Olga De Troyer, Anas Helalouch, and Christophe Debruyne. Towards computer-supported self-debriefing of a serious game against cyber bullying. In R. Bottino, J. Jeuring, and R. C. Veltkamp, editors, Games and Learning Alliance - 5th International Conference, GALA 2016, Utrecht, The Netherlands, December 5-7, 2016, Proceedings, volume 10056 of Lecture Notes in Computer Science, pages 374–384. Springer, 2016

Towards Computer-Supported Self-Debriefing of a Serious Game Against Cyber Bullying

Olga De Troyer [1], Anas Helalouch [1], Christophe Debruyne [1,2]

[1] Vrije Universiteit Brussel, Research Group Wise, Pleinlaan 2
1050 Brussel, Belgium
[2] Knowledge and Data Engineering Group, School of Computer Science and Statistics,
Trinity College Dublin, Dublin 2, Ireland

{Olga.DeTroyer,Anas.Helalouch}@vub.ac.be,debruync@scss.tcd.ie

Abstract. It is argued that reflecting on the in-game performance in a serious game is important for facilitating learning transfer. A way to facilitate such a reflection is by means of a so-called debriefing phase. However, a human facilitated debriefing is expensive, time consuming and not always possible. Therefore, an automatic self-debriefing facility for serious games would be desirable. However, a general approach for creating such an automatic self-debriefing system for serious games doesn't exist. As a first step towards the development of such a framework, we targeted a specific type of serious games, i.e., games displaying realistic behavior and having multiple possible paths to a solution. In addition, we decided to start with the development of a debriefing system for a concrete case, a serious game about cyber bullying in social networks. In particular, in this paper, we focus on different visualizations that could be used for such an automatic debriefing. We combined a textual feedback with three different types of visualizations. A prototype was implemented and evaluated with the goal of comparing the three visualizations and gathering first feedback on the usability and effectiveness. The results indicate that the visualizations did help the participants in having a better understanding of the outcome of the game and that there was a clear preference for one of the three visualizations.

1 Introduction

For serious games that try to induce attitude or behavioral changes by means of simulations, transfer to reality of what is learned is not obvious, i.e., it is not because the learner performs well in the game that this person will also show the desired attitudes and behaviors in the real world. It is argued in the literature [1]–[3] that reflecting on the in-game performance is important for facilitating learning transfer. Although they may be different ways to support reflections (e.g., reflection amplifiers [4] and self-regulation [5]), one possible way to facilitate such a reflection is by means of a so-called *debriefing* phase.

Debriefing in serious games can be described as the activity of reflecting on the gaming experience to turn it into learning [3]. Most digital serious games however do not include an explicit debriefing phase. If debriefing is foreseen, it is done by having

a human facilitator discussing with the player about his/her results. This is expensive, time consuming and not possible when the serious game is used in a non-facilitating space (e.g., at home) or when no expert-facilitator is available. Therefore, an automatic debriefing facility for digital serious games would be desirable. However, a general approach for creating an automatic debriefing system for serious games doesn't exist. Moreover, the development of such an approach is complicated by the fact that there are many different types of serious games, which may require different approaches.

Our focus of research is on the automatic debriefing of serious games that use a form of simulation in their gameplay. These games show realistic behaviors that are not too predictable, and have multiple possible paths to a solution. These characteristics can make the outcome of a serious game less transparent, which may actually impede learning when not complemented with an appropriate debriefing. In order to investigate how we can provide computer-supported self-debriefing for this type of serious games, we decide to start with a concrete case, the serious game BullyBook [6], and investigate how to incorporate self-debriefing into this serious game. BullyBook simulates a social network like Facebook, and has the specific didactic aim to let players experience how to behave in case of cyber bullying in daily conversations on social networks by being confronted to realistic cyber bullying cases.

As approach to the debriefing, we decided to opt for providing explanations on the course and outcome of the serious game but without explaining the details of the inner logic used by the serious game. Vig et al. [7] call this *justification*. While *transparency* reveals the mechanism of the algorithm used, justification is decoupled from the algorithm. We opted for justification because, in general, the exact algorithms used may be too difficult to explain, especially to casual users.

