Abstract
In this article we identify how computational automation achieved through programming has enabled a new class of music technologies with generative music capabilities. These generative systems can have a degree of music making autonomy that impacts on our relationships with them; we suggest that this coincides with a shift in the music-equipment relationship from tool use to a partnership.

This partnership relationship can occur when we use technologies that display qualities of agency. It raises questions about the kinds of skills and knowledge that are necessary to interact musically in such a partnership. These are qualities of musicianship we call eBility. In this paper we seek to define what eBility might consist of and how consideration of it might effect music education practice. The ‘e’ in eBility refers not only to the electronic nature of computing systems but also to the ethical, enabling, experiential and educational dimensions of the creative relationship with technologies with agency.

We hope to initiate a discussion around differentiating what we term representational technologies from those with agency and begin to uncover the implications of these ideas for music educators in schools and communities. We hope also to elucidate the emergent theory and practice that has enabled the development of strategies for optimising this kind of eBility where the tool becomes partner. The identification of musical technologies with agency adds to the authors’ list of metaphors for technology use in music education that previously included tool, medium and instrument. We illustrate these ideas with examples and with data from our work with the jam2jam interactive music system. In this discussion we will outline our experiences with jam2jam as an example of a technology with agency and describe the aspects of eBility that interaction with it promotes.

Keywords
music, education, interaction, musicianship, partnership, technology, agency, ability

Introduction
Digital technology has already generated questions about curriculum, pedagogy, ethics and musical practices. In this paper we examine a further question that is concerned with a shift in the relationship from musicians as users of a passive tool to musicians as creative partners with technology, as is possible when we use generative music systems.

Through our design of software for music education and field research using that software (See: Brown & Dillon, 2007), a question has emerged around how we view digital technology in this context and what is involved in defining the relationship between users and music technologies with agency? This question arose as we explored what happens when the computer takes on more
responsibility for musical decisions as a way of scaffolding novice musicians during collaborative improvisations. Our explorations focused on interactions around the jam2jam system where the computer generates music while users control parameters of the generative algorithm. With these kinds of interactions there is a decoupling of the gesture-sound relationship and the computer software makes decisions about the surface-level note events within constraints provided by the users. Interaction with generative music systems like jam2jam, have shown potential to provide unique opportunities for experiencing and learning about music, and require a particular set of abilities (eBilities) and developmental pathways.

**Representation and Music**

Music technologies have long been about representational forms. In the West, the development and use of common practice notation has been the most obvious of these. However, representations embedded in instrument design, including pitch relationships described by guitar frets and keyboard layouts, are also ubiquitous. These tools of representation have impacted significantly on musical cultures, musical uses have evolved and changed along with advances in the technologies of representation such as the printing press. There is also no doubting the impact of electronic and digital technologies on music over the last century. In particular the ability to represent sound in various audio recording formats and associated visualisations, from oscilloscope displays to waveforms on computer screens. These technologies have transformed our ability to externalise, reflect, analyse, manipulate and distribute music.

Of particular concern to us here, however, is the type of relationships musicians have with musical representations. As we have argued elsewhere (Brown 2007), we can characterise our usage of musical representations in two ways; as tool usage and media reception. In our use of music representations as tools, for example when we notate musical compositions or capture and edit a musical performance on a digital audio workstation, we use the technologies as mutable externalisations that can be consciously controlled. Alternatively, we may use music representations as mediums providing access to musical experiences, for example we might read a notated score or listen to an mp3 file of a musical production, during which we are often unconscious of the representation as it stimulates our senses to invoke a musical sensation.

