Educational Learning Outcomes in the Makerspace

Dalton Hargreaves

Summer 2022

Makerspace Background

The fundamental principle of a makerspace can be completely summarized as “learning by doing.” This principle is seen in almost all makerspaces across the world, with varying levels of implementation, integration, and permissiveness the users have within the space (i.e., rules, safety procedures, background training/instruction, etc.,). Learning by doing is arguably a fundamental principle in all facets of learning, especially in early childhood and adolescence. Traditional education centralizes on a model of “banking,” where a master of knowledge attempts to ‘deposit’ knowledge to all students equally within a specific timeframe. Formal assessment is used to measure the retention of students’ of what was deposited. This model is disputed by several educational philosophers, including Paolo Friere and Bertrand Russel. Both similarly conclude that the role of the educator is to draw out knowledge from the students and their interpretation of the world, while simultaneously instilling a thirst for learning within the learner.

The objective of the makerspace is to simply apply these principles in practice. Makerspaces provide a safe space that users can use to experiment and discover new technologies and projects without any prior background knowledge being necessary. The space is designed to encourage perseverance in the face of failure, instilling a mindset of growth and tenacity. The role of the makerspace can be best summarized by Bertrand Russel: “Education is not to be viewed as something like filling a vessel with water but, rather, assisting a flower to grow in its own way.” Learning by doing allows users to grow and learn in their own means and capacity, with support being available when requested or required.

BC Curriculum (K-12)

Big Ideas:

- “The big ideas consist of generalizations and principles and the key concepts important in an area of learning. They reflect the "understand" component of the know-do-understand model of learning.”
- “The big ideas represent what students will understand at the completion of the curriculum for their grade. They are intended to endure beyond a single grade and contribute to future understanding.”

https://curriculum.gov.bc.ca/curriculum/overview#curriculum-model

Core Competencies:

- Broken up into Three categories with various sub-categories:
    - Communication
        - Communicating
        - collaborating
    - Thinking
        - Creative Thinking
        - Critical and reflective thinking
    - Personal and Social (awareness/responsibility)
        - Personal Awareness and Responsibility
        - Positive Personal and Cultural Identity
        - Social Awareness and Responsibility

- Students develop Core Competencies when they are engaged in the "doing" – the Curricular Competencies – within a learning area. As such, they are an integral part of the curriculum. While they manifest themselves uniquely in each area of learning, the Core Competencies are often interconnected and are foundational to all learning.
- Before students enter school, development of Core Competencies begins at home and then continues throughout their life. Students encounter opportunities to develop their competence in formal and informal settings. They move from demonstrating competence in relatively simple and highly supported situations, to demonstrating independence in more complex and varied contexts. Competency development does not end with school graduation but continues in personal, social, educational, and workplace contexts.

https://curriculum.gov.bc.ca/competencies#unpacking

Summary:

The BC Kindergarten to Grade 12 provides a basic framework to examining learning outcomes within a makerspace. The principle of the BC K-12 curriculum is centralized on a "know-do-understand" model. This model, while designed for classroom education, provides an excellent model of thought for makerspaces. Users can come in with whatever they know about a subject, technology, or project. By doing so, they become familiar with how to use the technology within their means and learn more about the purpose of the technology, as well as why this technology is beneficial to our world. Through this 'doing' they meet the concept of understanding. The BC K-12 model is intentionally subjective in using the "know-do-understand" model, allowing students/users to progress at their own rate, comfort, and ability.

University of Texas at Arlington

- Competencies / Outline & Competencies (PDF)

    1. Identify the need to invent, design, fabricate, build, repurpose, repair, or create a new derivative of some “thing” in order to express an idea or emotion, to solve a problem, and/or teach a concept
    2. Analyze the idea, question, and/or problem
    3. Explore the idea, question, and/or problem and potential solutions
    4. Operate safely
    5. Assess the availability and appropriateness of tools and materials
    6. Produce prototypes
    7. Utilize iterative design principles
    8. Develop a project plan
    9. Assemble effective teams
    10. Collaborate effectively with team members and stakeholders
    11. Employ effective knowledge management practices
    12. Apply knowledge gained into other disciplines, workforce, and community
    13. Be mindful of the spectrum of cultural, economic, environmental, and social issues surrounding making
    14. Understand many of the legal issues surrounding making
    15. Pursue entrepreneurial opportunities

These 15 competencies are the main takeaway ideas/points of learning that the UTA makerspace wishes its users to ‘walk away with’ upon using their space. These skills are fundamentally all skills that can later be drawn into professional careers, workplaces, personal development, professional development, etc.