As a first step in the research, we decided to focus on experimenting with different visualizations that could be used to explain the outcome of the serious game. Visualizations have the advantage that they allow showing a large amount of information in a compact way. The other advantage is that we can allow the player to interact with them, which will make the debriefing an active process. To provide information about the interactions that took place in the game and to give feedback about how these interactions influenced the outcome, we combined textual feedback with three different types of visualizations, each focusing on a different aspect. A prototype was implemented and evaluated with the goal of comparing the three visualizations and gathering first feedback on the usability and effectiveness. The results indicate that the visualizations did help the participants to have a better understanding of the outcome of the game and that there was a clear preference for one of the visualizations.

The paper is organized as follows. Section 2 discusses related work. Section 3 provides a short presentation of BullyBook game, and section 4 presents the debriefing visualizations devised for BullyBook. In section 5 we present the evaluation. The paper is concluded with a summary, limitations of the work, and further work.

2 Related Work

In (serious) games, we can distinguish two mainstreams of research related to automatically explaining the game outcome. One group focuses on game analytics [8], i.e., analyzing game-related data. Most of these systems have the aim to provide *de-*

velopers insight in player behavior for improving the game [9]. In [10], [11], and [12], examples of visualization tools for this purpose can be found. The tools are in general for a specific game. When the players themselves are targeted as users, it is usually to facilitate community building and to allow players to compare their performances. Analysis of serious game metrics for monitoring the learning process is mostly restricted to a few parameters, such as the average time spent on a task, the average number of attempts, and the scores. An exception is the work in [13] that facilitates data analysis for single player open physics games by logging all basic actions of the player, but the data is used to allow developers to explore possible explanations for students' behavior.

Research in the field of debriefing demonstrates the importance of including debriefing activities to enable the learner using the new knowledge in other settings than the one in which it was acquired [14]. This retrospection usually happens when the game is finished, but in-game or pre-game debriefing is also a possibility. Very few serious games include an explicit debriefing but rather use in-game feedback as a reflection mechanism and an in-game or post-game assessment for monitoring the learning progress. Because this is not our aim, we will not discuss this type of work.

Cleophas [15] provides a framework to design and develop serious games for revenue management. This framework assumes 3 stages: the Briefing of the game and the conditions, the Game Execution, and finally the Debriefing, which includes a descriptive analysis and a casual analysis. In the descriptive analysis, the result indicators are analyzed and compared for all players, while in the causal analysis, the relation between user actions and resulting events are analyzed individually.

Pavlov *et al*. [16], apply structural debriefing for black-box simulations. This (extensive) strategy is based on the Structural Debriefing Protocol, which is a step-by-step description of how to debrief an activity using concepts of System Dynamics. This protocol was tested on LITTLEFIELD, a serious game that simulates a small factory that produces electronic equipment. This debriefing protocol consists of 8 steps and requires the construction of a dynamics model of the black-box simulation.

3 BullyBook

The BullyBook serious game was developed to help youngsters practicing how to behave in case of cyber bullying in a social network like Facebook. To achieve this, the player participates in a fictive social network. The player is represented in the network by the character Angelo who has a number of "friends" (Non-Player Characters (NPCs)). These NPCs interact with each other, as well as with the player, by posting messages on each other's wall or by liking posts. The player can intervene in interactions posted by the NPCs by reacting to a post or he can initiate interactions by posting new messages. Each level of the game gives the player an objective. For instance, for the first level the player has to "befriend" 3 persons (NPCs) from his network, meaning that the player should act as a friend to these people by offering help or support. No indication is given on how to achieve this goal (as this will be part of an accompanied course or serious game). But the game visually shows how the player is progressing towards his objective by means of a progress bar, and a color code shows the player's level of being befriended with the different NPCs.

Fig. 1 shows the main screen of the game. In the left most column, the list of NPCs (so-called "friends"), the objective, and the progress bar towards the objective are displayed. As explained, a color code is used as background for the pictures of Angelo's friends to indicate the level of being befriended: green for good; red for bad; and no color for neutral. The second column contains the player's wall and in the third column, we can see the wall of the NPC selected in the first column. On all the walls, the player can post messages or reply to posts by selecting a post from a given (dynamically adapting) list (see Fig. 1). The number of interactions per NPC is limited to avoid that the player is applying a try and error strategy. In the rightmost column newsfeeds are shown to allow the player to quickly navigate to the latest posts.