Despite our ability to engage differently with music representations, as we just outlined, the technology itself was largely inert. This held true regardless of whether the technology was a notational symbol system, a control voltage, or a stream of binary bits. The agency that was attributable to the music making or experiencing resided in a person; a composer, performer, listener, producer, engineer, and so on. This is not to discount theories of agency attributed inert artistic objects, such as those by Alfred Gell (1998), but here we are concerned with a more direct form of agency that implies the ability to take action, not simply to invoke it. The need to understand this direct form of agency in these technologies has emerged through our work with algorithmic performance with computers. In particular we have become conscious of the need for a profound change in how we use technologies that that have agency or that act as an active partner in music making and learning experiences.

**Generative and Interactive Music**

The primary claim for agency in the music systems that we are exploring in this article is their generative capacity. This means that the system can produce music, or musical suggestions. This
is usually via the application of rules programmed into it, or derived from its analysis of input. Obvious examples of such rules are those from music theory, such as the rules of counterpoint that can generate note sequences, or rules from sound synthesis or acoustics that can generated audio output. Alternately it may provide sonifications of mathematical functions (such as probability distributions or fractals) or data (such as rainfall records or internet traffic). Fuller descriptions of algorithmic music and audio can be found elsewhere (See for example: Roads 1996). Importantly, these generative processes result in music, typically as notated scores or rendered sonic output. While generative systems may be mechanical, as is the case with a music box, our interest is with less trivial generative systems and in particular programmed computational systems (computer software) that allow autonomy and where novelty arises from complexity or indeterminacy.

Given that we are concerned with interactions, then a secondary capability is that a system can respond to actions of the human partner, and does not simply function autonomously. Interactive music systems may operate, as jam2jam does, through parameter control or may ‘listen’ to human input either as gesture data (via MIDI, OSC) or as audio data (via a microphone), analyse this input and map it onto generative parameters. A more detailed overview of interactive music systems is beyond the scope of this article (see, for example, Rowe 2001). What is important for our purposes, is that the system is capable of participating in a dialogue with musicians, usually in real-time to facilitate improvisation and performance but computer-assisted compositional systems with whom interaction occurs at a slower pace may also facilitate a partnership relationship. In these kinds of technological partnerships it is the musicians judgment about how to interact effectively with these systems that constitutes a kind of musicianship, an eBility. An understanding of the required skills, techniques and processes should be the concern of the music educator and of the musician hoping to achieve a depth of understanding and a quality musical result. We believe that these understanding are assisted by the shift in mindset that can accompany a change in metaphor, in this case from technology as tool or medium or instrument to technology as partner.

Metaphors of Music Technology
History is replete with examples of technologies deployed for musical purposes. From developments in metal work techniques for brass instruments to those in electronics for amplification and sound recording. Developments like these in materials and manufacturing processes have enabled the invention and refinement of instruments and musical tools. The distinction between tools and instruments is often clear cut, such as the difference between a piano and a metronome. But creative ingenuity is never so simple, as pianos have been used as tools or aural training and metronomes as instruments, for example by György Ligeti in Poème Symphonique for 100 metronomes (Ligeti 1962). The Internet age of digital music distribution has made us very aware of technologies as mediums for music. Just as sound can travel over the Internet in digital form, it can travel over wires as electric current, and through physical mediums as vibrations. Notational systems and their printed representations on article as scores are also musical technologies acting as mediums.

In addition to thinking about technologies as musical tools, instruments and mediums (Brown 2000, 2007) we suggest that automated machines capable of independent action reveal a new metaphor, they can be considered as musical partners. Automated music machines, of course,
have history dating at least as far back as barrel organs and include familiar devices such as player pianos, Karaoke machines and MIDI sequencers. Automated machines such as these are certainly capable of playing along with human musicians or, more precisely, are able to be played along with. What we suggest takes automation to a new level is algorithmic computational systems capable of making adaptive choices in real-time. We suggest that such interactive music systems can include sufficient autonomy, or agency, that allows them to be classified as musical partners.

