Sound, Electronics and Music: an evaluation of early embodied education

Lauren Hayes
Arts, Media + Engineering
Arizona State University
Tempe, AZ 85287
laurensarahhayes@gmail.com

ABSTRACT

Discussions of pedagogical approaches to computer music are often rooted within the realm of higher education alone. This paper describes Sound, Electronics and Music, a large-scale project in which tutelage was provided on various topics related to sound and music technology to around nine hundred school children in Scotland in 2014 and 2015. Sixteen schools were involved, including two additional support needs schools. The project engaged several expert musicians and researchers to deliver the different areas of the course. A particular emphasis was placed on providing a form of music education that would engender creative practice that was available to all, regardless of both musical ability and background. The findings and outcomes of the project suggest that we should not be restricting the discussion of how to continue to educate future generations in the practices surrounding computer music to the university level. We may be failing to engage an age group that is growing readily familiar with the skills and vocabulary surrounding new technologies.

1. INTRODUCTION

There is a growing body of literature describing different ways of progressing within higher education (HE) music pedagogy, as many courses in music technology (MT) and electronic music begin to mature. There has been a rapid increase in the numbers of such programmes over the last fifteen years [1]. Undergraduate courses offering instruction in the history and practice of computer and electroacoustic music can be found in universities worldwide. Some of the most recent developments in pedagogy in this area include incorporating research-led teaching perspectives [2], advocating for extra-curricular interdisciplinary collaboration [3], stressing the importance of reflective writing in addition to musical practice [4], along with numerous accounts of existing courses from HE institutions around the world (see, for example, [5, 6]).

The large-scale project *Sound, Electronics and Music* developed out of the author's recent observations of undergraduate MT courses: by the time students undertake introductory modules in digital sound within universities, many of them are already familiar with, if not highly practiced in working with digital audio workstations and electronic sound production techniques. For example, within the undergraduate student cohort of the BA in Digital Culture offered by the School of Arts, Media and Engineering at Arizona State University, many first year students commence the course already in possession of such skills [1]. Several students are already producing their own electronic music by working with digital audio software, such as FL Studio. A symptom of this is that they often harbour the aesthetic determinism that commercial software can foster. Equipped with open-access, affordable software and an internet connection "millennials delve into an individualized creative process with their preferred tools at arms reach" [7].

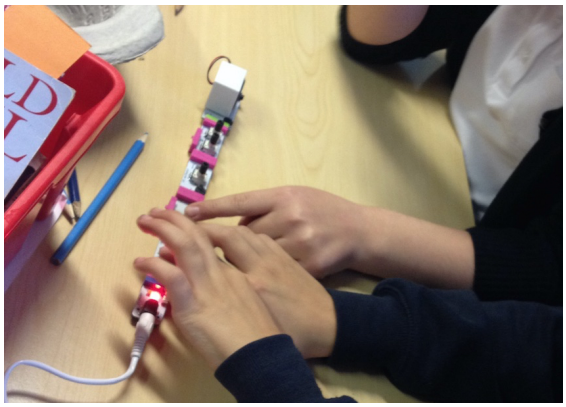

Figure 1. A collaborative performance on a KORG littleBits Synth Kit.

On the other hand, computer science and engineering are being marketed to younger children through low-cost computer hardware such as the Raspberry Pi [2], and electronic inventor kits including, for example, littleBits [3]. With the advent of touch-screen technology within mobile phones and tablets, many children are becoming technically engaged at a very young age: viral videos circulate on social media sites of one-year-olds using hand gestures observed from parents to interact with touch-screens. Even technology within schools has become ubiquitous, and standardised to some extent. All of the schools involved in this project are government funded, and use the same laptops and smartboard projectors on a daily basis in every classroom for curricular teaching. Computers are not only used by staff, but are often distributed among pupils. Schools

[1] Class survey taken at the start of the course MDC211 Introduction to Digital Sound in 2015 and 2016.
[2] https://www.raspberrypi.org/
[3] http://littlebits.cc/

