Making as Embodied Learning: Rethinking the Importance of Movement for Learning with Digital and Physical Tools

Michelle Schira Hagerman, PhD & Megan Cotnam-Kappel, PhD

Michelle Schira Hagerman is Assistant Professor in Educational Technologies at the Faculty of Education. Her research interests include teacher education, digital literacies and online reading comprehension. She is the Director of the Canadian Institute for Digital Literacies Learning. In her spare time, she is learning to make cold-press soap, to crochet, and to sew blinking LED lights into her clothes using conductive thread and the Lilypad Arduino.

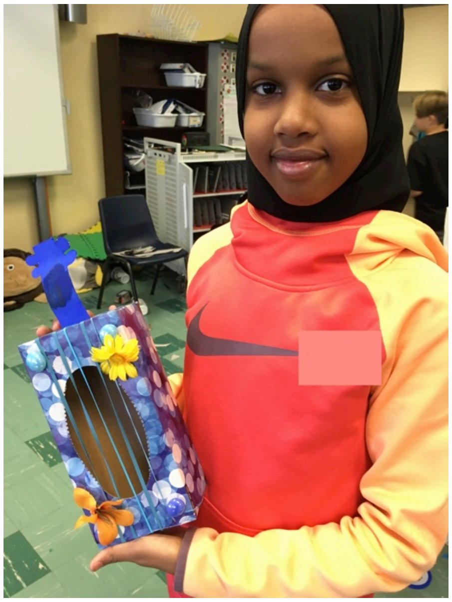
Megan Cotnam-Kappel is a Francophone Assistant Professor in Educational Technologies and a specialist in minority-language education. She is deeply committed to teaching and research that aim to close digital divides for minority groups across Canada. She is a founding partner of the Canadian Institute for Digital Literacies Learning, and led the Maker stream of the Institute in 2017.

Schira Hagerman and Cotnam-Kappel are currently collaborating on a longitudinal study exploring the possibilities of digital maker education for literacies learning with francophone and anglophone youth living in lower-income urban communities in Ontario.

Abstract

In this article, we rethink the inextricable links between learning and physical action. We position *making* with digital and physical tools as a pedagogical approach that aligns, theoretically, with embodiment.

Keywords: maker movement, making, embodied cognition, technology integration, literacies learning



"Je n'ai jamais cru que j'allais réaliser un instrument qui existe déjà. Alors, je suis contente de l'avoir dans les mains maintenant."

[I never believed that I would be able to succeed in making a real instrument. So, I am happy to hold it in my hands now.]

~Yasmine

Figure 1. Yasmine holding her ukulele.

Yasmine (not her real name) had never made a ukulele before. At first, as she told us that she did not believe she could do it. And yet, through a series of online explorations followed by sensory and physical activities — cutting, glueing, pulling, pressing, flipping, painting, watching, and listening — she figured it out. Yasmine did not start with a clear plan. Rather, her process was self-organizing. After watching some YouTube[LLC] videos and talking with her friends about what she might create, she chose a tissue box from a pile of recycled materials. Yasmine's process was slow and contemplative. She cut the box quietly and carefully. She walked around the room observing her friends' projects but said nothing. Back at the materials table again, she picked up some feathers, pompoms, and shiny stones. Turning them over in her hands she seemed to consider the aesthetic properties of these ornaments. Some of these she affixed to her box with the hot glue gun. Through our analysis of Yasmine's process of bricolage, it seemed that her explorations of these material resources (Wohlwend, Peppler, Keune & Thompson, 2017) and their affordances in relation to her emerging ideas allowed her to discover new principles of design through activity. In the ukulele, she made us see the physical and synthetic representation of Yasmine's understanding of sound; it is a physical assemblage of how she understands sound that can be performed through the strumming of fingers across elastic bands affixed tightly across a tissue-box sound hole (Wohlwend et al., 2017).

Yasmine and her classmates are participating in a four year longitudinal study that aims to understand how, if at all, maker projects – that invite the use of diverse tools and materials to create new things – might support literacies learning, critical and creative problem solving, collaboration skills, and their developing sense of agency. As we analysed students' gaze, captured with video-recording "spy glasses" worn as children worked (see Figure 2), we identified a range of socially-situated literacies practices. The students described their processes to one another and to their teacher; they asked questions and shared their insights; and they laughed with, challenged, and affirmed one another as they worked. Some students also disagreed with one another, or sought out affirmations; one boy showed off the double-guitar he crafted to his friends, stating how "cool" his work was with a deep sense of pride.

