the MEEGA model and its assessment questionnaire. Some questions have been modified to suit the scope of our application. The questionnaire is composed of three parts where each one evaluates a component of the MEEGA model. The questions are presented in Table 1, Table 2, Table 3.

Table 1. Questionnaire to evaluate the Motivation component of "Translation Loss" game.

Aspect	Question	Answer
Attention	Q1: There was something interesting at the beginning of the game that captured my attention.	( )( )( )( )( )
	Q2: The form, content, information, and excitement helped me to maintain attention to the game.	( )( )( )( )( )
Relevance	Q3: It became clear to me how the content of the game is related with concepts I already knew.	( )( )( )( )( )
	Q4: You considered the content of the game relevant to teaching requirements development.	( )( )( )( )( )
	Q5: You believe that the operation of the game is suitable for learning through a game.	( )( )( )( )( )
Trust	Q6: In the course of the game, I felt confident that I was learning.	( )( )( )( )( )
	Q7: The activities of the game were easy to understand and I could accomplish them.	( )( )( )( )( )
Satisfaction	Q8: Completing the stages of the game gave me a sense of accomplishment.	( )( )( )( )( )
	Q9: I am satisfied because I know that I will have the opportunity to use in practice the lessons I have learned from the game.	( )( )( )( )( )
Legend: ( )( )( )( )( ) Totally Agree/ Agree/Neutral/ Disagree/Totally Disagree		

We changed the format of the responses from a 7-point to 5-point Likert scale, in the ranges of Strongly disagree to Strongly Agree. We made this choice considering the difficulty people have in choosing from a 7-point scale.

In the next section, we present and discuss the results obtained from the selected studies.

5 Results

The evaluation of the students' experience was generally positive in all aspects. When there was an indication of disagreement by the students, this percentage was low, lower than 5.97%. However, for some statements there was an indication

Table 2. Questionnaire to evaluate the User Experience component of "Translation Loss" game.

Aspect	Question	Answer
Immersion	Q10: I did not notice the time passing while I participated, when I realize, it was over.	( )( )( )( )( )
	Q11: I felt stimulated to learn from the game.	( )( )( )( )( )
Challenge	Q12: My skills have gradually improved by overcoming the challenges in the stages of the game.	( )( )( )( )( )
Skill/Competence	Q13: I had positive feelings of progress during the course game.	( )( )( )( )( )
Social Interaction	Q14: I felt that I was collaborating with other colleagues.	( )( )( )( )( )
	Q15: The game supports social interaction between players.	( )( )( )( )( )
Fun	Q16: I was able to fit in and feel good during the game.	( )( )( )( )( )
	Q17: I would play this game again.	( )( )( )( )( )
Legend: ( )( )( )( )( ) Totally Agree/Agree/Neutral/ Disagree/Totally Disagree		

Table 3. Questionnaire to evaluate the Knowledge component of "Translation Loss" game.

Question	Answer
Q18: The game was efficient for my learning as compared to other discipline activities.	( )( )( )( )( )
Q19: The game contribute to my learning in the discipline.	( )( )( )( )( )
Q20: After the game I feel that I can better apply the themes related to the game.	( )( )( )( )( )
Legend: ( )( )( )( )( ) Totally Agree/Agree/Neutral/Disagree/Totally Disagree	

of neutrality by students. In this section, we present and discuss the answers of our research questions.

5.1 RQ1: What was the students' reactions to the Translation Loss game?

After the game application, we asked the students to answer the questionnaire described in Table 1 to 3 using a Google Form. We received 40 answers from the first application in University 1 (U1) and 27 from University 2 (U2) that we analyzed considering the components and aspects of the games evaluation methodology of Savi et al. [12].

