

Making in the Classroom: A Self-Study Examining the Implementation of a Makerspace

by

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Abstract

Making is a popular trend that holds many promises for classroom education, the most salient of which is as a vehicle for constructionist learning (Cohen, Jones, Smith & Calandra, 2017). In this self-study, I examine tensions that arose from implementing the makerspace concept in my grade 10-12 alternate classroom. Self-study is an ideal way to explore the application of makerspace in the classroom as it is both improvement-aimed and contributory (LaBoskey, 2004). This study found that my fear and uncertainty that arose in implementing a makerspace in the classroom contributed to privileging of choice and autonomy over other aspects of makerspaces. Self-study helped me to re-connect with my values and beliefs of supporting student empowerment and student autonomy through scaffolded practices. This self-study also highlighted the importance that fear plays in surfacing tensions that need attending. This rich description of one teacher's experience contributes to the conversation on how to bring makerspaces into the classrooms.

Keywords: self-study, makerspace, autonomy, fear, uncertainty, integrity

Dedication

To my family, for supporting me throughout this lengthy process.

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List of Acronyms

BC	British Columbia, province of Canada
DIY	Do It Yourself. A movement to empower non-professionals to develop skill, share information and learn. DIY also refers to the act or the product of repairing, modifying or building something without professionals.
GGTS	Glue Gun Toy Sculptures
P21	Partnership for 21 st Century Skills
SFU	Simon Fraser University
STEAM	Science, Technology, Engineering, Art and Math
STEM	Science, Technology, Engineering and Math
UBC	University of British Columbia

Glossary

3D Printer	A machine that uses a three dimensional drawing to build a three dimensional object, usually using plastic. It does this by layering down thin layers of material, gradually building up the object according to the specifications sent via a computer.
Alternate School	A separate site program for high school students which provides small class size and additional social and emotional support.
Arduino	A programmable micro-controller used to sense and control objects in the physical and digital world.
Free school/ unschooling movement	A movement that attempts to provide an open learning environment with as little adult intervention as possible. Students are expected to be self-directed in their learning process. While unschooling is often a subset of homeschooling, free schools are alternative schools organized by parents and educators.
Maker movement	A trend that involves people creating community, both online and in person, to facilitate tinkering, hacking, creating and making for fun, for profit and/or personal fulfillment. This movement is facilitated by but not limited to new technologies such as Arduinos, 3D printers, and laser cutters.
Makerspace	A place stocked with materials and tools to facilitate making.
Making	“Designing, building, modifying, and/or repurposing material objects, for playful or useful ends, oriented toward making a ‘product’ of some sort that can be used, interacted with, or demonstrated” (Martin, 2015, p.31).
Raspberry Pi	A credit card sized computer with no monitor, keyboard or mouse. It is a very versatile and inexpensive computer which requires the user to load an operating system, plug in hardware, design and run programs.

Chapter 1. Introduction

1.1. Making and Makerspaces

The maker movement is a social movement that encompasses a diverse range of people who are making digital and tangible products for fun, for profit and/or personal fulfillment. While people have always made things, the current maker movement is facilitated by the internet, where countless videos, instructions and templates allow non-professionals to learn how to do a wide variety of tasks. It is also propelled by rapidly emerging and increasingly affordable technologies such as 3D printers, laser cutters, and Arduinos. Makerspaces are workshops where people share tools, collaborate on projects, learn from each other and make things. Makerspaces exist as member-based facilities and within libraries, schools, museums, and science centres. The culture of the maker movement embraces creativity, tinkering, hacking, re-purposing, collaboration and fun.

The maker movement is sparking an exciting new trend in education. Makerspaces are popping up in libraries, after-school programs, and classrooms all over Canada. In Vancouver, elementary schools are hosting maker fairs, teachers are attending maker workshops, and secondary schools are offering makerspace clubs. This trend coincides in British Columbia, not coincidentally, with the launching of the new kindergarten to grade 12 curriculum. Many of the learning goals in the new curriculum have a strong alignment with the makerspace ideals of learning through making, creative thinking, problem-solving and design thinking. Teachers are motivated to find new ways of teaching in order to deliver the new curriculum and are looking to makerspaces and making as a possible vehicle.

1.2. My Initiation into Making

As a teacher, the idea of setting up a makerspace in the classroom intrigued me. I was enthusiastic about the possibilities for collaborative hands-on learning while integrating various technologies and skills. In the past, my hands-on teaching had been mostly limited to standard practices such as using manipulatives for math, science labs and art classes. I had ventured into outdoor environmental education, project-based learning and design challenges. But makerspaces felt different and new. Personally, I have always considered myself handy and good at figuring stuff out. I worked as a bike mechanic, I've done woodwork, I took a year of computer programming, I dabbled in knitting and sewing and I generally can fix things around the house. But I had no experience with any of the newer technologies such as Arduinos, Raspberry Pi, 3D printers, or laser cutters. I had never visited a makerspace nor did I consider myself part of the maker movement.

I first tried implementing a makerspace with my grade 5,6,7 class. I ran a weekly makerspace where every Friday I introduced an activity or challenge. Over the course of the year, it became very clear to me that implementing a makerspace in the classroom was a complicated process. I wanted to stay true to the idea of makerspaces and not just reproduce a traditional art, home economics or computer science class. I also wanted to promote hands-on learning, problem-solving and collaboration. I found that the majority of my projects ended up being step-by-step activities. When I eliminated the instructions and allowed them to learn through playing with the materials, I found that students lost interest quickly. I had some successes throughout the year, but I realized that I needed

some more professional development in order to truly understand making and how to implement making in the classroom.

Simultaneous to wanting to stay true to making, I was developing a critique of the Maker Movement. After attending Vancouver's Maker Faire in June 2017, I started to question some of the values behind the maker movement. While there were many individual makers displaying their work, I was surprised by the commercial element of the fair. I was also surprised to learn that the Maker Faire itself was part of a larger "Make" brand. I came to realize that making had a more corporate side. I have always identified with movements working towards economic equality, anti-consumerism, environmental sustainability and social justice. The realization that the maker movement had elements of consumerism and capitalism prompted me to want to understand more about the values and ethos behind the maker movement before I became a spokesperson for the movement via my research.

1.3. Statement of Problem

A recent review of 43 empirical studies on making and its role in education found no negative effects (Papavlasopoulou, Giannakos, & Jaccheri, 2017). The researchers conducted a systematic search and review of high-quality, relevant literature. They found that making in educational settings resulted in engagement in complex programming concepts, a positive effect on self-efficacy, increased engagement, improvement of students' perceptions of STEM, and a majority of studies reporting collaboration among students. While this is certainly a positive result in favour of using making in the classroom, the authors point out that this result "does not provide an in-depth

understanding of how to prevent poor practices that hinder students' engagement and performance" (p.77). Furthermore, the researchers found that the majority of the studies focused on extra-curricular content. They submitted that more studies are needed on classroom applications of maker activities.

Blogger and teacher, Brian Aspinwall, advises that use of the language around makerspaces in education can be corrupting the meaning of making (Aspinwall, 2016). Aspinwall emphasized that making is a culture not a space and materials. He advises that making comes from the constructivism and is about learning by doing. The culture of making involves allowing the freedom to take risks, fail and follow passions regardless of the chaos. Sheridan et al. (2014) also have some advice about what makerspaces should look like. They propose three themes of makerspaces: multidisciplinary to fuel innovation and engagement, a variety of learning arrangements and that people learn while and for making. While these sources provide some advice on what making is and is not, there still remains a void in research about how to implement true making in the classroom (Papavlasopoulou et al., 2017) In fact, Papavlasopoulou et al. (2017) address this in their conclusion. They recommend further studies into maker instruction within the classroom.

1.4. Research Question

In answer to Papavlasopoulou et al.'s (2017) advice, I decided to conduct a self-study of my implementation of my nascent makerspace. In the fall of 2017, I started at a new school, a grade 10,11, 12 alternate school, a program for students who have not been successful in regular high school. The students often face a number of challenges to

success, these may include poverty, marginalization, and mental health issues. I taught makerspace as an art credit one block each day for the first semester, from September until January. During this time, I conducted a self-study where I examined the following research question: in what ways is my makerspace helping me understand the tensions that arise with the implementation of a makerspace?

1.5. Research Paradigm

I chose self-study research both as a professional development model and as a research methodology. While there are countless studies on how to improve learning, there is a disconnect between research and practice (Mills, 2014). This could be because teachers do not find the research relevant, accessible, and/or persuasive (Mills, 2014). Self-study research positions the teacher as researcher. Self-study is a methodology used in educational research and teaching to better understand “oneself, teaching, learning and the development of knowledge about these” (Loughran, 2004, p. 9). Self-study seeks to investigate teaching both for individual growth and also to contribute to the educational community. In this way, self-study can lead to reconstruction and reconceptualization of education (Loughran, 2004).

Self-study is improvement-aimed (LaBoskey, 2004). Effective professional development increases the knowledge of teachers, develops new teaching practices and leads to improvements in student learning (Gibson & Brooks, 2012). Studies have shown that effective professional development is based on teachers’ needs; is collaborative; provides opportunities for practice and feedback; and is teacher controlled (Gibson & Brooks, 2012). Self-study research is a form of professional development that meets all

of these criteria. In self-study research, teachers choose a focus and work to improve teaching and learning by observing, reflecting, trying out new approaches, and getting feedback from others.

While self-study is beneficial to the professional development of the researcher, self-study also contributes to the educational community (Loughran, 2004). When done with rigor, researchers construct knowledge that is relevant to others and thus contribute to the teaching and research community (Hamilton & Pinnegar, 1998). To ensure rigor, the process of self-study research requires the researcher to be open to the vulnerability necessary to truly disrupt their perceptions, examine personal conflicts and allow a close scrutiny of their practice and beliefs (Loughran, 2004). Working with a critical friend provides the opportunity to rethink and reframe teaching practices, perceptions and beliefs in ways that might not be perceived by the self-study researcher working alone (Schuck & Russell, 2005). Through this study, I have worked, with the help of a critical friend, to make explicit my professional knowledge so that it can be scrutinized in order to understand the complexities of implementing makerspaces in the classroom.

