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Meaningful Making

Establishing a Makerspace in Your School or Classroom

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Makerspaces are creative spaces where people gather to tinker, create, invent, and learn. What do educators need to understand about maker pedagogies, and how can maker pedagogies support student learning across subject areas?

Mindset is key …

Maker pedagogies promote important principles including inquiry, play, imagination, innovation, critical thinking, problem solving, collaboration, and personalized learning.

- To see a maker mindset in action, visit http://thelearningexchange.ca/videos/maker-space-mindset/
- To learn more about a research project on makerspaces across Ontario, involving over 50 educators, administrators and tech facilitators, visit http://janettehughes.ca/lab/

Community *makerspaces* are becoming a widespread phenomenon. Makerspaces are creative spaces where people gather to tinker, create, invent, and learn. The maker movement was borne out of the increasing number of people who creatively engage in both physical (or tangible) and digital fabrication to solve an existing problem or need and to share their design and making with a community of like-minded innovators.[1] The increasing popularity of the maker movement and makerspaces is not surprising to MAKE magazine founder Dale Dougherty; as Dougherty argues in his **2011 TED Talk**, we are all makers.

Do-it-yourself (DIY) paradigms have recently re-emerged as a medium for creative expression[2] and self-directed learning.[3,4] As they gain popularity, these DIY models, rooted in design thinking and innovation, are beginning to move into the realm of formal education. In educational realms, the maker movement is associated primarily with science, technology, engineering, and math (STEM) or with STEAM (which adds a focus on embedding the Arts into STEM). More generally, maker pedagogies promote important principles including inquiry, play, imagination, innovation, critical thinking, problem solving, collaboration, and personalized learning.[5,6] Maker pedagogies build on project- and problem-based learning, design thinking, and remixing practices, all of which are often highlighted in media-literacy

programs. A current need in this area is to define best practices and to better understand how to utilize making for the purpose of learning.[1,7]

The maker movement has led to increased creation of new, in-school makerspaces for practising hands-on learning, encouraging girls to participate in STEM activities, and emphasizing the idea that every child can become an innovator.[1] Situated within a constructionist approach to education,[8] making connects the physical processes of constructing something with digital media. Making with digital media is not new in education; teachers have been working with their students to create digital stories and other digital texts for many years. The recent advent of user-friendly digital tools augments this digital fabrication, making it easier for students to create multimodal, multimedia content. Importantly, this positions students as producers rather than just consumers.[9]

Constructionist learning encourages students to learn from their own active engagement with raw materials. Papert, an early proponent of constructionism, proposed a "low-floor, high-ceiling" learning environment, in which students engage in digital coding in a form that depends little on prerequisite knowledge yet offers opportunities to explore and to build concepts and relationships well beyond students' formal grade levels.[8] Creating interactive stories, simulations, games, and both physical and wearable technologies entails using digital tools to integrate, critically analyze, synthesize, create, communicate, and collaborate.

Meaningful Making

Critical making goes beyond simply creating objects for the sake of creating objects (e.g., creating 3-D keychains); it concerns itself with technologies and their relationship to social life, with an emphasis on their emancipatory potential to bring about change and improvement. Thus, it connects two practices that are often considered separate: critical thinking and creative expression.[10] Critical making assumes that learning is most effective when students are active in making tangible objects in the world and are able to draw their own conclusions through experimentation across multiple media, constructing new relationships with knowledge in the process.[10] To avoid the dangers of trivialization of making "stuff" that will end up in landfill sites, educators should avoid the kind of quick demonstration projects typically associated with makerspaces, and move toward learning that is more meaningful and contextualized.[11] To facilitate this kind of contextualized learning, makerspace pedagogies can be used in close connection to the Ontario Ministry of Education curriculum documents. For example, during a novel study, students can design and print a 3-D model of the book's setting.

