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Adressing Special Educational Needs in Classroom with Cyber Physical Systems

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ABSTRACT

The focus of the current chapter is on humanoid robots as part of an inclusive education. It presents a brief overview of the main features of cyber physical systems which could be used as an advantage with children with special educational needs. Based on the specifics of the main types of special educational needs, a list of suggestions about the practical implications of educational robots to the classroom has been generated. A pilot study of the perception and attitude of children and teachers in a local Bulgarian school towards the application of cyber physical systems in education has been conducted. Based on previous research and the fundings of the pilot study, a few gaps of knowledge have been identified. First, the lack of empirical work on the application of technology to subjects, such as biology, chemistry, history, or to the development of social skills and creativity. Second, the scarce evidence of the long-term effects of interventions with children with special educational needs. Third, the lack of research on the attitudes of teachers with and without special educational needs children in the class towards educational robots. Last, but not least, the need for comparison of the perceptions and expectations of users of such technology across cultures.

KEYWORDS

Application of Robots, Children with Special Needs, New Bulgarian University, Percepyion and Attitude, Technology

INTRODUCTION

The focus of the current chapter is on the introduction of cyber physical systems (CPS) to the classroom as part of inclusive education. Due to the rapid advances in technology, the introduction of CPS to the interventions of special educational needs (SEN) is a few steps away. Although still non-existing in practice, this seems to be the natural course of events, considering the fast development of technology and its application in education and therapy. Efforts in the fields of mainstream education and assistive therapy have already been made and the results are promising. Robots could support the learning of children (Westlund et al., 2017), could be personalized to their needs (Leyzberg et al. 2014) and reduce the teachers' workload (Movellan et al., 2005). In order to integrate CPS into the work with SEN in the classroom, the following steps should be accomplished: development of specific computational features, identification of the specific needs of children with SEN, creation of educational robots that could fit these needs and preparation of the target population for this big change.

The feasibility of this idea depends on the collaborative effort of specialists from different areas. While engineers and technicians are working on the technical and computational improvement of CPS, psychologists need to identify the specificity of the needs of children with SEN in the classroom. Certain characteristics of CPS, such as time and spatial sensitivity, the variety of mechanisms of

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activation and the opportunity to tailor the system to the specific needs of the child make them appropriate for use with children with SEN. In order to achieve the latter, specialists need to know the specificity of the needs of such children.

The main groups of SEN include autistic spectrum disorder (ASD), dyslexia, physical disability, hearing and vision impairment, hyperactivity, and intellectual disability. The specific characteristics of each condition require modifications of the learning environment and teaching methods in order to meet the needs of the child. The successful implementation of educational robots to school would require thorough research and careful development of a plan.

However, knowledge about SEN and development of technology are not the only prerequisites for the achievement of this change in the educational system. Part of the great potential of robots is due to the high motivation of people to use them. The human-robot interaction (HRI) is a two-way process, which depends on one hand on the characteristics of the robot and on the other, on the expectations of the user. People's perceptions of robots depend on many factors, such as empathy, behaviour and anthropomorphism of the robot, age and gender of the user and others. The negative attitude of teachers or students towards educational robots could harm the work with them. Therefore, it is crucial to identify what is the attitude of parents, teachers and children before introducing robots into schools. However, attitudes could be different in different parts of the world. The investigation of perceptions in distinct areas would allow addressing the problem on a global level.

CYBER PHYSICAL SYSTEMS (CPS)

The development of technology has created new possibilities for development of many aspects of society. The application of computers, robotics and cyber physical systems (CPS) in engineering, medicine, therapy and other areas is being thoroughly investigated. However, the use of CPS as tools for assistance of children with SEN is a relatively new field and requires rigorous research.

CPS is a heterogeneous system of systems, which integrates physical, computer and communication components (Tan et al., 2009). These components are interconnected by feedback loops and act autonomously to produce a consistent response (Lee, 2008). In other words, computer systems recognize characteristics from the physical world, analyse them and produce the pre-programmed appropriate reaction. Computers recognize and react to physical activity by embedded systems, such as actuators and sensors (Tan et al., 2009). Sensors detect physical activity and convert it into information. Actuators receive signals and convert their energy into motion. Physical processes affect cyber mechanisms and vice versa. This interaction is characterized by time and spatial sensitivity (physical changes are reflected in cyberspace when and where they occur) (Tan et al., 2009). However, not all changes need to be reflected. Therefore, by pre-programming the parameters of the conditions of interest into the computer, the important changes are recognized by the cyber system as events. The detection of event results in action, or predefined reaction.

These characteristics give advantage to CPS compared to other technology. One of the reasons that make them appropriate for use with children with SEN is the variety of mechanisms of activation which could facilitate the adaptation of children with special needs to their daily use. For example, robots operated by CPS rely upon visual and auditory recognition mechanisms, pressure sensors responding to tactile stimulation, wireless control (from computers, smartphones, tablets). Children with special needs could experience difficulties with the activation of the robots (for example, due to motor control difficulties). The possible solutions of this problem include activation by the teacher or pre-set adjustments of the robot to activate as a response to different triggers (to execute a particular behavior at a set period of time, as a reaction to specific command or physical response by the child, such as eye movement). Alternatively, it could be activated by a push switch (large button or joystick) on the robot or on a remote control, by vocalization, or by pressure sensors on the armrest of a wheelchair, by chin or eyelid movement as an adaptation for children with severe motor deficits (Standen et al., 2016).

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