

Increasing Student Engagement and Well-being through STEAM in the LLC and Beyond

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Introduction

There are many factors that contribute to a student's sense of belonging, well-being, joy, and engagement at school. A Library Learning Commons is a hub and the heart of learning in a school's community. Teachers and teacher-librarians can collaborate through partnerships and use the LLC to extend the learning going on in the classroom. In many cases the LLC includes a makerspace for inquiry-based learning, STEAM, and developing global competencies. Students' inquiry and exploration of technology and STEAM based activities can potentially act as a catalyst for deeper engagement, learning, and in turn: joy and well-being. How can STEAM exploration stemming from LLC partnerships reach and engage all of our learners? Yes, classroom learning is being extended and more deeply explored in the LLC through STEAM and makerspace resources but how can we boomerang that learning back to the classroom, and ensure that that style of learning prevails in the classroom as well? Inquiry-based learning and teaching can make for a more student-centred approach. Student agency and ownership over learning encourages exploration and engagement with technology and STEAM in ways that are motivational, meaningful, and relevant to students and the ways in which they learn. In other words, student voice and choice is at the core of these types of experiential learning opportunities. Access to technology and STEAM-based projects (formal projects) or STEAM stations (informal, open inquiry with provocations/prompts) can leverage students' learning and build on global competencies such as entrepreneurship, creativity, and collaboration with their peers.

"In inquiry, we are all better together." (MacKenzie & Bathurst-Hunt, 2018, p. 28).

STEAM and technology-based learning experiences and opportunities are a great way to engage and motivate learners. Students are exposed to innovative and new ways of engaging with and showcasing their learning. They are tapping into their creativity, being hands-on, given the opportunity to think critically and go deeper in their learning by collaborating with their peers and their teachers/teacher librarians acting as a guide and support as they explore. Bringing in community experts (e.g., carpenters, woodworkers, artists, coding experts) helps bring to light the relevance and real-world connections; and potential career pathways. The real world connections that students explore through STEAM and Makerspace activities (coding, robotics, technology tools, and digital literacy) trigger more student engagement and incite more drive, passion, and motivation. This ties into Bruner's theory of constructivist learning and students as agents in their own learning. With the constructivist theory, students construct knowledge through active experiences, interacting with their learning, and making real-world connections. Students build on knowledge and problem-solving through hands-on experiences and exchanges with their peers (global competencies, collaborative learning, etc.). This type of learning has been known to transform student learning, as well as incite more student engagement, and readiness to learn.

S.T.E.A.M, inquiry-based learning, and makerspace activities are reflective of constructivism and underpin makerspace and LLC programs. Constructivism informs the type of learning that goes on in a makerspace and LLC (inquiry-based, hand-on, supportive of global competencies, etc.). As teachers and teacher-librarians, it is important to reflect on how constructivism can perhaps emerge in the LLC/makerspace and/or classroom (to and fro) and fully permeate a school's culture and learning community. The ways in which STEAM and Makerspace-based learning unleash student engagement and ownership in their making, creating, and learning will be further explored in the literature review and ensuing data.

Decoding STEAM: what does it consist of? Unpacking the terms

STEAM stands for *Science; Technology; Engineering; Arts; and Mathematics*. These strands can be explored in the Library Learning Commons (LLC) and LLC makerspace in many ways such as through Design Thinking, the Engineer Design Thinking process, and Global Competencies. The stages of Design Thinking include: *Empathize; Define (the problem); Ideate; Prototype; and Test*. These steps can be applied to creating and innovating (e.g., app design storyboarding and prototyping). The Engineer Design Thinking includes: *Ask; Imagine; Plan; Create; Test; and Improve*. This can be applied to creating Makerspace/STEAM projects, for example, using robotics (e.g: one STEAM project I collaborated on in LLC partnerships involved creating animal habitats and using color-coded pathways to explore animal habitats with Ozobot robots). These types of tasks encourage and build on the use of Global Competencies (also known as 21st century skills). These include: *Critical Thinking and Problem Solving; Global Citizenship and Character; Collaboration and Leadership; and Creativity, Inquiry, and Entrepreneurship*. Holism, relationality and Indigenous ways of knowing and learning are also at the heart of student engagement and agency in terms of their learning. This also ties into student well-being, belonging, and deriving joy from learning:

Holism is the core stance that integrates all aspects of learning - the emotional (heart); spiritual (spirit), cognitive (mind), and physical (body) ... in this knowledge system, well-being is the ultimate goal, and the four elements of heart, spirit, mind, and body cannot be separated (Safir & Dugan, 2021).

