Inclusive Makingspaces

Why 'Making' and not 'Maker'

The term makerspace is well known outside of academia. The name evokes images of workshops full of various kinds of tech and tools. These spaces are typically frequented by people who appear to be defined as makers by virtue of their presence in the space. For many, a typical vision of the maker is based on the image created by Dougherty's *Maker* magazine, which is famously credited with birthing the maker movement. Recently, some of the shine has rubbed away from the traditional makerspace, and the ethos shaped by Dougherty is now widely recognized as male dominated and fundamentally normative, much in the same way that typical science and math curricula are now being recognized in schools (Taylor, 2016, Carlone et al, 2014, Li & Schoenfeld, 2019). A key characteristic of makerspaces is that they form a closed community of makers which can exclude those who do not see themselves in this image.

Bringing makerspaces into K-12 education environments is therefore fraught with challenges. School populations are seldom homogeneous. Students have wildly different levels of creativity, confidence in their skills, and commitment to making. Some may be persons with disabilities who are not able to fully participate with all of the usual affordances in a typical space. In addition, curriculum setting bodies are becoming more and more aware of the need for equitable, culturally responsive, inclusive approaches to education, which are simply not ideals that are reflected in the makerspace (Ontario Ministry of Education, 2022). Teachers are another important consideration in makerspaces, as they are unlikely to see themselves as makers, and therefore may not be comfortable in such a space. The need for specialized staff to facilitate participation in the makerspace can be an insurmountable barrier for resource starved schools. Two additional factors can create significant barriers: curriculum requirements tend to mean that

teachers often feel obligated to constrain students' choices, and a perceived deficit in equipment can limit what can validly be defined as a makerspace.

Shifting the Narrative

The current concept of the makerspace is a significant divergence from its origins, which lie firmly in the ambit of Seymour Papert's vision of constructionism (Harel & Papert, 1991). Papert, inspired by Piaget's constructivist theories, built a complex (and suitably loosely designed) theory that might be described in one way (amongst many options) as centered on the premise of objects to think with (Harel & Papert, 1991). What is often overlooked about this aspect of Papert's vision, however, is his firm commitment to the idea that such objects must be deeply meaningful to students, and that it is the act of making the object, not the object itself which is of primary importance (Harel & Papert, 1991). Constructionism is about making; and making is a process. Making is not about the product.

Words have meaning and weight. Reviving Papert's foundational work and changing the terminology from maker to making can help to foster change in the ethos of the space. By placing the focus on the process students can be situated front and centre, regardless of their perceived identity as makers. Making can also be much more representative for students. They can see themselves in the materials they are using, the choices they make during the making process, and the models they use for inspiration. Properly implemented, a makingspace can be an exemplar of Culturally Relevant Pedagogy.

Making is not constrained by the presence of physical affordances; it is simply defined by the act of making. A ***makers***pace is most often identified by its tech and tools, and also by the perceived identity and expertise of the individuals who frequent them. A ***making***space can be as

simple as a craft corner or cart in a classroom, or perhaps even a box of materials stored under a teacher's desk. There is no minimum amount of equipment that constitutes a makingspace, and of course there is no maximum. Having 3d printers and a laser cutter in a space can augment, but should never determine, how a space is used for making. The real care in resource selection should be in making those selections culturally representative and suitable for all persons of all abilities using the space. Whereas a makerspace is populated by makers, a makingspace embraces anyone in the act of designing and creating any object, no matter how simple or complex.

Teachers in the Makingspace

Teachers are professionals whose identity is often predicated on being the expert in the room. Placing teachers in makerspaces can burden them with a perceived added requirement to develop a skill set for which they may feel ill prepared. The result is that teachers may tend to steer students towards the tools with which they feel most confident and may also result in them limiting the kinds of projects their students select. In a makingspace, a teacher is encouraged to be a creator alongside their students. They can and should be part of the process of creating and learning, an important part of which is learning about the tools and affordances of the space. Giving students increased agency in what they learn and how they learn it is an important part of giving students a voice in their learning process.