1.6. Outline of Thesis

In the following chapter, I look at the ethos of the maker movement and conclude that there is some divergence within the movement between the corporate, profit-driven element and an anti-consumerism DIY culture. Next, I analyse the elements and promises of the maker movement as presented by both advocates and researchers. I then examine the promises and potential of the maker movement for education. While I find the ideals and promises of the maker movement to be, by and large, unsubstantiated, I

conclude that the constructionist learning potential of makerspaces is backed by research. I also survey the research supporting making in the classroom with the goal of extracting concrete and research-supported ways of implementing a makerspace in the classroom, particularly with regards to marginalized youth.

Chapter three reviews the literature surrounding self-study as a research methodology, focusing on its relevance and suitability for this study. This chapter also explains my research methods, including data collection and analysis. In the following two chapters, I share my findings and discuss two themes: 1) the privileging of choice and autonomy, and 2) fear and uncertainty. I conclude that my fear and uncertainty with regards to implementing a makerspace in the classroom contributed to a privileging of choice and student autonomy while neglecting other elements of constructionist learning. This resulted in an unsatisfactory makerspace class and a misalignment of my values and practice. Self-study triggered an examination of my beliefs and educational philosophies and surfaced an internal conflict of my struggle to maintain integrity as an anti-authoritarian within the school system. This research helped me clarify my belief in student choice and autonomous learning while highlighting the importance of scaffolding students to work towards these goals. My examination of fear highlighted the importance of the role fear plays in surfacing tensions that need attending. Overall, this study helped me restore my integrity and understand ways in which I can implement makerspaces while keeping my practice, beliefs and values in alignment.

Through this account of my journey, it is my hope that others can use my tracks to engage in this conversation. By witnessing my journey, other teachers may be able to

imagine implementing 'making' in their own classrooms and think about how they will confront the tensions and problems they will encounter.

Chapter 2. Literature Review: Making and the Classroom

Implementing making in the classroom is a value-laden activity. To start with it implies an alignment with the maker movement. If I am going to use the language of the maker movement, the resources directly associated with it, and engage in the discourse regarding the maker movement, it is essential that I begin with a clear understanding of the discourse surrounding the terms making, makerspaces, and maker movement. The maker movement may promote itself as politically neutral, but a closer examination reveals at least two conflicting and overlapping ideologies. This review will examine the discourse surrounding the values, politics and role of the maker movement in society. Furthermore, making is often praised as being capable of transforming education. This claim must also be examined. If I am to promote implementing making in the classroom, I need to understand its pedagogical justification, examine the research that supports making in the class and review the literature that provides guidance on how to best do so.

2.1. Making: A Popular Trend

The maker movement can be thought of as a community of hobbyists, tinkerers, professionals, and artists who meet both face-to-face and online to share ideas, teach each other, and showcase products that they have designed and/or made. The products may be digital, tangible or a mixture of both and may be useful, playful or aesthetic in their purpose. Some products are made by the makers and some are designed by makers but the actual production is outsourced (Anderson, 2012). Martin (2015) defines *making* as:

“focused on designing, building, modifying, and/or repurposing material objects, for playful or useful ends, oriented toward making a ‘product’ of some sort that can be used, interacted with, or demonstrated” (p. 31). This definition captures both the environmental ethos found in some making communities and the production-oriented ethos found in other communities.

While people have always made things, recently the possibilities for making have greatly expanded thanks to the growing body of technologies that are becoming more affordable (Martinez & Stager, 2013; Dougherty, 2013). For example, as a child in the 1980s, I made plays up with my cousins and siblings. We performed them once to our patient parents. My child and his friends, using an iPad, make fast-paced action movies complete with digital effects. Some of his videos are on YouTube and have been viewed over 500 times. Those looking to make physical objects will find 3D printers and laser cutters open possibilities previously undoable. Using open source programs, people can design items to be cut out or printed. Physical computing is made accessible with The Arduino, a low-cost micro-controller that allows people to build programmable robots out of anything. For an easier entry point, there are many robots on the market that gameify programming, making physical computing easier to learn. Block programming makes both computer and physical programming simple and understandable. There is an ongoing flood of new maker products on the market that use electronics, physical computing, and some less technology-based modes (e.g. www.make.do and <http://strawbees.com>) to make making fun and accessible.

The internet might have the biggest impact on making culture by allowing easy access to the maker movement. A quick search will find instructions, videos and designs

for almost any project. There are entire websites dedicated to providing instructions on maker projects (www.makezine.com, diy.org and www.instructables.com) plus sites dedicated to specific areas of interest such as knitting, electronics, or 3D printing. There are also venues to showcase your work (e.g. [pinterest](https://www.pinterest.com)) or sell your work (e.g. [etsy](https://www.etsy.com)).

Make Magazine began popularizing the phrases ‘Makerspace’ and ‘Maker Movement’ with its first publication in 2005 (Cavalcanti, 2013; Martin 2015). Now there are both public and private makerspaces in cities throughout the world and a wide online community. Makerspaces, Hackspaces, FabLabs, and Techshops are just some of the names used for these spaces that are designed and stocked to facilitate making. In the Vancouver area, there are at least five member-based spaces offering classes, space and tools (for example: Makerlabs, Vancouver Community Laboratory, Zen Maker Lab). They offer members access to traditional tools and digital tools such as laser cutters and 3D printers. These makerspaces serve as a place for hobbyists, artists, start-ups, professionals, and the curious to share tools and expertise (Hui, 2014).

There is a growing interest in implementing making and makerspaces in educational settings. Many kid-friendly educational centres such as libraries, science centres and museums have embraced the maker movement. In the United States, there are places such as Tinkering Studio in the Exploratorium in San Francisco, Ingenuity Lab at the Lawrence Hall of Science in Berkeley, Maker Space at New York Hall of Science, and MAKESHOP at Children’s Museum of Pittsburgh. Canada also has a burgeoning educational-based maker movement. In Edmonton, Hamilton, and Sudbury, the public libraries offers makerspace programming and space for free to the public (Edmonton Public Library, 2017; Hamilton Public Library, 2017; “Greater Sudbury,” 2015).

Vancouver's Science World offers several maker-focused programs, including a Made in Canada exhibition during the summer of 2017. Universities are offering maker-focused summer camps for kids, for example, University of the Fraser Valley's GearBots or University of British Columbia's Maker Camp.

Educational websites entice teachers to try out making in their classrooms (for example, <http://www.makerspaceforeducation.com/>; <https://www.edutopia.org/topic/maker-education> and <http://spaces.makerspace.com/>). A quick search on Amazon reveals that there are a number of published books offering maker activities for the classroom (e.g. *The Big Book of Makerspace Activities*, *Maker Labs*, *STEAM students*, *Your Starter Guide to Makerspaces*). The Ontario government is offering educators instructions on how to set up a makerspace in the classroom (Hughes, 2017). British Columbia's biggest universities UBC and SFU are offering maker opportunities for teacher candidates through labs, courses and programs (for example: SFU Faculty of Education, n.d.; UBC Faculty of Education, n.d). A quick Google search will reveal that dozens of elementary and secondary schools in BC have jumped on board and have opened makerspaces, hosted maker fairs and started maker clubs.

While makerspaces may be just a fad, it is clear that this movement is supported by many stakeholders in education in both the private and public sector. It is imperative to take a close look at the beliefs and values associated with the maker movement to better understand its potential influences on and ramifications for education.

2.1.1. The Ethos of the Maker Movement

Although the maker movement is not a homogeneous movement with a united ethos, there are reoccurring themes. Valuing of collaboration is a recurring theme in the literature (Giannakos, Divitini, & Iversen, 2017; Cohen, Jones, Smith & Calandra, 2017; Seravalli, 2014; Sheridan, Halverson, Litts, Brahms, Jacobs-Priebe, & Owens, 2014; Martin, 2015). This collaboration can take place online via websites such as makezine.com or instructable.com where people share their ideas and instructions (Kuznetsov & Paulos, 2010). Collaboration also happens in physical spaces as described by Giannakos et al., 2017:

The contemporary movement for Makerspaces, Hackerspaces, and FabLabs...bring people together to generate new ideas and work on conceptual prototypes in an open environment, towards socially and globally relevant new product ideas and innovation (p. 78).

Sheridan et al.'s (2014) study of three makerspaces found that collaboration happened in both formal (workshops and classes) and informal ways (members helping each other). Another form of collaboration is the open source model, or commons model (Seravalli, 2014). Free and open sources allow and encourage anyone to borrow, modify and extend any code, design, or blueprint of a product. This form of collaboration has expanded the scope of the maker movement (Seravalli, 2014; Lindtner, Hertz & Dourish, 2014). This collaboration is different from the traditional corporate model of production where collaboration only happens within production teams. The open-source model of the maker movement allows anyone to participate, not just employees of a corporation or institution (Seravalli, 2014).

The maker movement also values innovation and creativity (Cohen et al., 2017; Giannakos et al., 2017; Martinez & Stager, 2013). Sheridan et al. (2014) found that the multidisciplinary nature of makerspaces facilitated innovation, in other words mixing and matching materials and media fueled creativity. Within this theme, Cohen et al. (2017) adds choice as an important element of the maker movement. Choice motivates people as it facilitates a personal connection with the process and the product (Dougherty, 2013; Resnick & Rosenbaum, 2013; Sheridan et al. 2014). Also, within this innovation theme is the valuing of a failure positive ethic (Cohen et al., 2017; Martin, 2015). Failure is viewed as an opportunity to learn and an inevitable part of any innovation.

