

Building 21st Century Skills Using an Academic Makerspace

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Abstract

This article focuses on the development of 21st-century skills in post-secondary students with the research specified in the development of these skills in Child Studies Capstone students, demonstrating that the use of academic makerspaces in curricula can facilitate the learning of 21st-century skills. This article reviews the literature regarding current information about 21st-century skills and their development in teaching and learning facilitated by academic makerspaces. A qualitative research study was conducted with participating fourth-year Child Studies Capstone students who had their Capstone course delivered in an academic makerspace. The research focused on the development of 21st-century skills, the impact of 21st-century skills on the practice of child and youth care, and the suggestions for the implementation of similar programming in other post-secondary institutions. This research study was completed at a university institution located in an Urban Centre.

Keywords

21st Century skills; makerspaces; child studies; capstone; youth in transition to adulthood; youth studies

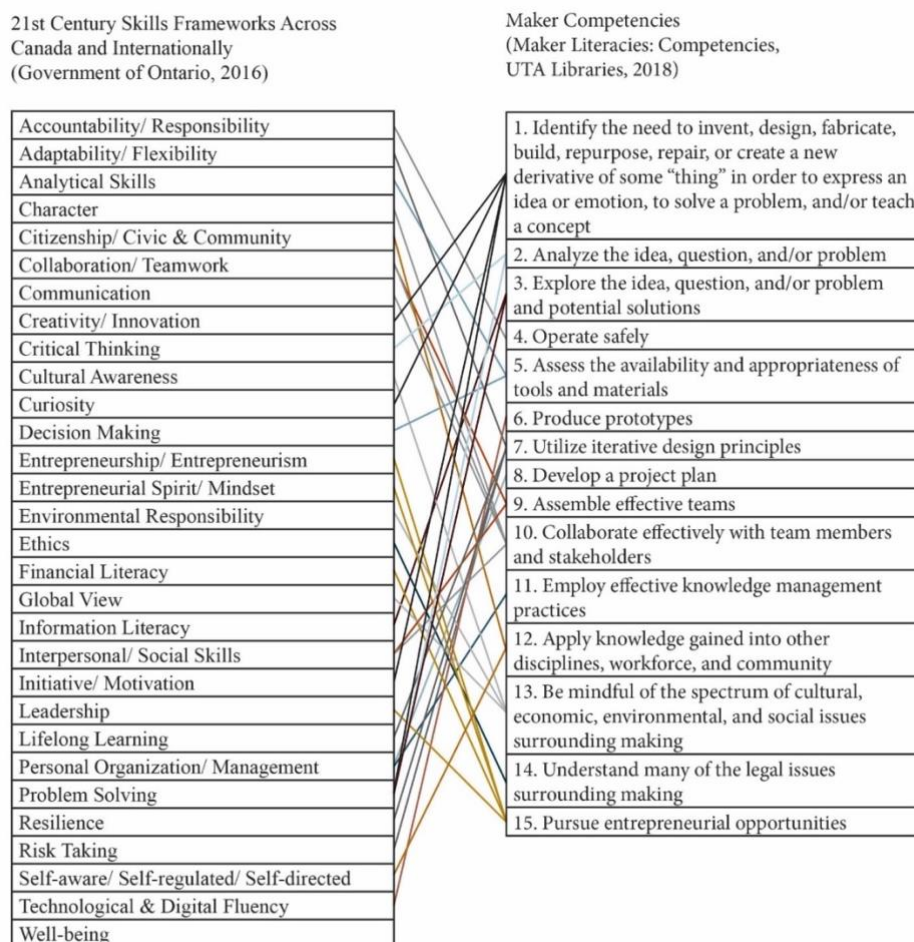
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21st Century skills are recognized globally as central to teaching and learning due to the increasingly complex and non-linear societal challenges facing graduates entering evolving labour markets. A report generated by Social Science and Humanities Research Council (Leveraging knowledge for 21st century teaching and learning, 2016) initiative found that there are research

gaps in balancing "the acquisition of foundational knowledge, stimulating deeper learning and fostering 21st-century competencies" (para. 1), especially when traditional teaching and learning techniques are challenged by increasingly technology-mediated environments. A Government of Ontario, Canada document (2016) showed that the need for developing 21st-century competencies is a global concern, and these skills will be necessary for almost all job markets.