The reason why these descriptions of tools are metaphors of music technologies, and not classifications, is because technologies can fall into many categories or be used in a variety of ways. The description above of how metronomes, designed as a tool, were used as an instrument by Ligeti is a case in point. Another example might be a sheet of paper, seen primarily useful as a medium for drawing music notations can be used as an instrument by striking it, ripping it, crushing it, blowing long it edge and so forth, and can be a tool in its function as a notational score or as device for prepared piano. Even the possession of agency can be seen as metaphoric, rather than classificatory, although in the sense we mean it in this article we focus on computational agency via programmed software particular to a small range of music technologies.

The case for considering the agency of technologies in creative domains was made in some detail by Alfred Gell in his book *Art and Agency: An anthropological theory* (Gell 1998). The focus of Gell’s work were visual art objects, from Western and Pacific cultures in particular, and his emphasis was on the agency of art and its ability to effect the world, usually by first effecting human action. In particular he was concerned to make this case within an art theory context of the time that he saw valued representation, symbolism and meaning. Rather, he states ‘I view art as a system of action, intended to change the world rather than encode symbolic propositions about it’ (Gell 1998: 6). Gell provides in-depth descriptions of the ways in which decorative art becomes part of a distributed mind and become social agents in cultural futures. As such, and because of the indirect effect through the influence of humans, the scope of agency in Gell’s system is quite broad because it relates to inanimate art objects by and large.

A stronger case for computational agency is made in the field of artificial intelligence. In this area researchers are generally concerned to duplicate in software the cognitive capacities typically found in human agents. The degree to which this is possible is a matter of debate as Terry Winograd and Fernando Flores remind us; ‘Since we accept the view that a person is a physical structure-determined system, we cannot be sure that a similar system made out of silicon and metals might not be equivalent to one composed on protoplasm’ (Winograd and Flores 1986: 104). Indeed, for some narrowly defined tasks such as playing chess and scanning for medical conditions, computational processes seem every bit as capable as humans. Our interest here is not in autonomous computational music systems that are equivalent to or replacements for human musicians, but rather complementary systems with which we can enter into a music making partnership. This view is present in artificial intelligence research by Winograd and Flores who argue, following Humberto Maturana’s observations in biological systems for computing systems that can enter into a ‘dialogue’ with people within a ‘consensual domain.’ ‘The consensual domain is reducible neither to the physical domain (the structure of the organisms that participate in it) nor to the domain of interactions (the history by which it came to be), but is generated in
their interplay through structural coupling as determined by the demands of autopoiesis for each participant’ (Winograd and Flores 1986: 49). While this quote is rich with significances that space does not permit us to follow up here, it points toward the type of more equitable musical partnership, or dialogue, that we suggest is possible with computational music systems with a level of agency we are interested in.

**Jam2jam**

Since 2002 an interdisciplinary team of researchers in schools in Australia, USA, Sweden and the UK have been developing generative technologies and classroom and community learning strategies in music education (See for example: Brown and Dillon 2007; Brown 2005; Brown and Dillon 2009; Brown and Sorensen 2009; Dillon 2004, 2009; Dillon et al. 2008; Dillon and Jones 2009; Ruthmann and Dillon In Press; Brown and Dillon In Press). In 2008 the project was provided funding support by the Australasian Cooperative Research Centre for Interaction Design through the Australian Government's Department of Innovation, Industry, Science and Research. Through this project we were able to establish research nodes in many countries with trial schools and communities and partnerships with software manufacturers and developers. The generative processes in jam2jam employ algorithms which involve the application of rule-based musical processes (Galanter 2003).

jam2jam employs networked generative technologies such that musicians who share the same computer environment can perform collaboratively as a group, both in the same place (LAN) and over the wide area network (WAN). Furthermore the performers are able to perform over the Internet with little perceptible latency because the information travelling across the network consists of digital gestures and numbers that translate into musical transformations. jam2jam uses a game-like interface or physical controllers attached to a computer via USB or wireless connection that link to a library of musical and video transformations that are widely variable and expressive. With a simple movement of an instrument icon up and down and left or right on an X-Y pad any user can make complex changes to music and play collaboratively on the LAN or WAN. No text, no images, no sound, no voice travels between users. They communicate entirely through listening to the sounds they make together. Norwegian researcher Sigrid Havel from Bergen described how the children in her school loved the anonymity of this kind of experience (Jordal Havre 2011). She reported that students were totally engaged with a musical and video performance experience. (See: http://www.youtube.com/user/jam2jamVideo).