This is also reflective of the TDSB's multi-year strategic plan that focuses on student belonging, achievement, thriving, as well as modern inclusive and revitalized learning spaces which connect to Makerspaces and LLCs (UDL, flexible furniture and learning spaces etc.).

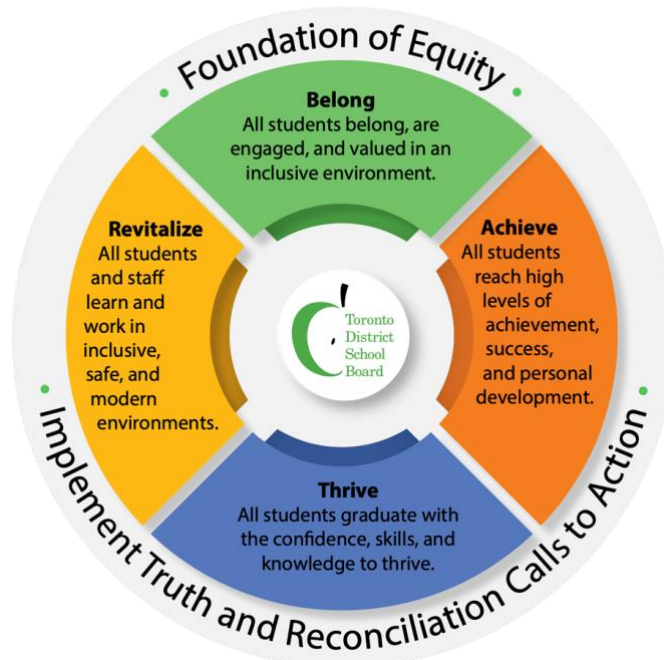


Table 1.1: TDSB's Multi Year Strategic Plan (TDSB, 2024)



Critical Thinking and Problem Solving	Global Citizenship and Character	Communication	Collaboration and Leadership	Creativity, Inquiry and Entrepreneurship
<p>I can solve meaningful, real-life, complex problems.</p> <p>I take concrete steps to address issues.</p> <p>I am able to design and manage projects.</p> <p>I acquire, process, interpret and analyze information to make informed decisions (critical and digital literacy).</p> <p>I engage in an inquiry process to solve problems.</p> <p>I make connections and transfer learning from one situation to another.</p>	<p>I contribute to society and the culture of the local, global and digital community in a responsible, accountable, and ethical manner.</p> <p>I engage in local and global initiatives to make a difference.</p> <p>I learn from and with diverse people.</p> <p>I interact safely and responsibly within a variety of communities.</p> <p>I am creating a positive digital footprint.</p> <p>I relate to the environment and am mindful of the importance of all living things.</p>	<p>I communicate effectively in different contexts in oral and written form.</p> <p>I ask effective questions to acquire knowledge.</p> <p>I can communicate using a variety of media.</p> <p>I select appropriate digital tools according to the purpose.</p> <p>I listen to understand all points of view.</p> <p>I am able to voice opinions and advocate for ideas.</p>	<p>I learn from, and contribute to, the learning of others.</p> <p>I am able to co-construct knowledge, meaning, and content.</p> <p>I assume various roles on the team.</p> <p>I network with a variety of communities/groups.</p> <p>I respect a diversity of perspectives.</p>	<p>I contribute solutions to complex problems.</p> <p>I am able to develop or enhance a concept, idea or product.</p> <p>I can make discoveries through inquiry and research.</p> <p>I pursue new ideas to meet a need of a community.</p>

Table 1.2: TDSB Global Competencies (TDSB, 2019, p. 61).

