ICT to Support Inclusive Education

Introduction to the Special Thematic Session

Marion Hersh[1(✉)], Barbara Leporini[2], and Marina Buzzi[2]

[1] Biomedical Engineering, University of Glasgow, Glasgow G12 8LT, Scotland
Marion.Hersh@glasgow.ac.uk
[2] ISTI-CNR, via Moruzzi, 1, 56124 Pisa, Italy
Barbara.Leporini@isti.cnr.it, marina.buzzi@iit.cnr.it

Abstract. This short paper introduces five papers about different ways in which technology can be used to support the education of disabled children and young people. The topics covered include music education (two papers), for children with intellectual impairments in orphanages and autistic learners respectively, science education for hearing impaired students, classroom participation at a distance for autistic students and a recommender app for open learning resources. The approaches used include games, exercises, body motions, animations, a quiz and a robot based system with audio, video and vibro-tactile interfaces. Most of them were successful, but only tested with a small number of children and young people. The presentation of these papers is introduced by a brief discussion of the role of ICT in making education accessible to disabled people. It notes that there has been a tendency to develop learning technologies for specific groups of disabled people rather than for all learners and this is borne out in the papers.

Keywords: ICT · Inclusive education · Disabled people

1 Introduction

There are an estimated 93-150 million disabled children [15] and about a billion disabled adults. Education is a basic right, but many disabled people experience multiple barriers to accessing it, including learning environments which are not fully accessible [16], their right to education not being fully recognised legally [2], negative attitudes and low expectations [10, 12], and limited financial support [5]. Inclusive education has been recognised as a human right in the Convention of the Rights of Persons with Disabilities[1], but progress to it has been variable across different countries.

ICT can be used to support inclusion by providing many different ways of representing information, expressing knowledge and engaging in learning, including assessment, to increase the groups they are accessible to. This involves both general

[1] https://www.unicef.org/disabilities/files/Factsheet_A5__Web_REVISED(1).pdf.

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learning technologies and assistive technologies designed specifically for disabled people. The use of ICT in education has the further advantages of teaching ICT skills, which are becoming increasingly important, and drawing on the increasing popularity and motivating effects of using ICT, particularly amongst young people.

However, ICT is a means not an end in itself or a universal solution and it needs to be supported by appropriate pedagogical strategies, which consider student diversity, as well as appropriate teacher education and career-long learning. Learning technologies need to be fully accessible to disabled and other students and take account of gender and the social and cultural issues, values and sensitivities of the diverse populations that might use them [4, 14]. For instance, a mathematics computer game with a young female central figure has been found to be popular with girls and also enjoyed by boys [1]. The inclusion of disabled people from different cultures as central characters in games and other learning activities could support the inclusion of disabled learners.

Rather than developing learning technologies which can be used by all learners, both disabled and non-disabled, there has been a tendency to develop specific technologies for particular groups of disabled learners. A number of learning technologies developed for disabled learners also have a therapeutic or rehabilitation focus. However, many technologies developed specifically for disabled learners could also be used by non-disabled learners and learning technologies for the general population should be designed to be accessible, useable and otherwise suitable for as wide a range of disabled learners as possible. For instance, educational games are increasingly popular, but their design does not necessarily consider the needs of disabled people, though accessibility and usability conditions have been developed [7].

Many disabled people require assistive technologies to overcome social, infrastructural and other barriers to participating in learning and to carry out learning activities ‘safely and easily’ [6]. Assistive technology availability varies greatly both between and within countries. The main factors that affect it are income, language and urban/rural area, with most of the assistive technologies available in English or the more dominant European languages and in urban rather than rural areas [8].

Education in science, technology, engineering and mathematics (STEM) is important, including for many careers, understanding the increasingly important public debates and policy formulation on issues such as cybersecurity/privacy management and genetically modified organisms, and daily living activities such as budgeting. However, disabled students are underrepresented in STEM [11]. Blind and partially sighted students often experience particular difficulties in accessing STEM [9]. This includes challenges experienced by screenreader users in accessing formulas, graphs and figures and carrying out exercises.

It has been suggested that new accessibility solutions for emerging technologies will tend to focus on the needs of people with cognitive impairments and learning disabilities, as well as technologies on mobile devices [17].

2 Session Papers

The session consists of five papers. Two present technologies for learning music and the other three for learning science, classroom participation at a distance and obtaining and presenting recommendations for learning resources. Two of the papers present technologies for autistic learners, one for disabled learners in general and the other two for hearing impaired learners and intellectually disabled learners in an orphanage. The music papers consider the value of developing music skills and creativity. However, there is a greater focus on the therapeutic aspects of music and the use of music to improve mood than there would be in the case of non-disabled people.

