The Robbers and the Others – A Serious Game Using Natural Language Processing

Irina Toma[1], Stefan Mihai Brighiu[1], Mihai Dascalu[1,2(✉)], and Stefan Trausan-Matu[1,2]

[1] University Politehnica of Bucharest, 313 Splaiul Independentei, 060042 Bucharest, Romania
irina_toma@rocketmail.com, sbrighiu@gmail.com,
{mihai.dascalu,stefan.trausan}@cs.pub.ro
[2] Academy of Romanian Scientists, 54 Splaiul Independenţei, 050094 Bucharest, Romania

Abstract. Learning a new language includes multiple aspects, from vocabulary acquisition to exercising words in sentences, and developing discourse building capabilities. In most learning scenarios, students learn individually and interact only during classes; therefore, it is difficult to enhance their communication and collaboration skills. The prototype game described in this paper aims to fill this gap and improve the students' learning skills in a smart learning environment suitable for a problem-solving game. In addition, the game is also an useful tool for teachers because of the integrated chat analysis that enables the identification of the most predominant points of view and the overall level of collaboration between participants. The game is developed as a bot on the Slack chat platform and reacts to user commands. At the end of a game round, the bot is to save the conversation transcript and send it to the *ReaderBench* framework for further chat analysis.

Keywords: Collaborative serious games · Smart learning environment
Conversation analysis · Online chat · Language learning
ReaderBench framework

1 Motivation

One important task in a 'smart' learning ecosystem is to help language learning both native children and foreigners that enter in that ecosystem. However, language learning is a long-term process that includes vocabulary acquisition, accompanied by its usage in a coherent manner, within more and more elaborated contexts. The language learning process that is currently available in schools and universities is based on memorizing concepts, repeating them and using them in sentences [1]. Our study focuses on enhancing these methods by incorporating them in a smart learning environment that makes use of gamification. Starting from serious games centered on vocabulary acquisition, such as Semantic Boggle [2] and Semantic Taboo [3], our aim is to move forward towards evaluating how students understand written texts [4].

In this paper we introduce a prototype serious game that focuses on improving the collaboration and communication levels of students. The game, *The Robbers and the Others*, is a problem-solving role-playing smart chat environment in which students are

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encouraged to discuss in order to find the people responsible for robbing a bank. The game is presented as a Slack bot [5], and uses ElasticSearch [6] and Firebase (https://firebase.google.com/) to store messages and search through the conversations.

2 Chatbots

Chatbots are software programs that interact with humans using a Natural Language Processing (NLP) interface. The concept emerged in the 1960s when the chatbot implementation was straightforward: it searched for simple keywords that matched the input of the user [7]. Nowadays, chatbots evolved into intelligent systems, which are no longer limited to pattern-matching or decision trees, but rely on NLP techniques and Machine Learning [8]. These systems are found in everyday life: education system, public relations sector, enterprise communication, and entertainment [9].

In education, chatbots have been used as Intelligent Tutoring Systems [10, 11] to help students learn new concepts. For example, *Chatbot* [12] is a didactic software instrument built to help students learn Computer Science concepts by programming the bot. The bot can connect to social media chats and reply to conversations. It provides contextual answers depending on the previous topics or in relation to the inputs of the other chat participants. Chatbot is given pairs of pattern-effect elements and responds with the effect when the pattern is matched. Students are responsible of writing these patterns and, by doing this, they learn basic Computer Science concepts.

In the enterprise communication area, many new chat systems emerge (e.g., Slack – www.slack.com, Skype for Business – www.skype.com/en/business, HipChat – www.hipchat.com). These integrate bots from the simplest ones, for tasks such as file sharing, notifications or white board for drawing schemas, to more complex ones, like triggering commands from textual conversations or agile management.

For the current work, Slack bots are of interest. Slack offers an API for creating bots that act similar to a human user. Some examples of bots include:

- *Sofi* (www.swipesapp.com) is a project manager chatbot available for Slack that assigns tasks to other people in the team at the manager's command. *Sofi* also chats with people about those tasks and when they are done, it assigns the next one.
- *MeetingBoot* (https://meetingbot.io/) checks availability of other people, searches for the best meeting times, books meeting rooms and notifies people when they are late for a meeting.

3 Game Description

The Robbers and the Others is a collaborative problem-solving game to be played in a group of minimum seven people. The purpose of the game is to solve a bank robbery case, identify the robbers and send them to jail. All interactions take place using text contributions and no images or animations are displayed to the users, only narrative segments. Moreover, all witness statements are collected through a Slack chat, enabling follow-up in-depth analyses of the transcripts.

