A Service Learning Approach to Developing a Kinect-based Showering Training Game for Children Who Do Not Talk

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Abstract

In this study, we combined social inclusion with a curriculum design emphasizing service learning to transform academic classroom curricula into meaningful services in community-based settings. In a service-learning curriculum at the junior and senior levels in Electrical and Computer Engineering (ECE), we implemented a service learning pedagogy to engage students in a social context. The curriculum encouraged students to work with special education schools in joint projects that help children with disabilities. In short, problem-based and service learning are integrated so that opportunities for students to participate in communities can be more meaningfully created. The framework of participatory research, which includes problem identification, intervention, and interpretation of results, was adopted. This framework offers students an in-depth perspective when they take action to implement changes in the community, as well as the broader society. A group of four junior students helped the special education teacher prepare the task analysis steps of showering and designed a shower training game. Six children with autism participated in the design process of the game and also used the game to acquire showering skills. Overall, the children's independent performance in terms of task correctness immediately increased when the game intervention was introduced, and all of the participants acquired and maintained the skills necessary for the task of taking a shower independently. Although they had very limited verbal skills, they used various other expressions to provide feedback, which made the game design possible. This project brought engineering students' attention to issues that arise for a large, yet marginalized, group of individuals. Through community-based participatory research, children with disabilities and their teachers were included as contributors and participants; so often professionals do things "to and for" people with disabilities instead of "with" them.

Introduction

In this paper, we discuss the design of a shower training game for children with autism who have not been able to take a shower independently. Shower training at special education schools is difficult, due to the lack of staff and shower facilities. This brought engineering students' attention to issues that arise for a large, yet marginalized, group of individuals. When starting a community-based participatory research (CBPR) project, student researchers, as outsiders, use their facilitating skills to create arenas for collective learning and creating common ground rather than defining the problem without involving insiders i.e. special education teachers and children with disabilities (Friedman, 2001). However, insiders and outsiders live in separate worlds (Chang, Wang, Chen, & Liao, 2011). CBPR researchers orient themselves to a new situation, learn about it, and prepare to manage it. For outsiders to take appropriate actions for interventions, action engagement (Rolfsen, Johnsen, & Knutstad, 2007) suggests that researchers involve themselves in everyday activities in the relevant parts of the organization to gain advantages. It also suggests that researchers be willing to understand the culture of insiders and systemic parts of their problem. Action

engagement provides researchers with cohesive relational ties to the insiders and insights into local organizational practices.

The CBPR approach has been used by the Service Design and Field Applications course to develop software skills in ECE by developing training technology for children who attend special education schools. Students who enrolled in the class were aware that it is a service learning class and community–based participatory research is mandatory. Partnering with two special education schools, three groups of ECE students designed three training games in the spring semester of 2016. The purpose of this project was to allow ECE students to design games and examine whether game technology is an effective way to teach elementary students with Autism Spectrum Disorder (ASD) to take a shower independently. Additionally, the students explored the long-term effects of using game technology on the maintenance of showering independently. We used two tools to measure students' outcome of the project: field observations, and semi-structured interviews. Field observations were conducted at the special education school once a month by two professors who advised the project team. The purpose of field observations was to find out the quality of interactions between students and children and the quality of communication between students and special education teachers. Semi-structured interviews were conducted in the first week and the last week of the semester. The pre-test and post-test data were compared to examine students' motivation towards science and technology learning, and their confidence levels in interpersonal skills.

Literature Reviews

The difficulties in verbal reasoning and short-term memory present both pragmatic and pedagogic challenges in teaching children with ASD to take a shower properly among other living skills through traditional methods such as verbal instruction and memorization tasks. Conversely, instructional strategies that incorporate visual supports (e.g., pictures, in vivo modeling, video modeling [VM]) are considered as evidenced-based practices that capitalize on the strengths of children with ASD (Kellems et al., 2016; Kellems & Edwards, 2016). Among visual supports, VM has increased in popularity in the last three decades due to the technological ease, decreasing cost of creating videos, and its strategic efficiency in teaching daily living, as well as functional, vocational, academic, and social skills (Kellems & Edwards, 2016). An alternative approach to the skill training of children with ASD is game-based training. The recent advancements of sensor and human computer interaction technology have made game-based training possible. Gamification of training involves the child playing a video game engaging in the target behavior and subsequently imitating it. Gameplay demands focus and attention, motivates the user to practice, and provides the user with a sense of achievement, even if they cannot perform that task in the real world (Chang, Kang, & Liu, 2014). Therefore, gamification has become a new candidate for intervention strategies in teaching a variety of skills to individuals with ASD.

