

TANGRAM QUESTS: A TABLET ADVENTURE GAME ASSISTING CHILDREN WITH HIGH FUNCTIONING AUTISM TO ENHANCE THEIR COMMUNICATIVE AND SOCIAL SKILLS

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Abstract

Children diagnosed with High-functioning Autism (HFA) have intelligence and language within the normal range of functioning, but present social skills deficits such as problems initiating social interactions, difficulty interpreting both verbal/non-verbal social cues, difficulty in anticipation of their turn and lack of empathy to others' distress. Most computer-based interventions for autism are designed for a single user. It is challenging to investigate whether a collaborative game on a single touchscreen device can help children between 6-11 of reduced social skills to collaborate with 'special peers', pursuing enjoyment and enhancing their social skills. Innovative contribution of the tool presented is based on the following: (a) continuing interactive process with an adult, caregiver, expert, or "special" friend (child) ensuring a structured supervising procedure, more effective in generalizing the acquired skills, (b) close association between the real and the virtual social environment, with degrees of liberty of imagination and improvisation, depending on the child's case/diagnosis, (c) social skill and emotional intelligence perspective, (d) possibility to alternate and focus on a wide spectrum/variety of levels difficulties, based on child's capacity/quality of functioning.

Keywords: High-functioning Autism (HFA), Tablet Adventure Game, Communication Skills, Social Skills development

1 INTRODUCTION

Smart devices such as tablets and smart phones enhance user experience through tangible interaction, graphics and animations. Although users are likely to decrease their social skills depending on the usage of this technology, multiplayer games developed for smart devices can also offer players the opportunity to communicate and interact with each other. Most games on touch screen devices are designed for a single user, however, it is challenging to investigate whether a collaborative game on a touchscreen device can help individuals of reduced social skills to collaborate with friends, pursuing enjoyment and enhancing their social skills.

Children diagnosed with High-functioning Autism (HFA) show lack of communication mood, inadequate use of eye contact, difficulties initiating social interactions, as well as 'problematic' emotional expression and understanding of others' feelings. They are significantly more deficient in cooperation, assertion, and self-control than their typically developing peers [3].

Tangram Quests is a two-player adventure game that motivates a child diagnosed with HFA to collaborate with a 'special partner' (a child of no syndrome or a caregiver) in order to solve a mystery as a team, overcome collaborative challenges and discover a hidden treasure. The game is designed on a touch screen split in two offering dedicated space for each player. The digital narrative, the tangram quests and mysteries that players must crack lead to an entertaining game, based, unlike most games for HFA, on treatment methods for children with HFA such as social stories [4] and Student Support Team interventions [5]. The game goals include prompting children to play in groups participating in a collaborative commitment process, waiting for their turn, controlling their behaviour in the classroom, avoiding stereotypical involvement and recognizing others' feelings. The tasks cannot be completed without their collaboration on a screen split in two, where one part of the screen is activated at a time for turn-taking (Figure 1). Our approach encourages children's collaboration as well as their interpersonal communication.

2 BACKGROUND

Traditional Social Skills Training for children with AS/HFA include role-play exercises, social stories, drama therapy, toys and materials for facilitating drama play, art therapy and music therapy [6]. Teachers and experts in Special Education often use the above interventions to help children with HFA face their communicative and social difficulties.

Social Stories are short stories that describe realistic social situations of everyday life, commonly used as a popular treatment method for children with HFA. Computer-presented social stories have already been identified as a beneficial method for remediating social skills deficits [7].

Adult-mediated and peer-mediated strategies have both been successful means of developing social responsiveness [8]. Nevertheless, children seem to prefer instruction presented by a computer to that presented by a teacher [9]. Lately, the research community has presented serious games for children diagnosed with HFA implemented for table-top displays and tablets.

Recently developed Serious Games, designed for tablet and table-top screens, usually focus either on enhancing collaborative consciousness using puzzle games and mathematical equations (e.g SIDES[10], CPG[11] and Raketeer[2]) or educating children on social and communicative patterns using quizzes. The shortcomings of the majority of tangible games for HFA include poor content connection with formalized intervention methodologies, step by step collaborative tasks, lack of evaluation processes and lack of follow up assessments to determine the stability of treatment over time.

Interesting research has also been conducted for the development of face recognition skills of children with HFA using computerized games. Results have shown that children present reliable improvements in their holistic recognition of a face based on its eyes features [12].

Related research has not yet identified the appropriate collaborative activities that could be combined to offer an integrated serious games suite targeting the social improvement of children diagnosed with HFA. Our approach puts forward, several social training methods, like collaborative puzzle games, computer-based social stories, face recognition for improving emotional consciousness and turn-taking restrictions, which are incorporated in one integrated game, so that the children would be able to improve a wide range of social, communicative and emotional skills.