Labels associated with the term 21st-century competencies include 21st-century skills, global competencies, college readiness, essential skills, career skills, employability skills, meta-skills. In general, 21st-century skills include skills such as collaboration, communication, digital literacy, citizenship, problem-solving, critical thinking, creativity and productivity (Van Laar et al., 2017). Many of these same skill sets are identified as to maker competencies. The University of Texas, Arlington, outlined an extensive list of maker competencies which include: problem identification, ideation and problem-solving, creativity, using tools and technology and prototyping; project management, collaboration and communication; knowledge generation and entrepreneurship (Maker Literacies: Competencies, UTA Libraries, 2018).

Figure 1
Mapping 21st Century Skills and Maker Competencies



Academic Makerspaces

Makerspaces are housing tools and technologies shared by communities of people to create things from crafts to prototypes for commercial products (Cambridge dictionary). Makerspaces can be small or large, urban or rural, subject-specific or general and are directly tied to the maker community, which is an open-source, worldwide, connected community of 'do it yourself' or 'do it with others' minded people who share resources and organize events like Maker Faires (Make Media). Maker culture is directly tied to learning, and the impact of academic makerspaces on teaching and learning is a nascent field of research. Maker education is being researched more extensively in the K-12 environment (Blikstein et al., 2017). As time progresses, K-12 students enter the post-secondary system with expectations that learning outcomes will include makerspace tools and technologies. As a result, the maker movement in higher education has increased in recognition in the last decade, and makerspaces have increasingly been incorporated on campuses. Much of the literature on academic makerspaces focuses on the founding, design and implementation of makerspaces on campus, but holes in the literature remain on the impact of making in undergraduate education, particularly outside of traditional STEM areas such as engineering (Rosenbaum et al., 2017).

A survey of research into academic makerspaces by Rosenbaum et al. (2017) suggested that the literature can be divided between reports that focus on program implementation, comparisons of makerspaces and curriculum development, and empirical studies demonstrating use patterns, user experience, impacts on attitudes and competencies and evaluation of activities. They note that there is also limited methodological diversity and that the majority of research they identified are self-report research methods. Recommendations for future research by Rosenbaum et al. include: to conduct more data-driven research to understand student experiences in makerspaces, to evaluate how maker education supports students in less traditional disciplines beyond engineering, to explore the impact of informal making on campus, and to conduct this research using more diverse research methods.

Learning through making is iterative and experimental and requires failure and learning from mistakes with the support of peers. This model harkens back to the model of experiential and organic learning grounded in the everyday community proposed by Dewey in 1916 in opposition to the rote learning that stifled curiosity and creativity (Eaves & Harwood, 2018). Curricular integration of makerspaces in higher education exposes students to opportunities for experiential learning in which students use inquiry-based approaches to build skills embedded in the design thinking process such as empathy building, creativity and innovation, collaboration, design synthesis, iterative problem solving with the use of prototypes and testing using human-centered design approaches impacting their academic, personal, professional growth (Cook et al., 2018).

According to Wallace et al., (2018), there is some reluctance by faculty in the post-secondary system to take up makerspace technology, suggesting that this may have to do with limited recognition of how these technologies manifest in student learning outcomes. In their research, Wallace et al., (2018) engaged faculty in creating assignments that included makerspace technologies and found that students gained skills in the area of decision-making, analysis, innovation, intra-personal (reflexivity) and inter-personal (communication) skills. The research presented here aims to make a meaningful contribution to the impact of maker education on

students in higher education through describing a novel collaboration between an academic makerspace, a Child Studies Capstone course and youth in transition to adulthood (YTA).