The game exposes three types of users: (a) admins – they can start/stop sessions and can add/remove other admins; (b) leader robber and others – the leader plans the robbery, while the others have access to the robbery details and the list of robbers; (c) detective lead and others – the leader setups the press release, while others have access to the press release details, the detective list, and the topics. The users interact in the chat window during the stages of the game, each described in detail below.

Robbery and Press Release Scenes. The plot of the game takes place in a fictional town where the bank is robbed. The robbing involves shooting and the police arrives too late; thus, specifications are unclear and witness questioning is required.

The actual game is started by the admin once all required users joined the chat room. In the first step, the robbers and the detectives are chosen randomly. For a minimum of seven players, two of them will be robbers, two detectives and the rest civilians. Each of them receives a private message similar to the one in Fig. 1. Robbers and detectives should discuss in different chat rooms the details of the robbery and, respectively, of the press release (see Fig. 2a).

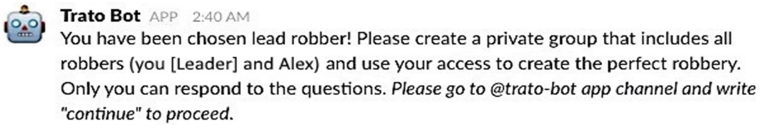

Fig. 1. The message sent to the leader robber at start up.

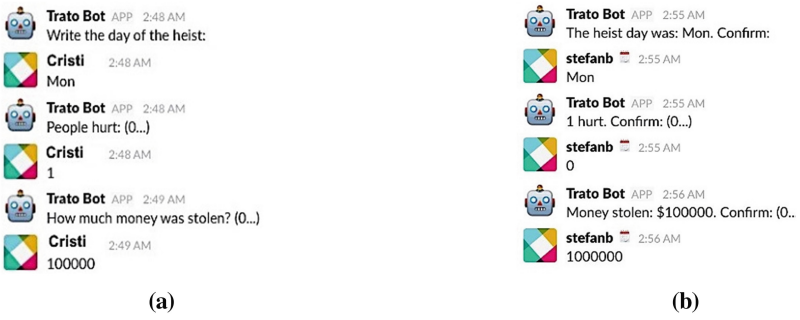

Fig. 2. The lead robber/detective decides the details of the robbery/press release.

After investigating the robbery scene and discussing with the witnesses over the chat, detectives discover information about the robbery: number of casualties, the weapons used by the robbers, and how much money was stolen. Next, they organize a press release that is not attended by the robbers.

For the press release, detectives can decide to change the information about the robbery in order to confuse the thieves. For example, if the robbery took place on a Saturday, they could say it happened on Sunday, or they could change the amount of stolen money (see Fig. 2b).

Town Hall Meeting. The plot twist of the story happens when the detectives announce the concerned citizens that they found the leader of the robbers and they are confident they would catch him soon. Hearing this news about the unknown leader, the robbers get frightened. During the following week, the detectives organize a new meeting in which the entire community presence is requested, including the robbers. The purpose of this meeting is to set some ground rules for the next discussions and decide on the list of topics. Detectives are in charge of changing the topic of the conversation, as some topics could reveal valuable information about the robbery. Each conversation is recorded by the Court Reporter and is available later on as XML transcripts. Figure 3a presents an excerpt from the conversation on the topic "Amount stolen". Here, the lead robber makes the first mistake, acting surprised when told about the amount of stolen money.

