Using Educational Robotics for Students with Learning Difficulties

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Abstract

Robots are widely used in manufacturing industry, military, space research, medical application and transportation. Using robot as educational purpose is a new method in the world. Educational robotic is a supportive learning environment for students to motivate them with attractive and interesting design for active participation. Educational activities with different types of robots support and reinforce of knowledge and skills of students with creation, assembly, design, motion and operation of robots.

This study aims to define current position of educational robotics for people with learning disabilities. Which will guide researchers to define pathways for development of educational robotic applications and methodologies. Authors of this paper are members of EC KA3 Multilateral project group, titled "Educational Robotics for people with learning disabilities (EDUROB)". This paper also includes validated data in the field, gathered from focus with interviews and surveys during EDUROB Project research activities.

Key words: Robotics, Educational Robotics, Special Education

1. Introduction

Robotics have been researched quite widely for their use in aiding rehabilitation, but they may also have uses in education as virtual tutors, as companions or as other interactive characters [1] . Cook et al. describe the importance of physical play in early learning, and describe the design of a system where children with physical impairments can engage in play activities through the use of a robotic arm that can be controlled by switches – this allows for 3D manipulations to be explored that are not possible using 2D computer environments [2]. Simpler robotics kits are already in widespread use in education, such as the popular NAO Humanoid and Lego Mindstorms, which are normally used to teach concepts of computer programming and engineering. Dautenhahn also describes the AURORA project, which explores the use of socially expressive robots as electronic 'pets' for young people with autism [3]. In this context, Dautenhahn suggests that robots have advantages over human interaction for this user group due to their predictability and reliability. Wainer et al. also explore the use of a robotics class as a means to encourage collaboration between school children with autistic-spectrum disorders, claiming that the nature of the technology is an effective way to leverage the existing interests of the children, resulting in a more effective intervention than social skills classes [4]. This suggests that there are potentials for the use of robotics in education that should be explored as these technologies become more widespread and affordable in the future.

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Educational robotics are started to use in education as an interactive learning tool but it is also effective supported materials for special education. Robots can be ideal in implementing experiential learning, an approach that can increase the independence of learners in terms of their ability to seek out and assimilate new knowledge [5]. Robots can be a useful tool in encouraging play interactions which is a key part of encouraging growth in developmental areas [6]. This appears to be one of numerous papers that focus on the general idea of encouraging play in special education students for example; [7-9] which also suggest that imitation through play is important in autistic children.

This paper presents the different educational robotic platforms that can be use into special education for different target groups like as mental retardation, pervasive development disorder (autism, asperger, rett), sensory impairment, motor impairment, learning difficulties, attention deficit hyperactivity disorder (ADHD), developmental delay, language and speaking delay, articulation disorders.

2. Pedagogical and Technical Requirements

For gathering need analysis about educational robotics for people with learning disabilities, surveys done with online tools and supported with face-to-face interviews. Focus group includes special education teachers, therapists and rehabilitation specialists total 15 professionals. Online surveys are applied to 52 special education teachers. These interview and survey data gives a brief explanation about expectations of end users. Pedagogical and technical requirements will guide researchers to define pathways for development of educational robotic applications and methodologies.

According to survey responds, typical teaching session for special education includes activity based teaching, learning through discovery, modeling, using ICT tools (tablet, special software, video), videos with dub, speech cards, pictograms so educational robotics easily adapt to teaching sessions for students with learning difficulties. Because most of the special education teachers perceive as major challenge in teaching of their students are divided into 2 groups as educational and social levels (Table 1).

Table 1. Educational, Social level learning and developmental requirements

Educational level	**Social level**
Basic key competences skills	Social learning
Memory skills	Task management skills
Perception skills	Self-presentation skills
Executive functions	Communication skills
Thinking strategies	
Detailed knowledge	

Educational Robotic applications and methods should address one of the requirements mentioned above. Educational benefits of robotic platforms should be “Students with special requirements are reaching new levels of learning through the use of robotics in the classroom”.

3. Educational Robotic Platforms

Selection of the robotic platform plays key role for designing and developing educational robotic applications and methodologies. Because; each robotic platform has different behavioral, sensory and programming capabilities. Each type of robotic platform could be used for specific teaching objectives. Some robotic platforms are more likely for research and technical teaching and study. With these type of robots developing educational robotic applications and methodologies will be limited. In Table 2 popular educational robotic platforms are listed with their educational level, features, programming languages and place of origins.