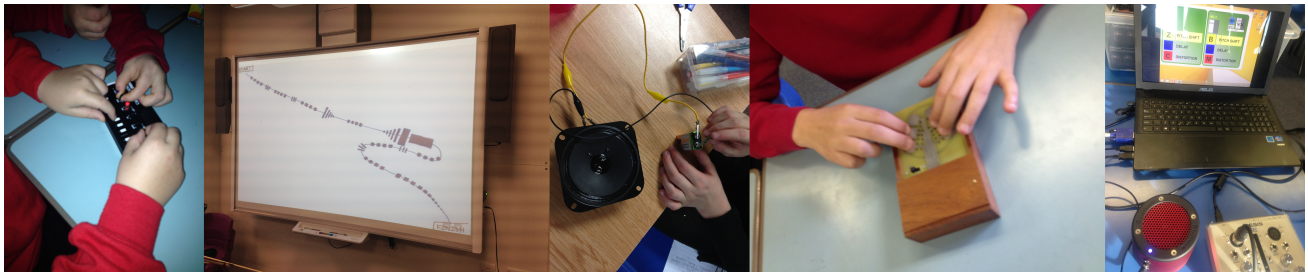

Figure 2. Pupils performing with graphic scores and hardware-hacked, commercial, and software instruments.

continue to foster traditional music education, which encompasses theory, aural skills, musical notation literacy, and instrumental training, yet there is clearly a technocultural space in which to develop a pedagogical approach to MT. Acknowledging this potential curricular opportunity—along with current leanings towards STEM education [8]—was key to the development of this project.

Sound, Electronics and Music was conceived as a ten-week programme. The aim of the project was to harness this new potential for accessible music education, which could engage pupils regardless of their musical and socioeconomic backgrounds. The project was funded for two consecutive years by Creative Scotland's Youth Music Initiative, which is aimed at providing high-quality musical activities for young people in Scotland. The programme was offered to around nine hundred 8-12 year old children in sixteen schools in West Lothian, Scotland. Sixteen one-hour weekly workshops were given in eight schools each week (two classes per school, eight schools per year). The course was offered to Primary 5-7 classes in the first year, and was expanded to include two after-school mixed secondary classes in the second year. Two additional support needs (ASN) schools were involved in the project and received all of the same course material as the other schools.

The curriculum was designed by the author, who was joined each week by a different musical practitioner. Each guest was given the freedom to contribute a unique perspective and set of skills. Of the seven additional musicians involved, five have completed or are currently completing doctoral studies in sound and music-related topics. In addition to the large number of workshops given, the project produced four new software applications designed in Max/MSP, which were distributed and remain on laptops within the schools.

2. OBJECTIVES

2.1 Inclusive Classrooms

The course was devised to inspire creative exploration from all pupils, particularly those who had no formal training in playing a musical instrument or reading traditional musical notation. Working with sound as a material—and using materials to make sounds—provides a non-preferential platform from which to create music. The experience of sound itself—how it is perceived, understood, and talked about—can be considered without necessarily having to engage with the solfège system, rhythm analysis, and so on. However, pupils who *were* receiving music lessons were encouraged to bring their instruments to the classes so that they could employ and expand these skills. Working from an experimental perspective, they were introduced to extended techniques, improvisation, and electronic augmentation.

Due to the exploratory approach taken in the workshops, there was very little modification needed to include pupils at the ASN schools. These sessions covered the same material, but were flexible in their delivery, allowing more time for exploratory play. The use of narrative was a helpful device here as it could be used to thematise the weekly sessions.