The percentages of all questions are presented in Tables 4 and 5. We observed that all components were well evaluated by the students. The *Motivation* was evaluated considering its four aspects: Attention (Q1 and Q2), Relevance (Q3, Q4, and Q5), Trust (Q6 and Q7), and Satisfaction (Q8 and Q9); the *User experience* is divided into Immersion (Q10 and Q11), Challenge (Q12), Competence (Q13), Social interaction (Q14 and (Q15), and Fun (Q16 and Q17); and the Knowledge was evaluated by questions Q18, Q19 and Q20.

Table 4. Results of students evaluation of "Translation Loss" game (part 1).

	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
TA	58.21	61.19	56.72	64.18	65.67	37.31	46.27	37.31	46.27	56.72
A	38.81	37.31	23.88	28.36	26.87	43.28	41.79	38.81	38.81	31.34
N	2.99	1.49	19.40	7.46	5.97	19.40	5.97	23.88	10.45	5.97
D	0	0.00	0.00	0.00	1.49	0.00	4.48	0.00	4.48	5.97
TD	0.00	0.00	0.00	0.00	0.00	0.00	1.49	0.00	0.00	0.00

Table 5. Results of students evaluation of "Translation Loss" game (part 2).

	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
TA	47.76	31.34	31.34	50.75	62.69	61.19	65.67	43.28	52.24	41.79
A	43.28	46.27	46.27	43.28	31.34	29.85	20.90	37.31	41.79	41.79
N	7.46	16.42	19.40	5.97	5.97	8.96	8.96	14.93	4.48	16.42
D	1.49	5.97	2.99	0.00	0.00	0.00	2.99	2.99	0.00	0.00
TD	0.00	0.00	0.00	0.00	0.00	0.00	1.49	1.49	1.49	0.00

Due to space constraints, the pictures and tables of each aspect per university can be found at our website `www.cin.ufpe.br/~jffv/papers/cibse2020`.

5.2 RQ2: Did the students consider that they improve their requirements communication and elicitation skills by participating in the game?

We present the results about the Knowledge (Learning) aspect in questions Q18, Q19 and Q20 in Table 5. 80.60% of the students agree or totally agree that *The game was efficient for my learning as compared to other discipline activities (Q18)*; 94.03% agree that *The dynamics contribute to my learning in the discipline (Q19)*; and 83.58% agree that *After the game I feel that I can better apply the themes related to the game (Q20)*.

We observed that the results obtained in the second stage were generally higher than the first. This can be compared to the difference of the contact that the client has in the traditional methodologies and agile methodologies. In the second execution of the dynamic at UFPE, we asked open questions regarding the game whose subjects' answers are presented below.

What problems occurred in both rounds? Regarding the problems faced, we received answers such as (Student 1): *"At first it was taking things from text to draw, and in the second trying to understand what the client was talking about, since the developers had not seen the image".*

(Student 2): *"In the first round the analyst in my group did not quite understand the client's description of perspective in which the image was being viewed. Already on Monday, the analyst was unable to pass to developers the proper proportion of certain parts of the image that the customer described."*

(Student 3): "In the first the difficulty of understanding completely without the help of the client and in the second, there was a lack of interaction between the developers and the analyst, given the client's presence."

Is there any relationship between the rounds and the development methods discussed previously in the class? *(Student 4): "Yes, everything that was presented in the classroom dynamics had already been cited by the teacher."*

(Student 5): *"Yes, but the approach was more external to the content, giving us the basic insight into how requirements-building works in practice."*

(Student 6): *"Yes, the study of methodologies behind software design, both traditional methodology, and agile methodologies."*

What was the biggest challenge you faced? *(Student 7): "Try to do what the customer really asked for."*

(Student 8): *"To be able to pass the details of the figure without being able to draw."*

(Student 9): *"The deadline for delivery of the final drawing."*

(Student 10): *"At first the communication. Already in the second moment, I believe that by being with the customer from the moment of conception until the end of the process, the number of details and the billing increased."*

Did you enjoy the performance of your team? Why? The majority of students liked the experience of learning from the game with comments such as: *(Student 11): "Yes, we were too excited.*