jam2jam software was first commissioned as an activity for a children’s music festival in Delaware, Ohio, USA. Since that time and across many different contexts and countries, we have seen looks of intense concentration and smiles on the faces of children and adults who use jam2jam. The driving concepts behind jam2jam, that we have come to call meaningful engagement with generative media performance, have a philosophical story, a pedagogical story and a design story. The features of jam2jam and its associated pedagogy have evolved with each iteration of design and application whilst the philosophy has deepened through dynamic interaction with these changes. All along, our intent has been to increase the value of creative experience for the users. Each software design revision has hinged upon maximising collaborative creative experiences that mimic collaborative improvisation in small acoustic ensembles. For example, that of a jazz ensemble improvising around a specified rhythmic, harmonic and pitch framework with a style set by the melodic ‘head’ and pitch and rhythmic

ideas bound to specified scales and rhythmic practices. Similarly, participants playing with jam2jam are able to engage with musical concepts such as density of activity, pitch range, duration, timbre, tempo and volume and express themselves through a simple interface design.

Figure 1: jam2jam grey showing the use of sliders to control musical parameters.

Currently network jamming systems work on three platforms. Jam2jam grey uses Java for both PC and Mac OS, Jam2jam AV uses Impromptu and operates on OSX 10.7, 10.6 and 10.5 and Jam2jam XO operates on the Linux based Sugar operating system made for the One Laptop Per Child-OLPC XO computer. This can also operate on most other computers using the Sugar on a Stick download: http://wiki.sugarlabs.org/go/Sugar_on_a_Stick

Figure 2: jam2jam_XO for OLPC

Regardless of the operating system the process works by allowing multiple users to control a generative music engine using either networked computers or USB and wireless controllers connected to a central computer. Sliders, X-Y pads or dials can adjust the density of notes, duration of notes, pitch, timbre, and so on. A performance can be a solo or collaborative activity and the change in sound is instant. With jam2jam AV this also applies to video, pictures and the web cam and an audiovisual performance can be made. A video can be recorded of a performance or rehearsal in real time and reviewed later or uploaded to YouTube. Meta data from the recordings can also be captured and visualized using ancillary software that represents creative choices and interactions (Brown 2010). This representation of interaction provides feedback about performers actions and creative choices synchronised with a recording of the performance. The system has potential for a wide variety of feedback and progress monitoring.

In recent trials with differently-abled young people jam2jam has been used to measure changes in attention and determine and describe the qualities of the activity in which they engage. Gaining and increasing attention is an important aspect of any learning and this generative process enables the harnessing of audiovisual activities within collaborative scaffolded environments to be measured. The engaging qualities of music and media becomes accessible and a new form of participation emerges that includes high quality sound and managed ensemble interactions enabled by the agency in the technology.

Whilst jam2jam makes musical interaction more accessible to novices it did, however, present a disruptive technological experience for many music educators and raised questions about the value and ethical dimensions of such technologies in music education as it challenged notions of authentic experience held by teachers and curriculum developers. We have made three claims about this why this kind of educational experience is disruptive, it suggest that 1) the computer is an instrument; 2) the network (of people and machines) is an ensemble; and 3) the Internet is a venue (Brown and Dillon 2007).

Each of these ideas challenges both the perception of music making and computer use. Firstly, calling a computer a musical instrument is challenging on several levels. Even in what is termed as music technology classes in schools the computer generally functions as a solo activity rather
than collaborative and is mostly a production or recording device rather than a performance tool, with the exception of electronic replicas of acoustic instruments. However, in the world of computer music there are even more radical practices emerging. For example, live coder’s perform music with laptops by typing computer code (See for example: http://vimeo.com/8732631/).