Despite these recurring values, there is some divergence with regards to ethos within the maker movement. There exists an emphasis on potential financial gain for individuals and corporations in some of the maker movement literature. Some see the open source approach to skills, technology, and ideas as an opportunity for entrepreneurs to tap into the creativity of the collaborative process (Seravalli, 2014). Dale Dougherty (2012), the founder of Make Magazine and a strong advocate of the maker movement, urges entrepreneurs and corporations to take advantage of the maker movement by using it “as a source of talent and ideas” (para. 9). North Vancouver’s ZenLab is an example of a makerspace that focuses on innovations for entrepreneurial purposes. On their home page, they advertise themselves as a “premier startup hub” (ZenLaunch Pad, n.d.). Chris Anderson, a former *Economist* and *Wired* writer, argues that making is igniting the third industrial revolution that will reinvigorate the American economy (Anderson, 2012). In Anderson’s third industrial revolution, the entire chain of supply is revamped. Makers are uploading their designs from their laptops to factories in the cloud, where much of the

work is done by robotic machine tools. Distribution is done via drop shipping directly to customers. Marketing is done via e-commerce sites such as Etsy. Purpose-built factories, distribution companies, marketing personnel, salespeople and a company to finance and oversee the whole process are all made obsolete with this new model. Anyone with a good idea and a laptop can make it happen, start-up costs can be obtained by crowd-source funding such as Kickstarter (Anderson, 2012). This is reminiscent of the American dream of individualism, where smart, hard-working people have an opportunity to rise to the top. There even exists an industry selling ‘making’ itself. Companies are selling maker kits with all the materials supplied and step-by-step instructions. TechShop is a chain of private makerspaces with locations all over the United States. Other entrepreneurs are making money by selling maker-themed birthday parties, summer camps, after -school classes, school visits and workshops to parents and educators. In these makerspaces, the making activities, materials and expertise required are sold as a package to the consumer.

The other ethos within the makerspace literature is the DIY (Do It Yourself) culture. Kuznetsov and Paulos (2010) describe DIY as the making, modifying or repairing of things without the aid of paid professionals. The ethos of DIY is one of empowering lay people to develop skills, share information, and learn (Seravalli, 2014). Much like the Arts and Crafts movement of the 19th century, which was a response to the deskilling of society, the assembly line and the industrial age (Krugh, 2014; Seravalli, 2014), the DIY movement, originating from the punk movement of the 1970s, embodied a rebellious, anti-consumerist ethos (Kuznetsov & Paulos 2010). DIY in recent years has come to embrace environmental ideals of re-use and recycling over mass consumption by

encouraging repairing or re-purposing used items instead of buying new (Seravalli, 2014). As the name suggests, DIY is about doing-it-yourself, sharing knowledge and helping others as a way to circumvent the capitalist economy. Seravalli (2014) argues that makerspaces are democratizing manufacturing and boosting innovation by facilitating “a new mode of production in which resources and means are treated as commons allowing for individuals to collaborate and perform production outside traditional structures” (p. 100). She even sees the potential for this new mode of production to not just be more “socially and environmentally sustainable way of performing production” but one “that could overcome the limits and problems of mass and capitalist production” (p. 100).

While both Seravalli (2014) and Anderson (2012) refer to a third industrial revolution, Anderson’s (2012) vision is not challenging capitalist ideology, just restructuring the supply chain. Seravalli’s (2014) vision is hopeful that this industrial revolution will not be “just the latest evolution of capitalist production” (p. 100), but rather a challenge to capitalism. The mainstream maker movement however, has a discourse that is focused on expanding markets and profits (Vossoughi, Hooper, & Escudé, 2016). Furthermore, the emphasis in the mainstream maker movement is on expensive tools that do not promote the DIY ethic of re-use and re-purpose, such as 3D printers and laser cutters (e.g. Anderson, 2012; Dougherty, 2012). The plastic in 3D printers is easily wasted and not easily recycled. Laser cutters are used for cutting purpose-made materials, not re-used materials. Many of the gadgets on the market for making such as Little Bits are made from new materials, mass produced, and destined

eventually for landfills. The DIY culture instead embraces re-using and re-purposing of all types of materials, as a way of diverting materials from the landfill.

While the mainstream maker movement literature is peppered with references to how making will transform the world, (e.g. Anderson, 2012; Dougherty, 2012; Giannakos et al., 2017) there is little discussion of the vision for this transformation, beyond the market place changes. This vague optimism reflects larger trend in modern western thought where there is an unwavering faith that all problems can be solved with technology (Selwyn, 2011). Lindtner, Bardzell and Bardzell (2016) warn that making does not have inherent abilities to transform industry and society into more fair and democratic organization. Their examination of long-term ethnographic studies with two transnational DIY making collectives found that it required work to realize any potential of ‘making’s utopian ideals’ (p. 81). They advise against what they term technosolutionism, “the idea that technology provides solutions to complex social problems” (p. 80). According to Vossoughi et al.’s (2016) review of the mainstream maker movement discourse, there is little desire to address complex social problems. The transformation being marketed is “more aligned with corporate values than social change” (Vossoughi et al., 2016, p. 212).

Another problematic discourse within the mainstream maker movement is the frequent conjuring of ‘innovation’ as savior. Innovation is presumed positive and capable of transformation in the making literature. For example, Giannakos et al., (2017) discuss the potential of making to “empower future inventors, innovators, and people who are going to change the world” (p. 77). The authors do not elaborate on what that change would be. Dale Dougherty (2011) in his TED Talk, features several innovations

from a drill powered scooter to space technology. He speaks of innovation as being an American value, one that everyone needs to embrace. I would like to trouble the innovation as ‘good’ narrative. There is a long history of scientific research and innovations being used to oppress marginalized people (Vossoughi et al., 2016). Innovations are new ideas, methods or technologies. They are not necessarily good or bad, but each innovation must be judged from an ethical, social, environmental perspective to determine its potential consequences. Lindtner et al. (2016) go even further and advocate a reflexive-interventionist approach to ensure that making is pursued not uncritically but in ways such that promote making’s democratizing potentials. They argue that technosolutionism inhibits the potential of making for producing its’ supposed utopian ideals. They call for careful reflection and intervention to steer making on a course that increases democratization. Dale Dougherty’s (2011) TED Talk does just the opposite; every innovation is celebrated simply on the basis of being innovative.

I have intentionally not capitalized “maker movement” to acknowledge and emphasize that the maker movement is not a homogenous movement with Dale Dougherty, founder and CEO of Maker Media, as a main leader and spokesperson. Though it may be argued that Dougherty is a spokesperson for the Maker Movement, (capitalization intended), his brand of maker movement is one clearly aligned with the ‘innovation is good’ narrative, profit and expansionism (Vossoughi et al., 2016). Within the maker movement as a broader movement of artisans, DIYers, crafters, hackers, tinkerers and, yes, entrepreneurs, there is not consensus that the current economic and political course of profit-driven and expansionist economies are the best way forward. I

prefer to align myself with the DIY ethos of sustainability, anti-consumerism and social justice.

2.1.2. The Promises of Making for Education

There are many, including President Barak Obama, who “view the maker movement as an innovative way to reimagine education” (Cohen et al., 2016, p. 218). There are however subtle differences in the way education is being re-imagined. One promise is that making will help prepare youth for the 21st century (Martinez & Stager, 2013; Giannakos & Divitini, 2016; Zipkes, 2013). Invoking the 21st century is a buzzword with little substance. The list of 21st century skills varies from source to source, but generally contain some very old ideas such as critical thinking, interpersonal skills and problem-solving (Naylor, 2010) along with technical skills to keep pace with emerging technologies. The term 21st century skills has also been popularized by the 21st century skills movement, embodied by Partnership for 21st Century Skills or P21, and driven in large part by the high-tech industry and the United States government (Naylor, 2010). While I agree with the importance of many of the skills identified by the 21st century skills movement, I question the motivation of any corporate-sponsored education movement. I am not interested in developing these skills in my students to prepare them to contribute to the high tech industry’s pocketbook. Any reference to preparing kids for the 21st century or giving them 21st century skills should be taken with a grain of salt. Twenty-first century skills are at best, nothing new, and at worst a cynical corporate agenda.

Another theme in the literature of making in education is to arouse interest in STEM (Science, Technology, Engineering and Math). The hope is to use making as a way to “empower future inventors, innovators, and people who are going to change the world” (Giannakos et al., 2017). Honey and Kanter’s (2013) book *Design Make Play: Growing the Next Generation of STEM Innovators* has the purpose of facilitating “opportunities through which today’s young people can become inspired and passionate science and technology learners” (p. 1). When innovation is invoked with regards to education it is used in an individualist approach to education: making will promote individual students to be innovative, and future world changers. The ways in which these future innovators will change the world is just as vague and undefined as the way innovation is used in the maker movement literature.

Martinez and Stager (2013) assert that making will transform education in a broader sense, not just by inspiring individuals. Here is a list of ways they promise making can transform education: “Classrooms could become places of great joy, creativity, and invention” (p. 3); making will “provide a meaningful context for understanding abstract science and math concepts” (p. 3); making will combine subjects; making will “enhance the learning process for diverse student populations and open doors to unforeseen career paths” (p.3); and finally making will enable schools to stop streaming students. This is a very ambitious list. The book provides instructions on how to implement making in the classroom but does not provide any evidence that making will make good on these promises.

The final and most salient promise of the maker movement for education is that making is a pedagogically sound practice that will improve learning. Most advocates for

making in education reference Seymour Papert's work and constructionist theories (e.g. Cohen et al., 2017; Halverson & Sheridan, 2014; Martin, 2015; Martinez and Stager, 2013). The promises of constructionism, unlike the other promises, are backed with a body of research. It bears taking some time to look at constructionism and examine in what ways making in the classroom constitutes constructionism.

2.2. Constructionism and Makerspaces

Constructionism is a learning theory that rose from Piaget's constructivist theories that asserted that knowledge is not transmitted but rather actively constructed in the mind of the learner (Kafai & Resnick, 1996). Papert (1991) describes constructionism by starting with its similarities to constructivism: "Constructionism shares constructivism's connotation of learning as building knowledge structures...[Constructionism] then adds the idea that this happens especially felicitously in a context where the learning is consciously engaged in constructing a public entity" (p. 1). Constructionism proposes that learning happens best when the learner is engaged with making some external artifact, that they purposefully reflect on the process, and they share with others (Kafai & Resnick, 1996). Brennan (2015) details the learning processes involved in constructionism by breaking it into four components: designing, personalizing, sharing and reflecting. These serve as useful guide to evaluate to what degree making is in line with the pedagogical roots of constructionism. I am going to use Brennan's (2015) components in context with constructionist literature as a lens to judge the claim that making is in line with constructionist learning theory.