3 DESIGN PROCESS

The Game Design process included subsequent steps of context research, research on existing games, defining design guidelines, design phase and implementation.

3.1 Design Guidelines

The design guidelines concerning the content, functionality and usability were defined by the research team, with respect to the needs of the children diagnosed with HFA. A team of experts in special education extensively informed the research team in relation to the characteristics of HFA and set functional limitations in terms of the design that contributed to the selection of the appropriate interaction techniques.

3.1.1 Content

The content of a serious game should be derived from the real-world needs and research methods related to HFA, in collaboration with educators specialized in HFA. Storyline and gameplay should remain funny and exciting for both children with HFA and their collaborative peers. The game should provide rewards at the end of each accomplished level or task. Quizzes should appear in a clever and exciting way, so that it does not appear obvious that the game aims to enhance the social skills of children with HFA. Customization options should also be provided to teachers and parents.

3.1.2 Functionality

The implementation of Interactions should work correctly and offer logical feedback. Animations may be incorporated in order to retain interest. A Multi-touch and multiplayer mode should be accurately implemented.

3.1.3 Usability

Help tips should be incorporated as the game progresses whenever it is appropriate, in order to help children make the right decisions and overcome game obstacles. Gestures on the tablet's screen should adhere to the common rules of the standard multi-touch tangible technologies. Minimal layout design is recommended, along with soft hues which are easier on the eyes. Game elements must have a specific and stable position on the screen, in order to be easily identified. Finally, a quick response of the game following a player's moves and the appropriate size of text and buttons are significant usability factors to be considered during the design process.

3.2 Paper prototypes

During the design phase, paper prototypes were created (Figure 1) and presented to pedagogues qualified in the field of special education, as well as technology and design experts. More specifically, three pedagogues, a Serious Game designer, two Computer Science specialists and an expert in Psychopathology and special education participated in a group discussion, during which their observations and suggestions for interactivity, visual and audio content of the game were recorded by an observer. Considering their recommendations, paper prototypes were cautiously corrected and the research team proceeded to the implementation of the game, having the constant guidance of the experts.

Among the findings derived from the collaborative sessions, researchers' recommendations for using short and literal phrases as verbal feedback were noted as well as displaying several animations to attract children's interest throughout the game and avoiding stressful activities that could lead to unpleasant feelings and refusal to participate. Turn taking was considered to be an important game element that could also be applied in the intermediate quizzes of the game. It was considered preferable to avoid presenting negative impact in relation to the feelings of the game's characters, as a result of incorrect player actions. Instead, the narrative should focus on indicating positive feedback related to the correct actions of the children as demonstrated during realistic situations of everyday life.

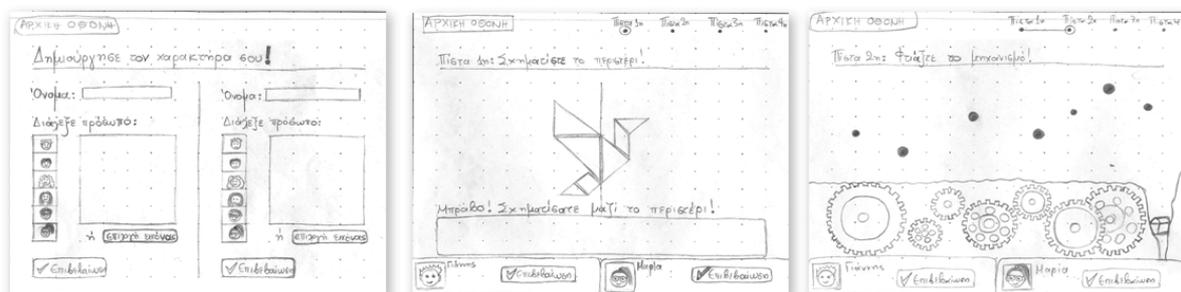


Figure 1. Paper prototypes

3.3 Basic gameplay

3.3.1 Tangram Puzzles

Players were required to solve tangram puzzles that constantly increase in difficulty as the story proceeds. The screen of the tablet is split in two parts with a dividing line. Names and avatars of the children are displayed at the bottom of the each part. There is a box containing several modules that can be used by players to solve the puzzle. Players have to choose the correct modules by turn taking and place them in the right position using drag and drop in order to make a proper structure. If they succeed, positive visual and audio feedback is communicated. There are four tangram puzzles in the game and each time they accomplish one, they succeed to proceed to the next level.

3.3.2 Memory quizzes of audio social stories - Multiple choice questions

Children listen to an audio story during which the characters express emotions triggered from specific facts. Both children collaborating as the game progresses are required to remember the story and then answer to certain questions, selecting the correct facial expression of each character according

to the character's emotional state in the story. At the end of the level, a key item of the storyline is discovered.

