15 Embodied music learning

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Introduction

There is excitement in the room when I enter the school's auditorium to attend my daughter's end-of-semester show. The parents take their seats, the light dims, and the young children march on stage and prepare to sing. The teacher starts a backing track, played overly loud through a pair of prominent speakers hanging high above the stage, and the children begin to sing. All goes well in the first verse and chorus, but the kids are so excited that many do not recognise the one-bar break before the second verse starts; the result is chaos. Some kids continue singing independently of the backing track, increasing their tempo. Those who waited for the extra bar get confused by the others, and many stop singing. The teacher stands in the front, gesticulating, trying to get the kids to sing together. The pre-recorded backing track plays on. Eventually, the teacher gives up and signals to stop the playback. The parents applaud encouragingly despite the chaotic performance. I see my daughter walk off the stage in despair. Afterwards, she says she will never sing with her class again. What went wrong? How could something as simple and natural as school class singing fail so miserably?

In this chapter, I discuss "embodied music learning" and explore how technologies can support new forms of musical exploration in classrooms. Ideally, technologies help "amplify musicality", an expression Brown (2014) uses to explain how the technologies of our time can enhance music-making, learning, and teaching. However, a problem with many current music technologies is that they are not "classroom ready", nor are the teachers adequately trained to use them effectively in classrooms. The result is poor learning and general techno-scepticism.

My entry point to embodied music learning is as a researcher on the crossroads between music cognition and music technology, and as a teacher in a generalist higher education music programme. I will start by introducing the "musicking" concept (Small, 1998) and merge it with recent theories of embodied music cognition (Clarke, 2005; Cox, 2016; Leman, 2008) and 4E approaches (Gutierrez, 2019; Schiavio & van der Schyff, 2018). Then, I give examples of how "musicking technologies" can be used in 4E-inspired teaching.

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Musicking

What does it entail to "learn music"? Is it to learn how to listen to music? To learn how to play an instrument? To learn how to build an instrument? To learn how to compose? To learn how to analyse? To learn how to appreciate music cultures? I like to think about all of these and use the inclusive verb "to music" to explain that music is not an object but an active process. When Small (1998) introduced the concept of "musicking", it broke with a tendency (in Western cultures) to objectify music. Throughout the 20th century, European musicology was primarily concerned with musical notation, and formal music training was focused on learning to play pre-composed scores on standardised instruments. Such a score-focused approach led to thinking about music as a "thing" rather than a process.

The objectification of music has not become less with the abundance of pre-recorded music surrounding us everywhere. One can easily live a life listening to music from morning to evening: from a home entertainment system in the living room, on the mobile phone while commuting, and on the radio at work. Even if you are not listening to music on your own device, there is often music in cafés, on the bus, in shops, and on both traditional and social media channels. Never has so much music been available, but most of this music is experienced passively, as background tracks to our lives. This may not necessarily be negative, but how does it affect our ability to make music ourselves? Moreover, how do new generations learn music in this—from an evolutionary perspective—new musical environment?

In the book *Ways of Listening*, Eric Clarke (2005) argues that listening is an embodied activity exploiting the multimodal capacities of our bodies. He builds on the ecological psychology of Gibson, who argued that "[o]ne sees the environment not just with the eyes but with the eyes in the head on the shoulders of a body that gets about" (Gibson, 1979, p. 222). Music is also experienced through such an "action-perception" loop. This is not only the case when dancing or jogging to music; people move to music even when they try to stand as still as possible (González Sánchez et al., 2018).

Figure 15.1 shows a model of "embodied music cognition" inspired by a more complex model developed by Marc Leman (2008). A performer can be seen as making music with an instrument. The interaction between the performer and their instrument is based on what I call "action-sound couplings" (Jensenius, 2022). The performer acts on the instrument, and the instrument re-acts with vibrations experienced in the performer's body and heard as sound through the ears. The action is based on an expectation of what will come, and the expectation is based on experienced actions. Similarly, the perceiver hears the sound from the instrument but can also see the interaction. I use the term "perceiver" instead of "listener" to stress that the experience of music is inherently multimodal. In the model, both the performer and perceiver interact with what Gibson (1979) called the "environment". The environment can be other people, a room, or something else external to the person in question.