- Course Connections

The UTA makerspace has been able to successfully cooperate and integrate its competencies and use of its makerspace into some courses offered at the university itself.

Connect to bc curriculum - blog post (see end of document)

Metis Holistic Lifelong Learning Model

https://firstnationspedagogy.com/CCL_Learning_Model_MET.pdf

“The Métis Holistic Lifelong Learning Model represents the link between Métis lifelong learning and community well-being, and can be used as a framework for measuring success in lifelong learning.”

“The Métis understand learning in the context of the “Sacred Act of Living a Good Life,” a perspective that incorporates learning experienced in the physical world and acquired by “doing,” and a distinct form of knowledge—sacred laws governing relationships within the community and the world at large—that comes from the Creator. To symbolize these forms of knowledge and their dynamic processes, the Métis Holistic Lifelong Learning Model uses a stylistic graphic of a living tree.”

“The Métis learner, like the tree, is a complex, living entity that needs certain conditions for optimum growth. As conditions change throughout the natural cycle, so will the regenerative capacity of the tree. The health of the tree, or the Métis learner, impacts the future health of the root system and the “forest” of learners. Métis people view lifelong learning as part of a regenerative, living system—the “Natural Order” that governs the passage of seasons and encompasses a community (or forest) of learners. Within this organic system, relationships are interconnected, and balance and harmony are maintained.”

Academic Tenacity

https://ed.stanford.edu/sites/default/files/manual/dweck-walton-cohen-2014.pdf

Academic tenacity is a concept that focuses on building a growth mindset. A growth mindset is one that is best summarized through conscious decision making that focuses on positive mental thinking when facing adversity, such as perseverance in the face of failure, willingness to try new things, and desire to grow through learning.

The key to this is using planning methods and creating short term and long term goals for success, as well as managing expectations to ensure that short-term goals are not too challenging for new users to keep returning and building new skills, while building to a long-term goal of for example a complex project.

How Can We Assess Learning Outcomes?

From research, assessment in a makerspace, at least from traditional standards of educational goals, such as summative assessment formats of tests, reports, or papers. Formative assessment methods seem more valid for a makerspace, as formative assessments follow a more informal action of assessment of students' learning outcomes, such as pop-quizzes, creative projects, short written responses, etc.
https://www.aeseducation.com/blog/formative-vs.-summative-assessments-what-do-they-mean
A major challenge to assessing a makerspace, is it is difficult to provide a number or grade to students' learning or skill-development, and is arguably impossible with the vision of the makerspace to be a truly neutral place of student-driven learning and growth.

One form of beneficial assessment for makerspaces is creating a system of growth through a gamified system of badge/trophy/point-collecting. This system allows students/users to choose the activities, projects, or skills they wish to learn, while also permitting other skills to be built, such as cooperation, design, project-based skills, etc. (badge assessment). Checklists/basic transcripts of skills could also be used, as it is also a simple system to keep track of which skills students have learned, especially for frequent users.
https://www.edutopia.org/article/assessing-learning-maker-education

Blog Post:

The Makerspace

The fundamental principle of a makerspace can be completely summarized as "learning by doing." This principle is seen in almost all makerspaces across the world, with varying levels of implementation, integration, and permissiveness the users have within the space (i.e., rules, safety procedures, background training/instruction, etc.,). Learning by doing is arguably a fundamental principle in all facets of learning, especially in early childhood and adolescence. Traditional education centralizes on a model of "banking," where a master of knowledge attempts to 'deposit' knowledge to all students equally within a specific timeframe. (Freire, 2000) Formal assessment is used to measure the retention of students' of what was deposited. This model is disputed by several educational philosophers, including Paolo Friere and Bertrand Russel. Both similarly conclude that the role of the educator is to draw out knowledge from the students and their interpretation of the world, while simultaneously instilling a thirst for learning within the learner.

The objective of the makerspace is to simply apply these principles in practice. Makerspaces provide a safe space that users can use to experiment and discover new technologies and projects without any prior background knowledge being necessary. The space is designed to encourage perseverance in the face of failure, instilling a mindset of growth and tenacity. The role of the makerspace can be best summarized by Bertrand Russel: "Education is not to be viewed as something like filling a vessel with water but, rather, assisting a flower to grow in its own way." (Chomsky, 2004, p. 38) Learning by doing allows users to grow and learn in their own means and capacity, with support being available when requested or required.