**From experimental electronic music making to schools**

The operations of jam2jam are particular to our work and innovations in the field of music education research, but interactions with generative systems in music is not new in the field of computer music research more broadly. The use of stochastic processes in compositional systems such as that outlined by Iannis Xenakis in his book *Formalized Music* (Xenakis 1977) shows how compositional decision making processes can be shared with stochastic computational systems. To some extent even the aleatoric process works of John Cage or serial works of Paul Hindermith, could be argued as early examples of musical systems where some agency was allocated to a process. The trend toward computational compositional autonomy was taken to its most sophisticated by David Cope’s Experiments in Musical Intelligence (EMI) system that analysed a database of works then composed new works based on a structural analysis and reassembling fragments of the music from the database. In more recent years, Cope has developed the Emily Howell system that works in a more interactive compositional way that would definitely be categorised as a partnership in the sense we mean even though it is compositional and not performative.

A more direct inheritance to jam2jam can be seen in performance systems that use generative processes, such as Robert Rowe’s Cipher system that grew out of his research into interactive music systems (Rowe 1994, 2001). In this work Rowe describes computing systems that ‘listen’ to human performances and ‘respond’ using generative processes. Another example of an interactive performance system is the Continuator by Francois Pachet (2002). The Continuator ‘listens’ to a short performance and then performs a variation on that material. This system follows a dialogue format with human and computer taking turn, whereas Rowe’s Cipher system operates as a duet where both play simultaneously. A more recent interactive music performance system is Toby Gifford’s Jabot that listens, analyses and responds in real time so that it operates as an improvisational partner (Gifford and Brown 2011).

These systems are present within professional contexts and are used by experienced musicians. Reports on the interactions with them, can provide insights into the types of interactions and abilities required by musicians who interact with them. Such insights, and our data from children’s interactions with jam2jam, inform our suggestions about the kinds of abilities or musicianship that these systems demand.

**eBility**

“What is the newfound relation of individual talent and productive work?” (McCullough 1996: 188)

If we accept the suggestion that music technologies with agency can provide a new type of relationship, then there is a new set of skills and knowledge required to take advantage of this music making opportunity. We suggest that an aspect of the ‘newfound relationship’ with digital tools that McCullough seeks is, in the domain of music, a new type of musicianship we call an
eBility; the capacity to successfully manage musical interactions with computational agents. Because interactions with computational agents employing generative music capabilities provide access to music making experiences in new ways, the notion of eBility impacts upon the ethics of the musical and learning transaction, the enabling and educative capacity of the interaction and the quality of the experience.

There are two distinct features of eBility that differentiate it from what has traditionally been considered musicianship. This traditional view, we take it, to revolve around the learning of the rules of Western music theory, developing aural acuity in the same, and the development of performance skills on voice and/or acoustic instruments. Firstly, in a musical partnership between person and generative music software there is a sharing of responsibility for the musical result and this requires some understanding and skill with the collaboration this implies. Thus collaboration is at the core of a person’s eBility, whereas traditionally their individual music making was at the core and collaboration was seen as an extension. When using the jam2jam system, responsibility for the surface level details of note-by-note sequencing were taken over by the computer and the musician needs to appreciate that their role is to augment this with parameter control. The two became parts of a musical feedback system, in a way that is perhaps more equal than in interactions with an orchestral instrument. Secondly, because of the responsibility-sharing between human and computational agents the types of skills required of the musician can be different. In the case of working with jam2jam there is an immediate focus for the musician on meta-level processes including density, pitch range, part balance, and the unfolding of form and structure. By contrast when developing skills with orchestral instruments the more immediate attention is on sound production, note selection, tuning, and timing. Thus skills and knowledge may develop in a different order, or in complementary relationship if a student has both conventional and interactive performance experiences.