Brennan (2015) aligns designing with making when she describes designing as “the active construction of all types of things” (p. 290). Research shows that designing employs many habits of minds such as critical creativity, persistence and hard work (Brennan, 2015). Designing involves complex thinking: from analysis of the problem, breaking the problem down into sub-problems, and identifying and negotiating constraints (Resnick and Ocko, 1991). In her study of kids learning design by making games, Kafai (1996) broke design down into the following components: planning, problem solving, researching, dealing with time constraints, modifying expectations, and bringing everything together into one project. Gargarian (1996) takes it one step further and advocates design as a sound learning approach when he deconstructs the processes involved in designing and connects these processes to learning theory demonstrating that designing is inherently an essential learning process. Gargarian sums up the importance of design: “Not everyone has to become a scientist or an artist but everyone needs to develop design skills” (p. 154). Gargarian asserts that through constructionist activities, students learn about design itself. Martinez and Sager (2013), spend an entire chapter on design thinking and its role within making. They call for tinkering-friendly design models that allow for creativity, planning, problem-solving and improvement. It is clear that the research supports Brennan’s (2015) ‘designing’ component as both promoting learning and as a major component of making.

Brennan’s (2015) second aspect of constructionism is personalizing: learners are especially engaged in construction when these things are personally or socially meaningful. This is an echo of Resnick and Ocko’s (1991) assertion that teachers need to put children in control. They found that children have more success when they formulate

their own designs and experiments and work on projects that they care about. Brennan (2015) details that ‘personalized’ also refers to the personalized engagement on a cognitive (assimilating knowledge or accommodating new ideas) and affective level (learner styles and self-concepts). Similarly, Resnick and Ocko (1991) recommend offering multiple paths to learning. In their study of Lego/Logo, they found that some start with programming, some architectural aesthetics, and some mechanical design. Kafai (1996) found that there were multiple ways of designing games and “no one ‘right way’ to start, continue and accomplish a design task” (p. 94). Personalizing is also a theme in the making literature. Martin (2015) asserts that a critical component of making is free choice. Halverson and Sheridan (2014) stress that an essential feature of a makerspace is people are free to move around and choose if and how to participate. Martinez and Stager (2013) emphasize that projects and prompts put forward by educators must allow the students a high degree of flexibility and creativity. For example, they caution against rubrics because they impose the teacher’s vision on the solution and products thus curbing imagination. They emphasise allowing the students’ voices and ideas to be heard and materialize (Martinez & Stager, 2013). Again, the constructionist literature supports Brennan’s assertion that personalizing is an important part of constructionism and the making literature reflects this component of constructionism.

Brennan’s (2015) third aspect is sharing. Brennan argues that learning happens through interactions with others: audience, collaborators and coaches. Evard (1996) argues that sharing not only can lead to improved iterations of the product, but also a deeper understanding of the concepts for all involved. Evard also found that

communication around projects helped develop a sense of community. Kafai and Harel (1991) found that there were two ways that students collaborated: within a working group where students worked together to share ideas and design and “a collaboration through the air” where “students interacted with free-flowing ideas and concepts” (p.103). Gargarian (1996) also emphasizes the importance of sharing through the concept of social constructivism: “The basic idea of social constructivism is that a community is more intelligent than any of its members, including its leaders” (p. 151). Resnick and Ocko (1991) concluded that community was essential and called on educators to encourage sense of community, share ideas, designs, and actual constructions. The literature on making also strongly emphasizes the importance of sharing (Sheriden et al., 2014; Martin, 2015; Dougherty, 2013) and collaborating as was explored already in this chapter. Martinez and Stager (2015) identify sharing projects and collaborating with others as two of the eight elements of a good project. Brennan’s ‘sharing’ is supported by the constructionist literature and reflected in the making literature.

Finally, Brennan (2015) describes reflecting as the fourth aspect of constructionism. Constructionism invites children to ask the following questions: “What do I want to create? What do I need to create it? What do I need help with? Why didn’t that work as I expected it to? Who might help me? Who might I help? How might I better approach all of these questions?” (p. 292). These questions invoke the process of thinking about thinking, or metacognition.

By encouraging students to think about their problem-solving process, constructionism can strengthen metacognitive knowledge (Pintrich, 2002). This metacognitive knowledge becomes a generalized problem-solving strategy applied to

other situations that improves students' ability to monitor (e.g. notice what they don't understand) and regulate (e.g. work towards understanding by getting help or researching) their thinking processes (Pintrich, 2002). Metacognition gives the learner a sense of agency by allowing them to self-monitor, self-regulate and self-assess (Hacker, Dunlosky, Graesser, 2009).

Several researchers have made a connection between constructionist learning and metacognition. Papert (1993) claimed that the constructionist model promoted metacognition by encouraging students to think about their learning process. Edvard (1996) found that the sharing and communication process that comes with constructionism contributed to metacognition. Harel and Papert's (1991) work shows that a constructionist model of math improved both performance and metacognition.

This is the one component of constructionism as proposed by Brennan (2015) that does not feature strongly in the maker literature. Martin (2015) does not include reflection in his list of essential components of the Maker Movement for education. Sheridan et al. (2014) did not identify reflection as an important component of makerspaces. Martinez and Stager (2015) mention only that reflection is an important part of iterative design and part of the learning process. They emphasize that teachers should not spend very much time on encouraging reflection, as it is part of the learning process "and should not be used as justification for impinging on learning time" (p. 81). This is in contradiction to Pintrich's (2002) research. He argues that while metacognition may come naturally to some students, the majority need to have it explicitly taught. Though the research shows that reflection is an important part of constructionism, the makerspace literature has not yet explored the role of reflection in making in any depth.

It would seem that, while the implementation of makerspaces in K-12 education is a very new idea, it is, appropriately, a recycling and re-mixing of several old educational practices and theories. Resnick and Rosenbaum (2013) note that the maker movement resonates with Dewey's progressivism and Papert's constructionism. Clearly, implementing making in the classroom fits neatly within the pedagogy of constructionism. Not only do advocates of making in the classroom overtly connect making to constructionism, three of Brennan's aspects of constructionism are well-reflected in the maker literature.

2.3. Making in the Classroom

It has already been established that there are many unsubstantiated promises with regard to making in education. There is however a small and growing body of literature that provides positive evidence with regard to making and education. Papavlasopoulou, Giannakos, and Jaccheri (2017) recently published a review of 43 empirical studies on making in education. Papavlasopoulou et al. (2017) examined only research papers that met the criteria of peer-reviewed, rigorous and credible. They found that most studies focused on computer programming and STEM. All studies used digital materials in the making. The authors found that making was successful in encouraging engagement with complex problem solving, promoting self-efficacy, and encouraging engagement and positive perceptions regarding the subject area. The study did not find any studies that reported negative effects in making.

Since then, further studies have found that making supports learning and promotes fun in learning. Chu, Angello, Saenz and Quek (2017) found that maker activities in

grade 3,4, and 5 science classes resulted in both observed fun and children reporting that they had fun. The report also found the maker activities had positive effect on learning outcomes. Giannakos, Divitini, and Iversen (2017) argue that making has the potential to promote joyful learning. Through the use of new technologies such as video game design, e-textiles and robotics, making can engender creative and joyful learning (Giannokos et al., 2017).

Two studies found that maker activities improved students' connections with science. Sheffield, Koul, Rekha, and Maynard (2017) argued that the girls “embraced their science experience as creators, critics and idea generators” (p. 160) because the makerspace provided an environment where not just cognitive matters were attended to but also affective (confidence, perseverance, enjoyment and engagement) and motivational factors were also provided for through engaging constructionist activities. Tofel-Grehl, Fields, Searle, Maahs-Fladung, Feldon, Gui and Sun (2017) found that using e-textiles instead of a traditional circuitry unit provided opportunities for connections with family, friends and teacher and resulted positive identity shifts with regard to science. The authors argue that, in particular, the tangibility, aesthetics and shareability qualities of the e-textiles encouraged students to develop a stronger interest in science in relation to important people in their lives such as family, friends and teachers (Tofel-Grehl, et al. 2017).

While these studies combined with the constructionist literature show that there is value in implementing makerspaces and maker activities in the classroom, they do not provide much with regards to the “how to” of such an undertaking. The following

section looks at the research that focuses on the logistics of bringing makerspaces into the classroom.

2.3.1. Implementing Making in the Classroom

Cohen et al. (2017) suggest that the infusion of elements of the maker movement into formal schooling must be done thoughtfully. The small but growing body of literature offers some evidence for moving forward in effective and thoughtful ways.

Cohen et al. (2017) contributed to this literature by developing a framework for bringing making into the classroom. They suggest that four concepts are key to the maker movement and constructionism and must be considered and accommodated when importing making into the classroom: creation, iteration, sharing and autonomy. They argue that making should enable creations that cross disciplinary lines and that involve repurposing or re-mixing. The authors submit that iteration provides opportunities for high order thinking such as analysis and evaluation. Sharing, according to Cohen et al. (2017), should happen within the classroom and beyond via the internet. Autonomy is an essential component of making and Cohen et al. (2017) assert that this can be supported through choice of making activities and collaboration between teacher and students when it comes to assessment.

Martin (2015) argues that the playful mindset is critical for implementing making in education. Play is at the heart of making and drives the motivation of making (Dougherty, 2013; Martin, 2015; Giannakos & Divitini, 2016). This echoes back to the play-based approach to education that has its roots in Vygotsky's theories of development (Whitebread, Jameson, & Lander, 2009). There is much research to support the claim

that play promotes learning, communication, collaboration, creativity, and problem-solving (Zosh, Fisher, Golinkoff, Hirsh-Pasek, 2013). Zosh et al. argue that the Maker movement is a good vehicle for promoting play-based learning. Martinez and Stager (2013) assert that play is an essential component of design. They argue that tinkering is playing in a creative, fail-free way that allows the maker to break out of what they know and imagine how things could be. In this way play can be purposeful and productive.