3.3.3 Quizzes related to Social stories in the classroom - Multiple choice questions

Both children are in the classroom. Through various situations in the classroom the children are asked to answer certain questions which will motivate them to consider their everyday behavior. Each time they select the correct answer, the teacher of the story gets happier. At the end of the game, emotional reward is offered in the form of verbal and auditory reward. The fictional teacher of the story shows her joy and rewards them by giving them access to the next level.

3.3.4 Observational games

Players should discover the correct position of items in a messy room. They choose an item as visualized at the bottom of the screen and, drag and drop it in a spot of the screen until all the items are placed in the correct position. At the end of the game, a significant item is offered to them as a reward.

3.4 Game Level Design

The children or players start by selecting their avatar. Tangram puzzles are used sequentially unravelling a hidden treasure narrative involving sound, animation and music.

At the first level, children form a dove solving a tangram puzzle. Then, they open a letter held by the dove which they can't read unless they pass the first challenge, e.g. remembering the emotions of characters of an audio story. When they manage to read the letter, they are directed to an old mine so that they find a chest.

At the second level, children assemble a mechanism placed in the old mine, using the visualized animated gears. When they succeed, they enter the shed of the mine and discover the requested objects in order to find a key to the chest. After completing the challenge, they find a map showing that the treasure is placed in the abandoned house of the great-grandfathers of the city's teacher.

At the third level, children build a bridge solving a tangram puzzle collaboratively and reach the house, but in order to unlock the door, they need to make their teacher happy. After answering correctly questions concerning their social behaviours in the classroom, the teacher opens the door and at the last level, they complete the last challenge so that the abandoned house becomes magically new.

Spatial perception of children, their skill of observation and their sense of partnership, are enhanced whilst enjoying the game. HFA children are able to improve their social behaviour following realistic social structures and strengthen their collaborative commitment after a common goal. The levels can be completed only after efficient collaboration. The customization of the tangram puzzles and the quizzes enables the experts to adjust tasks based on the skills of the children.

4 GAME IMPLEMENTATION

Tangram puzzles were used as part of the main levels of the game in order to enhance player collaboration (Figure 2). Meanwhile, intermediate quizzes and observational tasks are incorporated in the game as a part of the game plot, disguising the goal to improve skills, while decreasing the chances of creating emotional distress or psychological pressure on children with HFA (Figure 3). A game intended for children requires the element of fun to be successful, otherwise, it does not promote playful learning.



Figure 2. Tangram puzzles

The most prominent elements of the game were splitting the touch screen in two parts with one part of the screen activated at a time to indicate that each child plays in its turn and waits for the other player to complete a collaborative task (Figure 2). Moreover, there is a personalized section of the screen which includes information concerning the child responsible for each half-screen such as the child's name and avatar (Figure 4).



Figure 3. Quizzes



Figure 4. Avatars

Rewards are offered at the end of each level. There are informative screens about the progression of the game's storyline before and after the children's moves (Figure 5). Visual and sound feedback concerning potential either correct or wrong moves and answers is displayed and heard during the current phase of the game relevant to the 'owner' of each part of the screen. Game level design was implemented with Construct2, an HTML5 game creator. Our basic interaction design was developed with HTML5, JavaScript and XML.



Figure 5. Informative screens

4.1 Visual and audio cues

A progress bar is displayed at the top of the screen, indicating the current level and the route to be followed within the game. A progress bar of a key character's happiness is also presented, as well as several animations at the end of each level, indicating their accomplishments. The game offers visual and audio cues of correct and incorrect responses and provides tips to help children respond correctly to all questions. Animations and verbal reward in audio and text format are provided at the end of a tangram quest or quiz. Key items of the storyline are discovered after quizzes and observational activities (Figure 5). Items discovered by the player as the story progresses are also animated, so it is apparent that direct interaction is possible. Verbal and audio emotional reward is given after making characters of the story happy. The emotional impact on others is associated with the player's behaviour in realistic social stories. The game also provides players with visual and sound feedback for turn-taking, by changing the colour of the activated part of the screen and using verbal prompting so that the rules are respected.

5 CONCLUSION

We presented the design process of Tangram Quests, a multi-touch tablet game for children with HFA. Our research has concentrated on creating engaging activities in order to enhance the social and communicative skills of children with HFA. Tablet technology was used to support tangible interaction and face-to-face collaboration among players. We hope that the benefits of mobile technologies will encourage others to investigate the possibility of a whole new generation of games for children with HFA. The combination of several game genres is the key in order to meet the multidimensional needs for socialization, communication and emotional empathy of children with HFA. During the post-production phase, an informative evaluation process will be performed. Heuristic evaluation and think-aloud processes will be conducted by experts and groups of children of our target group, in order to acquire evaluation data concerning the efficiency of the game. A long evaluation phase is paramount in order to understand the specific needs of children diagnosed with HFA.

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