Students need to have agency in their learning in order to thrive. Agency consists of four domains: identity: “your ways of being, learning, and knowing in the world - is valued”; mastery: “the ability to build knowledge and demonstrate understanding as a learner”; belonging: “I see myself, and I am seen and loved here”; efficacy: “collective teacher efficacy, the shared belief among teachers in their ability to positively affect students....” (Safir & Dugan, 2021, pp. 102-104). All of the above concepts are integral to STEAM based learning, student engagement/agency, as well as ties into constructivism. The literature and data review will unveil how STEAM can impact student learning for the better and will answer some of those wanderings around how that type of learning can extend to the LLC/makerspace and ‘boomerang’ back into a classroom setting and beyond.

Literature and Data Review

A classroom makerspace is generally uncommon. The makerspace is usually hosted in a school community’s Library Learning Commons—a communal hub and heart of learning for a school community—that embraces the LLC model and a culture of making. A makerspace is defined as “a unique learning environment that encourages tinkering, play, and open-ended exploration for all” (Fleming, 2019). Makerspaces have been shown to increase student engagement and act as an incentive for learning: “As a rule of thumb, project-based learning and school makerspaces work much better as tools to motivate students than any marble jar, point system, or promise of pizza ever could”. (Bannan, 2016). According to Hennessy’s: *The Impact of Makerspaces on the Creativity, Innovation, Collaboration, and Engagement of Young Children*, hands on manipulatives and materials in a makerspace: “allows the children to take charge and build their knowledge and skill set with the guidance of the teacher, while also starting to adopt a sense of creative independence” (Hennessy, 2021, p. 13). This ties into student agency, belonging, and joy over their learning. Hennessy also states: “Makerspaces work with individual and collaborative skill sets and build knowledge and skills for children academically and socially” (Hennessy, 2021, p. 22). Building on those social skills strengthens global competencies and also relates to well-being and joy of learning at school. This again ties into the theory of constructivism and reflects Colegrove’s research article: *Makerspaces in Libraries: Technology as catalyst for better learning, better teaching*. Colegrove (2016) underlines the impactful transition from traditionally teacher focused to more student centred learning (including the learning that goes on in a makerspace) as constructivist in nature:
... recent decades have witnessed the practice of education evolving away from the traditional teacher-focused “transmission-style of teaching and learning, which were teacher focused, to a variety of constructivist perspectives which focus on how the learner constructs meaning through active and social learning and personal context” (Colegrove, 2016, p. 3).

Colegrove’s study highlights how STEAM and Makerspace based learning leads to more student engagement and entrepreneurship (global competencies):
Learning and engagement within the library makerspace seems to lead naturally to innovation and entrepreneurship. Due to the ready access to rapid prototyping equipment, combined with the creative abrasion and intellectual stimulation that

becomes largely unavoidable in such an active hub, it is perhaps not surprising (Colegrove, 2016).

What is important to note is that convenient access to ready-to-go makerspace materials to support exploration and student agency over learning is vital. A makerspace or STEAM corner would be of benefit in each classroom, outside of a communal LLC makerspace: “a centre or station approach in the classroom can be an effective way to begin integrating maker pedagogies without investing a lot of money” (Hughes, 2017, p. 3). Colegrove goes on to underline how makerspace learning environments lead to more active student engagement:

Motivated by curiosity and self-interest, and supported by the library resources, acquisition of 21st century skills ranging from information, media, and technology skills to innovation, life, and career skills are a natural outcome of engagement with the resources of the library. In addition to blending traditional roles of content provision with support of active and collaborative learning, opportunities for engagement and creative abrasion across steam disciplines are driving innovation and entrepreneurship across the community (Colegrove, 2016, p. 7).

In Pisarski’s *Finding a place for the Tween*, she resonates Colegrove’s observations and recognizes the makerspace as a place to build on global competencies such as collaboration, creativity, entrepreneurship, and student agency over learning : “Makerspaces consist of a community of makers that come together to create by sharing tools, skills, and knowledge—creating a place to learn a new skill, to become a creator, to connect with a community and build friendships, or to gain access to specialized equipment”. (Pisarski, 2014, p. 13).

