Cultural issues in implementing an integrated augmentative communication and manipulation assistive technology for academic activities

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ABSTRUCT

The learning experience is enhanced by a combination of seeing, speaking, and doing. Thus, providing assistive technologies that aid communication and manipulation can allow children with special needs to fully participate in the educational curriculum. This paper reports the development of an integrated augmentative communication and manipulation system for academic activities in Portugal, following the pioneering work at the University of Alberta, Canada. The system relies on augmentative and alternative communication software that runs on a standard computer and that was programmed to control a Lego® Mindstorms® robot enabling children to manipulate educational materials. The system was trialed in a pilot test by one child with cerebral palsy, aiming at validating the technical design before undertaking an evaluation of the system in school settings. Cultural issues regarding the development and use of an integrated augmentative communication and manipulation assistive technology for academic activities are discussed.

INTRODUCTION

As in most countries nowadays, the Portuguese basic law on education establishes, as a general rule, that children with special educational needs should be integrated in regular schools, taking into consideration their needs and with support from a special education teacher, if necessary. School curricula, educational activities, and evaluation methods should be adapted to meet children's capabilities. This raises the problem of giving children with communicative and manipulative disabilities the opportunity of fully participating in academic activities involving the manipulation of educational materials, while reasoning and communicating about their experiences. Current pedagogy, for example in math [1] and science [2], recommends the use of problem-based learning in hands-on activities while communicating about concepts. While Augmentative and Alternative Communication (AAC) systems can be used to overcome expressive language limitations, robotic systems have been used as tools for manipulation of educational materials [3]. But often children can only access one of the systems at a time, preventing them from communicating while manipulating objects, and vice-versa, thus limiting their learning experience.

In [3], an integrated augmentative communication and manipulation assistive technology system to perform math activities is described. Taking advantage of the infrared output available in the Vantage® speech generating device (SGDs), Lego® Mindstorms® robot commands were integrated into the communication system, thus enabling children to both communicate and manipulate objects through switch control of the SGD. Building on this study, this paper reports the development of an integrated augmentative communication and manipulation assistive technology for academic activities in Portugal.

METHODS

When [3] was conducted, dedicated SGDs were widely used in Canada to overcome communication impairments, while in Europe AAC systems have tended to be based on specific software that runs on a standard computer. This approach provides an integrated solution for communication and computer access needs. The Grid 2, from Sensory Software (www.sensorysoftware.com), is one of the common AAC software programs used throughout Europe, and is the prevalent AAC software in Portugal. The integrated augmentative communication and manipulation assistive technology developed in this study was thus based on this software. The Grid 2 provides speech output and computer control, accepting user inputs from many devices (e.g. switches or eye gaze systems). It is also possible to run user designed programs from within The Grid 2, thus providing a way for controlling external devices using other software running on the same computer. Lego Mindstorms NXT robots have been used as augmentative manipulation tools [4]. These robots can be controlled from a computer through a BlueTooth® connection. Microsoft® Robotics Developer Studio 2008 R3, a freely available programming environment, was used to control the robot (www.microsoft.com/robotics). A car-like robot with a flat surface to place educational items was built from the Lego parts. A gripper was added to manipulate objects and a pen was attached such that the robot movement leaves a trace behind the robot.

In Portugal, school curricular goals are set nationwide and schools adopt textbooks from a list of certificated textbooks. Still, teachers are free to use activities other than the ones proposed in the adopted textbooks to meet the educational goals. Thus, adapting educational activities to make them accessible for children with disabilities must be done in close cooperation with the students' teachers. For the purpose of pilot testing the developed assistive technology, common first grade Math activities were adapted to facilitate the comparison with the results in [3], where similar activities were used.

New communication grids were created for each activity, integrating task dependent vocabulary and robot control commands. From these grids it was possible to access the users' own vocabulary grids as well as to spell a message using a virtual keyboard.

One 9 year old child, diagnosed with bilateral spastic (tetraparetic) cerebral palsy, participated in the pilot study. The participant has no independent mobility (he is pushed on a manual wheelchair) and requires AAC for communicating, either using a communication book, or using The Grid that he accesses through row-column scanning controlled by a single switch located at his head. He is a very competent communicator, attends the third grade and, as attested by his mother, already acquired the necessary math skills to complete the purposed tasks. Thus, failure or difficulties in performing any of the tasks should be attributed to system deficient design. The participant was introduced to the system in one training session that took place approximately two weeks before the pilot test, where a simplified version of the training protocol in [5] was used. The child was asked to perform math activities such as "draw a line as long as the one I drew" or “pick the items that you can buy for 5 Euros” (see Fig 1).

Figure 1: System’s pilot test.

RESULTS

The participant had no major difficulties in using the system to accomplish the tasks, being able to control the robot and communicate. However, some robot technical problems were identified that should be corrected in new versions of the system. Regarding the communication grids for each activity, the position of the most commonly used robot controls within the grid should be optimized for scanning users. Additionally, new robot control modes should be implemented in order to facilitate driving the robot for long distances. A “press and hold” mode, both for moving forward/backward and for turning, would be useful for users that are able to control switch activation time. A “hit to run, hit to stop” mode would be useful for users that have good timing control of the switch.

DISCUSSION AND CONCLUSION

Developing an integrated augmentative communication and manipulation assistive device to be used in Portugal following the work in Canada [3] raises several cultural issues. From the technological point of view, different platforms for AAC are commonly used in North America and Europe. Having an AAC software running on a standard computer, as it is usual in Europe, can open the range of actions that can be controlled through the AAC system but, on the other hand, requires that some control modes that are present in all dedicated SGDs (e.g., press and hold) must be explicitly set for a user designed grid, often requiring technical skills. From the educational perspective, although in Portugal the curricular goals are set for the entire country, teachers have a lot of freedom inside their classes to run the educational activities they find the most appropriate to develop children's skills. Therefore, despite being useful to have a series of adapted academic activities so teachers can gain some insight into the system capabilities, the actual activities that will be conducted in the classroom must be discussed and prepared with each teacher.

Besides these cultural issues, issues exist regionally as well. AAC running on mainstream technology is becoming widespread in Canada, too. Likewise, different regions within the country follow different curricular guidelines. Replicating the protocol in two different countries has highlighted commonalities and differences, in platforms and guidelines, which will be important to facilitate future replication and expansion to new topic areas.

After the necessary modifications to the integrated augmentative communication and manipulation system that were identified in the pilot test, the system will be used by children with neuromotor impairments in regular classes in Portugal to support their participation in educational activities in different areas (e.g., mathematics, literacy, social studies). The experimental objectives will be to evaluate academic achievement when using the AT compared to without it and to assess teachers' perceptions of the use of the AT and its impact on the student and in the classroom (e.g., student's engagement with activities, sensitivity to distractions and social inclusion factors).

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