Child Studies Capstone Course

Students in the Child Studies degree acquire various skills and theories related to human and social development across the life span. The fourth-year Capstone courses are projects that link students to community agencies to create and deliver programs that meet the agency's needs, offering the students work-integrated learning experiences. In this case, the Capstone students worked with community agency YTA programs to teach youth 21st-century skills using the makerspace to help increase employability. This Capstone involved the Capstone students learning makerspace tools and technologies in the Maker Studio, a makerspace at their institution housed in dedicated spaces in the academic library. The technologies included: 3D printers, Laser Cutter, CNC machines, vinyl printing and cutting, sewing machines, electronics, robotics, mixed reality, emerging media and software. By taking a series of workshops to learn how to create using the tools and technologies, the Capstone students designed a program and delivered this program to the youth in the Maker Studio. The Capstone students identified the relevance of these technologies by seeking information from the Youth Employment program in their community as well as polytechnical schools to ensure what was being taught in the Maker Studio was helpful in employment or continued education for the YTAs.

The 21st-century skills acquired in the Maker Studio build on disciplinary expertise and are increasingly being understood as essential for success in current and evolving work environments (Government of Ontario, 2016). Teaching skills related to growing technologies is vital for any profession as the workforce changes from industrial production to a technology-driven knowledge economy, and skills that go beyond traditional literacy will enhance Capstone students' ability as professionals once employed in the field (Government of Ontario, 2016). By teaching these existing and emerging technologies to the youth, Capstone students will also be more confident as professionals when faced with these technologies in the workplace or can assist others with whom they work to see these technologies as accessible.

Youth in Transition

Youth may encounter challenges as they make the transition to independence from caregivers. In particular, youth in the child welfare system face more challenges than their counterparts as they are in greater need of support and maybe without a nurturing environment (Allen & Williams, 2012). The child welfare system provides services for the youth until they age out of the system (Aging out, 2019) unless they are qualified to receive post-intervention support.

Youth who have been in the government's care may be vulnerable to the underdevelopment of life skills, including skills that make the young person eligible for employment which can create difficulties with independence during adulthood (Allen & Williams, 2012). In contrast to their peers who may not be in the system and who are given chances to test limits and have learning moments in a safe and supportive environment, those youth in the system are given strict routines and little room for mistakes (Fordyce, 2017).

These youth do not have much say in the decisions that affect their lives since decisions are made by the court, social worker or key workers and oftentimes without the consideration of the youth. These decisions include things such as "where youth can go to school, whether they can have cell phones, whom they can spend time with, what extracurricular activities they can be involved in, whether they can get driver's licenses, and many other life decisions, both big and small" (Fordyce, 2017, p. 569).

It is not unusual for youth in transition to have experienced homelessness and might struggle with mental health or addictions issues, and likely have experienced trauma. These youth may have limited skills and may have difficulty finding employment for several reasons. As McCallion (2018) explained, these youth may have challenges with their executive functioning, which helps them to organize and plan, and when things go wrong may not bounce back as easily as those who have more resilience. Vance (2018) stated, "in the skill-building process, adolescents are drivers of their own development" (p. 967). Youth in transition may benefit from specific educational opportunities that rely less on a typical academic setting or expectations and instead increase success and learning through technologies offered in a makerspace. Offering diverse opportunities in a makerspace for youth transitioning to adulthood allows the young person to autonomously develop personally beneficial skills to their growth.

Study Objectives

This study investigated the experience of undergraduate Capstone students in a fourth-year human service Capstone course after having designed and delivered a program to youth in transition. We looked specifically at the processes that the Capstone students went through to develop and deliver the project. We did not look at the outcomes for the youth in transition which took part in the project.

The objectives of this study were to: understand whether the Capstone students themselves gained 21st-century skills, to make explicit how this experience could impact the Capstone students' future practice with children and youth, and to be informed about barriers and facilitators to learning 21st-century skills for post-secondary students in human service programs. The overarching question under investigation was: What was your general experience related to having been involved in this Capstone course and the design and delivery of the program to youth in transition and learning makerspace technology? Gathering this information assisted in how teaching 21st-century skills in the Maker Studio can be delivered or enhanced.