While these features of eBility we see as distinct, there are other features that are common to creative tasks more generally. Ken Robinson outlines four elements of the creative process as: 1) The importance of the medium, 2) the need to be in control of the medium; 3) the need to play and take risks; and 4) the need for critical judgement (Robinson 2001: 111). These provide a succinct encapsulation of important aspects of an eBility. We can see how these apply to performing with jam2jam. The digital medium and the specific characteristic of the jam2jam system itself need to be understood, and the control of parametric functions is at the core of these interactions. Like all creative activities, skills are developed through exploration of the possibilities and pushing the boundaries. It is not uncommon for us to witness children in jam2jam workshops moving all controls to their maximum value to see what happens. Finally, the ability to reflect and develop critical judgement is supported in jam2jam through its ability to record sessions for sharing and review.

**Implications for learning and teaching music**

The ability to provide learning environments that focus or delimit the responsibility of the learner is not new. This kind of scaffolding of learning is well established, for example Orff Shulwerk, Suzuki and Papert are well known for creating ‘junior versions’ of both instruments and systems for computers and music learning, as we have discussed elsewhere (Dillon & Hirche 2010). The kinds of partnerships with generative music software that we are addressing here continues this tradition. It should be remembered, however, that some interactive music systems such as live
coding practices, often utilise techniques that required quite virtuosic abilities to manage well. Therefore, the case of jam2jam and systems like it are ‘junior’ instances of these designed for accessibility and learning. Inherent in the construction of junior versions such as Orff Xylophones, the Logo Programming language and jam2jam is a design that focuses and bounds the attention of the user within an intrinsically attractive system that has expressive capacity but is tailored to child sized physical and cognitive abilities. These devices and systems also have embedded cultural values, like the C major scale in an Orff xylophone that focused the learning around defined and limited timbre and pitch materials.

We believe that technologies with agency present a similar kind of educative advantage and focus on a much larger and even more flexible scale. With generative systems like jam2jam both the interface or instrument can be tailored to users abilities and the embedded musical values can be contained within a musical algorithm as a system for interaction. Furthermore, these systems provide an intrinsically engaging approach to music making that encourages improvisation and playfulness with musical materials and scaffolds collaborative ensemble interaction. They potentially provide a collaborative performance space where both interaction with musical materials and members of the ensemble is supported and enabled.

As far as learning is advanced through generative performance, we have observed and documented a tendency for participants to activate discovery learning through doing. Participants demonstrate that through exploring personally and socially they gain concrete experiential knowledge about key musical concepts and collaboration. Even in short interventions that occurred in festival and community settings participants showed the ability to describe what they were doing in performance and how the instrument responded to their gestures. They also showed to teachers that they understood the musical concepts of volume, pitch, timbre, tempo and density more clearly in pre and post test studies (Burnard, Baxter, and Dillon 2010).

Another conceptual driver for the jam2jam research was the notion of engagement with each activity in personal, social and cultural contexts. This evoked the idea of a collaborative creativity that built upon the same foundations as ensemble performance and improvisation. The ensemble and performance features of jam2jam experiences are reported by participants to be an equivalent to the feeling of playing in an ensemble (Hirche 2011). The permission to explore, and permission to do this collaboratively, features highly in data associated with community music making.

The ‘fail safe’ nature of the network jamming experience scaffolds the quality of the sound and provides the capacity for participants to make musical aesthetic choices and respond musically to peers in the ensemble. It is these two qualities that are significant for music educators. The playful and engaging process of improvisation and explorations of sonic materials moves through modes of engagement from exploring through to embodiment then eventually leads to evaluative analytical thinking. This is similar to Swanwick’s description of the process of moving from sensory through embodiment to analytical knowledge (Swanwick 1994). Whilst Swanwick is referring specifically to experiential music making with acoustic instruments, the same experience and process has been repeatedly observed with users of jam2jam in networked ensembles. Added to this is the increased capacity to talk or write about musical concepts that has been shown in iterations of jam2jam research in Australia and the UK (Burnard, Baxter, and Dillon 2010).
Dillon 2010; Adkins et al. 2007; Dillon and Hirche 2010). The provision of a concrete and intelligence fair (Gardner 1993: 176) experience is manifested in partnerships with generative music systems that allows the musician to demonstrate their meta-level understandings and these experiences seem to be responsible for this shift in learning.