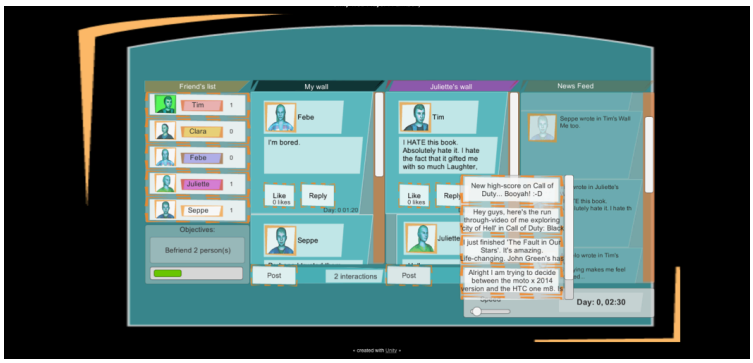

Fig. 1. Main screen of BullyBook

To realize the simulation of a social network, the iATTAC system was used. iATTAC is a AI-based system for realistic interactions between autonomous game agents in a social network environment [6] [17]. The autonomous behavior of a character is achieved by using the Reiss personality model [18]. This model consists of 16 basic desires, such as "eating", "power", "social contact", and "status". According to the theory behind this model, every human being tries to fulfill these needs, giving priority to the desire with the lowest value. The value for the needs decreases over time. The pace of decreasing is determined by the individual personality of every human being. This personality model is complemented with other components to form a complete personality, for instance rules can be added that can enforce certain behavior, e.g., a rule to express the "not standing up for victims" for a NPC.

To handle social interactions between NPCs, iATTAC uses Berne's transactional analysis [19]. At the core of this framework lies the concept of *social game*, which is a series of interactions that progresses to a well-defined, predictable outcome. An example of such a social game is a greeting. Each such social game has a list of roles (some can be optional), a series of strokes (fundamental units of actions), and a payoff (a social benefit for each participant based on the role he/she played). Social games, also called *rituals*, are used in iATTAC to define how the social interactions will occur, what type of NPCs are involved as well as their roles, and how the interactions affect the personality of these NPCs (i.e., what is the payoff). For instance, in a classical bullying ritual three roles can be distinguished (bully, victim, and bystander) and after being the victim of a bully, the basic desire for safety will increase for the bully.

4 Visualizations for Debriefing BullyBook

Giving insight to the player into the outcome of a game in BullyBook is not obvious. The player can reach the objective in a large number of ways; there is no single correct solution path. Each action can trigger an interaction of other NPCs and eventually lead to a step closer to, or further away from the objective. To provide insight into the effects of the different interactions, i.e., the player's own interactions as well as the interactions of the other NPCs, we should indicate how the different interactions have affected the outcome of the game. Only describing the underlying models used is not sufficient, as it does not give any indication on how the actions of the player have affected the outcome of the game. It is comparable to telling a student that the solution he provided for an exercise is wrong and provide him the theory once more. Most students will still not understand what exactly they did wrong. The teacher should indicate precisely which steps in the solution are wrong or correct, and why.

The information given to the player should provide sufficient information to allow him to answer the following questions: "Why have I won or lost?"; "How have my actions affected the outcome of the game?"; and "What interactions could I have performed to improve my results?". To enable this, we need to know which elements and actions impact the player's success or failure. Next, we have to decide on how do capture them, and how to present this information to the player in a way that (1) is understandable by the player and (2) allows reflection on the past actions. Section 4.1 deals with the capturing of the information and section 4.2 with the visualization.

4.1 Capturing Relevant Data

In BullyBook, different elements, such as time, personalities, and interactions, may influence success or failure in a complex way. To capture the essential elements we have used the concept of game states from [13]. Every time an interaction takes place (either initiated by the player or by a NPC), a state will be logged containing the interaction type and content, the time of interaction, the values for the personality desires of the NPCs and the player, as well as the progress towards objective.

4.2 Visualizing the Data

Three different visualizations, each focusing on different aspect and centering the data on one variable, have been developed. Using an evaluation, we have investigated which one(s) is/are best in the context of the debriefing of a BullyBook game.