Makerspaces and STEAM based learning naturally incur global competencies and enhance student engagement and well-being: “Makerspaces naturally promote the exploration of technology and science through hands-on activities that tie them closely with STEM education”. (Pisarski, 2014, p. 15). As outlined in the article *Library Makerspaces Spark Creativity*, this type of learning promotes creation vs. consumption: “A makerspace helps engage and connect students with technology and interests in a completely different way than they are used to. Rather than just learning how to consume everything around them, students are taught to create.” A more widespread makerculture at a school’s LLC and beyond would promote critical thinking and entrepreneurial approaches to learning in innovative ways.

A Library Learning Commons is constantly evolving in terms of the LLC growth stages (*exploring, emerging, evolving, established, leading into the future*). This reflects the Culture of Growth framework in the *Canadian School Libraries Foundations for School Library Learning Commons in Canada: A framework for Success*: “there is no end to the continuum as it evolves to keep pace with information and technology changes and school needs of the future.” (Canadian School Libraries [CSL], 2023, p. 14). This also conjures up the Engineer Design Thinking process and the *test* and *improvement* steps. We can keep going back to test and improve new approaches. Even if an LLC and makerspace is *established*, it can keep evolving and changing in order to *lead into the future*. This connects to the concepts of not only expanding

classroom learning to the LLC and makerspace but boomeranging it to and fro, from LLC to classroom and classroom to LLC.



Figure 1.3 (CSL, 2023, p. 15).

The Culture of Growth framework reflects and supports the constructivist theory and the importance of student agency over learning, as well as inquiry and STEAM based learning: “Participatory Learning: The first of the three facets of participatory learning environments (PLE) comes from students being active partners in their own learning, rather than passively receiving” (CSL, 2023, p. 16). A culture of growth approach in an LLC supports active learning experiences: “Designed to infuse inquiry learning approaches, evolving technologies and best resources as well as foster a love of reading and life-long learning. In the library learning commons everyone is a learner, and learning experiences empower intellectual, cultural and personal growth” (CSL, 2023, p. 16). It is important to extend learning from the classroom to the LLC, as well as from the LLC back to the classroom. This also connects to the framework of *accountability* in terms of the LLC growth stages and Leading into the Future:

We have not called these final words the conclusion, because there is no conclusion to the library learning commons program. It is in constant beta, characterized by dedication to lifelong learning, investigating new approaches, and modeling an inquiry mindset for all learners in the school. In the library, we believe in the power of inquiry, creativity, and the free exploration of ideas. That is the unique value of the library. Leading into the future means being able to express that unique value as we make connections to students and other educators, and as we engage in advocacy (CSL, 2023).

Now that we have explored some of the literature around STEAM and Makerspace learning and how it positively impacts student learning, engagement, and well-being - we will explore student street data from my school community, as well as explore next steps into realizing this makerspace *boomerang* vision and implementation plan.

Student street data and examining our LLC and school data

Our school has benefited from Community Connected Experiential Learning (CCEL) funding for three consecutive years. This type of learning upholds STEAM and Makerspace types of learning. Students explore STEM through the lens of skilled trades pathways. Our first two years had a carpentry focus, we are now veering towards engineering for the 2024-2025 school year. The survey collected some of the student perceptions and outcomes of the CCEL. Overall it was well received. More than 50% of students felt they learned more about the skilled trades, and 71% enjoyed the collaborative aspect (building on global competencies through STEAM).

We visited Oakwood CI's woodworking shop and collaborated with their teacher and highschool students. We sanded and primed our 7'ft panels, created a linkage woodworking craft, and arranged loose wooden parts as a hands on activity. How do you feel these experiences benefitted you?



