Getting better all the time: Using music technology for learners with special needs

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Abstract

This paper focuses on the category of electronic musical instruments described as 'gestural controllers' – motion sensor technology and specially adapted switches – which are widely used in special education. The therapeutic benefits of this technology in emancipating children from their cognitive or physical limitations are increasingly well-documented, but the educational implications remain relatively unexplored. The underlying premise of this paper is that the opportunity to learn a musical instrument is a basic human right which should be available equally to children attending special schools. But, can this interactive technology – with its emphasis on immediacy and accessibility – offer the challenges and expressivity and provide a real long-term musical learning trajectory in the same way that 'real' instruments do? A case study is described charting significant learning and progress through use of the technology over a six-year period.

Keywords: disability, differentiated curriculum, technology, music education.

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Introduction

However, profound an individual's degree of cognitive, sensory or physical impairment may be, very strong responses to music and sound can frequently be observed (McPhail, 2002). However, as Ockelford (2008) observes: "music education for children and young people with complex needs is still a pedagogical infant" (p. 3). In the traditional music therapy or special school music scenario, a passive experience of music, in which live or recorded music (often chosen by the therapist or teacher) is played to the listener, can be observed. In some music therapy approaches, there may be some minimal musical contribution from the 'client', but generally the harmonic and melodic content – the main 'engine' of the music – is determined by the therapist. Alternatively, where more active participation in music making is encouraged, *percussion* is the most typically used resource. This raises two problems. Firstly, it limits participation to players who have sufficient dexterity and coordination to manipulate percussion instruments. As McPhail notes, "in obtaining a resonant and rewarding sound from a hand drum it is necessary for the hand to strike the right part of the drum head and to leave the head as soon as it has made contact ... most 'able-bodied' adults find this challenging" (p. 23). Secondly it confines players to an unnecessarily restricted timbral repertoire, restricting them to a single 'family' of instrumental sounds which demand rhythmic accuracy with limited opportunity to explore melody or harmony. In this context, how useful are digital instruments and electronic interfaces which give the player control over a larger range of sonic possibility?

The idea of a musical instrument which could be played without any physical contact was first developed by Leon Theremin, the Russian composer whose 'Thereminvox' astounded audiences in the 1920s, and which can be heard on the soundtracks of many low-budget science-fiction movies. Most people have never heard of the Thereminvox, but nearly everyone has heard one played. The Theremin has been widely used in popular music and by many rock groups including Led Zeppelin. It is used in the theme from *Midsomer Murders*.

The development of contemporary gestural controllers (the most widely used examples of which are *Soundbeam* and *Midi Creator*) has been partly inspired by the Thereminvox. There are, however, two essential differences between the Theremin and current technology. Firstly, whereas the Theremin creates a fixed playing zone close to the device itself, Soundbeam (designed originally for dancers) incorporates a variable ranging control which allows the invisible beam to be compressed into a few centimetres or stretched out to cover an entire stage area. In practice, this means that the invisible instrument can be varied in size to accommodate the movements that the player wishes to perform, or is capable of performing. There are clear advantages to this in the special education context. If the notion of angling and focussing the beam on movement qualities of which the performer is capable is considered analogous to 'holding the instrument' correctly, then with the Soundbeam any way of 'holding the instrument' is equally valid and correct. The second key difference is that whereas with the Theremin variations of timbre were not available (pitch and volume being the only element over which the player has control, and only with a glissando style) modern digital instruments make thousands of sounds available.

These devices work by emitting invisible beams of high frequency sound inaudible to human ears. The ultrasonic pulses are reflected back into the device's sensor by interruptions of and movements within the beam. Information about the distance, speed and direction of this movement is translated into a digital code (MIDI) which is understood by a wide proliferation of electronic musical instruments. The system incorporates several principal control parameters. Variations in *Range* settings allow the length of the beam to be varied between 0.25 and 6 metres. Shorter beams concentrate note information into a relatively small space, a set-up which has proved to be of significant value in special education where player's ability to move expansively may be limited by disability. Longer beams allow a complete performance space to be 'live' with sounds. Musical material – timbres, scales, chord sequences, pitch ranges and other effects such as vibrato, chorus, volume and pitchbend can either be selected from a range of presets or composed afresh into the device's memory. A considerable degree of compositional exploration is possible without the need for a commensurate level of keyboard skill, or for any real time adjustment of hardware controls. A highly complex idea, possibly involving several hours or days of evolution, can be programmed in at the user's pace and then performed in real time with body movements, without any physical contact with the instrument.