The British Columbia Kindergarten to Grade 12 Curriculum

The British Columbia school curriculum has evolved in recent years to accommodate a larger philosophy of student-lead learning. The BC Kindergarten to Grade 12 Curriculum model provides a basic framework to examining learning outcomes within a makerspace. The principle of the BC K-12 curriculum is centralized on a "know-do-understand" model. This model, while designed for classroom education, provides an excellent model of thought for makerspaces. Users can come in with whatever they know about a subject, technology, or project. By doing so, they become familiar with how to use the technology within their means and learn more about the purpose of the technology, as well as why this technology is beneficial to our world. Through this 'doing' they meet the concept of understanding. The BC K-12 model is intentionally subjective in using the "know-do-understand" model, allowing students/users to progress at their own rate, comfort, and ability. (*Core Competencies | Building Student Success - B.C. Curriculum*)

University of Texas at Arlington

Within the Makerspace community, one of the leading designs and implementations of Makerspaces has been the University of Texas at Arlington (UTA) libraries' makerspace; the *UT Arlington FabLab.* The UT Arlington Fablab focuses on promoting its 'Maker Competencies.' Some of these competencies include:

> "Identify the need to invent, design, fabricate, build, repurpose, repair, or create a new derivative of some "thing" in order to express an idea or emotion, to solve a problem, and/or teach a concept," "Explore the idea, question, and/or problem and

> potential solutions," "Collaborate effectively with team members and stakeholders," and "Be mindful of the spectrum of cultural, economic, environmental, and social issues surrounding making." (*Maker Competencies | Maker Literacies*)

These competencies arguably share many similarities to the BC K-12 Core Competencies, which focus on Communication, Thinking, and Personal and Personal & Social awareness/responsibility. The BC Curriculum outlines these Core Competencies as "students develop Core Competencies when they are engaged in the "doing" – the Curricular Competencies – within a learning area. As such, they are an integral part of the curriculum. While they manifest themselves uniquely in each area of learning, the Core Competencies are often interconnected and are foundational to all learning." ("Core Competencies," Province of British Columbia | Ministry of Education,). These shared similarities promotes two main ideas; the first being that our Provincial education system is adapting and evolving towards more progressive and student-oriented learning strategies, and the second being that students who enter a makerspace modeled around the UTA-style competencies may have more understanding, willingness, and success from experiences within their BC K-12 education. For users who did not experience the BC curriculum, it is still possible to acquire the UTA-style competencies while using the space, since the competencies are oriented towards student-led learning, as well as by acquiring knowledgeable staff who are aware of these competencies and help users follow these competencies both directly and indirectly.

The Application of these competencies, and the adoption of both the BC curriculum Core Competencies and the UT Arlington Fablab competencies within the TRU Library Makerspace will provide users the opportunity to orient their experience to be more self lead in both learning and project creation/application. By integrating these competencies into the TRU Library Makerspace, users will hopefully gain more valuable experience and knowledge when working within the space, as well as develop and discover applications to their current studies, future studies, professional careers, or personal lives, by being inspired with a passion and desire for self-lead learning and learning by doing and trialing new concepts and materials. It is the The TRU Library Makerspace's goal to also become more integrated within TRU courses and competencies, allowing for students to directly use the space at the benefit of course projects/assessments, working with professors and instructors to integrate resources found within the TRU Library Makerspace into course instruction activities and/or materials.

For more information about the University of Texas - Arlington Fablab, visit:
https://library.uta.edu/makerliteracies/

For more information about the British Columbia K-12 Curriculum, visit:
https://curriculum.gov.bc.ca/competencies

This Post was written and edited by Dalton Hargreaves, a Student Research Assistant at the TRU Library Makerspace and a 2nd year Bachelor of Education student studying to be a K-12 certified school teacher.

Chomsky, N. (2004). *Chomsky on Mis-Education*. Rowman & Littlefield Publishers.

Freire, P. (2000). *Pedagogy of the oppressed* (30th anniversary ed). Continuum.

Province of British Columbia | Ministry of Education | *Core Competencies* | *Building Student Success—B.C. Curriculum*. (n.d.). Retrieved July 28, 2022, from https://curriculum.gov.bc.ca/competencies

UTA LIbraries | UT Arlington FabLab | *Maker Competencies* | *Maker Literacies*. (n.d.). Retrieved July 28, 2022, from https://library.uta.edu/makerliteracies/competencies