Through the Troll Forest: Exploring Tabletop Interaction Design for Children with Special Cognitive Needs

Ru Zarin[1]
[1]Interactive Institute Umeå
c/o Umeå University, School of Architecture
SE-90187 Umeå, Sweden
ru@tii.se

Daniel Fallman[1, 2]
[2]Department of Informatics
Umeå University
SE-90187, Umeå, Sweden
dfallman@informatik.umu.se

ABSTRACT

We describe the interaction design process of conceiving, designing, implementing, and testing Trollskogen, a purpose-built tabletop multitouch system featuring a range of small software applications, termed 'micro applications'. Each micro application is devised as a tool intended to improve or allow for exercise of social communication skills. Throughout the project, we have worked closely with a group of six children diagnosed with Autism Spectrum Disorder (ASD) or Down's syndrome, all in the age range of 5-8. The system has been designed together with the users, their teachers, and various experts as a complement to the current curricula. In this paper, the three main phases of our design process are described and we conclude the paper by reporting on and discussing some preliminary findings and observations from a small user study.

Author Keywords: Tabletop, Multitouch, Special Cognitive Needs, Children, Design, Learning, Social skills.

ACM Classification Keywords

H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms

Design

INTRODUCTION

In typical child development, young children acquire speech and language skills without explicit training. When it comes to children with cognitive challenges however—for instance those with Autism Spectrum Disorder (ASD), a developmental disorder affecting 1 in 150 births—these skills are only partially acquired through everyday interactions. Among these skills, speech plays a key role, as it is both a prerequisite for acquiring other skills as well as an important element when communicating with others. Without speech, young children may have great difficulty interacting and socializing with others, e.g. communicating their emotions, desires, and needs.

Researchers in HCI have been exploring the potential of technology for improving speech and language skills in children with various cognitive challenges. In this paper, we describe the process of conceiving, designing, and implementing a multitouch tabletop system for learning, improving, and exercising social skills among a group of children with Autism Spectrum Disorder (ASD) or Down's syndrome. Our custom-built multitouch tabletop system has been used in a classroom setting as a complement to traditional curricular events for learning, improving, and exercising vital communication skills.

While this paper focuses on the interaction design process and on what we regard as some particular considerations that need to be considered when working with these users, we also provide preliminary data, a discussion about, and some conclusions from a small user study to support our claims and stances.

Related Work

Recently, researchers and designers in HCI have been investigating the design of tabletop systems for children [5, 10] as well as highlighted issues of importance when intending to support users with special needs, including [1, 2, 4, 6, 8, 9]. Among these, we have been particularly interested in Piper et al.'s [9] study of using tabletops to facilitate and support medical discussion between a deaf patient and a hearing physician. First, their situation in some ways resembles our system's relationship and the interaction that occurs between our system, the users, and their teacher. Second, their participatory design process, where members of the deaf community as well as medical and communication experts were involved, has also influenced our process.

Other sources of inspiration are Sluis et al.'s study where a tabletop environment is used to help children learn how to read [10]; Piper et al.'s study of a cooperative tabletop computer game that provides adolescents with Asperger's Syndrome with a positive experience through which they can develop effective group work skills and build confidence in social interaction [8]; Battocchi et al.'s collaborative puzzle game developed for fostering collaboration in children with ASD [2]; and Hirano et al.'s collaborative visual scheduling system for autism classrooms [6].

DESIGN PROCESS

Trollskogen ("The Troll Forest") is a purpose-built tabletop multitouch system equipped with a range of small software

applications (see Figure 1). Each application is devised as a tool intended to improve, enhance, and allow for exercise of social communication skills.

The design process that resulted in the Trollskogen system can be divided into three phases: first, the design team conducted a contextual study including interviews with users, their teachers, aides, and experts in Down's syndrome and ASD. The second phase of the project consisted of scenario building and iterative prototyping, after which, third, the entire system was subject to user exposure, testing, and evaluation.

User Group

The user group we worked with throughout the design process consisted of six children, all of whom were in the age range of 5-8 and located in the Solna area of Stockholm, Sweden. They have all been diagnosed with either ASD and/or Down's syndrome. We believe that an important contribution of this particular study is the mix of children with different diagnoses. Often, new technologies in the area of assisting people with special needs are devised with a single diagnosis in mind. In such studies, it is possible to capitalize on one or more particular aspects of that diagnosis. However, when a system is to be used in the real world, such as in our classroom setting, one rarely finds groups where all members share exactly the same diagnosis. Rather, children with various kinds of cognitive challenges are often grouped together, making specialized measures difficult and the potential for individual solutions necessary. We thus found that for real-world use, it is an important challenge to devise the system in such a way that it does not exclusively deal with particular aspects of a certain diagnosis, but rather becomes a more general tool to exercise and improve some key social skills.