Sound therapy

In traditional music therapy, the less the client is able to say something with sound because of a physical or cognitive disability, the heavier becomes the therapist's responsibility for empathy and interpretation. The main focus and engine for the mood and meaning of the music which is happening is on the therapist. The creative and interpretative role is increasingly shifted away from the client with more profound levels of disability. This allocation of creative 'power' may have no clinical or therapeutic rationale, it may simply result from what is physically possible. New evidence suggests that the interactive, sensor-based technology described above can provide answers to this problem. The experience of *initiation* is central to the success of this approach, especially for individuals with profound disabilities. The power to *make something happen*, the vital 'that was me!' experience, can function as the foundation stone for further learning and interaction.

Ellis (1995, 1997, 2000, 2004) has provided the first systematic long-term evaluation of this type of technology's potential for children and adults with disabilities. The beam is positioned so that as soon as the child begins to move an interesting sound is triggered, motivating further movement and, eventually, radically enhanced posture, balance and trunk control. All of this is accomplished in parallel with a strong sense of engagement, fun and achievement. For the child, the therapeutic dimension of what is happening is irrelevant.

Ellis also discusses some of the broader aesthetic issues connected with his approach. These concern traditional (notation-based, using formal concepts of melodic, harmonic and rhythmic correctness) as opposed to more forward-looking (involving more open-ended ideas about musical validity, with less emphasis on right/wrong ways of playing music) approaches to music. Typically, music therapy may be embedded in a traditional model of music, where the 'client' is perceived as musically inarticulate, it being the therapist's role to 'interpret' and ameliorate a given condition. This is essentially an interventionist approach.

Sound therapy, in contrast, gives total expressive and creative freedom to the client. The therapist's role is to create a safe, non-judgemental environment in which player is free to investigate and enjoy the new expressive possibilities made available by electronic technology.

> Progression and development are still key objectives, but are achieved through the internal motivation of the child ... at all times the child is given the opportunity to independently take control of the situation as far as possible … progression is not prescribed in advance, but happens as a natural and additional part of activity, all stemming from the internal motivation of the child - a phenomenon referred to as *aesthetic resonance*. (Ellis, 1997, p. 175)

From systematic analysis of videotape session records, Ellis identified nine criteria of progression and development:

- from involuntary to voluntary
- from accidental to intended
- from indifference to interest
- from confined to expressive
- from random to purposeful
- from gross to fine
- from exploratory to preconceived
- from isolated to integrated
- from solitary to individual

He noted that even profoundly disabled children respond to Sound Therapy by performing, listening, verbalising, 'composing' with sound, often showing 'aesthetic resonance' through telling facial expressions; being actively involved for extended periods of time; revealing an ability for concentration not apparent elsewhere; beginning to discover, explore, give expression to and communicate their own feelings; and by making significant physical responses - movements and gestures which hitherto have not been seen, or have not previously been made independently.

> In addition, a change has been seen in behaviour patterns beyond the immediate environment of Sound Therapy ... some children are now more self-aware and are interacting ... other children show more tolerance and a growing awareness of other people, moving towards interpersonal skills. (Ellis, 1995, p. 39)

Russell (1996) also identified affective and expressive capabilities, previously unidentified or thought to be beyond the clients' capacity, which are unlocked through this medium of interaction through sound.

Bearing in mind the extremely short attention span of many children with special needs, students have demonstrated a remarkable capacity to focus on their improvisations for long periods of time, thought previously to be beyond their abilities ... those using Soundbeam for music education have discovered that children who are able to take control of their music making develop not only expressive and practical movement capabilities, but also create improvisatory music which has relevance and validity (p. 41).

New South Wales special school teacher Sarah de Jong endorsed this observation, describing learners who "really begin to blossom in the way they use (the beam) ... even the ones who have no language or limited vision are beginning to understand how to make it work – it seems like magic when you consider just how little of the outside world they can interact with in any truly meaningful way". Another recent example from Australia is the work of Randolf Reimann whose performing group *Tra La La Blip* has produced some impressive recordings.

Musical development

One of the problems with current discussions about music technology is that the terms of reference are never adequately defined. To the more traditionally-minded music therapist, for example, anything electronically powered might be defined as 'technology', including synthesisers developed in the 1970s. To most music teachers, 'technology' mainly refers to software packages designed to provide students with sound and sample libraries, and with the means to compose, arrange and record music using a computer. In special education 'music technology' is usually understood to involve interfaces of various kinds (e.g., switches, movement sensors) which facilitate for students the articulation of musical sounds.