(Student 12): *"I liked it. It stimulated our imagination, and our communication in the second round improved a lot."*

(Student 13): *"Yes, although we were unable to achieve the customer's wishes perfectly, the group interacted and had a great time."*

(Student 14): *"Yes, I believe a good team relationship helps in a more satisfying final work."*

However, some subjects got disappointed for not being able to finish the task: *(Student 15): "No. Because they did more than I said and took longer."*

(Student 16): *"no, because we did not get close to what the client wanted."*

(Student 17): *"no, we could have done better."*

(Student 18): *"No, because the first round did not go as the customer wanted."*

List at least two key competencies that can be related to the challenges experienced in the game. The competences related to the "Translation Loss" game that the students state as fundamental to requirements engineering are listed in Table 6.

Table 6. Competences related to the "Translation Loss" game the students listed as fundamental.

Good communication / Dialogue	14
Agility / Time Management / Deadline	10
Team spirit / Teamwork / sociability	8
Attention/Concentration	7
Understanding / Similarity / Interpretation of the idea requested by the client	4
Details identification	3
Drawing skills	2
Imagination	1
Organization	1
Commitment	1
Analysis skills	1
Client feedback	1
Logical reasoning	1

5.3 Threats of the validity

As the study subjects are undergraduate students with none experience in requirements elicitation and without previous contact with the game, we can consider them representative for the evaluation of learning from the game as also pointed out by related work [8]. Although the two executions of the game were well-evaluated by the students considering it an interesting game, we can point our some threats to validity [19].

The use of pictures instead of technical requirements artifacts, such as requirements models or software specification may affect in some manner the study results. However, we claim the approach presented in this work is a good start to teach RE since one of the main problems in RE is communication and coordination that happens in both traditional and agile methodologies [6]. We claim that first the students should be aware how important communication among stakeholders, specially with the client is, then we move towards teaching technical content. This is a good awareness exercise with students in the beginning of the course (first and second semesters) as in our executions. A follow-up approach would be explaining the differences of requirements types (functional, non-functional, business rules) and move to requirements specification documents or models which are the RE skills required for software development.

A related point is one can consider the game a general teaching methodology where the communication among different team roles is relevant rather than a specific approach for requirements elicitation. We disagree with the affirmation as previous discussed since the process of requirements elicitation involves communication skills with the team and the client. Finally, aiming to avoid the crossing influence among the different groups, we provide an incentive of determining a winner team that came closest of the figures, i.e the requirements of the client. The winner team graded some extra point as motivation.

6 Conclusions

The aim of agile methodologies is always to have the customer actively parting of the team. Constant contact with the customer enables rapid feedback and facilitates communication. Greater communication allows us to identify and solve problems more quickly [4]. The evaluation of educational material is an activity recognized as essential in the teaching and learning process because it is necessary to evaluate if an educational product can fulfill what was planned for it [12].

In this paper, we present an experience report of the application of a game conducted in two undergraduate classes of different universities. Our goal was to improve requirements elicitation and communication skills in those students by showing how risk management and system quality are positively affected by good customer collaboration.

From the student's feedback, we concluded that the objectives were successfully achieved. The challenge and satisfaction aspects of the game received scores above average. Nevertheless, the scores were lower than the other aspects. On the other hand, students learning received a high percentage of agreement.

The learning was effective; however, it is necessary to make some adjustments, as, for example, the definition of milestones of the game and to provide a more focused explanation on the common points, the agile methodologies and the game Loss in Translation.

As future works, it is expected to carry out further experiments with larger samples of students from disciplines that involve requirements engineering to improve further the application of this group game and understanding of the concepts involved. Another future work would be investigating the game application in industrial scenarios. An open question is *Could it be possible to teach improved requirements elicitation in already established companies?* We observe that there differences in instructing students and professionals, and the road to teaching requirements elicitation in the industry has not been paved yet, and it may be a very promising research niche.

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