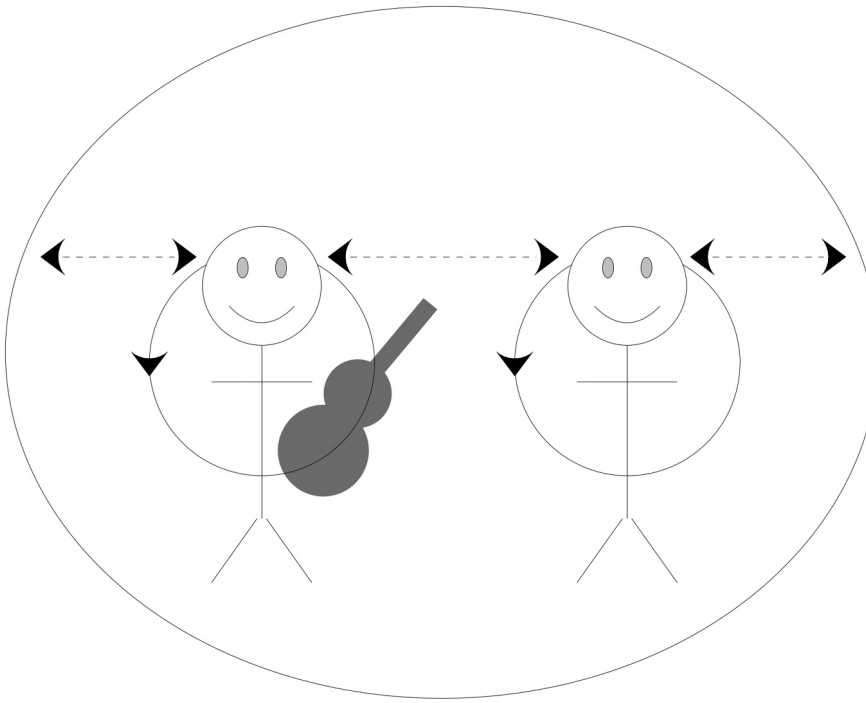

Figure 15.1 A simplified model of the internal action-perception loops of performers and perceivers, the performer's interaction with their instrument, the interaction between performer and perceiver, and their interaction with the environment. The model shows the complexity of a musicking situation.

The most important is a continuous action-perception loop, forming the basis for the enactment.

The musicking quadrant

Musicking is not limited to music performance or perception but includes various musical activities. Figure 15.2 shows a model of the "musicking quadrant", organised in a matrix-like structure related to time and function (Jensenius, 2022). Musical activities that happen "in time" include performing and perceiving music, while "out of time" activities include building instruments, composing pieces, producing records, and analysing music. This temporal distinction resembles the concepts of "online" and "offline" effects in embodied cognition theory, where offline is used to describe when action-related processes are temporally separated from relevant perceptual processing, thus contributing in a top-down fashion (Schütz-Bosbach & Prinz, 2007).

In the musicking quadrant, perceiving and analysing music can be seen as different ways of experiencing music, while the others are concerned with

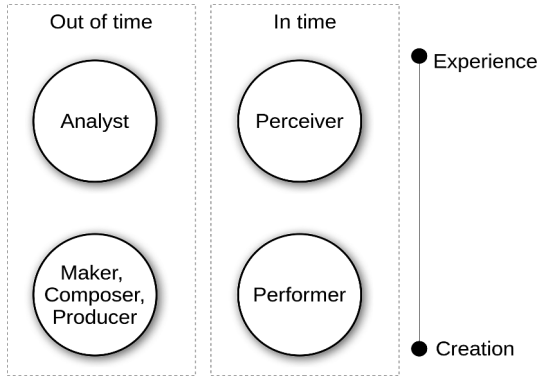

Figure 15.2 The "musicking quadrant", a model for investigating relationships between different types of musicking (Jensenius, 2022).

creating music. There are many overlaps between these roles. Composers may develop melodies, rhythms, and chord progressions while playing an instrument, and improvisers arguably compose "on the fly" during a performance. Still, the musicking quadrant helps explore what falls between categories, and it also helps explain why the Western music world is still primarily structured around these categories. Many higher education institutions have separate tracks for performers, composers, producers, and music theorists. Graduates have distinct career paths and are members of independent professional organisations.

New technologies challenge traditional conceptions of the roles in the musicking quadrant. Traditionally, instruments had to be built before they could be composed for and before someone could perform with them. Nowadays, instruments can be built during a performance, such as in the music genre called "live coding" (Blackwell et al., 2022): The performer creates sound on the fly while sitting on stage with a laptop and writing a computer programme projected on a screen for the audience to follow. The audience can watch the development of the instrument and composition (manifested on screen as code) while listening to the sonic output.

Other types of new music performance technologies also challenge traditional musicking roles. In what is often referred to as "new interfaces for musical expression" (NIME), the composition may be embedded into the instrument (Jensenius & Lyons, 2017). Then, composing may also include building the instrument, which blurs the boundary between the instrument maker and composer. Laptop musicians often perform with software that works in both real-time and non-real-time modes. The "composition" is usually not a traditional score but a collection of pre-loaded samples and presets in the software, blurring the lines between composer, producer, and performer.