2.2 Accessibility and Legacy

The project acknowledged that, while young people's affinity with technology is often purported to be fact, this is not a universal phenomenon within the UK, and can be directly related to socioeconomic status [9]. Lack of formal musical training or musical literacy among children can often be linked to low family income [8]. As such, the course was designed to work with technology that would always be available in class (school laptops and a smartboard projector), as well as utilising low-cost hardware and found materials. It was important to ensure that what was taught could be developed further outside of the classroom. Every new instrument or piece of equipment that was introduced was either available to purchase online at a low cost, or could be found in local hardware stores. This turned out to be crucial to the legacy of the project because children would often ask where they could acquire materials after each session. Despite the young ages involved, pupils would often enquire about audio programming languages, particularly after they had used software that had been designed specifically for the course. They were directed to open-source software (OSS) such as Pure Data and ChucK.

Each school was provided with a box of sound equipment. This contained a variety of items that were showcased during the weekly workshops. The kit included:

- a two-channel soundcard
- headphones
- a KORG littleBits Synth Kit
- two Makey-Makey invention kits
- a Minirig loudspeaker
- a Zoom H1 portable sound recorder
- microphones and stands
- cables
- DIY synthesizers, electrical components, batteries, and speaker cones.

A manual was left in each class, outlining ideas for lesson

Figure 3. Open experimentation with the Victorian Synthesizer.

plans, as well as providing detailed descriptions of how to connect and operate all hardware, and instructions for running the provided software.

2.3 Supporting Teachers

Recent research into the role of technology within education stresses the importance of getting teachers involved in the learning process: "Educators have to be willing to learn about and engage with new technologies so that, as with any discipline area, they are aware of new developments and how these can be used to inform the learning environment" [9]. In order to ensure that lesson content could be repeated and expanded upon, it was important to involve teachers from the outset. Continuing professional development (CPD) training was provided outside of the scheduled class time.

Many of the concepts involved in the course were new to both the class teachers, as well as the music teachers that were present. Out of the sixteen schools visited, two provided a music teacher, instead of the class teacher, to supervise the class. Out of the thirty-two classes involved, only one teacher had previously worked with any of the technology that was being used (the Makey-Makey invention kit). Another teacher was in the process of developing a new MT course for his secondary school pupils.

Teachers were offered two CPD sessions: one at the start, and one at the end of the course. These were an opportunity for teachers to spend more time familiarising themselves with the software and audio equipment. It also allowed them to discuss ways in which they could continue to foster the various skills developed during the workshops.

3. EMBODIED LEARNING

The broad range of relevant topics that could be taught at the school level has been documented elsewhere [10]. Rather than prescribing a particular set of lesson plans, this section expounds upon some of the key themes that were prevalent throughout the conception and execution of this project.

3.1 Course Design

The course comprised ten workshops. Learning was scaffolded by building upon the previous weeks' learned skills and vocabularies. In this way, a sense of continuity was established from week to week. Furthermore, at the start of each class, pupils were encouraged to present examples of sounds they had heard outside of the class via descriptions or recordings. These sounds were used both as material for listening exercises, and as samples for sound organisation and manipulation. Pupils were able to directly contribute their own material to the course.

The majority of the workshops were designed to facilitate embodied learning where possible. This draws on current research into embodied cognition, which is rooted within the philosophy of Maurice Merleau-Ponty. Merleau-Ponty suggests that it is through perception that we engage with the world, but that perception is linked to action itself, being something that we *do* [11]. Research into skill-acquisition [12] and, more recently, practice-based learning theory also stresses the important of the role of the body: "To the extent that learning/ knowing is a matter of doing, doing can only be performed through the efforts of the human body" [13].

3.2 The Practice of Listening

Listening was fostered as a core skill throughout the sessions. Pupils were encouraged to develop their listening practice both in and out of school. Working with Sound and Music's *Minute of Listening* [4] software, which is commercially available and has been specifically designed to be used in classrooms, pupils were given a space in which to focus on their perception of sound. They were asked to describe the sounds they heard, whether natural or synthetic, and were urged to develop vocabularies to describe these sounds. Opposite word pairings, such as loud and quiet, rough and smooth, were offered as prompts. Pupils quickly identified that many sounds lie on a continuum: for example, a recording of cricket chirps is actually made up of numerous short sounds.

