UNIVERSIDADE CATÓLICA PORTUGUESA

Project
UARPIE
2013-2015

Using Assistive Robots to Promote Inclusive Education

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Research team

Project
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2013-2015

UNIVERSIDADE CATÓLICA PORTUGUESA	SANTA CASA	University of Alberta	anditec	Escola Superior de Educação de Lisboa
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Manipulation

- Physical and cognitive development are closely connected
- Motor experience has a critical importance in development

(Butler, 1986; Piaget, 1954)

Manipulation

- Object manipulation promotes:
  - The acquisition of learning skills
  - Symbols emergence
  - Referential communication
  - The perception of the relations between objects

(Piaget, 1954; McCarty et al., 2001)

Motor limitations

- Physical impairments may limit the capacity of a child to manipulate objects
- This can lead to:
  - Compromised learning
  - Loss of motivation
  - Apathetic behavior
  - Decreased self initiative
  - Learned helplessness

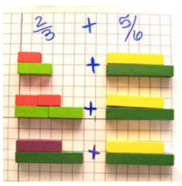
(Butler, 1986; Jennings & MacTurk, 1995; Poletz et al., 2010)

Learning

- Multimodal activities foster the learning experience

(van de Walle et al., 2010; NSTA, 2002)

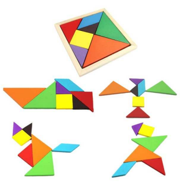
Cuisenaire rods



mathfour.com

www.learning4kids.net

Tangram



aliexpress.com

Learning

- Pedagogic theories, namely those grounded on constructivism and neo-constructivism, advise teaching through multimodal activities, providing students with opportunities for seeing, hearing, doing and telling

(Van de Walle et al., 2010; NSTA, 2002)



petitcolisee.canalblog.com http://www.peacefulpathwaysmontessori.com

Learning

- Children with motor and speech impairments may have difficulties accessing the curriculum content

"Cuerdas", Pedro Solís García

Robots

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- Robots may enable children with motor impairments to:
  - Independently manipulate objects
  - Explore objects and their relations
  - Create play opportunities

(Cook et al., 2012)

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- **Goal:**
  - Develop an integrated augmentative manipulation and communication assistive technology (IAMCAT)
- **Hypothesis:**
  - The IAMCAT promotes inclusion and learning by allowing children with motor impairments to manipulate educational items while communicating about their experiences, effectively participating in class activities

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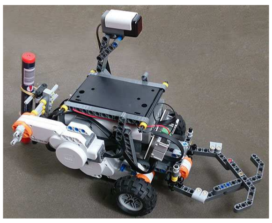
- **Experimental objectives:**
  1. Evaluate academic achievement when using the assistive technology (AT) compared to without it;
  2. Compare virtual and physical robotic systems in relation to #1;
  3. Assess teachers' perceptions of the use of the AT and its impact on the student and in the classroom

IAMCAT - Physical



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 2 software communication boards. The child interacts with the system through his/her computer access method

IAMCAT - Virtual

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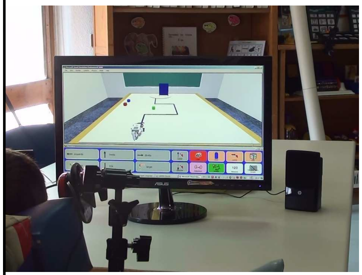

A virtual robot with virtual objects on a computer screen was also developed.
Rationale:
- Decrease cost
- Facilitate the use by non technical persons
- Facilitate dissemination of the assistive technology

IAMCAT tests

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- Nine children with disabilities integrated in regular classes used the IAMCAT to perform pre-school and first grade language, mathematics, science & social studies activities
- Before using it in the classroom, children were trained to control the robot using the IAMCAT

Participants - Children

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Participant	Gender	Age (years)	Grade	Robot	Access method
#1	F	5	Pre-school level 3	Physical	Direct (Track-ball)
#2	M	6	1st grade	Virtual	Direct (Track-ball)
#3	M	6	1st grade	Physical	Direct (Eye-tracking)
#4	F	6	Pre-school level 3	Virtual	Direct (Track-ball)
#5	F	5 / 6	Pre-school level 3 / 1st grade	Virtual	Direct (Track-ball)
#6	M	5	Pre-school level 3	Physical	Direct (Track-ball)
#7	M	4	Pre-school level 2	Physical	Direct (Track-ball)
#8	M	3	Pre-school level 1	Physical	Direct (Eye-tracking)
#9	M	3	Pre-school level 1	Physical	Direct (Eye-tracking)