Similar technologies and musical concepts are increasingly available to perceivers. New mobile phone apps allow for remixing tracks and adjusting musical parameters on the fly. Some artists release apps with multitrack versions of their songs that users can modify at will. This opens for more "active listening", in which the perceiver becomes a performer. It breaks with the century-long tradition of listening to pre-recorded tracks and engages the user actively with the musical material. New music technologies add enactment to musical experiences. Today, children have access to these technologies on their phones, tablets, and laptops at an early age. How does that impact music education in schools?

A failed performance

My daughter's school singing is an example of how music technology may both encourage and discourage musicking in an educational context. On the one hand, the choice of playback technology encouraged the children to sing, but on the other, it was also one of the reasons the performance failed. The problem was that neither the teacher—nor the children—had control over the pre-recorded song beyond starting and stopping the playback. This is an example of a non-interactive music technology that is difficult to use in a performance context where unexpected things may happen. Their performance was made inflexible thanks to technology without adjustment possibilities.

One could argue that engaging in musicking is positive regardless of the "quality" of the result and that there is also learning in failing on stage. However, it is counter-productive if it leads to children refusing to sing. I am sure the teacher had good intentions when choosing a professionally produced backing track to support the children's singing. However, if a backing track were to be used, choosing an interactive music technology that allows for a suitable control level would have been better. Many hardware and software solutions are available that allow for adjusting the tempo and pitch of the music being played, as well as jumping back and forth in tracks. Such tools are well known to DJs and laptop musicians but are less used in general music education. This is partly a technological problem; many tools are developed for experts, not learners and educators. There is also a knowledge gap. Many teachers are not educated to teach various types of music technology. Many higher education programmes still regard music technology as an "add-on" to other activities rather than an integrated part of musicking.

As a music technologist, I often stress that new music technologies do not need to exclude traditional technologies. We never had backing tracks when singing in class when I went to school; our music teacher played the piano and could easily adjust if something happened. Missing the start of a new verse is a classic challenge for accompanists. If it happens, one can easily skip a bar to catch up with the singers. For the teacher, choosing the right technology for the job is essential. The key is flexibility and the possibility to adjust while

performing. It does not matter whether the teacher uses a piano or a laptop as long as they know how to play them.

Very soon, there will be commercial systems with embedded musical artificial intelligence that could have saved my daughter's performance. Systems with built-in "machine listening" capabilities allow for adjusting the musical response similar to a human performer (Erdem et al., 2022). Such systems are actively explored among music technology researchers. As opposed to previous music technologies primarily targeted at experts, many new systems are developed for general interactive musicking. The machine integrates the roles of analyst and performer from the musicking quadrant, and it can even compose on the fly. It also allows humans and machines to engage in musical co-creation.

Even though I am optimistic about the future of musicking technologies, we should remember that it is perfectly fine for children to music without any technologies. Learning to sing without accompaniment is a valuable musical and social skill: It requires listening to others and adjusting one's singing accordingly. It may be more challenging to produce a well-sounding result by singing without a backing track (or a piano, for that matter), but it may still be worth it in the long run. Clapping while singing helps keep the beat, and walking or dancing even more. Many children's games are based on combinations of singing and various types of bodily behaviour. Then, there is no need for backing tracks to keep the rhythm and understand the song's structure.

An action-sound approach

How can embodied music learning principles and musicking technologies be used in classrooms? Over the years, I have developed an action-sound approach when teaching new bachelor's students about interactive music systems (Jensenius, 2013). This approach breaks with the traditional way of teaching music technology separately from other music disciplines. My approach aligns with the 4E cognition principles and should be possible to explore also in school education. In the following, I briefly describe how it can be implemented.

Embodied

Many of today's core educational technologies—including laptops, tablets, and phones—are "disembodied" in the sense that they force the user to focus their gaze and restrict their action potential. This often leads to sedentary laptop musicianship, pushing buttons with the fingers. I always start my classes with an embodied exercise. This could be asking students to make musical sounds with their mouths or tapping on the table. I try to use laptops as little as possible. Even though mobile phones have more limited processing capabilities than laptops, they allow for more physical interaction. I ask students to form small "mobile phone ensembles" that move in space and use various types of gestural control as an integrated part of their musicking.

Embedded

After getting the students moving, I ask them to move to a different location. Making a sound in a dry classroom differs from producing the same sound in a highly reverberant space. For example, corridors usually provide a long reverb time, completely changing how sounds are heard. This engages the students to listen to the space and make sounds that fit their environment. By moving through the space, they also understand how location impacts sound wave radiation. Facing a corner is completely different from standing in the centre of a room.

Enacted

Many students approach musicking from the perspective of traditional musicianship: singing or playing a pre-composed song. That is fine if the aim is a specific performance. However, there is much learning involved in daring to improvise freely. This requires the coordination of the interplay between performing sound-producing actions on an instrument and the re-action of the instrument on the body. Again, this requires balancing listening and performing. It may be daunting, so I often approach improvisation by setting a timer: improvise freely for one minute, then take a one-minute break, and then improvise freely for one minute again. The breaks are significant: They stop the flow and let the student start over in the next run.