Promoting a Maker Culture

What distinguishes a makerspace from a place where people make stuff is the inherent culture. A makerspace is much more than the equipment that is housed there. A makerspace should be committed to a culture of innovation and should provide the skills and foundation that students need to succeed in this kind of learning environment.[12] A maker culture promotes risk-taking, learning from mistakes, problem-solving, and developing an ability to persevere when tasks are difficult. It also fosters higher-order thinking skills and opportunities to share learning at local and global community levels through Maker Faires and websites such as **www.instructables.com**, **www.thingiverse.com**, and **www.DIY.org**.

Considerations for Establishing a Makerspace

Purpose: Makerspaces promote collaboration and community engagement through sharing. Every makerspace is unique and should be based on the needs and interests of the community of makers. Take time to find out what students want to do in the makerspace and tailor the space accordingly. For example, consider whether the focus will be on STEM or STEAM education or otherwise.

Space: Decisions about what to include in your makerspace will also depend on what space is available in the school and who will be using the space. It should be accessible to all students but may only accommodate a small number at a time. Most schools are setting up makerspaces in school resource centres/libraries, but with more schools moving to a BYOD model, the former computer lab may also be a space that can be converted.

Budget: The financial commitment required to establish and maintain a makerspace is significant, but there are ways to stretch the budget to provide more making activities. Recycling and upcycling can empower students to make in eco-conscious ways. Although many costly makerspace classroom kits are available for purchase, there are also generic or low-cost alternatives that can reduce costs; for example, common items such as LED lights and batteries can be purchased in bulk or at the dollar store. See **http://janettehughes.ca/lab/** for other suggestions.

Tools and Materials: The purpose of your makerspace will help determine which tools, supplies, and materials you will need to purchase. For example, are both a 3-D printer and laser cutter necessary, or will just one of these tools be enough to get started? Will there be media equipment, such as a green screen and video recorder? If the students are going to create games and coding, MaKey MaKey innovation kits will enable them to build game controllers. If young students are going to practise circuit work, they can begin with paper-based circuits and move to more sophisticated tools, such as Raspberry Pi microcontrollers, as they become more advanced.

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Making in the Classroom

For educators who do not have access to a fully-equipped makerspace in the school or local community, a centre or station approach in the classroom can be an effective way to begin integrating maker pedagogies without investing a lot of money. In setting up the centre, it may be helpful to keep in mind that maker pedagogies embody the principles of Universal Design for Learning, because they enable the use of multiple means of representation, expression, and engagement. Further, although makerspaces are typically associated with STEM subjects, they can be integrated with other subjects as well. Below, I offer three examples (based on current research) of centres that may be set up to enhance the literacy program through an integrated approach.

Electronic Textiles Centre: Wearables or e-textiles are clothing and accessories that include lights, sensors, motors, and micro-computers and are becoming more popular in athletics, fashion, and the health sector. Students engaged in any literature study can experiment with e-textiles by creating simple designs for bracelets, T-shirts, hats, puppets, bookmarks, or garments to represent characters in a novel. See **http://sewelectric.org/diy-projects/** for some simple ideas to get started.

Coding/Gaming Centre: Scratch is a free programming language that allows even the youngest students to create and share interactive stories and games. Students can design stories from "scratch" or they can use existing projects and integrate them with what they are reading in class to create something new. Examples of interactive stories can be found at **https://scratch.mit.edu/studios/1978609/**.

3-D Printing Centre: Digital fabrication has advanced rapidly in just a few short years, and students do not need to print their final products to engage with the fabrication process. Tinkercad is an easy-to-use design

program that allows students to design anything they can imagine. The website offers online tutorials and a gallery of existing designs that can be adapted. A large repository of designs can also be accessed at **www.thingiverse.com**. Students can design sets, props, or symbols based on any piece of literature. Imagine your students designing a modern Globe Theatre when you introduce Shakespeare!

In Sum

It can be a challenge to find a suitable and dedicated space to house a school makerspace and to properly outfit that space with the most current tools and technologies. The benefits of a makerspace, however, are certainly worth the effort and cost, especially when issues of sustainability are foregrounded so that students can participate in recycling and upcycling programs. A designated place – whether it be a room in the school learning commons or library, or a centre or station in the classroom that changes its focus regularly – allows students to benefit from playing, tinkering, discovering, designing, and even failing.

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