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SUPPORTING THE STRENGTHS AND ACTIVITY OF CHILDREN WITH AUTISM IN A TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT

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ABSTRACT

This paper introduces four principles for the establishment of a technology-enhanced learning environment with and for children with autism spectrum disorders and presents results on how the principles were actualized in relation to children's actions in the environment. The study was conducted as action research premised on the children's active roles as participants and developers, the empowerment of children's strengths and creativity, and the modifiability and transformability of technology solutions. The learning environment consisted of four workstations: symbol matching, building with bricks, storytelling, and game playing. According to results, the strength-based approach and versatile technology solutions engaged children with autistic features as active participants and creative actors. This engagement is crucial for creating new possibilities for the children's education and everyday life.

KEYWORDS

Autism spectrum disorders, children, technology-enhanced, learning environment

1. INTRODUCTION

The contents of this paper reflect an ongoing research project that investigates the actions of children with autism spectrum disorders (ASD) in a strength-based technology-enhanced learning environment (Voutilainen et al., 2011). The structure of the paper is twofold. First, the paper will introduce four principles for the establishment of a strength-based technology-enhanced learning environment, and second, it will present and discuss findings on how such a learning environment worked for children.

The technology-enhanced learning environment included many technology solutions for children's learning. Versatility of the technology solutions meant possibilities to foster children's creativity and potential skills that a single technology solution might not have been able to emerge. With respect to its strength-based learning environment focus, this paper stresses the importance of establishing and developing a learning environment based on the strengths (e.g., special skills, interests) and creativity of children with ASD rather than on the problems and deficits associated with autism. This emphasis on strengths and creativity is important as these aspects have been less researched and understood than other features of autism (Happé and Frith, 2009).

A learning environment's characteristics, for example, class arrangements, computers, laboratory experiment kits, teaching methods, learning styles, and assessment methods, influence learners' academic achievements and other learning outcomes in cognitive and affective domains (Doppelt, 2004, 2006; Doppelt and Schunn, 2008). The impact is even more remarkable when learners have special needs such as autism (Sze, 2009; Verdonschot et al., 2009; Williams, 2008; Williams et al., 2006). A growing number of studies suggest that interactive causal multisensory environments are stimulating for people with disabilities (Williams, 2008; Williams et al., 2006). In addition, recent research indicates that children with ASD, for example, benefit from environments that provide structure while allowing them to express their personalities in the learning choices they make (Sze, 2009).

There is evidence that an “autism friendly” environment needs to be based on individual assessment, focus on social understanding and communication, be developmental and structured, and use visual supports (Guldberg, 2010; Parsons et al., 2009, 2011). Potential sensory processing difficulties need to be taken into account and environments adapted accordingly (Bogdashina, 2003; Frith, 2003). It is also important to consider a number of other dimensions, including teaching practices, learning contexts, and child characteristics, when building a supportive and activating learning environment for children with ASD.

2. STRENGTH-BASED TECHNOLOGY-ENHANCED LEARNING ENVIRONMENT

There were four main principles that established the learning environment in the research project: 1. Children’s creativity and active roles; 2. Children’s strengths; 3. Modifiability of technologies; and 4. Transformability of technological solutions to everyday life contexts.

1. Children’s creativity and active roles as participants and developers in a technology-enhanced learning environment. This first principle investigated the diversity and creativity in children’s behavior – aspects that have been less researched compared to more typical features of ASD (e.g., repetitive and invariant behavior) (Napolitano et al., 2010). The learning environment enabled the children’s active role by letting the children interact with many kinds of technologies. Technologies were selected to be diverse so that the children could use them in various ways through different kinds of interfaces (e.g., touchscreen, mouse, physical tiles, and motion-based interface). Various and changing pedagogical contents of technology applications (e.g., funny games, number and picture tasks, creating stories, building models) were to tempt the children’s engagement and creativity.

2. Comprehensive support of the emergence of children’s strengths. The majority of research on children with autism and technology attempts to find solutions to problems connected to ASD (e.g., Austin et al., 2008; Bernard-Opitz et al., 2001; Powers, 2006). This learning environment, however, focused on children’s strengths during activities in the environment. There were several ways to support the emergence of children’s strengths. The use of multimodal interaction, the utilization of different senses (visual, auditory, tactile, and kinesthetic), and the individual modifiability of technical solutions could help determine the children’s individual strengths. In addition, a roomy space with minimal external stimuli was to support children’s concentration on activities at workstations and give them a chance to monitor or to interact with other children while working in the environment. Also action group session routines (e.g. joint beginning of the session) were to enhance the clarity of the learning environment. However, as the environment was meant to be as natural as possible, changes in routines and the organization of the environment were possible when needed.