Bullock and Sator (2017) found that a “peaceful approach” (p. 64) facilitated an environment conducive to making. The researchers implemented a makerspace with teacher candidates, where they positioned themselves as collaborators instead of leaders and engaged in making alongside the participants. They found that this led to an environment where people felt safe to experiment and ask questions; people engaged in dialogue; there was collaboration; and participants felt free to make mistakes. This peaceful atmosphere allowed participants to be creative and allowed for the integration of science and technology without the stress of a task-oriented approach. The researchers had previously identified four principles crucial to maker pedagogy: ethically hack, adapt, design, and create. They found that through dialogue there was opportunity to “create and sustain the conditions for these four principles” (p.68).

Giannakos et al. (2017) recommend “design tools, kits, and spaces for individuals to promote ‘low- floor’ (easy-to-start) and ‘high-ceiling’ (to create increasingly complex projects over time) opportunities for young people” (p. 79). This observation is corroborated by Somanath, Morrison, Hughes, Sharlin, & Sousa (2016) experience with starting off by introducing a combination of programming and Arduinos with at-risk youth. Only one student completed the project, the other seven gave up in frustration.

Somanath et al. (2016) concluded that is essential to have a low entry point with regards to any use of technology. Bennett and Monahan (2013) found that in their design lab that early circuitry activities failed because kids didn't get the loop. They discuss their struggles finding activities where kids were designing and not merely assembling. They realized that getting to the place where one is ready to design can take considerable time. One has to learn some concepts and how to use some tools and materials. Bennett and Monahan (2013) solved their dilemma by finding problems that were engaging for a wide variety of people and materials that required almost no training. Gargarian (1996) suggested that microworlds (such as today's Scratch) provide an opportunity for users to discover powerful ideas with little training. Similarly, Somanath et al. (2016) discovered that allowing students to discover as opposed to following step-by-step instructions improved engagement and creativity. This echoes Papert's (1991) assertion that children learn through making as well as Sheridan et al.'s (2014) conclusion that learning is in the making. Gargarian (1996) asserts that discovery learning is the preferred way to learn. He argues that it is important to provide an environment where there is no floor and no ceiling so that students can discover without direct instruction.

2.3.2. Making with Marginalized Youth

One criticism leveled at the studies of making in education and the maker movement is that there is little focus on studying and including groups that are marginalized (Richard & Giri, 2017; Papavlasopoulou et al., 2017; Vossoughi et al., 2016). This is a pertinent criticism to my self-study as I work in an alternate senior high school where the majority of the students are considered marginalized or at-risk. There are a few studies that attempt to address this gap in the literature..

To start with, Vossoughi et al.'s 2016 essay suggests what not to do. This essay criticizes attempts to include non-dominant groups, such as racialized, working class, at-risk youth and girls by imposing the framework of bringing making to the underprivileged so that they too can benefit from the wonders of making. Within this framework, the dominant culture is framed as expert, teacher and owner of making, whereas the non-dominant group is framed as empty slate. This does not recognize the historical and current context and expertise of making within immigrant, working-class and racialized cultures and within women's work. Instead these communities are "targets of intervention rather than sources of deep knowledge and skill and dominant communities are reinscribed as being ahead, with something to teach or offer rather than something to learn" (Vossoughi et al., 2016, p. 212).

Calabrese Barton, Tan and Shin's (2016) study responds to this criticism with a case study of non-dominant youth in an afterschool makerspace program. Instead of framing their participants as targets of an intervention, the authors view the youth as agents of transformation. They are interested in how the youth re-organize, disrupt or expand the makerspace through their making activities. The students chose to make artifacts that were rooted in their "deep and critical knowledge of the needs of their communities" (p.290) and that drew on their knowledge of issues inside their communities. The youth also chose to make artifacts to address these issues demonstrating a care and attachment for these communities. By including their communities as a source of knowledge and inspiration, the youth redefined the making activities and makerspace. Calabrese Barton et al. (2016) found that youth, similar to the

makers in Sheridan et al.'s (2014) study, repurposed and mixed tools, materials, practices and relationships from various communities.

Somanath et al. (2016) found that practical, real-world design challenges as opposed to abstract projects engaged the students. This study also found that students needed 'discoverable options' not an end product to emulate. Somanath, et al.'s 2016 study was of particular interest to me as it was within a Canadian context and focusing specifically on at-risk youth. The students in this study, like my own students, face many barriers to success due to life circumstances and have had fewer experiences of success with regards to technology. This study found that students responded more positively to constructivist learning opportunities than instructivist lessons. They found that students valued opportunities to personalize, use creativity and make things relevant to themselves over being given step-by-step instructions (Somanath et al., 2016). The study also found that students needed both a low entry point for technology and the flexibility of multiple entry points. When entry points were too high or inflexible, students gave up quickly, were unwilling to experiment and had low motivation. Again, creativity was theme that emerged from the study. Instead of being a result of makerspace activities, Somanath et al. (2016) found that opportunities for creativity were an important motivator.

Richard and Giri (2016) show how inclusion means that the making activities must allow learners to explore their intersecting and diverging experiences, critique and redesign media representations with accessible tools. They designed a makerspace workshop that facilitated group projects that used both physical and digital interfaces. They found that the criterion of using two different interfaces encouraged distribution of work and thus collaboration. The format also valued different areas of expertise. The

shared artifact increased computer identity among previously non-computer identified participants, self-efficacy, and motivation. Holbert (2016) also found that acknowledging and welcoming the making done by non-dominant communities and accommodating values and goals of communities were essential to creating inclusive making spaces. Again, Brennan (2015)'s constructionist principle that people are especially engaged when the construction is personally meaningful is supported by these studies of making in education.

Papert (1987) warned us over 30 years ago not to rely on the tools of construction, but rather understand the technology should stay back seat to people and culture:

Technocentrism refers to the tendency to give...centrality to a technical object...a tendency to think of computers as agents that act directly on thinking and learning; they betray a tendency to reduce what are really the most important components of educational situations – people and cultures – to a secondary, facilitating role. (p. 23)

Similarly, Brennan (2015) asserts that constructionism, and by extension my study of makerspaces, should focus on the significance of culture in learning. These two authors emphasize that it is not the tools or materials that determine a makerspace, but the people, the cultures they bring with them and the culture they create together. Calabrese Barton et al. (2016), Holbert (2016) and Richard and Giri (2016) show successful examples of allowing culture and people to be the driving force of making, not technology.

2.3.3. Summary of Research

To summarize, making is effective in education when it is carefully guided by constructionist pedagogies, and when the students' strengths, interests, cultural values and knowledge are valued. Making activities must be structured to allow both for elements of design thinking and for play/discovery learning. A safe and productive

learning environment may be fostered by making alongside students and engaging in dialogue about making, instead of positioning oneself as expert, non-participant and outsider. Activities with easy entries points but limitless possibilities allow for every student to engage at their level, personalize their learning, and encourages creativity and imagination.

Chapter 3. Methodology

3.1. Self-Study Methodology

This was not just a simple journey into how to implement ‘making’ in the classroom. While that was my initial intention, I came to realize in my first year of experimentation with makerspaces, that there was much more to examine with regards to makerspaces than a simple how-to guide. As is evidenced from the review of the literature, makerspaces, making and the maker movement open up some deeper philosophical, pedagogical and value-based discussions. Though using self-study to research makerspaces is a brand new field, Bullock and Sator (2015) assert that self-study has potential to provide “productive empirical techniques” (p. 226) with regards to making and education. Bullock and Sator (2017) found that self-study facilitated a deep analysis of their makerspace pedagogy and how their personal identities contributed to their practice. Similarly, self-study allowed me to “unpack and portray the complexities of teaching” (Loughran, 2005, p. 13) with regards to makerspaces. Self-study is a methodology that facilitated a thorough examination of the underlying issues of values, pedagogy and philosophy that shaped the choice and the method of my implementation of makerspace and helped me work towards ideological alignment (Hildebrand, 2007) of my values and the way I take up making in my class.

LaBoskey (2004) asserted that self-study is both improvement-aimed and contributory to the professional community. Self-study has been an ideal way for me as a classroom teacher to improve my practice while contributing to the practical and theoretical field of making in education. As there is little research done on the experience

of implementing making, and even less on implementing making with at-risk youth, the self-study of my journey provides useful information for other teachers interested in trying out making.

3.1.1. Self-Study as Professional Development

An essential part of my self-study has been the examination of my values and beliefs with regards to making in the classroom. Beliefs and values influence all aspects of teaching from planning, classroom practices and what teachers say and do (Hildebrand, 2007; Pajares, 1992). Furthermore, all educational beliefs and values are related to a broader belief system (Pajares, 1992). Values are both intentionally selected and implicitly embedded in the curriculum. We cannot separate beliefs and values from knowledge (Pajares 1992). Hildebrand (2007) suggests four layers of values from social practices down to core values. The first level is pedagogical practices: what we do and say in the classroom. Level two is principles and metaphors: guiding rules and signposts that we claim direct our practice such as making in the classroom. Level three is philosophy of education: beliefs about education, how the world works. Finally, level four, core values: “statements of what is prized or considered worthy, moral/or important” (Hildebrand, 2007, p. 57). She argues that self-reflexivity is required to test each level for consistency and alignment. In my self-study, I used self-reflexivity to de-construct and analyze my values and beliefs especially with regards to making and constructionism.

3.1.2. Self-Study as Research

Self-reflexivity is both a tool for ensuring the alignment of values and a research method that ensures quality research. It is of course the job of all teachers to reflect on their practice and strive to improve (Hamilton et al., 2008). How is self-study any different? According to Hamilton, Smith & Worthington (2008), self-study is differentiated from routine professional reflection by the examination of personal values and professional work and by reflexivity. Perhaps, as Dinkelman (2003) suggests, it is the systematic nature of this reflection and the goal to reveal knowledge with regards to practice that differentiate self-study from routine reflection.