Table 2. Popular educational robotics platforms

Name	Educational level	Features	Programming languages	Place of origin
Arduino Robot[14]	Secondary, Vocational Education, University	MOBILE ATmega32u4 microcontroller 32KB flash memory, keypad, full color lcd, sd card reader, speaker	Arduino	Italy
Thymio II robot[15]	Primary, Secondary, Vocational Education, University	MOBILE 16 bit PIC24 processor	ASEBA scripting language	Switzerland
Robotino[16]	Vocational Education, University	MOBILE Intel Atom, 1.8 GHz, dual core, 4 GB RAM, 32 GB SSD Various sensors, Full HD Camera	C, C++, Java, .NET, Matlab, Labview and MS Robotics Developer Studio	Germany
Lego Mindstrom NXT[17]	Secondary, Vocational Education	STEM EV3 Brick control center and power station, 4sensors, 4 motors, USB port, micro SD card port, built-in speaker	Lego Mindstorms EV3	Denmark
Robotis Play[18]	Primary, Secondary	STEM CM-150 controller embedded with buzzer, mic and 3x IR sensors, Touch sensor, IR sensor, RC-100B remote control and bluetooth module	R+ Task (C-based GUI)	Korea
Fischertechnik Computing[19]	Primary, Secondary, Vocational Education	STEM Module Robot TX is based in 32-bit ARM 9 processor, 8 MB RAM, 2 MB flash, display (128x64 pixel), monochrome	Propetary app. "ROBO Pro", C compiler	Germany
Engino Robotics ERP[20]	Primary, Secondary, Vocational Education	STEM 32-bit ARM CORTEX-M2 micro controller, 256 Kbytes FLASH, 64 Kbytes RAM	ERP Software	Cyprus
Aldebaran NAO[21]	All Levels	HUMANOID Intel Atom @ 1.6 GHz two HD cameras, four	Chorographe C++, Python, Java, Matlab,	France

		microphones, sonar range finder, two infrared emitters and receivers, inertial board, nine tactile sensors, eight pressure sensors Ethernet, Wi-Fi	Urbi, C, .Net	
Robotis Bioloid Premium[22]	Secondary, Vocational Education	HUMANOID Controller CM-700 based in Atmel ATMega2561 embedded mic, mini USB port, 1 gyro sensor, 1 distance sensor, and 2 IR sensors	Robo+ Task Robo+ Motion	Korea
Robotis Darwin OP[23]	University	HUMANOID 1.6 GHz Intel Atom Z530 on-board 4GB flash SSD, 20 actuator modules (6 DOF leg x2+ 3 DOF arm x2 + 2 DOF neck)	Linux Open platform	Korea
RoboKind Zeno R-25[24]	University	HUMANOID OMAP 4460 dual core 1.5 GHz ARM Cortex A9 processor with 1 GB of RAM and 8 GB of memory, wifii and bluetooth.	Java	USA

There are a lot of educational robot platforms for different target groups in all education levels. Increasing the number of robots available and increase the range of behaviors and interactions to allow for a greater degree of applicability [10,11].

Most of the educational robots which are suitable for students aged over 12 have a control unit and special program interface to upload written codes and also write new or modified programs. The control interfaces must be improved to allow teachers to control the robots without having experience of programming [11-12] . Similarly, there is a need for teacher moderation of behavior, perhaps through speech commands [13].

4. End User Responds About Robotics in Classroom

For guiding future and present educational robotics researches face-to-face interviews are done with focus group between September – December 2014. 15 professionals attended these sessions. Key findings are given below; these findings will be basis potential activities for design and development of educational robotic applications and methodologies in Turkey. Responds and suggestions are grouped for specific training activities from individual development program and curriculum designed by Turkish Ministry of Education.

It is possible to use the robot to make exercise for:

- Cognitive development. It should be good idea for developing motor skills for students in preschool years. Student can try, repeat and learn with robot the actions like as clap hands, touch fingers, paste things onto paper, open and close a button, build a tower of

many blocks, complete puzzles with four or more pieces, manipulate pencils and pastels well enough to color and draw, draw a circle onto a paper.