In the vein of Pauline Oliveros' Deep Listening practice, pupils were encouraged to listen to sounds from daily life and nature, as well as silence. Interestingly, several pupils claimed that they recognised many of the abstract sounds played to them during the listening exercises. Computer games and film soundtracks were cited as the source of this familiarity. As Oliveros points out, developing a listening practice contributes to creativity and communication skills: "It cultivates a heightened awareness of the sonic environment, both external and internal, and promotes experimentation, improvisation, collaboration, playfulness and other creative skills vital to personal and community growth. Plus it's a ton of fun" [14]. Listening exercises also required that the pupils developed an awareness of their bodies. They were asked to consider their posture, how much they were fidgeting, how still they could sit while listening, and whether particular sounds made them feel relaxed or agitated. They were also asked to experiment with both eyes-open and eyes-closed listening.

3.3 Authoring Sounds

Having developed an awareness of listening as a practice, pupils were given portable sound recorders. Tasked with collecting different sounds from around the school and grounds,

[4] http://www.minuteoflistening.org/

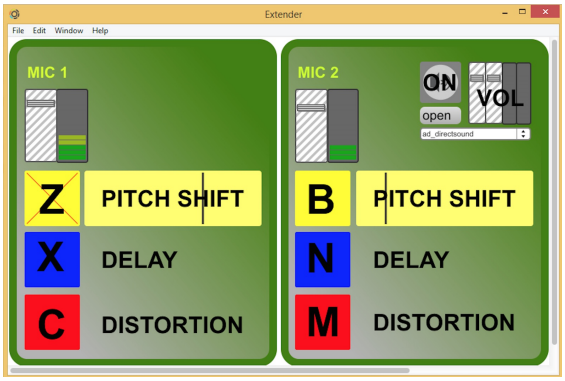

Figure 4. GUI of Max/MSP app for augmenting acoustic sounds-makers.

the pupils were given free reign to experiment. They were shown how to excite different objects and materials, and how to work with the combination of headphones and a sound recorder to zoom in on sounds that may not have been deemed interesting without focused listening. This form of embodied learning enabled pupils to move around the school, seek out new sounds, discover interesting action-sound combinations, and take on a truly investigative role. This supports Mark Johnson's claims about the importance of artistic investigation: "the value of an artwork lies in the ways it shows the meaning of experience and imaginatively explores how the world is and might be primarily in a qualitative fashion. Therefore, art can be just as much a form of inquiry as is mathematics or the empirical sciences." [15].

The Zoom H1 recorder was used because nearly all recording can be done using a single start/stop button. After the sound collecting was completed, pupils would play back the recorded samples to each other in order to guess and describe the sounds that had been gathered. They then would discuss how these sounds could be transformed into music. The collected sounds were reviewed, categorised, and named. Working with the smartboard projector, pupils were encouraged to use their recorded sounds as compositional material within several specially designed Max patches. One of these was devised to allow a collaborative class composition. Pupils would collectively vote on several variable sound parameters. These included selecting a part of the sample to be played back and looped, changing the pitch, or adding an amplitude envelope over the duration of the looped sound. The pupils would quickly determine which settings would produce the most interesting, or indeed most humorous results. For example, speeding up the sound of recorded speech, particularly when it was that of the teacher, was often requested.

These sample libraries grew throughout the sessions as pupils contributed their own recordings from out with the workshop time. Each class collectively defined their own unique aesthetic.

3.4 Making and Hacking

As Nicolas Collins points out in his book on hardware hacking, computers can be an awkward interface and "sometimes it's nice to reach out and touch a sound" [16]. Working with classes of between twenty and thirty primary school children would not suit a model where each pupil was working individually on a computer. Furthermore, time spent focusing on the smartboard projector had to be limited in order to keep attention. Collins' philosophy seemed even more fitting in this context: "The focus is on soundmaking performable instruments, aids to recording, and unusual noisemakers... the aim is to get you making sounds as soon as possible" [16].