Research Methods

Participants and Recruitment

All eleven Capstone students were invited to participate in a focus group, and seven participated. It may be an important consideration to note that not all the students chose this Capstone project and instead had been placed in this class. This may have contributed to the turnout since a student may not have been interested in the Capstone project or the research. An additional consideration for the turnout from the Capstone students was that the COVID-19 pandemic reached our

community at that time, the institution was closed, and many students returned to their home communities outside of this jurisdiction.

After receiving human research ethics approval from the university, students were recruited during a class when the instructor was not present. Capstone students had already been trained on makerspace technologies, thereby minimizing the influence on their decision to participate. For example, if students thought they might not get training unless participating, they felt compelled to participate.

A researcher who was not the Capstone course instructor set a mutually agreed-upon time to participate in the focus group. Having a non-instructor researcher conduct the interview decreased any conflict of interest with the student-instructor power dynamic.

Data Collection

Data was collected through a single focus group interview that took place for approximately one hour. The interviewer was the makerspace specialist and not the course instructor. The focus group was conducted via a secure virtual platform.

While there were particular questions for the group, it is not unusual for new questions to emerge based on the participants' content (Creswell, 2014). Therefore, not all the questions likely to be asked can be predicted. Questions to assist with probing for information were: what was it like to have to learn the technology prior to delivering the program? What were the barriers and facilitators for your learning? What did you anticipate related to program delivery occur?

If you engaged in learning new technologies again, what would you change, enhance or keep the same in relation to what you learned during your makerspace experience? Did your participation in this Capstone increase your own 21st-century skills, and if so, how will you use these in your work with children and youth in the community?

Focus groups are considered appropriate for gathering information related to planning and evaluation (Wilson, 2016). Participants in focus groups can respond to each other's input, take the content deeper, and potentially lead to new ideas. Focus groups are deliberate discussions (Rothwell et al., 2016), and because of the interaction between participants, knowledge and awareness of the topic increases. Increased knowledge potentially leads to change in future practice; potentially, this focus group process could assist in needed changes.

Analysis

Data were analyzed using a qualitative interpretive process. Since we sought to understand experiences and processes in relation to a particular phenomenon, we conducted a qualitative interpretive study. According to Cresswell (2018), asking about perspectives and collecting this data via focus group matches an interpretive-phenomenological methodology. In qualitative methods of inquiry, research can follow a particular structure; however, in an interpretive approach, the presentation of the content and the structure may vary (Cohen et al., 2000), and

interview questions can flow from the content of the interview and cannot always be predetermined.

Data were analyzed using an open coding method (Thomas, 2006) by the three researchers involved in this project. The three researchers were the instructor of the Capstone course, the makerspace specialist and the research assistant. The focus group provided an opportunity for Capstone students to share their lived experiences of the phenomena under study. For the purpose of qualitative analysis, the three researchers met once to discuss and collaborate on potential codes, then independently read the transcript and coded these on their own. Once codes were added to the transcript by each researcher, another meeting took place to create themes based on the coded section. By working on our own, then comparing and contrasting our findings, we reached a consensus that increased rigour and the validity of the themes and general findings.

Findings

Numerous themes were identified as we analyzed the data. These were: learning the 21st-century skills in a makerspace, teaching in a makerspace, and recommendations. Each of these themes has several sub-themes, which will be elaborated on below.

Learning 21st Century Skills in a Makerspace

21st Century Skills

Salvia et al., (2016) noted the importance of making and doing in order to foster the acquisition of 21st-century competencies. Capstone students admitted that they were not initially aware of what 21st-century skills were. Upon reflection, there were several 21st-century skills highlighted by the Capstone students as standing out for them as learners and as teachers of the youth. A Capstone student explained that when evaluating, which 21st-century skills were being employed by youth working on a project, "I was trying to work with him [on]what skills he needs, I was noticing ones that I was using too, and it helps to have two examples." Salvia et al. (2016) used the term digital fabrication based on do-it-yourself (DIY) to describe making, explaining that it is a creative practice rooted in design and construction that emphasizes the development of 21st-century skills including problem-solving, critical thinking, and collaboration. The Capstone student responses in this research supported this notion and named critical thinking, problem-solving and social skills as the most developed 21st-century skills while working with the tools and technologies in the Maker Studio.