2013/2014

2014/2015

Participants - Teachers

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		RE (9)	SE (9)
Age	20 - 29	1	-
	30- 39	4	6
	40 - 49	2	2
	50 - 59	2	1
Service time	0 - 9	2	1
	10 -19	3	4
	20 - 29	3	2
	30 - 39	1	2
Background	BA / MA Child Ed.	7	5
	BA Primary Ed.	2	3
	Other degrees	-	1
	Special Education	2	9

Training protocol

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- **Goal of the robot training protocol**: develop the following skills
  - driving to any workspace location
  - picking and placing objects
  - using the pen to trace lines, and
  - communicating using the Grid system while controlling the robot

Training protocol

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- **Familiarization activities**: knocking over stacks of blocks in front of the robot, and to the left and to the right of the robot
- **Slalom course trials**: drive the robot through a course with a different number of obstacles
  - While lifting the robot pen up and down
  - While gripping an object
  - While “saying” randomly chosen words

(Adams&Encarnação, 2011)

Clinical observation

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- Participants went through a variable number of sessions ending the training when their 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
- Another participant did not achieve a level of independence using the system, always requiring prompting of the robot commands

Quantitative assessment

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- The following 12 robot skills were graded according to the level of prompting when applicable

Move forward	Use long /short steps	Drive the robot to the required location
Move backward	Pen up/down	Avoid obstacles
Move left/right	Open/close gripper	Pick and place objects
Turn left/right	Sequencing (equal/different) commands	Draw lines with the robot

- In each session, worst, best and average performance were recorded

Quantitative assessment

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- Scores were given according to the following prompting hierarchy (Dynavox, 2011)

Score		Example for knocking over a stack of blocks
GM	Goal met	Child performs the activity after being tell that he/she should knock over the stack of blocks
IC	Indirect Cue	"Have you noticed that you may control the robot to knock over the stack of blocks?"
DVC	Direct Verbal Cue	"You need to drive the robot towards the stack of blocks"
DPC	Direct Pointer Cue	"You need to select this robot control cell"
PA	Physical Assistance	Guiding participant's hand in order to make the necessary selection

Quantitative assessment

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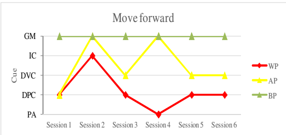
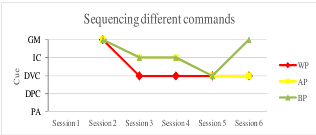
- Participants' performance shown by coding of the level of prompting required to achieve each robot control or communication goal did not stabilize for all participants along all goals

Participant #1





WP – worst performance; AP – average performance; BP – best performance

Quantitative assessment

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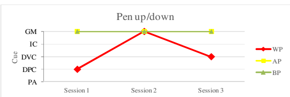
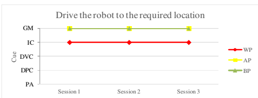
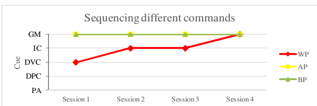
Participant #2





Participant #3



WP – worst performance; AP – average performance; BP – best performance

Quantitative assessment

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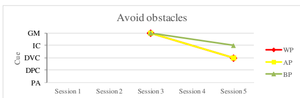
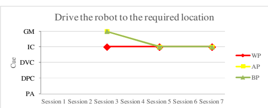
Participant #4



Participant #5



WP – worst performance; AP – average performance; BP – best performance

Discussion

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- Children may start losing interest after a few sessions, performing below their true abilities and failing to improve
- Task complexity increases along the sessions aiming at improving children’s mastery over the system
- For such young participants, performance measures may have a strong behavioral interference, reflecting not so much their abilities to control the robot but rather their motivation to perform

Discussion

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- 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

Discussion

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- **Quantitative evaluation** helps to identify
  - Robot control and communication goals that need to be addressed in each training session
  - The skills that were not mastered by the child and should be addressed by reprogramming the robotic system or by appropriately designing the academic activities

Classroom sessions

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- Participants used the system in their regular classes to perform pre-school and first grade language, mathematics, science & social studies activities
- A portfolio of IAMCAT-adapted activities was presented to the teachers for them to better understand the capabilities of the IAMCAT
- Activities were prepared with the participant's teachers

Classroom sessions

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- Activities were proposed to the entire class: each participant had the opportunity to perform the activities using the IAMCAT and his/her peers did the activities with pencils on paper or cutting and gluing, as required by the particular activity

Classroom sessions

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- All necessary physical materials or the virtual scenarios were prepared by the research team (in one case by the teachers)
- In general, classes were conducted by the regular teachers
- The special education teacher or one of the researchers provided technical support for the robot, and academic and robot control support to the study participant

Classroom sessions

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- Three classroom sessions were organized for each child, one dedicated to each curricular area
- Classroom sessions were videotaped
- To evaluate teacher's perceptions, participants' teachers were interviewed and a content analysis of the interviews was performed using the Atlas.ti® 6.2 software (Roberts, 1997)