Information technology in the musical and speech development of mentally retarded (sic) children in an orphanage by Natalia Taligtseva, Svetlana Konovalova and Valerii Lutkov from a pedagogical university in Russia discusses the use of information technology such as SmartBoard and the LiteBim light and sound system to develop several games and exercises. They include reproducing the sounds of animals or objects, mnemonic diagrams to support learning songs and producing different rhythmic accompaniments to music. The exercises and games were tested by seven 8–11 year old children with intellectual disabilities living in an orphanage and led to a significant improvement in their musical skills. They learnt to correlate previously unfamiliar sounds with objects, sing more confidently and produce correct rhythmic accompaniments, which only a few of them were able to do previously.

Promoting creative computer-based music education and composition for individuals with autism spectrum disorders by Georgios Kyriakos from an English university presents a version of the Terpsichore software built with SuperCollider and able to convert code into sound clips, sequences, visual structures and buttons able to carry out various actions. The interface was transformed into a standalone app for Mac computers. There are two modes. The TOM mode supports composing original tonal music phrases. The SIP mode is intended to make learners concentrate on overall sound content rather than its tonal components. The software was tested by 28 autistic students aged 12 to 29 in Greece in a four months pilot study with the support of three tutors. The majority of the autistic students liked Tepsichore's graphical layout and generally reacted positively to it. Participants performed better on modifying musical phrases than composition, but that was probably to be expected, as original composition requires specific talent. Use of the software was generally found to improve participants' emotional state.

WebMoti by F.S. Asmy, A. Roberge-Milanese, M.C. Rombaut, G. Smith and D.I. Feis from two Canadian universities describes a software and hardware robot-based system that supports the classroom participation of autistic students when they are unable to attend in person. In addition to other factors that may prevent in person attendance, many autistic people experience high levels of stress and anxiety [3] and are distressed by noise which seems not to disturb non-autistic people [13]. The student uses an XBox game controller to control a small classroom based robot from a remote location such as their home. They can start and end the live video conference, and control the sensory input by turning video, audio and vibrotactile elements (provided through two pillows) on and off, control the camera and use an animated hand to indicate they want to participate. This allows personalisation of the educational session. The system was tested weekly for about five weeks with a first year autistic university student and two 8–10 year old autistic primary school students. Pre, midway and post study questionnaires indicated that WebMoti helped the students follow the lesson plan with their class without sensory overload. However, further tests with more students are required. It would also be useful to investigate modifications for different age groups.

Development of a learning support system for science using collaboration and body movement for hearing-impaired children: learning support for plant germination and growth conditions by Ryohei Egusa and colleagues from five different Japanese universities uses a game based approach involving body movements, animations and a quiz. It is aimed at correcting misconceptions and teaching correct information about plant germination and growth, but could be generalised to other science areas. It was tested with 17 6–9 year old hearing impaired children. The system was found to support collaborative game playing and collaborative approaches to learning science for hearing impaired children. However, the proportion of correct answers is not stated and the authors indicate that the participants were strongly influenced by other students' moods when playing the quiz and that there is a need for further development to encourage children to use scientific ideas in decision making.

Promoting inclusive open education: a holistic approach towards a novel accessible OER recommender system by Hejer Brahim, Mohamed Khribi and Mohamed Jemni from a Tunisian university proposes a recommender system for teaching, learning and research materials that are available under an open licence with no or minimal restrictions. The aim is to propose resources which are best suited to the particular learner's needs and characteristics. The recommender involves data acquisition and processing, data modelling, the learner's profile and the recommendation. It also covers accessibility tasks. However, further work is required to develop and test the recommender.

3 Conclusions

The five papers presented here cover diverse areas of education, including music, science and distance participation in classes. Several of them use multimodal or alternative interfaces and/or games of different types. Accessibility to all groups including disabled people, particularly those with sensory impairments, can generally be improved by offering multiple and multi-modal options for accessing the system. At the same time there need to be easy options for turning off modalities to avoid sensory overstimulation to autistic people in particular. A personalised approach to learning and customization features offered by educational tools can be particularly beneficial to disabled learners better and fit their learning rhythms and needs.

The results of tests of the technologies presented here have been positive, but have generally only involved small numbers of participants. The distance participation system was tested by two 8–10 year olds and a first year university student. This raises questions as to whether there are both learning technologies which are suitable for all ages and those which should be adapted to make them age appropriate. New education strategies could exploit the fast dissemination of technology, including virtual reality, the internet of things and tangible environments to make the learning experience more immersive, multimodal and engaging. However, care will be required to ensure that the resulting learning approaches take account of the accessibility and other needs of disabled learners.

There is thus a need to consider the compatibility of assistive and other technologies to enable disabled learners and teachers to use the full range of available tools and technologies and get the most out of them. This may require new approaches to design that take this need for compatibility into account. Finally, further research will be required to investigate how best to use ICT to support universal inclusive education and meet the needs of the full diversity of disabled and non-disabled learners and teachers.

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