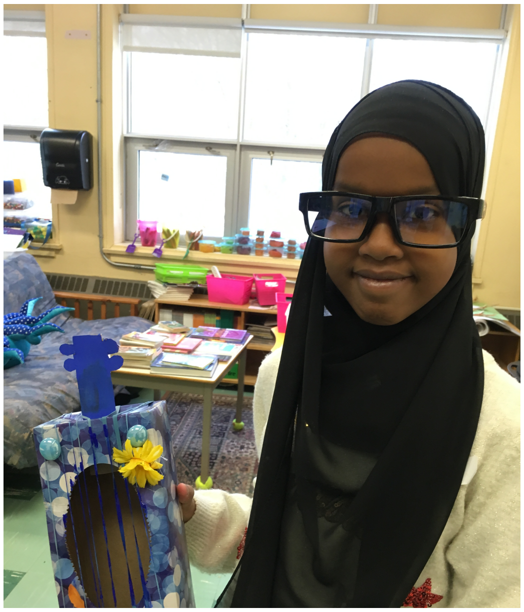


Figure 2. Yasmine wearing her Diggro “spy” glasses, which have a small camera in the bridge that records up to one hour of video and audio. Data are stored in three-minute snippets and downloadable via micro USB cable.

We were especially struck by the complexities of students’ movements, actions, and their talk about their physical processes. Their movements seemed integral not just to the physical creation of their projects (which we expected to see) but also to their planning, to their information seeking, and to their multimodal process of composition using Chromebooks™ and Google slides. At any given moment as the musical instrument project played out, students were moving around their classroom, watching one another, touching materials – their own and those of their classmates – manipulating tools, cutting, glueing, holding, pressing, flipping, pushing, pulling, tying and navigating. As they planned and wrote up multimodal representations of their maker processes, they used the touchpad of their Chromebooks™ to crop images, to copy, to insert and to resize. All of this active work was accompanied by explicit wonderings, by descriptions of their actions, by peer-to-peer and teacher guidance, and verbal expressions of emotion: frustration, confusion, surprise and joy.

The observed physicality of the learning was not our initial focus, but it grew impossible to ignore. We began to wonder deeply about the foundational, embodied mechanisms for learning that students use during Maker projects. As teachers ourselves, these observations disrupted long-held assumptions. We had never considered that students’ movements were as important as their abstract understandings of key literacies concepts, nor that students’ thinking and learning *could not happen* without these movements.

In what follows, we present a brief overview of embodiment as a learning theory and articulate connections from the tenets of the theory to Making as a pedagogical approach. We conclude with recommendations for embodied instructional design informed by our research and the work of other scholars.

Embodied Cognition

Arthur Glenberg (2010) writes that "a basic claim of the embodiment framework is that all psychological processes are influenced by body morphology, sensory systems, motor systems and emotions." (p. 586). Theories of embodiment suggest that thinking is shaped by information that our bodies gather about the world. Barsalou calls the body and the environment "external informational structures that complement internal representations" (2010, p. 717). According to his theory of grounded cognition, our brains constantly leverage the environment as a scaffold for thinking through our senses. Cognition doesn't happen once information comes into our brains. Rather, cognition happens as we interact with the world. Understanding is generated in activity. Consider laptop computers and word processing applications. Using a traditional cognitivist perspective, we might say that these technologies are receptacles for our ideas. From an embodied perspective, however, the computer is an external informational structure that allows us to see, hold, and move words in ways that would not otherwise be possible for our brains. In turn, what we assemble externally feeds back into our internal representation of our own ideas and (re)shapes what we understand. In this way, our thinking *is located in* our physical and sensory interactions with the keyboard, screen and touchpad. From this perspective, Yasmine's new understandings of sounds and music are located in her making, and in the ukulele itself.

You might read this and say: of course our minds and bodies are inextricably dependent on one another. How could this *not* be the case? Historically, learning scientists have been concerned with higher order cognitive processes such as language, critical thinking, and metacognition, all of which presumably happen in the mind. Proposing that the body is the foundation for higher order thought, that sensory perception is inextricable from abstract cognitive processes, and that humans use the environment to scaffold cognition are relatively new ideas for both psychology and education.