By making new instruments and hacking existing devices, pupils were encouraged to use their imagination and discover new affordances of objects. Junk materials such as paper tubes, water bottles, and elastic bands were turned into acoustic sound makers. Makey-Makeys were connected to fruit, conductive tape, pencil graphite, and chains of the pupils' own bodies as a means to trigger sounds. Pupils devised modifications to John Bowers' *Victorian Synthesizer* [16] by sending electrical signals through sharpeners, spectacles, and their classroom furniture (see Figure 3). This process of appropriation enabled the pupils to gain authorship of their new instruments, and also become an intrinsic part of their deployment. This type of playful embodied learning, involving the manipulation of physical objects, has been proven to enhance learning [17].

3.5 Improvisation and Collaboration

Improvisation was used within many of the sessions as a way to help the pupils make sense of the wide array of new sounds that were being produced. On the occasions that they were not forthcoming with their music, pupils were encouraged to play works such as John Steven's *Click Piece* [18], or create and then perform graphic scores for each other (see Figure 2 for some of the graphic scores and instruments used for improvisation). By being non-prescriptive about the aesthetic outcomes, there emerged a "space for open-ended inquiry, an investigation of cause and sounding effect" [8].

Collaborative working was encouraged. This took the form of whole class collaboration, where decisions on how to sculpt a piece, or select samples to use, were made either through voting, group discussion, or turn taking. Small group collaborations also enabled instrumentalists to work with newly-appointed *live electronic performers* who would manipulate sounds made by their classmates through a Max patch that could be operated swiftly using a computer keyboard and trackpad (see Figure 4). Acoustic instruments, voice, and found-material sound makers all were pitch-shifted, distorted, and delayed. Further collaboration took place within the physical instruments themselves, where often two or more players would perform on a single instrument at once. For example, when playing the KORG littleBits, one performer would select pitches, while another would open and close the filter (see Figure 1). Other forms of collaboration were established by the pupils themselves: performances would often feature clapping, singing, speech, conduction, or in the case of the Makey-Makey sessions, movement and whole body contact.

4. EVALUATION

> *I loved it because its two of my favourite things, tech and music, together.* [P]

The delivery of the project was evaluated by post-workshop surveys, which were distributed to all class teachers. Teach-

ers were invited to assess various aspects of the course such as the professional delivery of the sessions, as well as its impact on the education, skill acquisition, and health and well-being of the pupils involved. This was done through a rating system. This was combined with qualitative evaluation, which took the form of written comments from both pupils [P] and teachers [T] on the feedback forms. Additionally, teachers were invited to further expound on their opinion of what had taken place in the final CPD sessions.

One of the most common themes that appeared within the feedback—from both teachers and pupils—was the value of the interdisciplinary nature of the course:

> *This has been an excellent series of workshops, delivered in a interesting and interactive way. The pupils have all responded very well to them, exposing them to a wide range of skills and experiences (not limited to music - but includes some science etc).* [T]

Teachers also noted that while much of the material was also new to them, they were confident that many of the skills learned could be applied to other subject areas:

> *As a teacher I have learned a lot as it was not an area I knew much about. I now feel I have new knowledge and skills that I can use with future classes and the workshop has demonstrated good links between different areas of the curriculum (music and science).* [T]

In addition to identifying potential links with other academic areas, teachers commented on the benefit to the social and communication skills of the pupils:

> *[S]ome of the sessions delivered were cross - curricular. E.g. Science with electricity, Health and Well Being and how music can make you feel different emotions, Writing and responding, talking and listening amongst others.* [T]

The course was also successful in the two secondary schools in which it was delivered. Teachers remarked on how it complimented new MT courses that were being introduced:

> *I have already informed the Music departments in all WL secondary schools about the experience and have recommended it... The subject matter was a departure from the normal curriculum delivered in the Secondary Music curriculum and this complimented the Music Technology course that we have introduced this year at Nationals level.* [T]

The scope for experimentation and the hands-on approach, they suggested, could support the more individualised computer-based work that had recently been implemented in the curriculum.