For the purposes of this paper, we have concentrated on this latter category, that is, instruments defined as 'gestural controllers' which allow the player to perform without any physical contact with the instrument. This technology, which has been widely adopted in special schools (including approximately 150 in Australia) since the early 1990s and increasingly used in mainstream primary and secondary schools, provokes interesting questions about the issue of musical development because the claims made by the developers and manufacturers ('anyone can make music' ... 'instant!' ... 'accessible!') create the impression that students will be enabled by the technology to perform musically without having to invest any work in it. If you can do something straight away, how much is there to learn? This may be a peripheral issue in a therapeutic context, but in the educational domain it is central. One of the interesting findings in Ockelford's research was that special school questionnaire respondents who were asked about attainment and progress appeared to perceive these two phenomena as interchangeable.

> *many responses to the … questionnaires did not distinguish between attainment and progress in music ... often, after completion of the section headed 'attainment' ('A'), the corresponding section for 'progress' ('B') just received the response "see section 'A'. (Ockelford, 2008, p. 26)*

Progress is what motivates effort and learning in any curriculum area and this applies equally to students with special needs. Is it possible to square the circle? Can we provide students with a learning environment which offers very immediate rewards irrespective of individual entry-points in terms of their learned or innate skill whilst simultaneously incorporating challenges which will demand enhanced ability, so that there is a progressive and motivating learning trajectory? Csíkszentmihályi's (1990) ideas about 'flow' are very pertinent in this context; indeed he specifically uses a musical example - playing jazz - as the epitome of flow: a state in which there is total absorbtion in the activity, there is direct and immediate feedback, the individual is in control and – crucially in the context of this discussion about accessibility on the one hand and development on the other – there is a balance between ability level and challenge. If the activity is too easy it soon becomes boring; if it's too difficult the experience becomes stressful and demotivating.

Some of the less informed characterisations of gestural controllers need to be challenged here. Soundbeam can be described thus: 'you wave your hand in the air and this triggers a random selection of notes' and whilst this may have been a more or less accurate description of earlier incarnations of the technology, with the current version of the machine the player needs to evolve a complex set of skills in order to avail himself or herself of the myriad musical possibilities that are available. 'Cyclic' triggering means that successive beam interruptions will play notes and chords sequentially allowing for the accurate (or inaccurate) rendering of melody and harmony with all the skills of phrasing and timing that this involves. Key changes, particularly if more than one player is involved, demand spot-on timing. The use of MIDI controller data (to apply effects such as vibrato, pitchbend, chorus, panning, phasing, portamento, reverb) in real time demands considerable skill, and it would challenge anyone to exploit fully the ensemble possibilities of the system with up to twelve separate timbral, melodic and harmonic parts being deployed simultaneously. The entry point may be simple and accessible but the software is sufficiently refined to allow for a developing musical intelligence which can be as sophisticated as the user wants it to be.

This sounds hypothetical, and it would be accurate to reflect that Ellis' research (which currently constitutes the most widely published research in this area), although it *does* include a model of observed progression and development in terms of motivation, coordination and affective response, does not concern itself with the development of *musicality*, and it is to this issue which we turn finally. The authors' research over the past seven years provides us with a cogent case study which directly addresses this issue.

Soundbeam has played a part in CT's musical development from his earliest contact with it as a 14 year old in March 2003. This youngster is diagnosed with a mixed form of cerebral palsy. He exhibits stiffness in the muscles, decrease in the range of movement in the joints, involuntary movements due to rapid and uncontrollable muscle tone changes, and poor fine motor control. All of this has meant that playing a conventional musical instrument, even drums, is impossible for him. Soundbeam however has allowed him to learn to play instrumental sounds melodically and rhythmically, and to compose original music of a quality at least equal to that of many able-bodied young people of his age. This can be considered an example of musical development at its simplest in that the equipment has given him the opportunity to manipulate sound in a controlled manner in the way that the able-bodied can do using conventional musical instruments.

CT's earliest Soundbeam work (Spring 2003) shows some understanding of phrasing as well as a flair for melody. *Duet 2* features CT playing a low flute sound to a 12 bar blues guitar accompaniment. He starts playing a single note repeatedly in a rhythmic way that fits well with the guitar strumming until I comment on him 'liking that note' at which point his playing develops more melodic movement. I, in turn, respond by playing more rhythmically and the remainder of the piece returns to the single repeating note style with further melodic experimentation. He breaks up his playing with pauses throughout, as a real flute player would, which gives a sense of phrasing, and towards the end responds in an appropriate way to some stops – the only indication of this being the accented strums on the guitar. CT stopped as well with the net result of clear musical interaction, reflecting genuine musical interchange and communication.