The evidence for embodiment, however, comes from diverse research methods and traditions. Neuroimaging studies, for example, have found that when we imagine, we activate the same parts of the brain used when we are actually processing visual information with our eyes (Kosslyn, 2005). Several studies have shown that when students move their bodies to enact a concept or process using physical, virtual or augmented reality models, they learn more than comparison groups who only listen to the same content, watch the process or engage fewer sensory channels as they interact with complex scientific principles (e.g., DeLiema et al., 2016; Stull, Gainer & Hagerty, 2018;). Over decades, George Lakoff and his colleagues have demonstrated that metaphorical language is grounded in foundational sensory experiences with the physical world. For instance, if someone was *wearing blinders*, or has *had the wool pulled over their eyes,* they literally could not see the world. Metaphorically though, these expressions refer to someone whose understanding (vision) is limited by strict adherence to a particular ideology and whose understanding (vision) has been compromised through trickery. Interestingly, we see evidence of embodiment in Yasmine's own words too, when she described her completion of her ukelele. She said, "Je suis contente de l'avoir dans les mains" [I am happy to have it in my hands]. An apt choice of words given that she created the ukelele with her hands. In this way, we see that process and product may be inextricable.

Making as embodied learning

Cognition, it seems, is built partly on grounded sensory and physical interactions with the environment. As teachers we need to know that the development of abstract thinking skills such as language, (inter)disciplinary problem-solving, mathematics, and values such as equity and social justice, are rooted in students' interactions with their physical world. Making and Maker-oriented projects ask students to manipulate materials and to use both digital and physical tools and applications in new ways, for new purposes, and to make things that they have never made before. More than the latest trend in technology integration for classrooms, Making may actually be a teaching method ideally aligned with the ways that human systems of cognition are built. Indeed, as Abrahmson and Lindgren (2015) write, "a child balancing on a seesaw is developing more than physical coordination -- she is building an embodied sense of equivalence that one day will inform her moral reasoning about social justice" (p. 371). For Yasmine and her classmates the processes of Making and tinkering with physical and digital tools in their classroom may equip them with new sensory motor skills. These skills lay the foundation for embodied understanding of themselves as agents in the world who can create new things, new systems, new policies, and new opportunities for themselves and others.

How can teachers design maker activities to support abstract thinking?

In terms of activities, materials, and instructional techniques that teachers can use, Abrahmson and Lindgren offer evidence-based recommendations (2015). They suggest that teachers should design activities that draw on students' capacity to move and act on the world, to use their senses and bodies to explore the properties of diverse materials, and to perform new actions for a range of increasingly challenging purposes with a range of technologies. Ultimately, instructional goals should help students to gradually develop new perceptuomotor schemas that allow them to use tools in increasingly sophisticated and novel ways, and to develop functional metaphors, as in the see-saw example, for higher-order concepts. Certainly, in-the-moment feedback in response to students' questions, co-production, and hands-on coaching will move students toward deeper expertise. In one study by Danish, Enyedy, Saleh, Lee and Andrade (2013), second graders explored the properties of matter through collaborative role play and interactions with augmented reality representations of particles. The students consistently noticed fundamental relationships between particle movement and temperature, but needed teacher supports, such as guided questions, to be able to articulate what they noticed. In their study, the embodied activity enabled children to experience core scientific principles; teachers, though, supported the children's meaning making through dialogue and reflection.

Wohlwend et al., (2017) suggest that teachers might also become enmeshed in the "assemblage of meaning", and in the playful, emergent meaning making that happens through spontaneous co-production in a Makerspace (p. 458). In this way, the structures of power are distributed, and the embodied, self-organizing, and emergent assemblage of meaning can unfold according to the learners' needs (Wohlwend et al., 2017).

A maker-oriented classroom looks like a hive of activity, with every student moving in different ways as their understandings and purposes evolve. For some teachers, this might feel chaotic. As Yasmine's teacher, Mme S., told us, the level of activity in her Maker-oriented classroom felt overwhelming at first, but the discomfort she felt – as she learned to embrace her students' unpredictable, active, and emergent learning processes – was also valuable. By relinquishing her need to control the activity and noise level, and by positioning herself as a co-questioner and co-learner with her students, she saw them gain confidence and become more autonomous in their ability to find solutions to their own learning challenges. Certainly, there is risk involved in a shift toward a more intentionally active and embodied approach to learning in schools. Mme S. acknowledged the importance of leadership support, and of colleagues with whom to co-plan, share and assemble emergent understandings of themselves as Maker-oriented teachers.

As teachers ourselves we confess that we have judged some student movement as “off task” in the past. If all psychological processes are influenced by body movements, by sensory, motor and emotional systems, then behaviours that look like frivolous inattention may actually be the foundations for new ideas and understandings. Theories of embodiment help us to see that when movement is constrained or discouraged in our classrooms, so too is student learning.

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