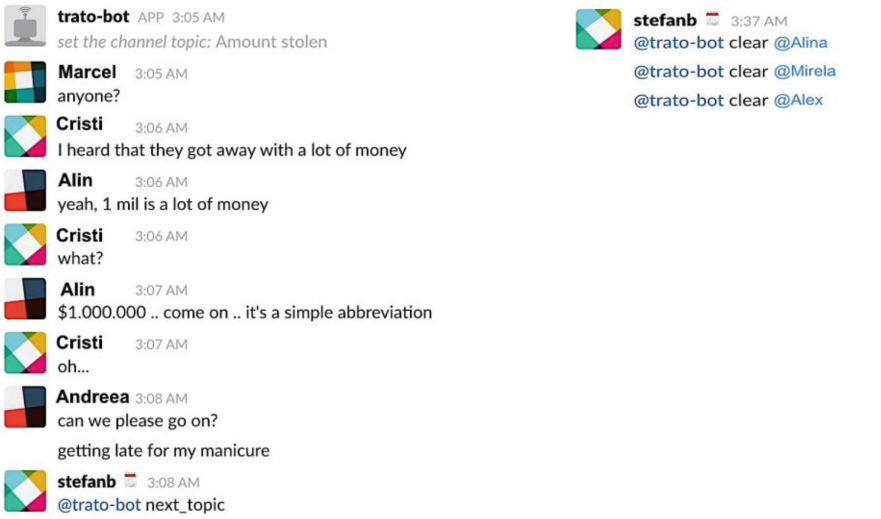

Fig. 3. **(a)** The lead robber makes the first mistake. **(b)** The detective clears two citizens and one robber.

Game End. After the topics end, the detectives lock people in the town hall for few minutes; the Court Reporter also leaves, so the discussions are not recorded. The robbers panic when the detectives return and say they solved the case. Detectives have no evidence to convict anyone, but they hope that the robbers will confess if put under pressure. They call the names of most people in the room, but, one by one, people are dismissed as innocent. The rest of the citizens would be held for additional questioning. As a final push, after 24 h, detectives decide to lower the robbers' sentence if they confess. Depending on the robbers, they would all get away if nobody confessed, or go to jail otherwise. The game can be lost by the detectives if they clear more robbers than 50% plus one robber, or won if the number of cleared civilians is higher than 50% minus one robber. As seen in Fig. 3b, the lead detective clears one of the robbers; therefore, the robbers win.

4 Chat Analysis

At any point in the game, the admin user can request the chat transcript. Once the transcript is generated, the bot sends it to the Computer Supported Collaborative Learning processing endpoint from the *ReaderBench* framework [13] for analysis. The response covers the level of involvement in the chat corresponding to each student. This information is most valuable in a visual format, where teachers can follow the contributions of each student, their evolution in time in terms of active participation (see Fig. 4), or of collaboration with their peers (see Fig. 5). Based on this information, teachers can decide how students collaborated in solving the problem, whether they understood the discussed topics and propose exercises to improve students' collaboration and comprehension levels.

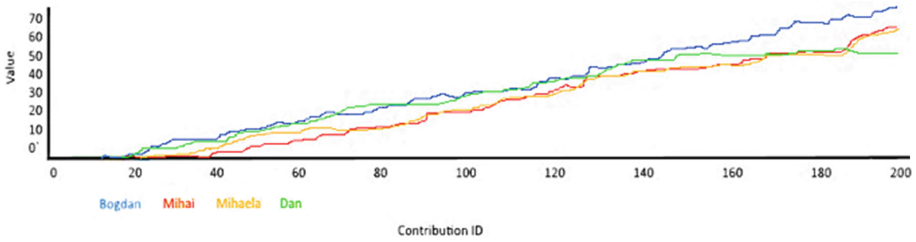

Fig. 4. Participant evolution graph.

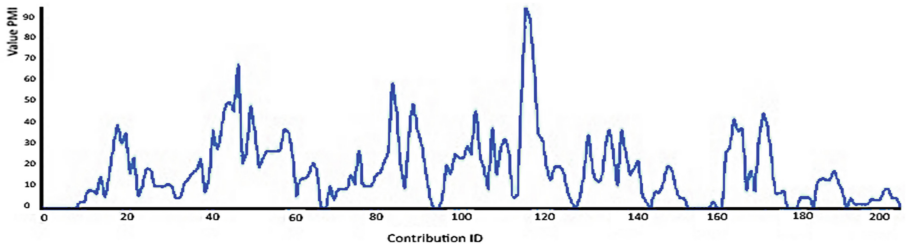

Fig. 5. Collaboration between participants throughout the conversation.

5 Conclusion

On the path to language learning, students are first confronted with vocabulary acquisition. Having a strong vocabulary base, they feel confident in moving towards the next step – understanding written texts and participating in conversations. Our study focuses on providing students an alternative language learning process, a smart gamified environment in which they learn by playing. The serious game prototype presented in this paper focuses on improving students' communication and collaboration skills. This is achieved in a fun, competitive, and smart environment where students play the roles of thieves, detectives, and civilians in a bank robbery. All student interactions are held in

a chat environment, provided by Slack, where the conversation flow is dictated by a Slack bot called *trato-bot*. The educational value of the game comes from the integrated in-depth chat analyses based on the conversation transcripts. This is valuable for teachers as they can easily identify the most active students in the game, provide them feedback and suggest exercises to improve students' comprehension and collaboration levels.

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