Extended

Once students are comfortable with their own instrument—whether traditional acoustic or novel electro-acoustic—I ask them to improvise together. Musical improvisation is a form of group-based "problem solving". You need to be alert, attend to what others are doing, and contribute something yourself. It requires a constant interplay between mind and body, body and instrument, and an attuned focus on the group's output. Sometimes I ask students to use microphones and small amplifiers when performing together and produce the same sounds while changing microphones and speakers. They can also explore connecting microphones and speakers in various constellations so that they lose track of their "own" sound. This is an efficient way of learning microphone technique, but, more importantly, the students learn to appreciate the distinct qualities of various amplifying technologies.

From sound-making to music-making

I developed my action-sound pedagogy after several years of more conventional teaching. Instead of teaching digital signal processing from beginning to end, I focus on essential musicking skills: how to build an instrument, produce sound, listen to the sound, and play with others.

Even though novel instruments open new musical avenues, they are still what Libin (2018) calls a "[v]ehicle for exploring and expressing musical ideas

and feelings through sound". Laptops and mobile phones can be such vehicles, but so can a coffee cup and a pen when used as a percussive instrument. A rubber band can be attached to a chair and function as a string instrument, and a bottle can be turned into a wind instrument. The students learn that they can create sounds with any object in their vicinity. They just need to use their imagination when picking objects, position themselves in a suitable acoustic environment (or improve the acoustics through microphones and speakers), and listen to the sounds they produce.

There are several reasons why I avoid using traditional instruments in my teaching. One challenge is that most traditional instruments are hard to master. People practice the violin for years before it sounds "nice". Another challenge is how many traditional instruments are built around specific musical logics. Magnusson (2018) argues, "[i]nstruments are impregnated with knowledge expressed as music theory". Many of them, including the piano, favour musical genres based on the Western, tempered, 12-tone system. A recorder helps the user to play tones within the tempered tonal system. A guitar in a standard tuning makes playing songs in A major easier than F major, and a piano affords playing songs in C major on the white keys.

The piano is an example of an instrument in which the performer has relatively little control over the sound. One hits a key and gets a sound. I often say that the piano has two "degrees of freedom": the pitch (which is controlled by deciding on which key to hit) and the velocity (which determines how loud the sound will be). Thus, the piano is quite limited in its sonic capabilities and lends itself better to creating combinations of tones, such as playing chords in various combinations, than playing single melodies.

Several traditional acoustic instruments can be seen as music makers in addition to being sound makers. Organs have systems for playing intervals with one finger. Chord progressions are integrated into the instrument design in accordions. Many electro-acoustic instruments have continued this trend of embedding musical knowledge. Today's digital music systems can play sophisticated musical structures independently, and AI-based instruments can make music in any style and interact successfully with human musicians.

Unfortunately, many 20th-century music technologies are "disembodied": they have been developed based on the limitations of available technologies rather than the capabilities of human bodies. Many music technologies have an abundance of buttons and knobs encapsulated in square boxes with lots of cables (Jensenius & Voldsund, 2012); they have masculine designs and names (Jawad, 2020), and have not been particularly accessible (Frid, 2019). Fortunately, there has been an "embodied turn" also in music technology research over the last years (Lesaffre et al., 2017). Corintha and Cabral (2021) analyse how three digital musical instrument prototypes employ principles from 4E cognition. They highlight that developing one instrument that covers all dimensions is difficult. This aligns with my reasoning for not focusing on one particular instrument.

What I find most exciting is that many new interactive music systems continue to explore the blurring of roles in the musicking quadrant. Composers and performers build instruments themselves, instrument makers integrate

complete compositions in their designs, perceivers interact with pre-recorded musical elements, and analysts participate in performances. This also means that it is increasingly difficult to define an instrument or limit the capabilities of a media playback system. This is why I prefer to talk about *musicking technologies*, technologically based systems that allow for exploring music in various ways beyond traditional musical categories. They will not replace traditional music technologies but will complement them and, hopefully, allow for more active musicking in the future.

In sum, one of my ambitions is to develop new embodied musicking practices and related technologies, thereby opening more exploration between the different parts of the musicking quadrant. Traditionally, music performance has been considered the most embodied musical practice. Composition is often taught theoretically, using symbolic representations (musical scores). The analyst's role has also been theoretical, reducing musical experiences to words, numbers, or other symbolic representations. However, both composition and analysis rely on embodied knowledge, which can (and should) be emphasised in music education. The musicking quadrant can be a tool to help talk about different musical engagements and explore various types of musical—and bodily—engagement.

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