Many teachers remarked on how the workshops seemed to appeal to those children who would not usually engage in group work, as well as those who often struggled in class:

> *Over the weeks I have witnessed some pupils being able to demonstrate their abilities in this area who find engaging in some academic work challenging.* [T]

Involving a range of different practitioners to deliver the workshops gave the pupils a broad view of existing practices within experimental and computer music. Unsurprisingly, the pupils were most responsive to the more hands-on workshops such as hardware hacking:

> *The pupils all really enjoyed the workshops and were enthusiastic to learn new and different ways of making music. They also looked forward to the different special guests who were invited each week to share the expertise in different areas. A really worthwhile project.* [T]

In rating the course, all teachers either agreed or strongly agreed that it had provided their pupils with new transferrable skills, as well as developing their social, emotional, and linguistic capacities. All of the responses to the question about increased employability were either neutral, or deemed the question not applicable. Only a single response addressed this topic:

> *I anticipate pupils being more able to work independently in the expressive arts.* [T]

The younger students gave appraisal by making thank you cards with drawings of their favourite activity. Older pupils gave succinct statements such as:

> *I think this was really fun and I enjoyed it very much #WouldRecommend.* [P]

In addition to the unanimously positive response from the pupils and staff, a further outcome worth noting was that in at least two of the schools, children took the initiative to set up their own electronic sound and music sessions. These took the form of lunch-time clubs where dedicated pupils took ownership of the equipment and would distribute it among other interested parties during the lunch hour. This often resulted in more sound recordings, short performances which were included in the next official workshops, and also further questions about how the equipment could be used.

5. CONCLUSION AND FUTURE WORK

This paper has described the development, implementation, and evaluation of a large-scale pedagogical framework for computer-based and electronic music undertaken within primary, secondary, and ASN schools. This research provides evidence to support the assertion that computer music and MT have a place within the pre-university classroom. This is firstly demonstrated by the overwhelmingly positive feedback and evaluations that were received.

Secondly, experimental musical practice provides an excellent forum for inclusive and embodied learning to take place. By engaging in practices such as listening, sound collecting, recording, hardware hacking, and instrument building, pupils became physically invested in their own learning. As Adam Tinkle suggests, “Rather than relying so exclusively on externally imposed norms and traditions to determine and delimit each step up a childs ladder to musicianship, what if instead music education was self-education in which students were, like citizen-scientists, set loose to probe and document the sounding world?” [8].

This was also supported by the ease with which the course could be implemented within the ASN schools.

Thirdly, this project builds upon related research—where teenagers were given the opportunity to design their own instruments, supported by mentors—that suggests that a participatory approach to music technology can help to generate interest in the broader fields of science and technology across genders [19]. The interdisciplinary applications of the project was evidenced through the feedback received. Nevertheless, recent studies of MT in HE institutions suggest that, despite technology's potential for democratisation, "existing ideologies of gender and technology, and social class differences, are being reinforced or even amplified through music in HE" [1]. Certainly, we must proceed with "careful reflection" [1], while we design MT courses for future generations. One of the teachers involved in *Sound, Electronics and Music* described it as:

> *A fantastic and motivating course... ideal for a very boy-heavy group,* [T]

which clearly suggests that there is still work to be done.

While legacy was an important consideration, further developments could improve this. Developing cross-platform apps that could be shared by teachers on *any* laptop, and using OSS, such as Pd, throughout would also be helpful to maintain continuity. All the sounds and music produced within the course were documented and stored on each class' laptop, with a view to being hosted on their school's website at the end of the course. Due to security restrictions this has not yet been implemented. This would provide further opportunities for pupils to discuss and comment on their peers' work.