3. Modifiability of technologies. This principle emphasized the children’s active role and creative actions in the learning environment. Pedagogical content and technological implementation of applications are often predefined before use in learning environments because they are often designed for specific purposes and certain learning objectives; therefore, children and teachers rarely have opportunities to modify physical technology devices or content. Technology solutions with specific purposes for children with ASD are for example mobile devices to improve communication skills (see De Leo and Leroy, 2008) and scheduling (see Hayes et al., 2008), virtual learning environments and computer games for developing social skills (see Battocchi et al., 2009; Cheng et al., 2010) and games for exercising (see Finkelstein et al., 2010), and robotics for improving social skills (see Fujimoto et al., 2010). These technology solutions have indicated advantage for children with ASD within the specific purpose, but by enabling the modification of pedagogic content, the solutions might be applicable to other educational domains.

The learning environment established in this research project realized the modifiability of technologies by enabling modification of physical elements (e.g. physical tiles) and pedagogical content (e.g. tasks and visual content) to applications by both children and adults. Choices for modification were based on the children’s interests and iterative feedback after participation at the workstations and observations of children’s action at the workstation. Thus, the participating children had an untraditional and unique role in the study since they operated as innovative and active research partners (Druin, 2002; Marti and Bannon 2009; Olkin, 2004) rather than just as objects of inquiry. The teachers’ and school assistants’ roles were also important in the development of the technologies since they knew the children’s individual pedagogical goals in school.

4. Transformability of technology solutions to everyday life contexts. Commercially available technologies (e.g., robotics) are often too expensive to use in education (Bryant et al., 2010). Another obstacle to applying and transforming technology solutions to everyday life contexts is how time-consuming technologies are for teachers to learn and how difficult they are to use (Copley and Ziviani, 2004). Research on advanced technologies confirms children with ASD benefit from various technologies (Finkelstein et al., 2010; Williams et al., 2002; Williams et al., 2006) and thus supports applying technologies in education for them. It is therefore important that applications are easy to use and modify without technical expertise or external support to fit children's needs and wishes in everyday life contexts like school.

3. METHOD

3.1 Participants

Research participants included four children with autistic features in one comprehensive school for children with special needs. Two of the participating children were boys (ages 9 and 11) and two were girls (ages 8 and 13). The children faced many challenges in their actions and learning, yet had multiple strengths, such as good visual senses, and a variety of ICT skills. Each child had limited verbal language skills but each had various ways of communicating. All of the children used augmentative and alternative communication methods, especially picture symbols, in various situations.

3.2 Settings

The research project ran one-hour group sessions, called an action group, weekly, nine times each semester. At the beginning of each session, there was a short warm-up with greetings and researchers gave the children a pictured map of the workstations. Though the order of the workstations was predetermined, the children could choose a variety of tasks or games to work with at each workstation. The children worked individually at each station for 10 to 15 minutes, and the adults were advised to help if needed (e.g., setting the difficulty level of the task). The order of the workstations varied for each child every session.

A technology-enhanced learning environment was set up in a spacious room in the school building. There were four technology workstations in the learning environment: symbol matching, building with bricks, storytelling, and game playing (Figure 1).

Figure 1. Symbol Matching, Building with Bricks, Storytelling, and Game Playing

At the symbol matching workstation the children had tasks of matching a symbol from the computer application to the corresponding symbol or a theme by pressing on one of six tiles. The children chose the topic for the tasks and changed the symbol cards on the tiles according to their selection by themselves. At the building with bricks workstation the children built a LEGO® Duplo or basic LEGO® construction from the model on the computer application. The children chose a task from three alternatives: 1) building from the picture of the whole model; 2) step-by-step building of the model; or 3) a memory game that hid the model during the child's construction. The children adjusted the difficulty level by changing the number of the bricks in the application. At the storytelling workstation the children created stories by using a picture-based computer application and a touchscreen. Pictures were categorized. Children created stories by dragging and dropping the hand-drawn pictures into the story's timeline, and also by drawing pictures of their own. The stories were saved to the story library. The children could print out their stories and put together their own story books. At the game playing workstation the children played short Kinect Adventures! games by Microsoft Game Studios. Each child played the games by using his or her whole body to control the game, for instance, jumping, dodging, and using their hands. Games were flexible, allowing a variety of movements as long as the player stayed within the play area.