Results – teachers' perceptions

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Assessment of project development

Pedagogical process:

- Careful selection and planning of the activities
- Adequacy of activities and resources
- Insertion of the activities in the class/group dynamic

Inclusion of the participant during the sessions:

- Class positive reaction to the activities
- Interaction with peers during the activities
- Peers collaboration attitudes during the activities

Results – teachers' perceptions

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Assessment of project development

Difficulties identified by the teachers:

- Group management (e.g., distribution of attention time)
- Individual support to the child (e.g., extra time needed to complete the tasks)
- Use of the AT (e.g.: physical robot space requirements; regular teacher lack of experience in using AAC devices)

Results – teachers' perceptions - robot

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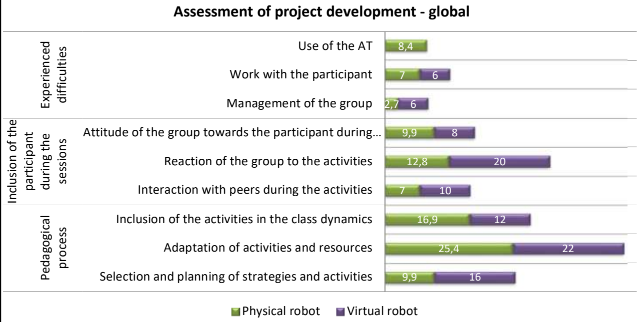

Results – teachers' perceptions - robot

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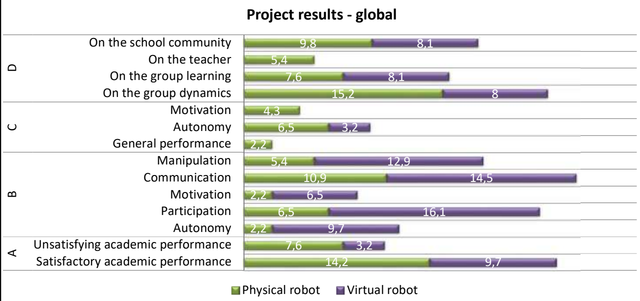

A- Child assessment wrt goals; B – Relevance of the AT in the child performance;
C – Irrelevance of the AT in the child performance; D – Impact in school and class

Results – teachers' perceptions

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Project impact on the class and on the school (examples)

In the group dynamics:
- Enriching experience to the group
- Acknowledgement by the group of the child capabilities

In the group learning experience:
- Possibility of addressing different curriculum content

On the teacher:
- Facilitator of the communication with the child

On the school community:
- Acknowledgement by the other educational agents of the child capabilities

Results – teachers' perceptions - robot

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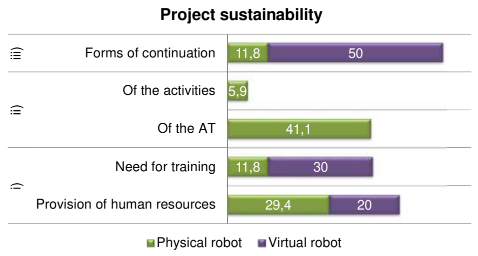

i) Teacher support; ii) Suggestions and iii) Proposals

Conclusions

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- Teachers considered the IAMCAT a valuable resource that can be integrated in regular classes and that is compatible with the teachers' curricular planning and management
- However they pointed out the need for proper training and for the presence of another teacher / teaching assistant in class

Available resources

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SISTEMA INTEGRADO DE MANIPULAÇÃO E COMUNICAÇÃO AUMENTATIVAS

MANUAL DO UTILIZADOR

UARPIE - Using Assistive Robots to Promote Inclusive Education
Utilização de Robôs de Apoio para Promover a Educação Inclusiva
(PTDC/MHC-CED/4199/2012)

INTEGRATED AUGMENTATIVE MANIPULATION AND COMMUNICATION ASSISTIVE TECHNOLOGY

USER MANUAL

UARPIE - Using Assistive Robots to Promote Inclusive Education
(PTDC/MHC-CED/4199/2012)

Available resources

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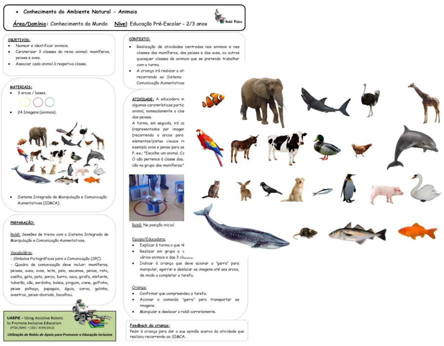

Acknowledgements

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