Acknowledgments

This work would not be possible without the insight and expertise of Nancy Douglas, who facilitated the entire project through West Lothian Community Arts and astutely identified its potential impact. I would like to thank all of the experts involved for their enthusiasm and imagination: Jessica Aslan, Emma Lloyd, Christos Michalakos, Zack Moir, Yann Seznec, Greg Sinclair, and Shiori Usui. This project was generously supported by Creative Scotland.

6. REFERENCES

[1] G. Born and K. Devine, "Music Technology, Gender, and Class: Digitization, Educational and Social Change in Britain," *Twentieth-Century Music*, vol. 12, no. 02, pp. 135–172, 2015.

[2] J. R. Ferguson, "Perspectives on Research-led Teaching," in *Creative teaching for creative learning in higher music education*, L. Haddon and P. Burnard, Eds. Ashgate Publishing Company, 2016.

[3] E. Dobson, "Permission to Play: Fostering Enterprise Creativities in Music Technology through Extracurricular Interdisciplinary Collaboration," *Activating Diverse Musical Creativities: Teaching and Learning in Higher Music Education*, p. 75, 2015.

[4] D. Moore, "Supporting students in music technology higher education to learn computer programming," *Journal of Music, Technology & Education*, vol. 7, no. 1, pp. 75–92, 2014.

[5] H. Timmermans, J. IJzermans, R. Machielse, and G. van Wolferen, *Education On Music And Technology, A Program For A Professional Education*. Ann Arbor, MI: Michigan Publishing, University of Michigan Library, 2010.

[6] C. Boehm, "Between Technology and Creativity, Challenges and Opportunities for Music Technology in Higher Education (long version/CIRCUS 2001)," *CIRCUS*, pp. 55–72, 2001.

[7] D. Walzer, "Sound Exchange: Reframing Music Composition Educational Practice," *Leonardo Music Journal*, vol. 25, pp. 34–36, 2015.

[8] A. Tinkle, "Experimental Music with Young Novices: Politics and Pedagogy," *Leonardo Music Journal*, vol. 25, pp. 30–33, 2015.

[9] M. Baguley, D. L. Pullen, and M. Short, "Multiliteracies and the new world order," *Multiliteracies and technology enhanced education: Social practice and the global classroom*, pp. 1–18, 2009.

[10] A. R. Brown, *Computers in music education: Amplifying musicality*. Routledge, 2007.

[11] M. Merleau-Ponty, *Phenomenology of Perception (C. Smith, Trans.)*. Routledge and Kegen Paul, 1962.

[12] H. Dreyfus and S. Dreyfus, "The Challenge of Merleau-Ponty's Phenomenology of Embodiment for Cognitive Science." in *Perspectives on Embodiment: The Intersections of Nature and Culture*, G. Weiss and H. F. Haber, Eds. New York: Routledge, 1999.

[13] A. Yakhlef, "The corporeality of practice-based learning," *Organization Studies*, vol. 31, no. 4, pp. 409–430, 2010.

[14] P. Oliveros. Across Boundaries, Across Abilities. [Online]. Available: http://deeplistening.org/site/content/about

[15] M. Johnson, "Embodied knowing through art," *The Routledge companion to research in the arts*, pp. 141–151, 2011.

[16] N. Collins, *Handmade Electronic Music: The Art of Hardware Hacking*. London: Routledge, 2009.

[17] A. S. Lillard, "Playful learning and Montessori education," *American journal of play*, vol. 5, no. 2, p. 157, 2013.

[18] J. Stevens, J. Doyle, and O. Crooke, *Search and reflect: A music workshop handbook*. Rockschool, 2007.

[19] A. Thaler and I. Zorn, "Music as a vehicle to encourage girls' and boys' interest in technology," in *5th European symposium on gender & ICT. Digital cultures: participation–empowerment–diversity*, 2009.