The children gave immediate feedback about the workstations after interacting with the technologies. The feedback system consisted of a black piece of cardboard with three picture-word feedback cards and a photo of the workstation. The feedback cards had drawn pictures of facial expressions (linked with matching words): very happy face (I liked it a lot), neutral face (I liked it a little), and sad face (I didn't like it). In this respect, the feedback scale was similar to one used with children in technology development projects using a participatory design model (see Nissinen et al., 2012; Read et al., 2002; Read and MacFarlane, 2006).

3.3 Data Collection and Analysis

The project conducted qualitative action research. The main research data were collected by videotaping each child's actions using two video cameras per workstation to analyze the child's actions while seeing what was happening on the screen at the same time. The additional data were collected by observing the children during the action group sessions. This paper's results are based on data collected between February 2011 and May 2012. The researchers analyzed the data via content analysis by organizing and reviewing the data according to the four principles that guided the establishment of the learning environment.

4. RESULTS

According to results, the project's strength-based technology-enhanced learning environment facilitated the emergence of the children's activity and creativity. For instance, the children immediately started using the applications or choosing equipment linked to the workstations (e.g., cards for the tiles) upon arriving at the station and quickly learned compensatory ways to proceed if there were problems with technologies (e.g., using buttons on the keyboard instead of out-of-order tiles) or the equipment (e.g., using red bricks instead of missing orange bricks). All of the four children with autistic features showed strong interest in the new application features and new tasks or games in the environment, as the next example shows.

> At the beginning of the session, we presented a new task for the symbol-matching workstation called "Hypernyms task." Iris, Ian, and Olivia chose the new task as the first task at the workstation. Eric scanned the new cards in his turn. The school assistant asked if he wanted to take the new task. Eric immediately started to place the new cards into the tiles. (Observation notes, March 2012, transcribed into English)

The participating children's charm of novelty was remarkable considering many researchers report that children with ASD have restricted interests (see Ala'i-Rosales and Zeug, 2008; Baron-Cohen and Wheelwright, 1999; Folstein and Rosen-Sheidley, 2001). While the researchers executed changes in the learning environment based on routines familiar to the children, the children's interest in change emerged from the beginning of the project, even when the workstations and procedures were novel to them. According to the findings, the versatility of the workstations in the environment and the possibility of making choices at each workstation seemed to support the active role of the children. In addition, similar to many previous studies (e.g., Finkelstein et al., 2010; Williams et al., 2002; Williams et al., 2006), technology itself was extremely motivating for all participating children in the project.

The role of the teacher or school assistant working with the child in the technology-enhanced learning environment was also significant in many respects. The teachers' and assistants' contributions were important in helping the children overcome possible problems in an application's functionality or a task's difficulty. In addition, the school assistant's positive tutoring and feedback was relevant in helping the given child grasp a new task and learn to do the task by himself.

Considering the results, the technology-enhanced learning environment brought out the children's potential and strengths: the second principle in the establishment of the learning environment. As knowledge of the children's strengths, and often of the children's interests, was iteratively executed both in the content of the tasks and the workstations' technical aspects, the environment kept changing and thus continuously fostered emergence of the children's strengths. Their strengths varied from good visual perception to creating detailed drawings to athletic skills. Below is an example of one child's skills in making choices independently and moving fluently – skills which emerged especially in this environment since his actions were not very self-directed in the classroom setting.

> Ian trots to the play area at the game-playing workstation, chooses the first game, and plays it independently. Ian moves fluently and quickly to different directions during the game (stepping left and right, hands up, hands down, hands diagonally, stepping forward and backward, jumping) and collects lots of points. When he finishes the game, the school assistant says, “Really well, Ian, great,” and claps her hands. (Transcription of a video data clip, November 2011, translated into English)

Overall, the teachers and school assistants working with the children in the action group reported remarkable differences, especially in the children’s attention spans in the classroom setting compared to their attention spans in the technology-enhanced learning environment, in favor of the last-mentioned. Even though this finding requires more thorough verification in the future, it is of great interest since researchers commonly report challenges in the attention spans of children with ASD (Bogdashina, 2003; Frith, 2003).

The project iteratively realized and fulfilled the modifiability of technologies – the third principle of the establishment of the learning environment. The children’s iterative feedback played an important role in the modification process; however, the challenge at the beginning of the project was to get feedback from the children. Because the children were inexperienced in giving feedback, the researchers needed to carefully consider how to ask them for feedback. The feedback system described above seemed to work, as the next examples show.