Critical Thinking

The importance of critical thinking was discussed at length by the Capstone students, and they recognized that their experience working with youth in the Maker Studio helped to further develop the skills they already had. One Capstone student explained,

I think there is definitely a level of self-reflection involved with how good my critical

thinking skills were. It's definitely a 21st-century skill, but it's also like, you have to continually practice and be able to think about things critically that are not like, you know, textbooks. They are more like real-world grasped skills.

In post-secondary learning, critical thinking is considered a high impact teaching practice (Morreale et al., 2017). Capstone students are able to take their learning and apply it in novel ways once able to think critically.

Problem Solving

Another 21st-century skill the Capstone students identified as present in their experience was decision making and problem-solving, which involves critical thinking,

Problem-solving is something we are doing all the time. I forgot what statistic it was, but ECE's [Early Childhood Educators] were like making 500 decisions an hour or day; I'm not sure what it was; I could be completely wrong. Being conscious of that and being conscious of understanding that I do have the skill, or I do need to work on the skill and the role of critical thinking and to be able to think a few steps ahead and think on your toes. I think it's absolutely imperative for anyone who is working with other humans, regardless if they are children, youth or adults.

Fleming (2018) stated that "The outcome of maker education and educational makerspaces leads to determination, independent and creative problem solving, and an authentic preparation for real-world by simulating real-world challenges" (Section 4, para. 2). Capstone students identified that they were learning these skills at the same time as facilitating the learning of the same skills in the youth. A Capstone student noted, "you have to begin to look at how your actions have an impact and how we are evolving throughout society and becoming more useful of these 21st-century skills, you do need them and need to be able to help people learn them".

Technology

The Capstone students talked about learning technology in the context of 21st-century skills recognizing how important digital literacies are for themselves and the youth. A Capstone student noted that of the 21st-century skills, technology is becoming increasingly important, stating that, "I believe it will impact how we do our work with children and youth because their lives will be more impacted by technology. I expect that it will be part of our practice". A report by Anderson and Jaing (2018) showed that teen technology use was rapidly changing, and the use is "near-constant" (para. 36). Therefore, the use of technology will likely continue into adulthood and understanding technology and having some familiarity will be useful for anyone.

Failure

Makerspaces encourage unstructured, self-directed learning, the iterative design approach and focus on innovation through experimentation and learning rather than primarily on theoretical knowledge, which is supported (Mylon, 2018). The iterative design process and experimentation involve learning from failures. The Capstone students talked about the feeling of failure for

themselves and the need to become comfortable with it in order to model that comfort for the youth. One student stated,

I think that was a huge thing that we all almost did together, as we were able to see the lighter side in our own failures. If we can model that for the youth coming into the studio, then failure wouldn't be as devastating as it could be.

This was important to the Capstone students because they saw the youth as equating failure with rejection and instead worked to find ways to focus on the process more than the outcome. A strategy they described was, "focusing on the skills you're learning and what you're gaining from it during, even if the end result is not exactly what you expected in the first place, could be beneficial for them [youth]." The Capstone students showed empathy for the youths' prior experience and how failure might have a negative impact on them. They reflected on ways to open a conversation with the youth about failure. They recognized that failure means different things to different people and that their role might be to manage the expectations of perfection, especially when using technology. Being intentional about creating a space for failure to be acceptable was something the Capstone students acknowledged was necessary for the youth they were working with within the Maker Studio.

Challenge

Rosenbaum and Hartman's (2018) research into students' growth through maker education recognized that key factors behind the students' skill development were expert support, opportunities for practice, and especially the value of a challenge. The Capstone students in this study expressed that they were sometimes overwhelmed but challenged in a good way by the experience, particularly with the introduction to technology like 3D printing and writing code. One Capstone student explained,

My experience was very challenging at times, and I had to really focus on what I was doing, so it wasn't something that you could just walk in and learn. I felt if you wanted to excel at what you were learning in order to teach, you really had to focus on it. I thought it was challenging, but it was a really good challenge.