52 responses

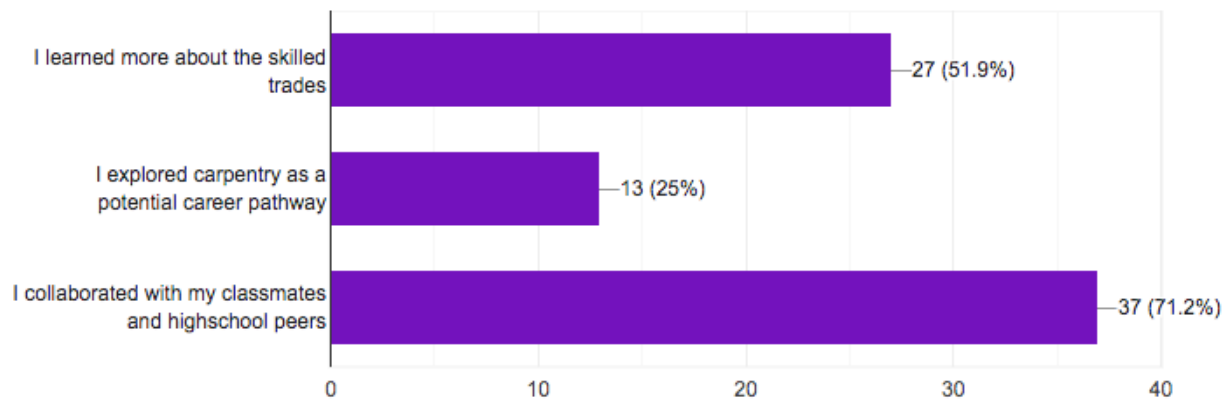


Figure 1.4

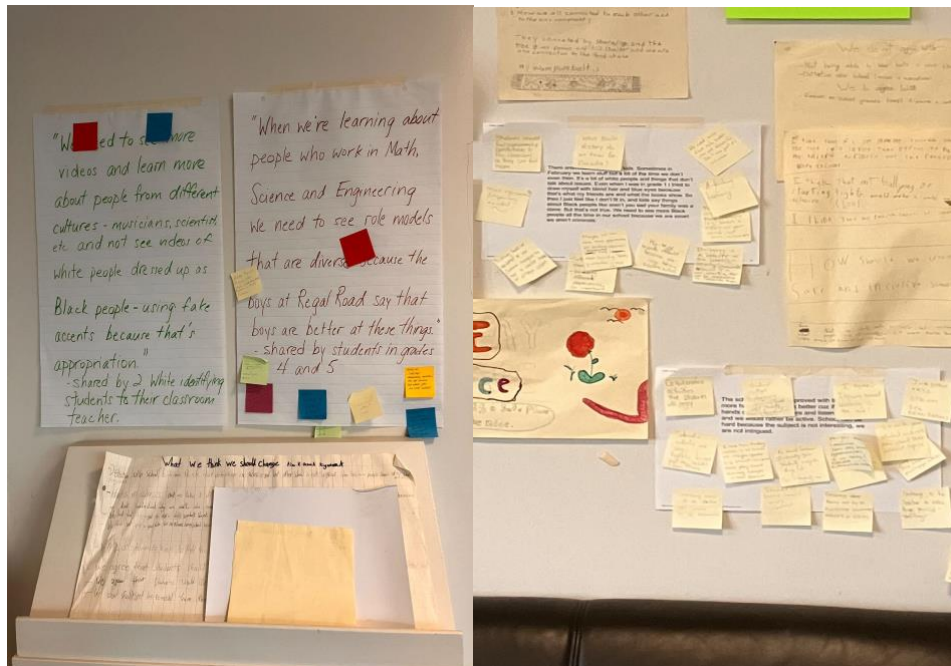


Figure 1.5 & 1.6

<p>Students wanted to learn about diversity (Black excellence, women leaders) in STEM</p>	<p>“We need to see role models that are diverse because the boys at RRPS say that boys are better at these things” (this data was shared by students in grades 4 and 5).</p>
<p>Students wanted more experiential and hand-on learning experiences</p>	<p>“The school could be improved with more hands-on learning experiences. It would be better because we would listen more and we would rather be active. School can be hard because the subject is not interesting, we are not intrigued” (collected from students in grades 4 to 6 when reflecting on how the school and class could be better/more engaging)</p>

Figure 1.7

Our student street data revealed that our students want to explore more about CRRP through STEAM. Students also revealed their wish to have more access to experiential and hand-on learning opportunities beyond the LLC and makerspace. How to honour our student voice will be revealed in the implementation plan.