Method

In this project, 4 students gamified independent shower training using the Kinect sensor to motivate children with ASD to engage in showering. Specifically, the students

developed a game based on Kinect's human gesture recognition technology, which has recently increased in popularity in the video game interaction design domain. The incorporation of gesture recognition technology prevented the children from having to wear intrusive body sensors. The game was designed according to the showering task analysis, which outlined the task steps involved in taking a shower and simulated them in the computer game. The students primarily used the Microsoft Kinect sensory device, Scratch software language platform, and Kinect2Scratch software tools to establish the training game. Scratch and Kinect2Scratch have been widely used by nonprogramming professionals to code games for education and entertainment. However, this was the first effort to combine Kinect, Scratch, and Kinect2Scratch to develop interactive games for children with ASD to engage in shower training.

Four male and two female elementary school children with ASD (Allen, Bart, Chris, Diane, Emilie, and Fred) participated in this study. All of the children were enrolled in special education services under the autism category and their cognitive and adaptive functioning fell within the moderate intellectual disability range. Specifically, the children were selected based on the following criteria: (a) diagnosis of autism or an intellectual disability, (b) an Individual Education Plan (IEP) goal to improve adaptive behavior related to personal care, (c) no physical disability which impeded the performance of the skill, and (d) agreeing to participate in the study. None of the participants had previous experience with Kinect. All six participants were given pseudonyms to protect their privacy, and informed consent was provided by the service organization, individual staff members involved in the study, and the main caregivers on behalf of the children with ASD. The study was approved by the Regional Institutional Review Board (IRB) under approval number LSHIRB No. 15-007-A2.

All of the participants attended a special education class for part of their school day to address functional or life skill difficulties; nine other children with various disabilities were also present in the classroom. Baseline, game-based intervention, and maintenance phases all occurred within the special education classroom. In the baseline phase, students measured the showering skill levels of the children when no training games were used. During the game-based intervention, the children played the game and also took a shower on their own in their home's shower room as the skill of showering naturally occurred in that location. In the maintenance phase, the game training was withdrawn and the children took the shower independently.

The game was called *Take a Shower!* and was designed according to an analysis of the 25 identified steps for taking a shower. The children were guided through each step in the task analysis by the game (see Figure 1). For example, a water fairy moves around each part of a body to guide children to wet the body of their player, and points were scored when they aimed their handheld showerhead at the water fairy accurately. Similarly, a germ demon moves around each part of the body to guide the children to apply shampoo; again, points were scored when they applied shampoo to the indicated body parts properly.

The experiment comprised three phases: (a) baseline, in which at least a few pre-probe sessions were performed to collect baseline data on the participants; (b) intervention, in which the gaming system was used to obtain the performance data for assessment; and (c) maintenance, conducted 2 weeks after the intervention was finished, in which the follow-up performance of the participants was assessed.

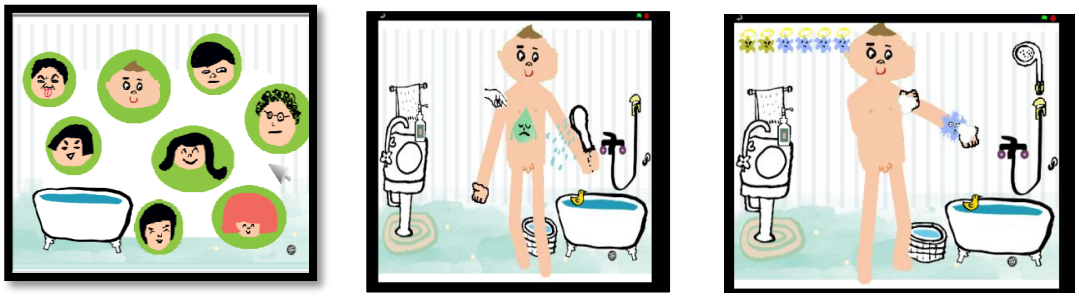

Figure 1. Shower training game designed by the student project team.