The first visualization, called *time-oriented visualization*, puts the focus on the time of occurrence of the interactions. The standard way to do this is to use a time line of events (i.e., interactions) on which the user can click to obtain information about the specific interaction (see top of Fig. 2). On clicking, the content of the interaction is displayed (middle part of Fig. 2). If the action is a "like" or a reaction, the original post is also shown. A feedback message is given to indicate the impact of the interaction (i.e., positive, negative, or no impact). Changes in the values of relevant personality characteristics of the targeted NPC are also displayed in a visual way (using bars - see lower part of Fig. 2). In case of a negative interaction, the player also has the pos-

sibility to ask the system what a better action would have been by clicking the “Better Action” button. In addition, a replay button (not yet implemented) could allow the player to return to that specific moment in time and allow him to replay the situation (see further work). The main advantage of this representation is its linearity and the ability to find critical interactions in time. The major drawback is that it does not permit to see the evolution of the personality values of an NPC and how the results of interactions between NPCs and the player influenced the game’s outcome.

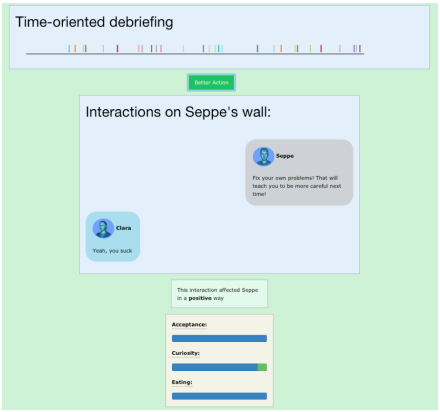

Fig. 2. Time-oriented visualization screen

The second visualization, called *character-oriented visualization*, puts the focus on the characters (player and NPCs) and tries to provide a clear overview of the relationships between characters during the game. This is done using a D3 chord diagram (see Fig. 3a). A line between two characters indicates that there were some interactions between these two characters. When hovering over a character name, only the relationships associated with that character are shown. The player can interact with this visualization in two ways. When a relationship between two characters is selected, a list of all the interactions between these two characters is shown (see Fig. 3b; green is a positive interaction, red is a negative interaction). The interactions in this list are clickable to show more information about the interaction. This is done in the same way as described for the time-oriented visualization. Secondly, the name of a character is also clickable, which leads to a screen where the interactions involving that character are shown on a timeline (see Fig. 3c). Below the timeline, the personality values of the character are shown for the selected time. This allows one to see how the personality values evolved over time for a character. The interaction details are shown each time an interaction is selected. This visualization solves the first disadvantage of the time-oriented visualization, but still has the disadvantage of not providing a clear overview of how the interactions affected the characters.

We therefore provided a third visualization, the *interaction-oriented visualization*. This visualization focuses on the interactions between the characters. The different characters of the game are shown on the screen; for each interaction between two characters, a small circle linked with the involved characters is added to the visualization (see Fig. 4). A red circle is used for a bad interaction, a green one for a good

interaction. The circles are clickable to get more information about the interaction (in the same way as for the two other visualizations). Because there is a risk that the visualization might be overcrowded (in case of many interactions), filters are provided. These filters allow one to select only good/bad interactions, to focus on a specific character, or to hide the replies and only show the original posts.

(a) (b) (c)

Fig. 3. (a) Overview of the relationships between characters; (b) List of interactions for a selected relationship between two characters; (c) Selecting one character in the character-oriented visualization shows the interactions of this character on a time line

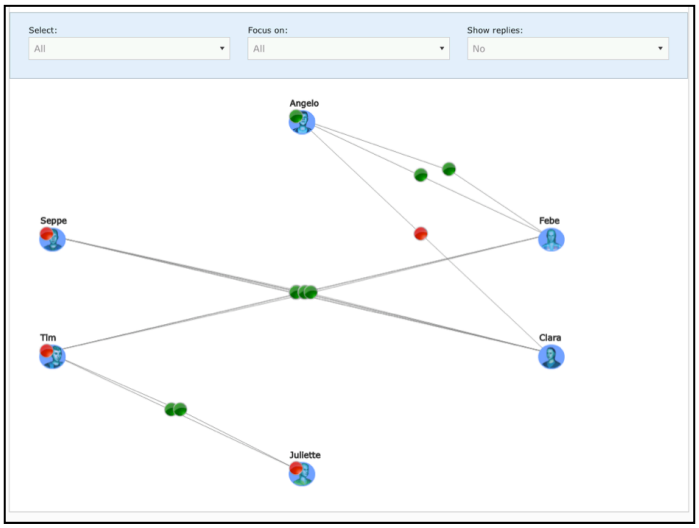

Fig. 4. Interaction-oriented visualization screen

5 Evaluation

In order to verify whether the proposed visualizations allow a better understanding of the outcome of a game and to evaluate which visualization(s) was/were most appro-

priate, we did a pilot study. A pilot study [20] is recommended for a first evaluation of the feasibility of a project, and is done by performing a small-scale experiment. For this purpose, the system was implemented as a web application consisting of three modules, one for each type of visualization. To perform this pilot study, a user experiment with 5 participants between 18 and 27 years old and all frequent users of social networks was conducted, as this is the target audience of the game.