> Olivia takes the feedback board by herself and the school assistant asks, “What did you like?” and at the same time Olivia says in a clear voice, “I liked it a lot!” The school assistant confirms, “You liked it a lot.” Olivia then attaches the photograph of the workstation under the happy face and says again, “I liked it a lot.” (Transcription of a video data clip, February 2012, translated into English)

> Iris immediately moves her finger straight back on the sad face. She points at it several times until the researcher names the picture, “I didn’t like it.” (Transcription of a video data clip, April 2012, translated into English)

Along with learning to give feedback for the workstations, the children’s participation in the modification process grew stronger. The children’s overall participation in the development of the project’s technology-enriched environment, however, was still limited and researchers need to develop more elaborate means of participation. The children’s feedback has nevertheless been a good starting point since it is unusual for children with ASD to be involved in the evaluation of their learning environments.

The technologies’ modifiability relates to the fourth principle in the establishment of a learning environment: the transformability of technological solutions to everyday life contexts. To be truly transformed to a school context, technologies have to be easy to use for both children and adults. If the application was too complex, the adult was not able to tutor the child on how to use the application appropriately or, therefore, to help the child perform the task purposefully. Clear instructions minimized the need for teachers and assistants to get support from technical experts or task designers and prevented misunderstandings of usage or technology content. It was helpful if the instructions were in sight in the tasks and games themselves and not hidden somewhere in the menus. According to the data, using only pictures in the applications was not informative enough to explain the task’s purpose. The availability of written language was also deemed important since some of the children could benefit from working with written language while working with the technologies, in turn increasing the technologies’ advantages considering the school context.

5. CONCLUSIONS

The purpose of this study was to present principles related to children’s creativity and strengths, and technology’ modifiability and transformability for the establishment of a strength-based technology-enhanced learning environment with and for children with ASD and to introduce results on how the project succeeded in actualizing the principles in relation to children’s actions in the learning environment. The findings indicate that the technology-enhanced learning environment introduced in this paper provided many opportunities for facilitating the emergence of potential skills, active participation, and learning of children with autistic features. In addition, the strength-based environment facilitated a chance to see the children according to their strengths rather than their challenges and to find diversified ways of supporting their learning. The modifiable and transferable technical solutions also facilitated individualized learning and teaching, thus increasing the possibility of the children's inclusion both in the school context and in society.

As technology plays an increasingly important role in children's lives in modern societies, children who are left out of this process are in danger of being disconnected from peers, cut-off from various opportunities, disadvantaged, and unskilled in terms of future work (Montgomery, 2007, p. 210; Vicente and Lopéz, 2010). It is crucial that technologies are continuously modifiable according to the interests, strengths, and needs of children with special needs, including autism. To meet the criteria of children's various situations, learning environments should contain multiple technologies. Every part of a learning environment should be taken into account: the people, the technologies, and the pedagogy.

Technologies should be developed with children with ASD – not just for them. Every child is entitled to an opportunity to make choices and affect their environment. It is crucial to establish multiple ways in which children with ASD can provide feedback and truly participate in the modification and development of technologies. Some recent studies (see López-Mencía et al., 2010; Nissinen et al., 2012) indicate that participatory evaluation, design, and development of technologies is possible for children with different special needs, including autism. An environment with multiple technologies provides a challenging yet promising starting point for participatory design. Since technologies interest children with ASD, the aim of the near future is to develop technical solutions that facilitate and diversify the children's inclusion in the development of their learning environments.

The transformability of technological solutions to everyday life contexts also calls for the involvement of all participants in the development process. Knowledge of the technologies and skills to use them in various ways increase the possibility that school personnel could also use technologies in everyday school contexts. As this study's results indicate, applications have to be easy to use and modify, from the viewpoint of both the children and the adults.

Although results are very promising, there are several limitations in this study. The emphasis of this article was on describing the establishment of the learning environment and its technologies and on the research's overall results, instead of focusing on an exact research area. The number of participating children was low, which has an effect on the generalizability of the results; however, the project's learning environment works as an experimental environment and the research's results can be further studied. In this phase of the project, the data was limited to a research period of a year and a half, which does not yet meet the criteria of a follow-up study. Future research will give more detailed information about the actions of children with ASD and the benefits and limitations of the project's technology-enhanced learning environment.

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