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Using technology-mediated music-making at school with children with autism and intellectual disabilities

a participatory multidisciplinary approach

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ABSTRACT

Despite the existence of extensive literature on the benefits of either technology or music in children with autism and intellectual disabilities (ID), research studies exploring the impact of interventions combining the two are scant. This paper presents a collaborative multidisciplinary approach between school staff, university researchers and a business in their development of a technology-mediated music-making system (i.e. the Cosmo units) that aims to improve the quality of life of the former population. Data were collected via observations of individual pupils and focus group interviews with the school staff. The results, discussed in the light of relevant literature, incorporate both the changes applied to the Cosmo system and the benefits for school staff, university researchers and the business through being part of this participatory project.

KEYWORDS

technology-mediated music-making, autism, intellectual disabilities (ID), participatory action research (PAR), multidisciplinary

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1 Literature review

Individuals with autism tend to have an affinity for technology and music, which can effectively be used to teach them new skills. Technology, on one hand, is predictable, with the same responses every time; moreover, it does not require understanding of social conventions and language skills [1]. Although there is vast amount of research in the field of autism and technology, most of it has involved children without intellectual disabilities (ID) [2]. Music, on the other hand, provides a fundamental channel of communication for people with ID as it 'goes beyond intellect and therefore is accessible to all levels of intelligence' [3]. To date, there is little research that combines elements of technology and music with the above population [4]. Therefore, there is a pressing need to explore how technology and music can be combined and then effectively used with participants who face severe and complex cognitive difficulties in addition to their autism.

A number of recent studies in the field of disabilities promote the notion of knowledge co-production between school staff and researchers [5,6]. This new form of working and doing research together is opposed to the older model of knowledge transfer in which a top down approach is implemented and 'expert' researcher academics train frontline practitioners in effective teaching strategies and interventions. Given the numerous advantages of working in a multidisciplinary team, widely reported in existing literature [7,8], the knowledge co-production model begins to bridge the gap between academic research and school practice [9].

The aim of this paper is to present the participatory collaborative aspect of a study focusing on a technology-meditated music-making intervention (i.e. the Cosmo units). The impact of this intervention on the engagement levels and social communication skills of young children with autism and ID has been discussed elsewhere [4]. It is noted here that this is one of very few studies having involved school staff in the research process from the outset [10], providing them with an active role in developing and implementing an intervention to be embedded in the school curriculum.

2 Methodology

Filisia Interfaces sought the University of Birmingham's guidance on testing their system in a school environment. More specifically, they obtained scientific advice on the development of the training software to better meet the needs of children with autism and ID and facilitate their training on a number of skills. The company offered technical knowledge and expertise in the development of the activities, and on-site support for running these during the data collection period of the research. They also

supported the two University researchers via telephone and email during this period.

The study followed a case study approach with a prominent participatory action research (PAR) element [11]. The researchers and the research participants worked in close collaboration during piloting, planning of the research design, and data collection, in this way forming a 'democratic partnership' [12] enabling both to learn and grow together. Thus, there was a genuine exchange between the different contributors of the study and in how the research was negotiated [13].

Five children with autism and ID (4 boys and 1 girl) and five classroom staff members (i.e. one newly qualified teacher and four teaching assistants) participated in the study. All children and staff came from the same Year 1/2 class of a special school in the UK. The Childhood Autism Rating Scale (CARS) [14], a behaviour observation scale, was used to assess the severity of autism symptoms, while the Symbolic Play Test (SPT) [15] was used to assess the children's early concept formation and symbolization, and to provide an age equivalent. Table 1 below shows the children's characteristics in detail.

Children's name*	Andy	Zaineb	Rehan	Sahil	Saadi
Sex	Male	Female	Male	Male	Male
Age	7.01	6.08	5.11	5.05	5.10
CARS score	40.5 (severe autism)	36 (moderate autism)	44 (severe autism)	47.5 (severe autism)	51 (severe autism)
SPT score	12	9	12	0	1
SPT age equivalent (months)	21.9	18	21.9	below 12	below 12

Table 1: Details on the children

After a two-month piloting in the school with children and staff of similar characteristics who were not involved in the main study, all children of the sample participated in eight 12-minute sessions with the Cosmo units over a period of 5 weeks. Data were collected via video-recorded observations of individual pupils and weekly focus group interviews with staff. During each session, the member of staff working with each child was present in the room (attached to the classroom) where the intervention took place in order to help the researcher to interpret the child's communication signals correctly, and make suggestions concerning the customisation of the system and the way it was being used by the researcher. The theoretical background of the intervention used to facilitate the Cosmo activities draws principles from a number of interventions such as Intensive Interaction [16], Musical Interaction [17], Small's thinking on 'musicking' [18] and Responsive Imitation Training (RIT) [19]. To maximise consistency, one researcher conducted all sessions. In each one, she let the child lead by imitating their sounds and physical actions, used short running commentaries and simple repetitive routines. She also often modelled actions with the Cosmo units, showing the child what was expected from them in each activity.