Results

This study assessed the effectiveness of the proposed system for elementary-aged children with ASD to acquire the skills of taking a shower. The percentage of steps performed independently for each child is presented in Figure 2. Overall, the children's independent performance in terms of task correctness immediately increased when the game intervention was introduced, and all of the participants acquired and maintained the skills necessary for the task of taking a shower independently. Specifically, the percentage of correct steps performed ranged from 82% (Bart) to 100% (Chris and Diane), suggesting that the game-based intervention was highly effective. Furthermore, the results indicate that the proposed system, in conjunction with operant conditioning strategies, can facilitate the progress of children with ASD taking a shower independently. The parents of the six children in the present study also gave positive feedback to the teacher and the project team for helping their children acquire showering skills. Moreover, students also collected data from the rest of the children in the same class who did not use this game to enhance their skills. The children who did not use the game still could not take the shower independently after the project. Therefore, the next step is to use the game to train another group of children with ASD who have not developed showering skills, and explore if the results can be generalized to the broader population of children with ASD or even to children with other disabilities.

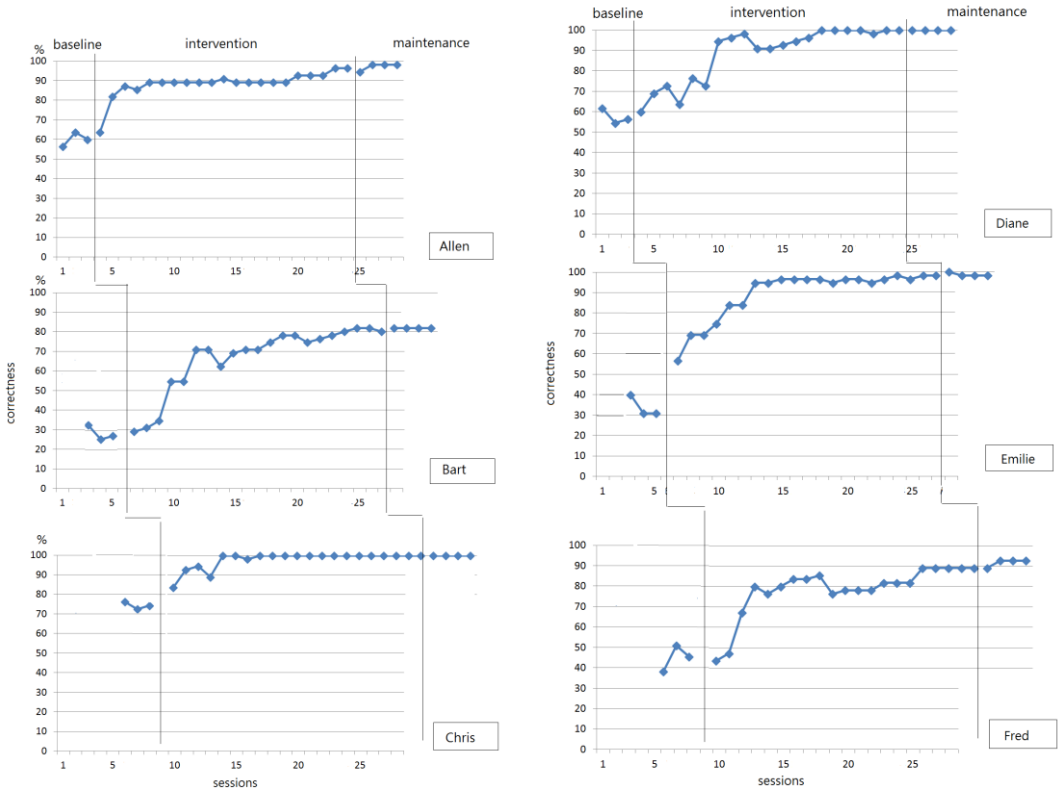

Figure 2. Shower training performance of the six children with ASD.