The pilot experiment was performed in a closed setting with the presence of an evaluator and for each participant individually. A participant first received a verbal explanation of the game, but without giving too much information about the debriefing system, as we also wanted to measure the usability of the debriefing system. Next, the participant played the game (one level), after which the participant filled out a post-game questionnaire to evaluate to what extend the player understood the outcome of the game and the effects of the interactions. For this, the player had to rate (on a scale of 1 to 5) statements, such as "I understand the outcome of the game", "My actions had the effect I expected they would have on the characters", "Deciding on my reaction to a bullying post was easy", etc. Then the participant could experiment with the three different visualization modules sequentially (in a random order to avoid that the results were biased by the order in which the visualizations were used). After each module, the participant was asked to answer a number of closed questions about the proposed visualization. For each visualization, the questionnaire was slightly different because some questions were adapted or specific for the type of visualization. We asked how easy it was to obtain a clear overview of all interactions, how easy it was to understand how the interactions affected other characters, how easy it was to understand what the visualizations represented. We also asked questions related to the usefulness of the visualizations for recalling and inspecting the course of the game. The overall usability was evaluated using the System Usability Scale [21].

The average result for the first questionnaire, focusing on the understanding of the outcome of the game and the interactions that took place (but without using any debriefing) was 3.1 (on 5). Although this result is not bad, it is also not good, as we have to consider that only one level was played. This first level is simple and therefore it is likely that participants who had trouble understanding the outcome of the first level will experience more trouble understanding the outcome of next, more difficult levels.

The average score for the time-oriented debriefing module was 3.8 (on 5). We think that this rather good score is mainly due to the simplicity of the visualization. Two aspects, one about the amount of details presented and one about a good overview of the interactions, were not as well received, indicating that although the simplicity of the visualization was an advantage, getting useful information regarding the game was lacking. The character-oriented debriefing received a better score: 4.1 on 5. This can be explained by the used two-step visualization. The first screen only shows the relationships between characters, and only after clicking a relationship the interactions between the two characters are displayed. According to one of the participants, this made the interaction more structured and "fun to use". Finally, the interaction-oriented debriefing received the best score: 4.4 on 5. This visualization provides a complete overview of the interactions and the filters avoid overloading.

The overall usability was evaluated with a score of 78, which indicates that the usability of our system is good (higher than 68 is considered better than average [21]).

This result is important because this indicates that the usability of the system did not have a negative impact on the results obtained in the other questionnaires.

Finally, the last questionnaire regarding the understanding of the outcome of the game and the interactions after the debriefing (with similar questions as in the first questionnaire) scored 4.3 (on 5) (while the score before debriefing was 3.1). The participants reported to have a better understanding of the game's outcome after having used the different visualization modules. This result indicates that the visualizations can play an important role in understanding the outcome of a game. On the question "I now feel more secure on how to deal with bullying situations on social networks" most participants replied neutrally. This can be explained by the fact that only one level was played and the context in which the game should be embedded (course material and a game to learn to recognize bullying situations) was missing.

6 Summary, Limitations and Future Work

This paper described the steps undertaken to create an automatic self-debriefing system for a serious games displaying realistic behavior and having multiple possible paths to a solution. We started from a concrete case, a serious game to deal with cyber bullying in social networks, and investigated how to incorporate debriefing into this serious game. We decided to provide explanations on the course and outcome of the serious game but without explaining the details of the inner logic used by the serious game. For this purpose, we first extended the game to capture all relevant data by means of storing game states. After this we investigated how we could present the information to the player in a way that would allow reflection on and understanding of the outcome of the game. We opted to do this by means of visualizations because visualizations allow us to display a large amount of data in a compact way. We developed three different types of visualizations, each focusing on a different aspect: time, the characters, and the interactions. We implemented a working prototype of the system and evaluated it in a pilot study. The results indicated that the visualizations did help the participants in understanding the outcome of the game better and that the interaction-oriented visualization scored best.