As Kajamaa and Kumpulainen (2020) noted, in a makerspace, students are challenged both individually and collectively. When in a new space, students are able to work more collaboratively and "novel technologies" (p. 415) lead to creativity.

Creative Capacity Building

Rotherham and Willingham (2010) expressed that creativity as a 21st-century skill is not something to be taught to students but rather developed independently through experience and practice. Despite feeling a lack of confidence regarding their creative capacity when the Capstone project started, multiple students expressed growth in their creative capacity through experiential learning in the Maker Studio. One student stated that "I thought that I was a creative person, but once I entered into the Maker Studio, I kind of learned a bit more about my own creativity." Another student, through self-reflection, identified that they

All did have these skills or the majority of them within us. I think identifying the skills really helped us fine-tune and work on something if we realize, oh maybe creativity is a really hard one for me or problem solving is something I can work on.

Creativity as a 21st-century skill can support the development of self-confidence through skill advancement, supporting the growth of other relevant 21st-century skills, including the ability to work in a team, problem solve and think critically (Salvia et al., 2016).

Self-Reflection

A foundational theme of 21st-century skills is that it provides students with experiential opportunities, facilitating growth through experience (Rotherham & Willingham, 2010). In their research, Colomer et al., (2018) stated, "experience is the basis of learning, but learning cannot take place without reflection" (p. 1). Self-reflection is considered a critical element for growing professionals as it further connects learners in the learning process, supporting growing professionals in identifying the implications of values and beliefs on their learning (Lew & Schmidt, 2011). Self-reflection as a learning strategy can support a meaningful learning experience, further enhancing students' education. Capstone students expressed that self-reflection was a tool they used to support their learning. Regarding their experience within the Maker Studio, one student stated, "I found I was really doing a lot of reflective thinking myself after the sessions about my own skills." Another student stated that "I had a really good experience, and it really pushed me, and I learned things about myself that I didn't know." Self-reflection was utilized by Capstone students as a method for self-discovery in their learning journey and competency development.

Makerspace and Staff

The Capstone students repeatedly said that the staff in the space created a comfortable atmosphere for Capstone students to overcome barriers to making and teaching with the tools and technologies they were initially unfamiliar with. One Capstone student said, "I think the staff at the Maker Studio was one of the biggest assets as a resource. You guys really helped us overcome the barriers of not being able to complete a project properly sometimes." Mylon et al., (2018) noted the importance of removing barriers to access in academic Makerspaces suggesting that it involves creating an atmosphere where students want to come back and bring their friends. Mylon et al., further explained that without people to transfer knowledge from experienced to beginner, makerspaces are just spaces. One student spoke directly to this,

For me, definitely, the human factor was the biggest. If you [maker staff] didn't provide the warm feeling and the supportive environment, whatever technologies you might have in the Maker Studio, youth would feel overwhelmed and feel risky to even try it out.

The Capstone students talked about seeing the Maker Studio as a community space where the relationships they built with staff allowed them to feel comfortable, create a sense of belonging, be motivated, and build confidence.

Teaching in a Makerspace

If one does not consider themselves creative or technological, teaching and learning in a makerspace may initially be intimidating. Several of the Capstone students expressed hesitation about their own competency in relation to the tools and technology that they were about to learn. For example, one Capstone student mentioned, "It was definitely overwhelming at first." According to Kurti et al., (2014), "Students must be attracted to the space and be inspired to use it" (p. 9). Some of the students in this Capstone chose this project, and others did not but were placed in this group regardless. Fortunately, the Maker Studio team was supportive and patient as the Capstone students learned the technology before they designed and delivered the Capstone project. The Capstone students also developed supportive relationships with each other.

Relationship Building

In any human service program, relationships are considered the foundation of our work. These Capstone students had been hearing about the importance of the relationship for three years, and some had existing relationships with one another. As they began to learn, they also began to rely on one another in new ways in order to teach the youth in the program. As noted in Fox (2019), not only do we have relationships with others, we have relationships with objects. In some ways, these Capstone students needed to find ways to have relationships with one another but also to the makerspace tools and then to the youth who would be part of their project. One of the Capstone students commented on their success as due to their relationships, "I think at the end of the day it stems down just to how we work together."

