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Language use during mathematics activities: differences between directing and doing hands on portions using a robot

Aim

Many classroom mathematics activities are done in small groups, and language is an important part of children's collaborative problem solving [e.g., 1]. For students who use AAC, being able to direct peers to manipulate objects can result in increased participation in activities [2]. Controlling robots from an augmentative and alternative communication (AAC) device for active participation in hands-on activities has also been studied [3]. Knowledge of the expected vocabulary for negotiating the activity, directing others, and getting help can inform decisions about what vocabulary is needed alongside robot control commands on an AAC system. It is possible that students would need less "helping" vocabulary if using a robot because they can do part of the hands-on tasks themselves.

Two participants who had physical impairments, but high linguistic and social skill, performed paired math measurement activities by directing a peer and by using a robot. The aim of the study was to gain an understanding of the language needed by students with physical disabilities to complete the tasks with and without a robot.

Method

There were two participants, a six year old boy in grade one and a ten year old girl in grade four; with speech and language skills within normal limits for their age. The boy had quadreplegic cerebral palsy, and had a spasticity treatment prior to the research sessions which resulted in a difference from his typical function in his upper limbs. The girl had spinal muscular atrophy with severe physical impairments affecting all four limbs.

The participants performed math measurement tasks with a peer, taking turns measuring two or three objects each in two conditions. Pair 1 compared the length of objects and Pair 2 measured objects in centimetres. In the baseline condition the pair interacted as they would normally. After training on robot use, in the intervention condition the participant used a small Lego Mindstorms ™ car-like robot with a gripper to perform the measurements, with the partner helping as requested. Participant 1 controlled the robot from an ACER ™ laptop with specialized software accessed through the trackpad, and Participant 2 controlled the robot from an Apple iPad Mini™ with the Lego Mindstorms Commander program, accessed by the touch screen.

Participant 1 compared objects by controlling the robot to move an object beside the comparison object, and Pariticpant 2 measured objects by moving a centimetre ruler attached to the robot alongside the objects.

Utterances were coded into four categories. 'Math-related' included language used to discuss math concepts, e.g., predicting and reporting results of measurements. 'Task completion' included utterances used to ask for help or direct the partner. 'Task-related' included utterances that were on task but not used to ask for assistance and not specific to math learning. 'Unrelated' included language that was not at all related to the task.

Results

For Participant 1, there was very little difference from baseline to intervention in the proportion of math related (from 27% to 30%) and task related (from 46% to 43%) utterances. The proportion of task completion utterances changed from 19% in the baseline to 8% in intervention. Upon examination of the utterances they were similar in nature in both conditions. Because of the spasticity treatment, this student was able to move objects side by side with his own hands, thus, the robot was of limited value to him. His utterances in both baseline and intervention conditions were requests to hand objects to him that were out of his reach.

For Participant 2, math related language was 15% in baseline and 25% in intervention, and task related language was 48% and 40%, respectively. Task completion language was 33% in baseline and 25% in intervention. The task completion language changed with the introduction of the robot to include more specific directions for the measurement procedure. Examples of task completion language in the baseline were, 'Try one of those ones over there' and 'I can't tell, come over here', and in the intervention the participant said things like 'Thats too far on the measuring stick' and 'I want it right at the edge'. One time, Participant 2 asked her peer to 'put it [the object to measure] down some more', and when the peer didn't put the object where needed, the participant moved the robot to line the object up at the "0" on the ruler.

The data was subsequently examined for specific language used (words and phrases). Many examples were identified, including math related language ("longer than"), task related comments ("you're next"), and requests ("can I have the…", "grab the …."). Examples of the participants' comprehension of the math concepts were also identified. For example, at the beginning of the intervention, participant 2 was asked to estimate the length of her first object. Her response was "2 inches". When provided with metric units to choose from she responded with "I don't know.... inches". Spontaneous use of the correct centimetre unit was observed after she had estimated and measured three objects using the robot.

Discussion and Conclusion

Task related language was the highest proportion of language during the session for both participants in both conditions. The proportion of task completion language was higher for Participant 2 than Participant 1 in both conditions, possibly due to her more

significant physical limitations. The proportion data and language observed can be used to inform possible vocabulary choices for similar activities.

This study also outlined other aspects of communicating about math that can be examined during robot use. First, when Participant 2 lined up the object with the 0 on the ruler, it showed her solid understanding of the concept. Second, being able to use the robot illuminated difficulties understanding and using math related functional vocabulary (centimetre).

While use of the robot did not necessarily reduce the need for "helping" vocabulary, this study provides us with a number of variables to consider tracking in future studies, for instance: specific vocabulary used during similar activities, understanding of mathematics concepts, and review of “helping” vocabulary needed for students using AAC devices.

Declaration of Interest

The authors disclose they have no financial or other interest in objects or entities mentioned in this paper.

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