To deal with this, we opted to involve our users very early in the design process. While far from an unusual design approach, it has nevertheless been important because of the rather obvious cultural and experiential gap that always exists between designers and users, but which we think of as even more evident when dealing with a group of users whose members, first, are much younger than the members of the design team and thus have other frames of reference and sources of inspiration, and second, have different cognitive challenges that from time to time make their experiences of the world subtly different from those of the members of the design team. Engaging 'real' end users in all phases of the project hence becomes a crucial means in bridging this experiential gap [3] as well as an important source of inspiration for design.

Contextual Studies

To gain insight into challenges and opportunities among our group of cognitively disabled children, we conducted a contextual study that consisted of visits to a hospital and three different schools for students with cognitive disabilities, as well as in-depth interviews with professional caregivers and teachers at these sites, eight in total. We collected observational data in the form of video clips, images,

and notes. Back in our research lab, we created story-sheets, documenting our individual experiences as small scenarios that were shared and discussed with the research group. These enabled us to reflect on our experiences from the field and they helped us flesh out themes that could inspire future design direction.

Ideation and Micro-Application Prototyping

Based on these themes, design progressed into the second phase through the construction of a number of so-called 'micro applications', i.e., small Flash-based applications intended to improve or enhance particular aspects of our user group's communication skills. A reason for this approach was that we quickly realized that abstract representations of interfaces and interactions—such as sketched interfaces on paper—that can be very effective with other user groups did not work well at all with our users, most likely because of the metaphorical gap that we as designers introduced between the representation and to what that representation corresponded. However, with the much more direct micro applications approach, ideas could quickly materialize, be exposed to users, tried out and evaluated with students, teachers, and experts, and inspire new ideas in an iterative process. In total, we constructed more than 20 micro applications during this phase of the design process, each of which took on average a day to build.

After several rounds of iterations, a general theme was chosen for the overall framework. This was done to help create a cohesive structure for the larger system intended to embrace a number of micro applications. We chose *Trollskogen* ("The Troll Forest") as a theme, which both ties the project to a traditional Swedish landscape setting as well as creates the opportunity to utilize various mythical characters frequently appearing in Swedish folk stories of the forest, such as trolls, elves and fairies.

Figure 1: The Trollskogen tabletop setup

PROTOTYPE DESIGN AND IMPLEMENTATION

From the many micro application iterations and the forest theme that emerged, the final system was constructed. The system's main user interface presents the user with a forest setting, where icons depicting various kinds of mushrooms are used to represent different micro applications (see Figure 1). When touched, each icon takes the user to a specific application with which the users can interact. Each micro application is intended to improve, strengthen, or exercise

one or more particular aspects of our user group's communication skills. When a user is done or just becomes bored, it is easy to quickly return to 'the forest' (the main screen), from anywhere in the system. The system's interface is thus intended to be very flat and comprehensible while it at the same time should allow teachers to add or hide individual micro applications depending on who is using the system.

When we tested the system with our users (reported below), the following four micro applications were used:

The Forest Cabin Program

When one has entered the cabin by touching its icon, three areas are available for exploration. Each area reveals a story about a social situation that may arise in that setting. This application thus uses social stories combined with an exploratory interface and a speaker voice that continually tells a story about the place and its inhabitants. Embedded throughout the cabin are several small interactive elements, used to stimulate touch and interactivity while providing a playful element to avoid a passive viewing experience.

Figure 2: The Forest Cabin and the Finger Paint micro applications

Devised to utilize social stories to reinforce and strengthen behavior in social situations—such as saying 'Excuse me!' when interrupting adults engaged in conversation; saying 'Goodbye!' and 'Hello!' when entering and leaving the house; learning to only touch your own food while eating dinner; and so on—it represents a type of training especially constructive with Autistic children.

The Dancing Troll Program

The dancing troll application uses microphone input to trigger, control, and manipulate various animation sequences of an animated troll figure. With their voices, users can control a dancing troll figure on the tabletop. Here, we sought a way to help the users improve intonation and enunciation by promoting muscular growth in the mouth. This specific application was conceived through our interviews with teachers and aides, through which it became clear that use of certain mouth muscles also promotes speech articulation by strengthening muscles in the throat and vocal chord area. With tonal languages like Swedish, where emphasis on vowels is often required to pronounce certain words properly, this is considered a particularly useful exercise.

The Finger Paint Program

This rather basic yet quite appealing application was designed to allow users to creatively paint a scenario or story using certain forest characters with their hands and fingers directly on the screen. Users are given access to a palette of colors and an open canvas to draw pictures or simple words. The sketching board can be easily printed out for parents or caregivers to see and discuss. Some of the characters from the Trollskogen theme can be used as outlines for painting and coloring. This application also serves as a break from other activities and can be used as a tool to calm a child when very upset.