A key feature of making is that it is not mimicking. Teachers in makingspaces cannot require that their students simply copy a provided model. Teachers may provide an exemplar to students who need additional scaffolding, but exemplars should act only as seeds for developing ideas. This loss of prescriptive control can be a challenge for some teachers, but the making mindset can help to alleviate that discomfort.

UCC - Constructing an Inclusive Makingspace

UCC is a resource rich institution. We have two technology equipped spaces that largely conform to the traditional model of a space outside of an academic institution. We are currently in the process of assessing these spaces with an eye to ensuring that we have truly inclusive makingspaces that are welcome not only to all of the members of our own student body, but also the members of the community at large.

As part of our International Baccalaureate (IB) MYP program, all UCC students take a Design stream course in Grades 6 through 10. Digital media students work primarily in a dedicated film space, but coding and product students are primarily situated in the Design Labs, which is the nomenclature currently used for our makingspaces. All students are encouraged to visit the main lab space outside of their scheduled classes. They are invited to work on projects of personal interest, whether or not they are related to coursework or connected to school in any way. Recent projects have included a student who design and built a model of a lightsaber for personal interest, a student developing a robotic arm for an outside program, and a student designing and building a modular system for modelling playing spaces in Dungeons & Dragons for his own use this summer and that of a club at school for next year. Increasingly, students in Grade 10 are connecting their Personal Projects (an MYP requirement) to the Design lab. We also encourage various school clubs to situate themselves in the space. The Robotics team, coding club and electronics club might seem like obvious users, but the space is also the site where the Rubik's Cube club and Creative Council meet.

One of the key features that all users of the space can rely on is the consistent presence of support in the space. The foundation of this support is a full-time lab facilitator who is a talented and dedicated expert in making. She provides expertise in all of the affordances of the lab, as

well as creative support and teaching expertise as needed. It is also important that she provides a gendered presence as an expert in our all male environment. Given the usual associations of makerspaces, her expertise carries even greater weight. The lab space, under her supervision, is open every day after school and during student free time for student use. In addition, the facilitator shares her expertise, both within the Design department and throughout the entire school. Our science lab technicians have recently been under her tutelage with an eye to encouraging additional options for science students to incorporate making into their scientific experiments and investigations.

Our facilitator is also an integral part of intentionally working towards a more inclusive space. She is an expert on inclusive design, and provides a level of in-house expertise that helps to direct our efforts. Under her guidance, the space is being reconsidered for affordances such as the height of working surfaces and reachability of hand tools and supplies. A recent initiative included moving the stock of these hand tools and basic supplies to easily accessible wall displays to increase their visibility and increase student awareness of their existence in the space.

Future Steps

In Lab Affordances

(This is meant to be a beginning framework. Ultimately, the affordances in our space should be ever changing based on the wants and needs of our users. This can be accomplished only by listening to the voices of those users.)

Software Scaffolding	Although training and assistance are available, some students can be intimidated by or hesitant to try advanced software. We have a standard suite of software that ranges from TinkerCad to Fusion 360. We are working to provide additional tutorial materials on the entire range of software, and to ensure that students understand that there are entrance points to software aided design that do not require advanced expertise.
Fabrics	Our spaces have sewing machines, but only limited fabrics are currently standard, typically including canvas and leather. Adding a wider variety of fabrics might facilitate making that is not necessarily considered stereotypical for male students, and will provide a greater set of options for all genders in the community at large.
Craft Supplies	One of the downsides of a highly equipped lab on the technology front is that it is easy to lose sight of the importance of basic supplies. Although we have limited quantities of markers and some minimal craft items such as craft sticks modelling clay, these items are not typically kept well stocked. Increasing the range of craft supplies and ensuring their consistent availability may allow students who do not feel comfortable with more advanced technology to find an entry point to making in the space. New additions will include (but not be limited to) acrylic paints and paint brushes, various cardstock options, various types of modelling materials and tools
Traditional Artisan Tools	Leatherworking is already a part of the space, and certainly fits with the stereotypical male dominance of the community. In our outdoor schools, students are introduced to carving as a craft, but we have no continuity with this in the design lab. We might also be doing a disservice to our students by not having knitting and crochet needles, embroidery hoops and threads, and even quilting supplies available.