- Speech and language therapy that include difficulties with fluency (stuttering), making sounds and words, making sentences, understanding what others say, using language socially.
- Speech and language delay and disorder. Robots can be programmed for tell a story, speak with sentence length of 4-5 words, use its vocabulary of about more than 250 words, ask name and last name, name of street, repeat several nursery rhymes, identifies colors, shapes, asks many questions like "what?" and "who?" and give feedback.
- Receptive language skills to understand words and language. Building blocks can be good exercise with robots. By this way, students can develop receptive language with attention and concentration, pre-language skills, social skills, play skills.
- Following instructions to develop the ability of students to act on requests. Student can listen the robot to find something in classroom. It will be good exercise for hearing, understanding, attention and concentration, working memory, following the steps (number of steps depends on student's age).
- Balance and coordination to maintain a controlled body position during task performance. It will help to get attention and concentration to maintain attention to a specific task for an extended period of time. Also it will be helpful for body awareness, hand-eye coordination and postural control.
- Play skills and social skills exercises to learn about the environment, bodies and place in the world around students.
- Starting conversations (greetings, talking, resolving problems), develop emotions (identifying, interpreting, predicting, acting and responding), control behaviors (meanings, emotions).

It is clear that some problems and barriers might make it difficult to use educational robots in the way specified. Those are:

- Lack of technical experience of special education teachers.
- Lack of special education teachers' capacity to program of robot for different reactions and answers.
- Comprehensive programming needs for speech and language therapy activities.
- The level of school provision of high-tech equipment.
- Educational needs to get a research-based developed curriculum.
- Educational needs about in-service training to use robot and curriculum modules.
- Technical requirements (software, wifi, batteries).
- Cost of the robot.
- Broken down or damaging robot by students.
- Problems to get real human voice for exercises if it is not possible to record parent's or teacher's voice.
- Difficulty attending and listening to robot (it can vary depending on the student's age).
- Does not pay attention sometimes.

- Fails to follow instructions accurately.
- Struggles with following longer instructions and commands.
- Looks at teacher or around blankly when robots give students an instruction.
- Avoids carrying out instructions.
- Forming friendships and engaging in positive interactions with robot.
- Social isolation as students will struggle to participate activities.
- Inability to repeat robot actions, which will limit the options for play with robots, a means of catching up it.

Recommendations for special education teachers during the use of educational robotics in the classroom are:

- Robot will show the actions for each motor skills exercise but actions must be very slow and teacher also can pause it to explain deeper, if necessary.
- Students listen and watch the robot actions. After SEN teacher motivation, he/she will start to try, repeat and do them.
- Robot will start to talk student for oral motor skills exercise but actions must be understandable and similar to human voice. Teacher will stop it to repeat again and then robot should check the pronunciation of student.
- Students listen the robot speak: a story, sentence, nursery rhymes.
- Student give answer to the questions about name and last name, name of street, "what?" and "why?" questions.
- Students give answer of the questions colors, shapes etc. and see/listen robot's feedback.
- Students listen robot to follow instructions.
- Students listen very carefully to instructions to find something (example: go 3 steps forward, then 1 step to the right). This can be reversed so that the child has to give someone else the instructions)
- Robot will help student to follow instructions and commands and help student to understand and complete routine and unfamiliar tasks around home and school.
- SEN teacher should check the followed instructions and if something is wrong or is not totally true, robot should repeat and students should try again.
- Robot will show the actions for building blocks but actions must be very slow and teacher also can explain deeper, if necessary.
- Robot will draw shapes, use different color pen and ask them to students.
- Robot will explain how to use tools for handcraft. It must be very enjoyable if robot will give the tools (scissor, gripper, rope, glue) to our students as an assistant.
- Robot can start to dance to improve attention to task and alertness levels in readiness to respond quickly by students when they lose their balance.
- Robot will show the steps simple sorting and matching and ask students to do them for sensory play (experience objects through students ‘senses), exploratory play (experience to figure out functions and limitations of objects), symbolic and imaginative play (learning to substitute one object for another or coming up with a new function for an object).

5. Conclusions

This study represents current position of research on educational robotics for people with learning disabilities. Which is a quite new topic for researchers in the field of mechatronics, electronics and software programming. Paper includes real data gathered from professions in the field of special education teachers, therapists and rehabilitation specialists total 15 professionals.

Findings of these interviews and surveys will guide researchers to define pathways for development of educational robotic applications and methodologies. This paper also represents that use of robotics for education of people with learning disabilities is possible and valuable. Respond from focus group and papers in existing literature shows that educational, social level learning and developmental requirements could be addressed by this methodology effectively. Therefore authors hope that awareness of researchers and quality of research outcomes will be improved with this paper in the field of Educational Robotics for Students with Learning Difficulties.

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