Writing is the tool for reflexivity and the data for the researcher. “Researcher reflexivity creates physical evidence of personal and theoretical tracks through a created text, evidencing the researcher's deep learning and unlearning” (Kleinsasser, 2000, p. 156). Writing makes visible thoughts and helps develop reflexivity by making explicit ones developing theories, biases, research dilemmas, and vulnerabilities.

Fuentealba and Russell (2016) recommend double looping as described by Argyris and Schön (1974) as a tool to help the researcher challenge their underlying assumptions, beliefs and values. Argyris and Schön (1974) argue that people have 'espoused theories,' the beliefs and values that they believe inform their actions and 'theories-in-use,' beliefs and values that are reflected in their behaviors. They suggest that the two are often not in synch. In the double looping model, when a person is unsatisfied with the consequences of their actions, they are encouraged to question, not just their actions (single loop) but their underlying governing theories. For example, if my lesson did not go well, instead of questioning my actions, how I taught the lesson or the content

of the lesson, I need to look at my governing assumptions, values, or beliefs that shaped the lesson.

A critical friend is another essential tool of self-study. As Garbett (2012) explains, the researcher may look in the mirror and see what they are expecting to see. It may take another person to allow the researcher to see another perspective. "This interactive element of self-study allows the researcher to focus on self, engage in reflection through interaction with a critical friend and self, and ultimately improve practice" (Hamilton, et al., 2008, p. 21). A critical friend can also help with triangulation of data. Creswell (2015) suggests triangulating with different individuals, while Bentz and Shapiro (1998) suggest that researchers triangulate using different theories. A critical friend helps insure the validity of the research through both types of triangulation. These tools, writing, double looping, and using a critical friend, contribute to ensuring that self-reflexivity is done in such a way as to ensure the validity and credibility of the research.

3.1.3. Self-Study as Contributory

Bullough and Pinnegar (2001) suggest that self-study becomes research when it makes clear links to issues that are relevant to others. Self-study is a methodology used to develop knowledge about teaching and learning, through understanding one's own practice and self (Loughran, 2004). Self-study seeks to investigate teaching both for individual growth and also to contribute to educational community. As Hamilton and Pinnegar (1998) state, "one's educational practice improves, accounts of it and therefore knowledge about it is added to the knowledge base of the teaching and research

community” (p. 243). When done with rigor, it can lead to reconstruction and reconceptualization of education (Loughran, 2004).

The current research on making in education is limited, especially when concerned with marginalized youth. While the literature provides some evidence on the efficacy of making in education, there still remains a void in research in how to implement making in the classroom (Papavlasopoulou et al., 2017). Papavlasopoulou et al. (2017) recommend further studies into maker instruction within the classroom. The landscape of making and the maker movement is a complicated mosaic of conflicting values and varied practices. Implementing making in an alternate classroom must be done with sensitivity and informed by research and constructionist pedagogy. Navigating these landscapes with open eyes and integrity requires rigorous self-reflexivity.

3.2. Methods

3.2.1. Data Collection

Journaling is the data collection method commonly used in self-study (Hamilton & Pinnegar, 2009). Teacher journals are classroom narratives, interpretations, reflections, and “a place for writers to expose their personal feelings and perspective” (Hamilton & Pinnegar, 2009, p.123). Journals recognize and provide space for the emotional journey of professional development (LaBoskey, 2004). Within self-study, journals are written with purpose and are both a location of data collection and data analysis (Hamilton & Pinnegar, 2009).

In this study, I relied mostly on my journal as a source of data. From the beginning of my makerspace journey, in September of 2016 with my grade 5,6,7 class

and throughout the fall of 2017, while running my grade 10,11,12 makerspace, I kept a journal, a mole-skin notebook, in which I wrote after every makerspace session while the memories were still fresh in my mind. On occasion, I would write some notes during class. My notes helped me reflect on what happened during the class and how my actions, my methods, and my philosophy were shaping the development of my makerspace. While this study focuses on my experience teaching the grade 10, 11, 12 class, I engaged with my journal from the previous year upon occasion to gain knowledge and insights.

In order to differentiate my journaling from routine reflection and work towards a formalized critical reflective practice (Dinkelman, 2003), I strove to examine personal values and practice by making explicit my thoughts, feelings, biases, theories and vulnerabilities. I was also mindful that an essential component of self-study is that it is relevant to others (Bullough and Pinnegar, 2001). To this end, I made an effort to capture the intentions of my actions, to stay close in my reflections to the constructionist and makerspace literature, and to always look for ways to improve my practice.

In January and February, I reread my journals and responded to my journal entries with more journal entries. By this time, I had started another semester of makerspace which I was running differently from the previous class. I found myself in dialogue with my old journal entries as a makerspace teacher. I was both arguing with my old journals and learning from them. I was learning about myself as a teacher and I was learning about teaching from revisiting both successes and challenges of the previous semester and year. I also I found myself returning to papers I wrote 20 years ago for my

undergraduate degree and teacher candidate year in order to examine and revisit my philosophy of education.

Between September and January, I met three times with a critical friend, a teacher and former colleague. In picking my friend, I took into consideration Schuck and Russell's (2005) assertion that a critical friend must be supportive and constructive with their feedback. I chose this friend as we have a long history of mutual respect and critical dialogue with regards to teaching alternate students. We taught together in a grade 9/10 alternate school for 10 years. I had initially considered choosing a different colleague, one who runs a makerspace with gifted elementary students. But as Schuck and Russell (2005) conclude, within critical friendships, "context is central to understanding practice" (p. 120). I felt it was essential to have a critical friend who deeply understood the context of alternate schools. This critical friend was able to refract the image of myself and my practice that I was creating in isolation. Her insights opened up different possibilities of interpretation and provided me with insights I was unable to acquire on my own. Because of our longstanding relationship of mutual trust, she was able to provide challenging feedback which I was able to accept (Schuck and Russell, 2005). During each session, I took notes of my thoughts as they were occurring. Afterwards, I would write longer journal entries as I digested my new perspectives and insights. I came to look forward to the sessions and found myself preparing what to talk about next. My conversations with my critical friend allowed me to engage differently and more thoroughly with my practice and my beliefs, thus improving my practice (Hamilton, et al., 2008).

3.2.2. Data Analysis

Data analysis in self -study is an ongoing recursive process within the data collection (Hamilton & Pinnegar, 2009). From the onset, I was rereading past entries, responding to myself with notes in the margins and further entries. As I reread my journals at different points in time, I looked at the journals from multiple lenses (Coia & Taylor, 2009). Coia and Taylor (2009) talk about how interpretations of narrative are multiple not fixed; that time, another’s response or revisiting literature can open up new interpretations. For example, after meeting with my critical friend, I would have a new perspective based on our discussions and her contributions. After rereading the makerspace literature, I reread the journals with a constructionist lens and new insights emerged. When I read my journal entries in the new semester, I had a whole new take on how to implement makerspaces. This varying of perspective contributed to the validity of my findings (Coia & Taylor, 2009). Each new lens generated more data by inspiring more journal entries. As Hamilton & Pinnegar state, “the recursive nature of data collection–analysis–interpretation enlivens the research process and pushes toward the evolution of ideas to uncover possible insights and oversights” (p.149).

As my experience grew and my analysis evolved, I noticed patterns emerging from my journals. I responded to those themes with more journal entries. There was never any point where the data collection phase ended, I continued the discourse with my data throughout the analysis phase. In February, I used thematic analysis (Braun and Clarke, 2006) to develop themes from the data. In the first round, I reread the journals and broke the entries into sections, coding each section with a short (one to four word) summary of topic, issue or emotion represented. I then went back and sifted through

these notes, identifying patterns and potential themes. Because I had been revisiting the data throughout the collection process, certain themes had already emerged as points of interest. As a self-study, I was concerned with improving my practice (LaBoskey, 2004). With this focus, I narrowed my themes to ones concerned with my practice and my values. I also narrowed the themes to ones that were relevant to my research focus, namely, the implementation of makerspaces in the classroom. When examining my journals, two themes were persistently reoccurring: choice/student autonomy and fear/uncertainty. The theme of choice/student autonomy often appeared in relationship to my ideas around student motivation and assessment or evaluation. This theme promoted an examination of my beliefs and values around education and my practices. The second theme, fear and uncertainty, prompted a personal journey of identifying ways in which fear and uncertainty shaped my vision of a makerspace in a senior alternate.

Chapter 4. Privileging of Choice and Autonomy

An examination of my journal reveals a trend where I privileged student autonomy, specifically, giving students freedom to choose what to make, as an important aspect of a makerspace. In a journal entry from the previous year, I made two-column notes contrasting the difference between traditional schooling and makerspaces.

Traditional School	Makerspace
Schedules	Choice of timing
Assignments	Choice of work
Grades	No grades
Teacher as Audience	Audience of interested peers

(Nov. 1, 2016)

By situating traditional schooling and makerspaces as binary opposites, the entry was defining makerspaces through a contrast with traditional schooling. In this polar relationship, makerspace offered autonomy; therefore, traditional schools are defined as restrictive, taking away autonomy. This entry clearly privileges the makerspace while maligning traditional schools as being controlling and inauthentic.

In a later entry, I made a comparison between hobbyist learning and school learning. I noted that “hobbyists are motivated by personal interest whereas at school one has to learn” (Sept.15, 2017). In this entry, makerspace is aligned with hobbyist learning. I wrote that makerspaces involved a balance of internal motivation, inspiration and perseverance. In contrast, I wrote that schools balanced inspiration, coercion and structure. Both spaces require inspiration, but my entry implied that traditional schools use coercion and structure while lacking internal motivation. While I did not refer directly to “autonomy” or “choice,” it is implied that a makerspace does not need

coercion because participants are internally motivated presumably because hobbyists by definition have autonomy and choose projects that interest them.

