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Training on the use of an integrated augmentative manipulation and communication assistive technology for academic activities

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Background
Current pedagogy advises teaching through multimodal activities, providing students with opportunities for seeing, hearing, doing and telling (e.g., [1, 2]). Children with physical and speech impairments may experience difficulties in accessing curriculum content. Following the groundbreaking work reported in [3, 4], we are developing an integrated augmentative manipulation and communication assistive technology (IAMCAT) to enable children to manipulate educational items and communicate about their learning experience [5]. Several studies have demonstrated the potential of robots as assistive tools for play and academic activities [6, 7, 8]. In the IAMCAT developed, manipulation is via a Lego Mindstorms car-like robot with a gripper and a pen attached. The robot is controlled through cells in The Grid[1] software communication boards. A virtual robot with virtual objects on a computer screen is also being developed. The use of virtual robots in order to decrease cost and to facilitate the use by non technical persons as well as the dissemination of the assistive technology was also explored in [9]. The child interacts with the system through his/her computer access method. Children must be trained in robot functions before classroom use of the IAMCAT in language, mathematics, science & social studies activities. This paper reports on this training, discussing the training protocol, the results achieved by five children with disabilities that went through a number of training sessions, and methods to evaluate the performance of children when using the system.

Method
Based on [10], a robot training protocol was designed to develop the following skills: a) driving to any workspace location, b) picking and placing objects, c) using the pen to trace lines, and d) communicating using the Grid system while controlling the robot.
Five children in regular classes in the Lisbon area with different degrees of physical and speech impairments were recruited (two 5 year olds, and three 6 year olds; two males and three females). Three used the virtual robot and two the physical robot, as dictated by chance. Informed consents

1 www.sensorysoftware.com

were obtained. Participants had a variable number of training sessions with their performance evaluated by robot control and communication goals. A prompting hierarchy based on [11] was used.

Results

After a number of training sessions, skills levels stabilized, as evaluated by the clinical perception of the research team conducting the sessions. Three of the participants were not able to control the robot in its frame of reference and a new control method was programmed enabling them to control the robot in their own reference frame (e.g., left control always made the robot move to the child's left regardless of the robot orientation). Another participant did not achieve a level of independence using the system, always requiring prompting of the robot commands. Participants' performance shown by coding of the level of prompting required to achieve each robot control or communication goal did not stabilize for all participants along all goals, thus revealing a discrepancy between qualitative and quantitative evaluations. Several factors may impact the quantitative evaluation. In order to keep children engaged, the training protocol should include a set of different playful and meaningful robot activities. Nevertheless, children may start losing interest after a few sessions, performing below their true abilities and failing to improve. Another aspect that may confound quantitative results is the fact that task complexity increases along the sessions aiming at improving children's mastery over the system. However, the quantitative evaluation of the participants' performance allowed for planning the following training session, selecting activities aimed at developing the skills that were still not acquired by the child. Additionally, it helped to identify when it is necessary to program the robot to perform more of the task to make the system usable by a particular child.

Conclusion

The training protocol was effective for children to learn the necessary skills to use the IAMCAT to perform educational activities. Evaluation of children's performance using the system should be done both qualitatively and quantitatively. In the end, it will be a combination of the qualitative perception of the child's performance and the time available for the training sessions that will dictate when to transition to classroom utilization of the IAMCAT to perform academic activities, but the quantitative evaluation helps to identify the robot control and communication goals that need to be addressed in each training session and, ultimately, the skills that were not mastered by the child and thus should be addressed by reprogramming the robotic system to meet different children's needs or by appropriately designing the academic activities.

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