We have to note that the pilot study has limitations: the participants played only one level and the number of participants was limited. To evaluate the actual effect on the understanding of the outcome of the game and the impact on understanding how to behave in real life cyber bullying situations, more levels should be played and a larger scale evaluation including quantitative as well as qualitative measures, and over a longer period should be performed.

One feature that was mentioned but not integrated in the current prototype is the replay functionality. This functionality can have a positive effect on the reflection process, as it resituates the player in the context of his decisions. Another extension that we like to consider is the possibility to ask the debriefing system to explain (in words) why a certain interaction occurred. As for the implementation of the prototype, the system is currently a web application that must be used after having played the game. An appropriate integration of the two would obviously be better and might have an impact on a player's overall experience.

References

1. Peters, V. A. M., Vissers, G. A. N.: A simple classification model for debriefing simulation games: Simul. Gaming, vol. 35, no. 1 (2004) 70–84
2. Fanning, R. M., Gaba, D. M.: The Role of Debriefing in Simulation-Based Learning: Simul. Healthc, vol. 2, no. 2 (2007) 115–125
3. Crookall, D.: Serious Games, Debriefing, and Simulation/Gaming as a Discipline: Simul. Gaming, vol. 41, no. 6 (2010) 898–920
4. Verpoorten, D., Westera, W., Specht, M.: Reflection amplifiers in online courses: a classification framework: J. Interact. Learn. Res., vol. 22 (2011) 167–190
5. Winne, P. H.: Experimenting to bootstrap self-regulated learning: J. Educ. Psychol., vol. 89, no. 3 (1997) 397–410
6. Cebolledo, E., De Troyer, O.: Modelling Social Network Interactions in Games: Intelligent Narrative Technologies and Social Believability in Games: papers from the AIIDE 2015 Joint Workshop (2015) 82–88
7. Vig, J., Sen, S., Riedl, J.: Tagsplanations: Explaining Recommendations Using Tags: Proceedings of the 14th int. conf. on Intelligent User Interfaces (2009) 47–56
8. Medler, B., Magerko, B.: Analytics of play: Using information visualization and gameplay practices for visualizing video game data: Parsons J. Inf. Mapp. 3, vol. 3, no. 1 (2011) 1–12
9. Wallner, G., Kriglstein, S.: Visualization-based analysis of gameplay data – A review of literature: Entertain. Comput., vol. 4, no. 3 (2013) 143–155
10. Medler, B., John, M., Lane, J.: Data Cracker□: Developing a Visual Game Analytic Tool for Analyzing Online Gameplay: Proceedings of the SIGCHI conf. on Human Factors in Computing Systems (2011) 2365–2374
11. Hoobler, N., Humphreys, G., Agrawala, M.: Visualizing Competitive Behaviors in Multi-User Virtual Environments: Proceedings of the conf. on Visualization'04 (2004) 163–170
12. Andersen, E., Liu, Y.-E., Apter, E., Boucher-Genesse, F., Popovic, Z.: Gameplay Analysis through State Projection: Proceedings of the 5th int. Conf. on the foundations of digital games (2010) 1–8
13. Harpstead, E., Myers, B., Aleven, V.: In search of learning: facilitating data analysis in educational games: Proceedings of the SIGCHI conf. on human factors in computing systems (2013) 79–88
14. Nicholson, S.: Completing the experience: Debriefing in Experiential Educational Games: Syst. Cybern. Informatics, vol. 11, no. 6 (2013) 27–31
15. Cleophas, C.: Designing Serious Games for Revenue Management Training and Strategy Development: Proceedings of the 2012 Winter Simulation Conference (2012) 140:1–140:12
16. Pavlov, O. V., Saeed, K., Robinson, L. W.: Improving Instructional Simulation With Structural Debriefing: Simul. Gaming, vol. 46, no. 3–4 (2015) 383–403
17. Cebolledo, E., De Troyer, O.: iATTAC: A system for autonomous agents and dynamic social interactions - the architecture, vol. 9090 (2015)
18. Reiss, S.: The Normal Personality: A New Way of Thinking About People. Cambridge University Press (2008)
19. Berne, E.: Transactional analysis in psychotherapy: A systematic individual and social psychiatry, Ravenio Books (2016)
20. Lazar, J., Feng, J., Hochheiser, H.: Research Methods in Human Computer Interaction, John Wiley & Sons (2010)
20. Brooke, J.: SUS - A quick and dirty usability scale: Usability Eval. Ind., vol. 189, no. 194 (1996) 4-7