From the beginning of the grade 10,11,12 class, I privileged student autonomy. This was much different from my grade 5,6,7 class where I provided structured activities during makerspace time. I started the 10,11,12 class with the following principle: You can make anything, but you must make something. Recapping the second class, I wrote, “I said in this class we make stuff. You can work on your own projects or you can do the activities that I provide. Every day I will have something for you to do. You are welcome to join in with my activity or do your own thing” (Sept. 7, 2017). In my journal, I reflected that I wanted to show them that I was a facilitator to their making, not a director.

I did not want to sabotage their freedom to choose their projects by evaluating final products. Instead, I wanted to prioritize the process. I chose to focus instead on self-assessment. I had them brainstorm on what they should consider for self-assessment. They came up with participation which they defined as making with effort; creativity/ingenuity/resourcefulness; and respect of others, space and tools. The students self-graded each term based on these criteria. They had to justify their grade with a written reflection.

4.1. Issues that Arose in my Autonomy-Focused Class

A review of my journals reveals that I encountered many dilemmas when I gave students the mandate of working on a project of their choosing. I found that choice

worked well with a small minority of students. Unfortunately, the majority of students struggled with this format.

For a few students, I was very satisfied with my structure of maximum choice. I was impressed by the diversity of projects that these students took on: woodworking, sewing, electronics, music composition, and mixed media. I noticed that when students were engaged in a project, they got to work as soon as class started and even worked on it outside of class. There was sometimes a lull between projects, a time of tinkering, searching the internet, socializing, but soon a new project would be on the go. On days when these usually busy students did not work, I was able give space and recognize that the making process has its ebbs and flows. I could not expect them to be creative and motivated every day. Often, these engaged students took on a leadership role by providing direction, motivation and organization for a group project. Struggling students looked to these students for ideas and inspiration. I reflected several times that when a student chose their project, they had internal motivation. I enjoyed the enthusiasm and energy of the students when they were internally motivated to learn. Also, I noted the amount of learning that went into some of the projects. Students learned how to compose a letter, use a sewing machine, play guitar, build a motor, collaborate, delegate, problem solve, plan and persevere. I concluded that the rewards were inherent. These students appeared to be doing the work for themselves, not for grades.

A reoccurring concern that came up for me was that I felt that some students chose activities that were not challenging. Glue-Gun Toy Sculptures were such a common theme, that I began referring to them in my journal as GGTS. When I asked teachers for donations for my makerspace, I was flooded with old toys. This happened at

both schools. In the 10,11,12 class, I had an entire filing cabinet dedicated to old toys. In both the 5,6,7 class and the 10,11,12 class some students would choose to make Glue-Gun Toy Sculptures. Basically, this entails gluing toys together to make a sculpture. Sometimes the sculptures were creative or clever in the mix-matching of toys and the way they were positioned. Others seemed to have little thought behind them. Students also used their time at maker space for imagination play. One group made cardboard finger puppets of space ships and spent the majority of the time playing with the spaceships. Another group invented elaborate marketing schemes with shaved pencils. In both situations, the making process was negligible, with little problem-solving. The creativity and collaboration was mostly centered around the play that followed the making. As for the numerous glue-gun toy sculptures, they required minimal planning, problem-solving, collaboration or creativity. The students seem to enjoy making them. I tried really hard in my journal to see these activities as productive in some way. I praised students for using toys in unusual ways. I engaged students in discussions on the thought process behind their sculptures. I encouraged them to add electronics.

Ultimately, I found myself questioning the value of these activities. It made me realize that I while I valued autonomy, I also valued other aspects of making. I wrote: “Do I challenge the GGTS? Do I challenge the students?” (Sept. 15, 2017). I then brainstormed on the purpose of makerspace. My list included challenge yourself and invent. Later, in a conversation with my critical friend, I articulated making to be about problem-solving, creativity, reflecting, sharing, collaborating. I expressed my concern that many of the kids did not get to do any of this because they couldn’t solve the problem of what to make and defaulted to GGTS or similarly easy activities. I was

realizing that by prioritizing choice, I was neglecting other elements of makerspace that were important to me.

My bigger dilemma centred around students who had trouble choosing what to make. Students who were not engaged in a project tended to avoid makerspace activities. They would try to work on homework in class, wander, watch other students, or get into trouble by breaking school rules. I had to try to balance giving them time to figure out what to do, with not giving them too much time to find trouble. I struggled with classroom management because students did not know what to do. This problem was compounded by the changing composition of the class. For the first month, every week, at least 2 students joined the class. At one point, there were 16 students enrolled and seats for only 14. This pattern of student enrollment is typical for alternates as many students switch from mainstream in September and October. This constant influx of students made it difficult to establish a routine of making. I had to orient each new student and revisit the rules and purpose of the class. Because both making and choice were new concepts for the students, I spent quite a bit of time revisiting previous discussions on what making can look like. Some students, I reflected, did not buy in. I noted in my journal that I spent most of my time monitoring students who were supposed to be working on projects, some inside and some outside. I often found them doing other activities, some against school rules. I wrote that I felt some students regarded choice as an opportunity to do as little as possible. I wrote on several occasions that I worried students were taking advantage of the structure of the class (Sept. 28, Oct 12, and Oct 16).

By November the chaotic feeling subsided and the class settled into working. In my journal, I attributed the change in tone to the drop in the number of students enrolled. Nine students had left my class, all of whom had struggled with figuring out what to do. These students all left for different reasons, some quit coming to school, some quit coming to morning classes (my class was in second period), and some were transferred to other schools. Only one dropped out of the class to join another class. The seven students who remained all eventually found projects on which to work. This pattern of enrollment was not unique to my makerspace class. All of my classes experienced similar completion rates. I reflected on November 15 that the atmosphere had shifted from adversarial to appreciative. I wrote about how students voiced that they enjoyed this class because without the pressure to do assignments, ideas started coming to them.

I still struggled with finding value in many of the projects the students chose. I wrote that only two students chose projects which required them to acquire new skills. I noticed that all the other students consistently chose to work on projects that were not challenging for them such as drawing, making a collage, and glue gun sculptures. I also reflected that while the latter students were working on projects, beyond a couple of students, I rarely saw the enthusiasm and internal motivation I assumed would come with student autonomy.

4.2. Reframing My Philosophy of Practice

When reviewing my journals, I started asking myself, “why was autonomy so important to me?” It was obvious that the class structure around choice was not successful for the majority of students. Why did I think it would work? Why did I

prioritize choice? What did this say about my underlying philosophy of education?

Hamilton and Pinnegar (2009) emphasize the importance of examining present moments where present, past and future come together. They contend that careful consideration of these moments has the potential for creating deeper understandings and opening up new pathways. Part of this examination is to “identify the pasts that are residents in the present and the future orientations that rewrite the experience of the present as we capture an account of it” (p.24). I started doing some research into my past to help me understand how my pasts were influencing my present moments.

As evidenced by my initial journal entry, I approached this makerspace project with a dichotomous framework. I was operating from the assumption that on the side of makerspace, was internal motivation, self-directed learning, authentic learning and engaged learning. On the side of traditional school was external motivation, assigned work, meaningless work and unengaged students. This view of the education system was rooted in my past readings and beliefs that traditional schooling stunted intellectual curiosity and promoted conformism. As an undergraduate, I was particularly moved by John Taylor Gatto’s (1992) article, “The Seven Lesson School Teacher.” It resounded with my own dissatisfying experience in grade school. I found the book on my bookshelf, and spent some time revisiting this early influence on my philosophy of education. The first and third lesson explain how school stunts curiosity and promotes indifference. According to Gatto, this is done through short lessons on many unrelated topics. Students are not allowed to get into something too deep because the bell will sound and it will be time to change subjects. Gatto also argues that everything is taught out of context, disconnected facts, none of which are chosen by the students. In this way

students are taught to study many things superficially and without passion or curiosity. The lesson of “Intellectual Dependency” supplies that students are trained to let the trained experts (teachers) make all the important choices, such as what to learn, what to think, what to do. School, Gatto argues, teaches students to depend on others to make decisions for them. The sixth lesson, “Provisional Self-Esteem,” ties in nicely. This lesson suggests that schools teach students to base their self-worth not on self-confidence or self-efficacy, but on external evaluations in the form of tests, grades and report cards. School, according to Gatto, robs children of their natural curiosity, teaches students to be externally motivated and stunts their ability to make choices.

It was my critical friend who first helped me identify the pasts that were influencing my present moment. She pointed out that my class was structured like a free school. I realized there was some truth to this. I had, in the past, been interested in the free school movement. As a young person, I was drawn to the ideals of A.S. Neill, his philosophy mirrored my own ideals, or perhaps my ideals mirrored his: that “free children will be self-motivated, integrated, able to seek out the learning they need in order to pursue interests that are truly their own...rather than being ruled by externally imposed standards and goals” (Graubard, 1972, p. 14). When my friend mentioned the similarity to my class structure and free schooling philosophy, I was surprised. I had not been conscious of this connection.

I found myself wondering whether I still supported the free school and unschooling movement¹. In order to understand my current philosophy of education, I

¹ The free school movement and unschooling both attempt to provide an open learning environment with as little adult intervention as possible. Students are expected to be self-directed in their learning process. While

needed to revisit my pasts, in particular my beliefs with regards to free schools or unschooling. I admit to owning five books on alternative schooling, free schooling and unschooling. To qualify for the teacher education program, I volunteered in three different schools. Two of them were schools that allowed a high degree of self-determination and choice. Even re-reading the books now, I am enamoured by the promise that students “would be happy, considerate, honest, enthusiastic, tolerant, self-confident, well-informed, articulate, practical, co-operative, flexible, creative, individual, determined people who knew what their talents and interests were, had enjoyed developing them, and intended to make good use of them” (Gribble, 1998, p. 2). Obviously, I have had a history of sympathizing with the free school/unschooling movement.