The Capstone students created a pilot project in the fall term, which was then redesigned based on feedback for the winter term delivery. The Capstone students reached out to the various agencies with programs supporting youth in transition to invite youth to participate. However, they received limited uptake, "we had a big barrier with youth attending because we didn't have that basis relationship yet." Capstone students realized that the relationship to the youth was a missing ingredient; therefore, they went to the youth programs and engaged with youth in their activities at the agencies before then inviting them into the Maker Studio, "that was really important for us to build that before they got excited about even coming into the studio." Understanding that the Maker Studio would be foreign to the youth meant that the Capstone students needed to use themselves as a familiar transitional object. Relationships are essential when working with youth in transition. The Capstone students nurtured relations with the youth and with each other to build a cohesive team in order to deliver a successful project.

Team Cohesion

While learning in a makerspace, a sense of community can be developed, and Bijman (2017) noted that both a practical sense of community and an emotional sense of community are important. Bijman also recognized that community relates to social capital through a shared experience, and collective activities act as bridging projects where bonds can be built. The Capstone students already knew each other and had been working on the shared Maker Studio project, which helped to support them in building relationships with the youth when they came

into the Maker Studio. When discussing the importance of their team cohesion, one participant said,

At the same time, working as a group in an environment that is very supportive, helped me to gain generally a positive experience. The increasing of the creative capacity, I think in terms of expanding myself within the group rather than personally, to overcome obstacles or challenges or limitations. I believe it was possible because I was working in a group in a supportive environment.

When discussing how the team worked with the youth, another Capstone student stated, "What I experienced within the team working together and that's what I and as a team tried to facilitate and provide for the youth in transition that we work together." The social bond that was created between team members through shared teaching and learning was modelled to the youth in the program, which may have created the sense of community that another participant identified as "A much more approachable environment for everyone."

Reduced Hierarchy

By creating this "approachable environment," the Capstone students were able to reduce the hierarchy of teacher-learner. Doing so was proposed by Kurti et al., (2014) as a way for collaborative learning to take place and potentially reduce the fear and intimidation that one might feel in a space full of foreign tools and technologies. Capstone students recognized this importance and that by

Providing a comfortable space and atmosphere, as well as giving empathy and a sense of belonging that helped them [the youth] to feel more relaxed and get out of their comfort zone and try different technologies and really build a rapport with us and the relationship that was needed.

The Capstone students stated that there was an "elimination of hierarchy" when they were learning along with the youth. One Capstone student noted that they "Just needed to remind me that the success of the program is learning with the youth as well." Learning together leads to building and creating social bonds, allowing all learners to be more vulnerable, reducing fear. A reduction of fear was noted for both students and the youth, "Sharing personal experiences of success and failures through learning."

Motivators

A final sub-theme that emerged related to teaching and learning in a makerspace was motivation. Again, this relates to both Capstone student motivation and the motivation of the youth coming to the studio to participate in the program. Motivation can be related to social bonds in that individuals might experience motivation if they feel unsupported socially or emotionally (Symonds et al., 2019). Motivation as social support came through when a Capstone student stated,

I think just meeting with the team beforehand and being like, ah, my day is just not going well today and then just kind of getting that all out, and as soon as the kids started arriving,

I was like okay, it's time to put that away and let's focus on this, and I think that really helped.

The Capstone students also had to be thoughtful about what might motivate the youth and then created a program that included food,

I think the food was a huge motivating factor. It's a tangible incentive for them to come back" and achievement, "seeing the satisfaction on the youth when they were able to finally take their finished product home, or they were able to complete a project.

It is important to note that incentives can also be demotivators because they might reduce intrinsic motivation (Murayama, 2018). However, as noted by the Capstone students, seeing the youths' satisfaction kept them motivated and that starting with an external incentive may have been necessary for the youth in government care and in transition to adulthood to participate in the program. Potentially when a learner is not motivated to be in a makerspace, the teacher may have to find appropriate motivators before the learning becomes intrinsic.