Student Assessment

Field observations and semi-structured interviews were used to measure students' outcome of the community-based participatory research project. As their sense of action engagement developed, the students became increasingly self-motivated and committed to the project. Their software skills improved as they tried to move the project forward. The accomplishment furthered the motivation towards learning advanced software skills. "I didn't like programming before I took the course. Now I am glad I can program a game that really helps people," said Student A. Community-based participatory research in this project also helped students develop problem solving skills by leveraging the context in problem solving. In the design process, the students were not sure whether the Kinect sensor was suitable for the children with ASD because it was used for the entertainment of typically developing children and adults. Therefore, students designed simple Kinect-based games and set up weekly game workshop for the children. These games included whack-a-mole and Shoo Fly Don't Bother Me. The purpose of the workshop was to measure the acceptance of the Kinect-based games, the ability of hand-eye coordination, and the pattern of children's game playing. These were very helpful to the design of the target training game. Through field work, the students were also gradually able to gain insight into the daily tasks undertaken by the special education teacher, and which made sense of seemingly minor yet important details in the field study. For example, Bart once touched the back of one of the ECE students, who did not realize initially that Bart rarely touched strangers unless he wanted to make friends with them. The ECE students learned that the active participation of the special

education teacher and the inclusion of her local knowledge had helped accomplish relevant results and usable services. “I used to think of game programming as purely technical so I focused on studying software languages and development platforms. Now I realize the importance of including the context of problems and the feedback from users,” said Student B. Furthermore, action engagement not only helped identify the common requirements of both the special education community and the ECE students, but also exposed creative conflicts in implementation priorities. The community-based project enabled engineering students to receive an insider perspective, helping them to feel more confident in their understanding of the problems of others. “I was afraid of discussing with people because I was not confident in expressing myself. I was not even sure I could get along with children in the special education school. The project is a challenging experience to me and I am glad I survive. Now I am more confident in talking to people,” said Student C. The findings suggested the community-based participatory research project positively influenced the ECE students’ motivation in professional development, skill levels of problem solving, and interpersonal communication.

Lessons Learned

The engineering students identified some of the problems faced by children with ASD who attended a special education school, worked out solutions to implement change, and reflected on the process. The service learning project improved the quality of professional development for several reasons. First, action engagement improved the students’ domain knowledge of local work practice through personal involvement. Additionally, personal involvement by the students enhanced their emotional understanding of some children’s problems that need to be solved; through emotional understanding, the students also became self-motivated to ensure that the project succeeded. The game prototype that they developed became their tool in the interventions to solve real problems, which triggered feelings of being valued in the process of intervention and was a powerful incentive. Finally, action engagement built mutual trust between the special education and ECE communities, and created a shared sense of good intentions, which can be critical for both parties’ commitment to overcoming difficulties and challenges together when the project encountered obstacles (Chang, Wang, Chen, & Liao, 2011; Rolfsen, Johnsen, & Knutstad, 2007).

Before the students participated in the project, they did not have experiences in voluntary services or working with people with cognitive impairments. Some students witnessed the special care system and then realized how much the teachers contributed to the quality of life of people they cared for, what a different life the people with disabilities lived, and how hard the people with disabilities had to try to become self-contained. Students considered the project a life changing experience.

References

Chang, Y. J., Kang, Y. S., & Liu, F. L. (2014). A computer-based interactive game to train persons with cognitive impairments to perform recycling tasks independently. *Research in developmental disabilities*, 35(12), 3672-3677.

Chang, Y. J., Wang, T. Y., Chen, S. F., & Liao, R. H. (2011). Student engineers as agents

of change: combining social inclusion in the professional development of electrical and computer engineering students. *Systemic Practice and Action Research*, 24(3), 237-245.
Friedman, V. J. (2001) Action Science: Creating Communities of Inquiry in Communities of Practice. In *Handbook of Action Research*, eds. Reason and Bradburyn.
Kellems, R. O., & Edwards, S. (2016). Using video modeling and video prompting to teach core academic content to students with learning disabilities. *Preventing School Failure: Alternative Education for Children and Youth*, 60(3), 207-214.

Kellems, R. O., Frandsen, K., Hansen, B., Gabrielsen, T., Clarke, B., Simons, K., & Clements, K. (2016). Teaching multi-step math skills to adults with disabilities via video prompting. *Research in Developmental Disabilities*, 58, 31-44.

Rolfsen, M., Johnsen, A., & Knutstad, G. (2007). Action engagement: improving researchers' involvement in action research projects. *Systemic Practice and Action Research*, 20(1), 53-63.