Cosmo is a versatile award-winning system originally designed for people with conditions such as brain injury, cerebral palsy and stroke. The system comprises of (i) specially designed hardware devices, (ii) a software platform connected to the devices featuring a variety of activities and (iii) a data analytics platform that may be used for the assessment of user progress. The Cosmo devices are connected Internet of Things (to IoT) devices that have been specifically designed to be used by people with additional needs. The devices use a patent-pending technology that makes them both highly sensitive to touch (activation at 10 grams of force) and very sturdy, in order to withhold the wear in special needs classrooms. The size and shape of the devices has been designed to suit the needs of people with musculo- skeletal problems, and the trigger threshold of the devices is adjustable (between 10 grams and 3 kilograms) to support users whose movements are sometimes involuntary, such as people with cerebral palsy or brain injury. The devices are semi-transparent and contain Red, Green and Blue LED lights, able to light up in a variety of colours. The devices have bi-directional communication to tablets. This allows them to both send messages to the tablet when pressed, or receive instructions, e.g. to light up in specific colours, or notify users of the need to take an action. The Cosmo application ('app') operates only on iOS devices and has been developed in Swift, a general-purpose programming language developed by Apple Inc. It currently contains 14 activities that use the pressure sensitivity and colour of the devices, as well as the microphone and speaker of the iPad. The app is compatible with iOS 9+ and only runs on iPads that have Low Energy Bluetooth installed. The app can collect data on the users' physical skills (e.g. reaction time, sequencing skills, logical reasoning) and motor skills (e.g. speed of movement, force and tremor). The collected data is then anonymized and cryptographed to support its safety and regulatory compliance and can be shared with teachers and/or therapists to support learners' assessment. Data analysis uses Python and Django programming frameworks, and future versions of the system will use machine learning to auto-adjust the difficulty of the activities, as well as data mining to provide new insights to therapists.

Ethical approval for the study was given by the University of Birmingham's Ethical Review Committee (Application for Ethical Review: ERN_15-0559A).

3 Results and Discussion

* All children's names are pseudonyms

The results section presents the main developments for the Cosmo units and the benefits of working in a participatory multidisciplinary approach for the school staff, the researchers and the company.

As the Cosmo units began to be used by children with autism and ID, several adjustments to the devices became necessary, principally concerning the on-off switches, the devices' sturdiness, and the material of the devices. Early device designs used sliding on/off switches. Several children enjoyed switching the devices on and off, affecting Bluetooth connectivity. As a result, the engineers replaced them with switches needing to be pressed continuously for 3 seconds for their activation. Additionally, as children with autism and ID can be prone to damage the equipment (not only through incidences of upset but also as part of their exploration of the units), the design of the devices was altered to withstand everyday classroom use in special schools. Some of the children found the silicone cover of the early design distracting; taking it off and putting it back on in a repetitive way, preventing them engaging with the activities. The engineers removed the silicone covers and gave the devices a smooth and 'sanded' texture.

Beyond changes to the devices themselves, this collaborative, multidisciplinary work had an impact on the school staff. School staff had the chance to watch the researchers working with the children, and obtain their views on other aspects of their practice. This accords with one of the main benefits of PAR, that of bridging the gap between academic research and practice [20]: school practitioners often feel excluded from what is happening in academia. Research participants had also the chance to be trained, at no cost, in up-to-date interventions within their own school's setting. Although they did not receive a formal training, they experienced and learned about interventions such as intensive interaction, musical interaction and RIT as well as Small's musicking theory, and had the chance to ask the researchers further questions. Professional development training is another very important strength of PAR [21]; teaching assistants, in the light of current cuts to Education budgets, rarely receive extra training apart from the few statutory 'INSET'[**] days. Concurrent with this is the notion of empowerment [22], especially for teaching assistants who do not often have the chance to voice their opinion. Finally, teamwork is another significant advantage of PAR [23], often neglected in schools due to the quick pace that staff have to work to. The teamwork is also particularly important given that teaching staff working with pupils with special needs are reported to experience high rates of stress and burnout [24], especially those working with children and young people with autism [25].

[**] In Service Education and Training: in-site training for school staff

The benefits of working in multidisciplinary ways were equally important for the researchers and the business. Working closely with school practitioners gave the researchers valuable lessons as to how better plan research and understand the constraints of using interventions in real-world environments. Additionally, the researchers benefitted from working with a business. Businesses have their own priorities. They provide important funding for research, especially in the field of Education where funding is restricted. With funding comes an expectation that the research will deliver a satisfactory outcome for that business. In this project, the researchers appreciated working with people with whom they shared the same language. The company staff were open about their reasons for doing the project (maximising profit for their product), and so the University researchers challenging to combine testing what the company wanted to be tested with developing something meaningful for teaching staff and children. Working closely with engineers helped the researchers to appreciate the work involved in developing a product like the Cosmo units; it altered their perspective on the company's demands which had sometimes, before, been considered unreasonable. Simultaneously, the engineers learned the importance of creating technology that was easy to use, met the needs of the specific population (e.g. through not distracting them or challenging their sensory sensitivities) and could be used independently by non-proficient technology users. The need to develop collaborative research programmes between businesses and universities has been widely reported [26] and the barriers of such collaborations have been examined [27]. However, this argument has primarily been developed for the so-called 'hard sciences', with similar collaborations in disciplines like Education being still scarce.

4 Conclusion

The current study provides an example of school staff, university researchers and a business working seamlessly and successfully together towards developing a technology product to improve the life of people with disabilities. A bottom-up approach was followed with teaching staff having participated in different stages of the research. Literature increasingly recognizes the need for researchers and schools to forge effective and collaborative partnerships for the benefit of both [28]. By collaborating with researchers, school staff can often show them ways of finding solutions to everyday problems, increasing the ecological validity of the research while recognising the constraints of carrying out research in 'real world' environments. On the other hand, researchers can support school staff in conducting methodically robust and ethically sound research. Such collaborations considerably enhance opportunities for knowledge co-production in research, especially with individuals who have been traditionally ignored or silenced such as teaching assistants and newly qualified teachers. The role of the company in this project was also critical. Without their know-how and technical support the changes suggested by the school staff and university

researchers could not have been implemented, and the practicability, usefulness and effectiveness of the Cosmo units would have been limited.

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