Anonymity and distributed experiences with jam2jam are interesting outcomes of the network jamming research. Jordal Havre in Norway reported that students enjoyed the safety of musical communication without knowing whom they were playing with (Jordal Havre 2011). In a sense anonymity seemed to decrease the pressure of social performance and verbal representation of self to musical gestures and non-verbal communication through art making. We suggest that this is perhaps an anathema to the social pressure experienced by many adolescents with their daily contact with social media. The distributed experiences with music making over the Internet offers potential for isolated locations such as we have in Australia or even in countries where, in winter, co-present social activity is diminished.

For educators these kinds of systems offer accessible experiences, low-pressure collaboration, extended relationships through online interaction and concrete experiences that potentially provide a support for developing musical knowledge. Beyond the practical application of generative technologies this research has also identified qualities of interaction and engagement that have an extended value for both experience design and for describing and evaluating student engagement. In this context then, eBility can be further understood as a deepening of the quality of intrinsically motivated activities so they can be more expressive and the development of strategies to engage with less intrinsically attractive actions (Dillon 2007).

**What happens when the technology has agency?**

The answer to this question is far reaching. Whilst it is exciting to see the effects and powerful engagement and potential for learning of this kind of technology it also disrupts how we perceive both learning and teaching music. New teaching strategies need to be developed, new resources for sharing learning strategies and new policies developed to accommodate both the technology access and the teaching and learning experiences. In schools where we struggle with what Wikipedia means for information access and authenticity we are not really prepared for the next device that will write the essay for us. See for example http://Qwiki.com that assembles presentations based on key words and accesses information available through Wikipedia and YouTube. Increasingly cloud computing is offering powerful transformative services that assemble very professional media products. Our experience now with jam2jam has provided a taste of the difficulties in policy, teacher understanding, student engagement and access to new ways to participate that traverse the spectrum of responses. The appropriate way of engaging with these technologies involves an impassioned recognition of the affordances. As Per Skold at Humfryskolan in Sweden says ‘[jam2jam] gives me a perfect tool for working with cooperation and socialization.’ Per has assessed the affordances of new technology and uses it to enhance participation and meaningful engagement. He has identified the qualities of music experience of ensemble music making and perceived how this can be harnessed for collaborative creativity.

**Conclusion**

In this article we have introduced the concept of eBility as the capacity to successfully manage musical interactions with computational agents. eBility defines a development of musicianship to
include partnerships with technology. The ‘e’ at the beginning of the word is not just symbolic of its attachment to electronic technology, it also refers to a need to understand the ethics of the musical and learning transaction and the educative potential of this kind of experience. In one respect it signifies the identification of a new aspect of contemporary musicianship and on the other the need for constructivist learning strategies that leverage the enabling and enlightening qualities of such a partnership with technology. Our research with jam2jam has presented to us the possibilities and disruptions of digital partnerships and their effects on what is perceived as musicianship and what is valued as musical knowledge. The notion of computational agency presents us with new curriculum and pedagogical challenges and, like all technologies, it reveals and conceals; it presents educational affordances and evokes disruption. Refining and identifying the qualities of eIBILITY as a musicianship can harnesses the qualities of technologies with agency in a way and that enhances experiential music learning. Unlocking this capability is contingent upon first acknowledging the difference between a tool which passively interacts with the user and one with computational agency that acts as a partner in the creative process.

References