LEGO™	Although the lab is well stocked with Lego, it has not yet become a common material for prototyping and design. This is likely at least in part because of the challenges of Lego from a clean up and maintenance point of view. It will require a pedagogical shift to find ways to better incorporate Lego.
Braille LEGO™	We are currently in the process of preparing to implement this specialty item into the space. This requires training on the part of our department members. Although we do not currently have any students in the school who have need of this material, as we open up to the community this may well become an important addition to the space.
Simple Robot building systems	We currently support building robots using the VEX and Arduino platforms. Both of these require a considerable amount of manual dexterity. Adding platforms that do not require tools to assemble and also lack complex wiring requirements can increase accessibility to students with limited dexterity. Candidates include Mbots, MicroBits, and Edison.

Broader School Initiatives

Part of the school mission focuses on student, staff and faculty wellness. We believe that it is possible to reposition the Design Lab within the school as a space where wellness is recognized as a benefit of participation. We want to deliberately acknowledge the role of creativity in wellness, and remind the student population of the role of the Design Lab as a space where creativity can be nurtured. We also want to encourage students to feel that the community is supporting all levels of making. By finding a welcoming community students can define their own parameters of inclusivity for participation.

We have some concrete steps we hope to implement to begin to move towards these goals.

1. Intentionally carving out school day time for non-course making. We propose Making Mondays. This is challenging given the almost constant academic programming in the existing spaces. However, our school schedule includes a flextime 45 minute period most afternoons. The space often hosts clubs and other organized events, but we will reserve the space on Mondays for a variety of design focussed activities - while still allowing individual students to work on projects if they choose. To increase the community participation, we will try to attract various activity leaders (staff, faculty, students) with a broad range of areas of expertise. An initial brainstorming session has led to ideas such as baking, paper crafts (who wouldn't love a paper airplane day!), food chemistry, clock making, and simple catapult building in addition to the usual range of tech options.

2. This summer we will begin to build an ‘idea’ board that provides project seeds that are intentionally tied to curriculum, to have in place for September.

3. We hope to add a purposeful reconstruction zone. We will be purchasing simple mechanical and electronic items for students to disassemble and repurpose as desired. This seeks to include students who may want to ‘tinker’ but do not have a project idea of their own.

4. We are in the early stages of reaching out to local higher education partners to bring in an even wider diversity of role models. By offering post-secondary students resources and the opportunity to make within our space we hope they will inspire more of our students to interact with them and learn from them as they focus on their own projects while sharing with our students. Ideally the learning will go both ways.

5. We are in the process of initiating a long-term project under the umbrella of our Principal’s Innovation Fund. This proposal includes enhancing UDL practices within the school by intentionally including making options for fulfilling MYP assignment in every academic discipline. If the project is approved, a pilot project in Science will begin in September.

6. A longer term dream is to create an entirely unprogrammed making space that is truly available to all students at any time of day. Libraries are often the home of such a space and we have both the facility and the physical space to implement this. Many other stakeholders must become involved, however, to put this into practice.

References

Carlone, H., Johnson, A., Eisenhart, M. Cultural Perspectives in Science Education. (2014). In N.G. Lederman & S.K. Abell (Eds.), *Handbook of Research on Science Education*, Volume II (pp. 665–684). Routledge. https://doi.org/10.4324/9780203097267-43

Harel, I., & Papert, S. (1991). *Constructionism : research reports and essays, 1985-1990.* Ablex Pub. Corp.

Li, Y., & Schoenfeld, A. H. (2019). Problematizing teaching and learning mathematics as "given" in STEM education. *International Journal of STEM Education*, *6*(1), 1–13. https://doi.org/10.1186/s40594-019-0197-9

Ontario Ministry of Education (2022). Science: Grade 9, De-Streamed (SNC1W).

Taylor, B. (2016). Evaluating the Benefit of the Maker Movement in K-12 STEM Education. *Electronic International Journal of Education, Arts and Science, 2*(Special Issue), 1–22.