In a piece called *Andes*, CT uses a Pan Pipe sound playing a 16 note B minor pentatonic scale. Structurally it can be considered to consist of three sections. The first (bars 2 to 5) is a running sequence of 1/16th notes utilising the full range of the pitches available. This is followed by eight bars made up of syncopated short groups of notes that almost seem to be uncertain of where to go next. From bar 14 the playing adopts a more melodic character using a narrower range of (nine) notes in an even 1/16th note style but still with a syncopated 'feel'. The short pauses / rests break up the playing in a phrase-like manner as though the 'player' is taking breaths that, in combination with the tone generator voice (which includes a distinct blowing attack element) and staccato playing, produce a sense of expression despite the lack of any dynamics (not available from Soundbeam 1).

The sequencer was set to 'quantise on record' (in 1/16th notes) and this obviously helped to 'tighten up' the playing to some extent although this method would also have been used by CT's fellow students when using computers to compose music. What made me feel that these early pieces were so significant was that they were recorded during the second and fourth sessions respectively of a four-session project that took place over a nine week period. CT did not have the benefit of several weeks of Soundbeam practice before the recordings were made, yet the results were impressive, particularly for someone with his particular condition.

CT's early playing was quite melodic though after a while he developed a style that tended to be somewhat wave-like in nature, particularly evident from viewing the recorded notes in the sequencer. A couple of examples of this are two instrumental explorations he made in year 10, one using a clarinet voice *(Bubbles)* and a second on violin *(Summer Breeze)*. Variations to his manner of playing can be seen in a trumpet improvisation *(Millstones)* recorded during his year 11 GCSE (General Certificate of Secondary Education) studies. Here, the first 35 bars, played without the guidance of a metronome click, are distinctly melodic and show signs of an 'internal' sense of pulse awareness, particularly over the first eight bars. The melodic shape and range of notes used makes for a very authentic short trumpet piece, and in the hands of a skilled composer/arranger could be developed into a full composition for brass ensemble.

Pitch sequences used with Soundbeam, whether established musical scales, melodies or chord progressions, are generally developed to reflect musical objectives. Whilst waving one's hands in the beam will produce a seemingly 'random selection of notes' if done without any clear intent or listening on the part of the player to what sound is being produced, it is possible to intentionally repeat note patterns identically and with variations. This, after all, is how musical melodies are constructed and has been demonstrated in CT's work a number of times. A recent example is a guitar-based composition (*25 Museums)* which uses strummed guitar loops and arpeggiated guitar patch chords (harmonised on the C major scale) triggered via switches, plus acoustic guitar melody and tubular bell played with the sensor. The loops and chord progression (developed in three sections) were CT's own choice from the chords available and were played into the sequencer with quantisation.

The acoustic guitar melody uses 12 notes of the C major scale (A3 – E5) and the first verse consists of four phrases played without quantisation over a chord progression of C, Dm, F and C, each chord strummed for two bars. Each phrase is of a similar length, the first three ending on a sustained E4 whilst the last ends on a sustained C4 note of similar duration. This gives a sense of intentional phrase construction. The second 'verse' also consists essentially of four phrases, though slightly less clearly defined than in the first verse. However, both the first and second phrases cover a similar range of notes to their equivalents in verse 1 with phrase 1 ending on a sustained high E4 whilst phrase 2 this time ends on C4. The notes in phrase 3 start lower down but quickly run up to utilise a similar range as verse 1, phrase 3, and it ends on a sustained E4. The last phrase uses a similar range of notes to verse 1 but an octave higher though there is a slight delay, with the majority of the notes falling in bar 17 rather than bar 16. The very short 'grace' notes (resulting from CT's hand moving between notes whilst still in the beam due to poor fine motor control) and the variations in note velocity give the impression of authentic guitar techniques (such as hammering-on) and add to the sense of expressiveness. Whilst some rehearsal of ideas was done before recording, CT did not spend weeks preparing the melody part so there is clear evidence that he exercised control over the Soundbeam, intention and 'composition' in the note ranges used.

Another of his recent pieces, *Back in the Andes*, clearly illustrates CT using phrasing in an intentional way. Throughout the piece he breaks up his melodic pan pipe playing to match the pauses between the chords that he had played into the sequencer using five switches, each set to play several voicings of chords built on the scale – one chord for each switch. As he played the pan pipe melody, he watched the computer screen intently and, when asked if he was using the sequencer display (of the chords) as a guide, confirmed that this was the case.