Implementation plans to achieve a makerspace boomerang effect between classroom to LLC and LLC back to the classroom

As we continue our culture of growth and oscillation between the *established* and *leading into the future* LLC and makerspace growth stages (in our LLC), we have finally come to a point where we have doubles of resources to lend out to classrooms. We now have an LLC *and* class set of Dashbots, Ozobots, MakeyMakeys, Microbots, and Robot Mice. This enables us (me the TL and classroom teachers) to sign out robotics to classrooms for classroom STEAM based projects. This is a result of the building of resources, and acquisition of funding over several years. LLC partnerships also come into play. By partnering with the teacher-librarian, teachers can build capacity in terms of robotics (if unfamiliar or unsure how to fully exploit them - many teachers are of course comfortable and adept, which is also a mutually beneficial partnership for TL and teacher), in order to bring them back into the classroom setting for future STEAM/makerspace type projects. LLC/Makerspace partnerships in STEAM can help inspire teachers to develop new ways of engaging their students, tapping into their interests and talents, as well as build on global competencies through hands-on and experiential learning - and bring that back with them into their homerooms.

Setting up some simple loose parts and consumable/recyclables STEAM carts in each classroom is also a way to implement the *making* beyond the LLC. Teachers can

collect recyclables or donations for take-apart centres or simple STEAM stations (e.g: tech take apart and classify station; tubs of: stacking cups, origami, duct tape creations, string games etc.). One of our classroom teachers has started setting up a loose parts makerspace/STEAM corner in her classroom. She took pictures of each item and labeled each tub in order for her primary class to grab and “make” when doing class-based STEAM exploration or activities.

This year’s CCEL will honour our student street data. We will be partnering with a community partner who specializes in coding and culturally relevant resource pedagogy/equity. This will be a school-wide initiative. Students will explore engineering as a skilled trade through STEAM and robotics making. Our 2024-2025 CCEL involves APP; 3D printing; and Robotics development tracks. [CCEL: Monthly Implementation Plan](#). Our hope is that this will help realize this makerculture vision for elevating student engagement through STEAM stemming from our LLC and branching out across our entire school community.



Figure 1.8 Mini makerspace classroom example

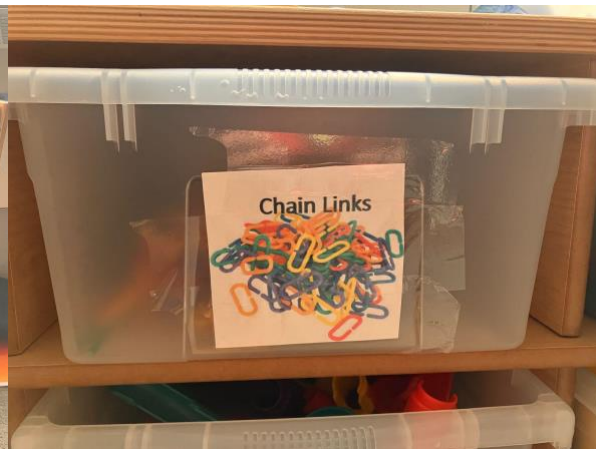


Figure 1.9 Close up of simple STEM tub example

Conclusion

STEAM, makerspace, holistic, and constructivist approaches to teaching and learning have shown to enhance student engagement, elevate learning experiences and opportunities in impactful and positive ways, as well as transform student-learning. The literature data reveals the importance of hands-on and student centered learning anchored in global competencies. The student street data revealed the wish for more school-spread experiential and hands-on and STEAM based learning. As a teacher-librarian, I see the joy it sparks on a daily basis. STEAM and hands-on experiential learning allows the students to build on their independence, curiosity, and creativity, as well as learning by *making/doing*. By practicing ongoing reflection in terms of our LLC’s culture of growth, we can continue to build on the *test and improve/establish* and *lead into the future* stages of our LLCs growth continuum by branching our LLCs makerspace off into mini makerspaces in corners of each classroom. For example, benefitting from collaborative partnerships in the LLC and then borrowing a robotics set for the classroom, or collecting consumables for class based STEAM, as well as partaking in our school-wide CCEL - these are all ways in which STEAM and

makerculture can propagate beyond the LLC and throughout classrooms and the school like a spider plant propagating spiderettes. (I do love a plant analogy). In summary, the *culture of growth* in an LLC keeps on continuously growing and spreading in a school community.

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