Talking Symbols

This application was created to facilitate communication by providing visual and audio aids to help users form sentences. Using virtual, on-screen 'pictograms'—a pictographic language that use symbols based on simple pictures of objects instead of letters—each symbol can be freely placed on the table surface. When in close proximity of another pictogram, the application automatically and visually links the two by drawing a line between the symbols, signifying the construction of a sentence. To have the system playback the sentence, users are able to touch and drag a speaker icon to the sentence and the system then 'speaks' each word in the sentence, highlighting each pictogram during the process. The pictogram language is widely used in schools and therapy centers across Sweden. The talking symbols application is devised to let children work with symbols they already know as well as learn new ones while being engaged in constructing meaningful sentences. Learning to use pictograms is also a major stepping-stone towards learning written language.

PRELIMINARY USER TESTING AND FEEDBACK

We tested the system in situ in a classroom setting with our six users. First, the whole group could interact and explore the system together, after which the users one at a time, together with their teacher, were encouraged to interact with each of the four micro-applications. After each session, we discussed and talked about what happened both with the user as well as with their teachers.

Seeing how the children interacted with the system was both puzzling and inspiring. It also provided input to the completion of the system, ranging from more general ideas to the redesign of specific interface elements. For instance, we found that the users were pressing quite hard on the surface with their fingers. This means that the system, first, needs to be rugged, solid, and fixed in place to endure use, and, second, that each movable or touchable interface element would need to be of a certain minimum size to be useful. We also came to realize that some of our early interface elements, particularly those devised for navigation purposes, relied on subtle abstractions, generalizations, and metaphors that while fairly obvious and unambiguous to us were in fact rather unclear and confusing to the users. Also, while the users quickly grasped the idea of putting pictographic symbols onto the stage and connecting them with each other, our way of dividing the collection of available pictograms 'off stage' into shelves or folders had them struggling to find specific pictograms and they quickly lost

interest if they could not immediately find the pictogram they were after. Another issue we gained insight into had to do with how to design and when to show the mechanism to exit or reset an application. One of our micro-applications was continually reset even when its task was not fully completed, which turned out to lead to a great deal of frustration and anger. Insights like these provided invaluable clues as to how to further improve the system.

DISCUSSION

As noted by Lepistö et al. [7], there are methodological issues involved in studying attitudes among children with special cognitive needs that suggest a data collecting approach that relies on complimentary methods. We have concluded that our system was well received by both students and teachers. We build this claim on a triangulation of direct user observation, discussion with our users, as well as separate discussions with their teachers. While using the system, the users seemed to genuinely enjoy what they were doing and they also stated that they so did after each session. Especially the finger paint program attracted attention and engagement from the users, something that was particularly noted by their teachers. We have also noted that our users required or at least appreciated clear structure and order; they cherished being able to work and manipulate objects in a direct way, with their hands, preferably in the form of games; that engaging interaction and rewards tended to motivate our users and helped them stay concentrated; and that generalizations and abstractions on the contrary tended to disengage and bore them.

In terms of contribution to the growing field of tabletop system aimed at supporting users with special needs, our micro applications approach might be the most novel element. Throughout the design process, we found this to be a useful way to collect ideas from various sources, quickly ideate design concepts around them, and then implement and try out the designs with real users in a non-abstract, direct way. The micro application approach has been interesting to us because, first, the main menu offers some degree of autonomy for the users to select among various micro applications in an understandable and very direct way. Second, the main menu also allows different micro applications to appear to or be hidden for certain users, depending on their particular cognitive challenge and the particular pedagogical situation. This provides some degree of control on the part of the teacher. Third, micro applications allow the system to be expanded quite easily over time; it makes it customizable to fit different kinds of user groups (as no two groups are the same); as well as it allows for fast switching between micro-applications that have specific purposes (such as vocalization exercises) to for instance more general, fun, and relaxing games. We have found this especially useful, as a particular characteristic of many of the kids participating in the study has been that they can become bored very quickly. In those situations, it is very handy for the teacher to be able to quickly and effortlessly switch to something he or she knows that a particular kid likes.

Future Work

We are in the process of planning a longitudinal study where the system will be a natural part of the everyday curricula during a longer period of time. Data from such a study, together with in-depth interviews with the children, their teachers, and experts in the area, can reveal more about the system's potential role in the classroom.

CONCLUSIONS

We have described the process of designing Trollskogen, a multitouch tabletop system for classroom use devised as a complement to current curricula for children with special cognitive needs. The current system features a range of 'micro applications' intended to improve, strengthen, or exercise one or more particular aspects of our users' communication and social skills. To design the system, we have worked closely with a group of six children diagnosed with Down's syndrome or Autism Spectrum Disorder (ASD) in the age range of 5-8.

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