Over his six years as a Soundbeam player, CT had been exposed to a wide variety of musical styles and instrumental sounds. The way that instruments work has been explained to him. He had been encouraged to think about this when playing a particular sound. This has contributed to the development of his 'instrumental' playing and has also led to the development of greater complexity in his compositional work. He uses switches, up to eight at a time, to play chords (these may play a single chord each or may have several voicings of the same chord) which allowed him to choose which chords to play and when to play them rather than simply playing a set progression as would be the case with a single switch playing in cyclic mode. Sensors are generally used for melody playing and this required CT to listen to the backing as he played and chose appropriate notes to fit it.

CT originally used Soundbeam 1 with a synthesiser unit but for almost five years he has used the software version in combination with Reason music software. This allowed us to use much higher quality sounds and more intricate settings which, in turn, have offered him far more musical possibilities – an example is the use of MIDI controllers. Depending on the instrumental sound used, the note velocity MIDI controller set to vary according to speed in the 'beam' has often been used to give a degree of dynamics and this works particularly well with woodwind samples as it can produce breathing and 'tonguing' effects.

The development of CT's musical memory has been demonstrated in several examples where a switch was set to play a pitch sequence of a given melody using cyclic triggering. Although the right notes will be played in the correct order, they need to be triggered with appropriate timing and duration for the melodies to make musical sense and to be recognisable to a listener. This technique was used during his year 11 GCSE course to play *Summertime* to a rhythm section backing that I had programmed into Reason's sequencer, and as part of his Welsh Joint Education Committee (WJEC) studies at college to play *Gymnopedie No.1,* also to a programmed chordal accompaniment in the sequencer. The course moderation comments included

(*Gymnopedie* No.1) was performed fluently; the one slip did not compromise the performance and so warranted the maximum 15 marks

In the case of *Summertime*, CT played rhythmically close to the 'usual' melody, but also improvised around the rhythm in a very jazzy style, developed without any external suggestion or prompting, playing around with the timing to some extent but without spoiling the essential nature of the tune.

The musical examples described above highlight various pieces of CT's musical learning. His concentration and listening skills have developed considerably through using Soundbeam – arguably to a greater degree than may be the case for someone learning a conventional instrument where accurate/appropriate notes can be produced by playing at prescribed positions on the neck of a guitar or by pressing particular keys such as on woodwind instruments. Soundbeam's non-tactile playing interface makes it impossible for the player to 'wing it' through a performance: absolute concentration and continuous self-monitoring is demanded. Through playing Soundbeam he has developed a degree of command over some of the involuntary movements associated with his condition and much greater fine motor control which has allowed him to play expressively. Far from being simply a case of waving his hand in the air to trigger a random selection of notes, his use and understanding of how phrasing and space gives music more interest, meaning and 'life' has developed considerably over the years. Since using the Soundbeam and its MIDI control capabilities he has learned how different ways of moving and the speed of movement produce different playing styles (e.g. legato, staccato etc) that add to the expressiveness of music. He has learned that different musical instrument sounds require different playing techniques in order for the resulting sound to closely resemble the real life instrument. These last two points clearly address the issue about the capability of electronic instrument devices like gestural controllers to produce music of depth, expression and feeling matching conventional musical instruments.

The quality of some of the music CT has produced is testament to the considerable time and effort he has invested in developing his Soundbeam playing skills and the learning he has achieved, both of which have allowed him to explore, give expression to and communicate his own musical ideas and feelings. On more than one occasion he has described playing Soundbeam as being 'like flying'.

Conclusion

It is increasingly clear that children across a broad spectrum of ability/disability, even those labelled as having severe and profound complex needs with global developmental delay, can display innate musicianship providing that an appropriate medium can be found within which this ability can be expressed and explored, and that musical learning and development is not an inappropriate goal for these young people.

It is extremely encouraging that one of the UK's leading examining boards, the Associated Board of the Royal Schools of Music, recently hosted a pilot forum involving music consultant David Ashworth (whose 'Teaching Music' website includes a lively and animated debate on the subject), Drake Music, and the Soundbeam Project with the aim of establishing a research initiative examining the idea of a set of graded examinations in the use of electronic technology for live performance. The challenge now is to evolve teaching, curriculum and assessment resources and protocols which will enable young people with and without special needs to undertake their journey of musical learning using contemporary electronic technology with appropriate recognition and accreditation for their advancing achievements, and this initiative represents a very positive beginning for that important objective.

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