Recommendations

The feedback received from Capstone students demonstrates that teaching and learning 21st-century skills in a makerspace is different for post-secondary students than for youth in transition. They made several recommendations regarding the time taken for learning tools and technologies for themselves and the youth and had differing opinions on the design of the Maker Studio and whether it facilitated creativity or not for themselves as learners and the youth as learners.

While there were fewer time constraints for youth entering into the space, the Capstone students in an academic course felt more time pressure. Capstone students found the time constraints challenging and recognized that they needed more time to process the different things they were exposed to in the Maker Studio. One student recognized that the structure of the academic calendar makes this difficult by saying,

Yes, so more time, and at the same time, is that feasible with the way the semester runs? It's hard because I know for us it was a bit rushed, I think. We were building a group from the ground up and really had to get going.

The challenge of the academic calendar and open hours of the Maker Studio was something the Capstone students recognized as impeding their learning, and they suggested smaller groups and facilitating more one-on-one learning for the Capstone students would have been more effective.

I was wondering while it was happening...I know it's hard with staffing and hours and whatnot, and to almost do it in small groups rather than eleven of us trying to learn simultaneously. I found that personally very difficult. For me, I need a lot more one on one instruction.

To ease some of the time pressure, Capstone students recommended creating manuals for learning the Maker Studio tools and technologies faster, "something visual rather than with lots of words,

you know, where the arrow is, where the cursor is. I think having the pictures would really speed up learning as well." Capstone students also wondered if it would have been beneficial for them to learn the technologies at the same time as the youth were learning and suggested that when teaching the youth being able to explain which technologies were more difficult than others and "guiding them through the different levels would also be more structured and at the same time very rewarding as well for us too."

Some Capstone students reflected on the design of the Maker Studio and suggested that it did not stimulate creativity. They suggested that if the space was immense, they could have smaller groups and not be distracted by each other sharing tables. They said that the space could be less like the rest of the library with its formal structure, white walls and tables and instead if it was more colourful with "different pictures of drawings on the walls and the space and the colours I thought would really make it fun for the youth who are coming and really exploring their creative skills." Another student, however, said, "my only concern with having it, so fun is type A personalities love the linear, so how could we make it so if you have the space to accommodate all personalities?" One Capstone student's opinion of the space supported this opposition by expressing that they enjoyed the space, "the space was so nice. It felt like it wasn't a project because I felt like I was going to have fun, and that's what made me work harder, and the atmosphere and the environment was so light and so vibrant."

The Capstone students enjoyed the collaboration with the Maker Studio, saying that "this Capstone was such a wonderful opportunity to be creative but also did some front-line work as well, and I really appreciated that." In this particular project, the link to the community and the makerspace when working with youth in transition made sense. While some academic programs or faculty may not readily see the opportunities for their curriculum to be taken up in a makerspace, we encourage faculty to think about post-secondary student engagement in a makerspace. In this institution, the Maker Studio staff were able to envision with the faculty member on how to use the space and make it conducive to learning outcomes.

Conclusions

The research presented here demonstrates that there is evidence to suggest links between the kinds of learning that happen in makerspaces and the learning of 21st-century competencies. The discussion during the Child Studies Capstone students' focus group makes it clear that to be aware of what is considered 21st-century skills meant a reflection on their own competencies in these areas. This awareness and the development of those skills was deepened when they were required to teach 21st-century skills to the youth. The Capstone students came to understand the importance of skills like digital literacy, problem-solving, failure tolerance, creativity, communication, and self-reflection for themselves and for youth in transition. These Capstone students also realized that they were building their own capacity to teach these skills to the youth they will work with in the future. Additionally, the Capstone students will be able to build on this capacity as they move into their professional careers. We believe the Capstone students who engaged in this research provided rich data to assist with measuring student success as it relates to 21st-century skills and assists with understanding the importance of including makerspace technologies in post-secondary student learning outcomes. Building on the Capstone student experience, further study is

recommended on how youth in transition to adulthood can be empowered to learn 21st-century skills using makerspace tools and technologies.

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