However, this sympathy was not without misgivings. On deep introspection, I realized that I have spent 20 years wavering back and forth between supporting the free school and unschooling methods and being critical of them. My book collection and volunteer experience speak to my support. I have also considered sending my own child to a democratic school that is very similar to a free school in its focus on self-determination and intrinsic motivation. However, simultaneous to this I was engaged in a critical view of the free school and unschooling movement. In my last year of my undergraduate studies, I wrote a paper on the historiography of educational reform. Re-reading the paper all these years later, I was surprised by my critical examination of the free school movement. I had argued that the free school movement was limited in

unschooling is often a subset of homeschooling, free schools are alternative schools organized by parents and educators.

enrollment by relying on a high degree of parent participation, teacher volunteerism, and private tuition. In this way, the free schools were largely accessible only to people with financial means to volunteer during the day and pay tuition. The teachers were not unionized and enjoyed neither living wages nor benefits. I had also criticized the schools for emphasizing self-expression and anti-authoritarianism over encouraging students to think critically. This paper clearly comes on the side of reform of public education through critical pedagogy which encourages learning that is tied to self and social empowerment (Giroux & McLaren, 1989; Kozol, 1981). My actions over the years also reflect a criticism of the free school and unschooling movements. After volunteering at a free school, I recall my criticism of the unlimited access to video games. Some students spent weeks, even years choosing to play video games and Dungeons and Dragons. Another criticism I had of school where students had complete choice was there was no diagnosis or remediation for students with learning disabilities. For example, a student with dyslexia would never choose to read, and might never know that they had learning disability. Many years ago, I had a job supporting home-schooling parents. Again, I remember feeling uncomfortable with the learning taking place in the unschooling homes. I had serious misgivings with Lego being the closest kids got to doing any math. I have always worked in public schools, albeit mostly in alternate schools. I also chose to enroll my own child in public school, in the Montessori track. Though I did consider a free school because of my misgivings about the school system. I decided against it because of the lack of structure. I did not want my child playing video games all day. While my work and parent choices have steered away from traditional school structures, I have never chosen free or unschooling.

I believe I was not entirely conscious of my changing stance with regards to free schooling and unschooling methods until this self-study. An examination of my actions shows that I while I had been sympathetic to free schools and unschooling, I did not in practice support their philosophy of total choice. Why did a distant past where I believed in complete choice play such a prominent role in my present? What happened to my critical analysis of free schools, unschooling and complete choice? How can I believe two contrasting ideas simultaneously and not be aware?

4.3. Autonomy in the Makerspace Literature

There is, in my journal, an emphasis on internal motivation as an important feature in learning and education. Internal motivation had become, for me, the brass ring of education. Much as Ryan and Deci (1991) contend that self-determination, “having the full sense of choice” and “doing what one wants” (p.253) is the origin of intrinsic motivation, I believed that this motivation could be obtained through giving students choice: students when given the freedom to pursue their interests would be self-motivated to learn. My journal situates evaluation and assessment as impediments to internal motivation when used as a tool to externally motivate students to perform to imposed standards and goals. While this is a reflection of my early readings on education (e.g. Gatto, 1992; Kohn, 1996; Llewellyn, 1998), much of the makerspace literature that I had been reviewing also demonized traditional schools, this time holding makerspaces as beacon of hope to transform education.

In the literature, makerspaces offered up an ideal learning experience. Sheridan et al. (2014) found in their study of three diverse makerspaces that these spaces facilitated

innovation and creativity where people learned in order to make and learning happened in a variety of ways such as online research, collaboration, discovery learning, demonstrations and workshops. Makerspaces are reported to be creative and rich learning environments within a participatory community (Halverson and Sheridan, 2014). Martinez and Stager (2013) criticize the limits of instructionism, “the teaching theory underlying most of American education” (p. 72) arguing that it fails even with the transmission of knowledge. They posit that making can transform education and make classrooms “places of great joy, creativity, and invention” and that students should “engage in tinkering and making because they are powerful ways to learn” (p.3).

I was enamoured by the promises of the maker movement. With regards to “choice;” makerspaces allow users a high degree of selection of materials and tools from which to choose (Martin, 2015). Researchers of the maker movement often stress the importance of autonomy as a defining feature of makerspaces (e.g. Dougherty, 2012; Halverson and Sheridan (2014); Peppler & Bender, 2013; Resnick & Rosenbaum, 2013; Sheridan et al. 2014). The few studies of non-dominant youth and makerspaces emphasized the importance of youth taking ownership of their work through autonomy (Calabrese Barton et al., 2016; Somanath et al., 2016). Calabrese Barton et al.’s (2016) study found that the choice played an important role in youth making activities. By allowing choice, youth made artifacts that drew on their understandings and knowledge of their communities and showed care and attachment for those communities.

4.4. Missing the Point: Autonomy Misinterpreted

In order to reproduce this environment within a school environment, I focused on promoting autonomy by allowing the students full choice for their making projects. I continued to support autonomy by allowing them to self-assess their work. As is evidenced by my journal, I encountered many problems with the full choice structure. There are several reasons for this failure.

First, mandatory attendance was a major difference between makerspaces and my classroom. In makerspaces, learning is not regulated (Halverson and Sheridan, 2014). While my class had some flexibility, as my class was a general Art credit there were many ways their work met the learning objectives of the course, it still had mandatory attendance. In retrospect, I realize that I modelled my class after community makerspaces where participants have complete freedom including freedom to not participate. Halverson and Sheridan (2014) argue that makerspaces “value individuals moving in and out of a space freely” (p.501). My makerspace instead was within the traditional school timetable. Students’ freedom was much more limited. They were not free to come and go, they had only two options: attend regularly or transfer out permanently.

Secondly, I lacked a community of practice (Halverson and Sheridan, 2014). Only a couple of my students were truly engaged. There was not a community of making, a free flow of ideas and enthusiasm. My class did not become a place “of great joy, creativity, and invention.” Freedom of choice became a burden for most students. Rule breaking, boredom, unsatisfying projects were the norm.

Thirdly, I had not prepared my students for choice. My critical friend provided me with some valuable feedback. She pointed out that providing complete choice to students with 10-12 years of schooling that provided limited choice was too big a change. Students are used to a teacher telling them what to do. She also argued that the maker-movement mostly comprised white middle-class hipsters who been brought up to believe that they can do anything. Her observation is backed by the literature (Grenzfurthner & Schneider, n.d.; Vossoughi et al., 2016; Chachra, 2015). In contrast, I was teaching the most discouraged learners in the district, students who been asked to leave regular high school. My friend invited me to consider what was in the students' way, what obstacles were preventing them from making. I answered that they did not know how to start a project, some did not know what a reasonable beginner project would be, some did not have the confidence to try, some had learned helplessness, and some no idea what they could possibly make.

After talking with my critical friend, I looked at my class structure with a new lens. Instead of seeing the students as unmotivated and uninterested, I realized that problem was that I did not help students transition from the regular system of teacher-controlled schooling to student-directed learning. I wrote about how without marks and assignments, students were lost, they did not understand how to play with these new rules. "They did not sign up for this. They signed up for the teacher to tell them what to do" (Jan. 29, 2018). I was changing the buy-in from teacher-assigned grades to self-direction, self-motivation and an interest in making things. Unfortunately, some students were not interested in this new game. A regular complaint from some students was that they just wanted me to tell them what to do. I did provide an activity every day for

students to do, but students rarely chose to do my activity. When students are not given choice, they simply do what the teacher assigns. The teacher rewards the students with grades. With my new rules, there was no reward, no reason to do the teacher-assigned activity. Students instead chose to do their own thing, and that was often very easy small projects or very little. I began to see the problem as not so much as a dichotomy between teacher-control vs student autonomy, but rather helping students transition from teacher-controlled environment to a more autonomous learning structure. Being self-directed is an important skill that needs be taught and scaffolded like any other skill.

4.5. Scaffolding Autonomy

While Cohen et al. (2017) emphasize autonomy in their exploration on how to bring makerspaces into formal education, they recognize the incongruence of the autonomy available in makerspaces with formal education. Despite this issue, the authors prioritize autonomy, citing motivation, engagement, development, learning, performance, and psychological well-being as being outcomes of increased student autonomy. This justification for autonomy is in line with my values and beliefs around education and autonomy. Cohen et al. (2017) propose that autonomy could be promoted by giving students choice with their making projects within the boundaries of the learning objectives. Instead of complete autonomy, students are offered a structure in which to make choices. This proposition is one way to scaffold autonomy, offering choice within limits. In this way students don't need to choose everything but are given a high degree of autonomy within a project.

Cohen et al. (2017) identify assessment as another area where autonomy can be promoted. Cohen and colleagues recommend students working with teachers to identify criteria for success for a given project. In my journal, I recognized assessment as a location where educators assert control over students through criteria and judgement. My response was to hand control completely over to students. Cohen et al. (2017) suggest a scaffolded step towards total autonomy: a collaborative model with teacher and student in dialogue together to establish criteria.

Similarly, the constructivist literature offers ways to accommodate choice within a classroom. Brennan's (2015) analysis on constructionism identifies personalizing as one of four elements of constructionism: learners are especially engaged in construction when these things are personally or socially meaningful. The constructivist literature recommended offering choices and honouring different paths to learning (Resnick and Ocko, 1991; Kafai, 1996). These researchers show how choice can be embedded in the classroom setting in ways that allow students to take ownership over their learning and their projects without getting lost in wondering where to start.

In a way, I was engaged in a discovery learning project of my own. While I had read Brennan's (2015) and Cohen et al.'s (2017) advice before attempting my own makerspace, I had narrowed in on the autonomy and choice element without reading the fine print. Maybe it was as, as Martinez and Stager (2013) put it, TMI- too much information. I was not prepared to be so front-loaded. I needed to learn for myself.

Chapter 5. Fear and Uncertainty

Looking back over my journals, I was surprised by my dichotomous thinking. I found it hard to believe that I had convinced myself that a running a class where students had full choice would be a good idea. Over my 17 years of teaching in public schools, I have always prioritized student autonomy but I have always scaffolded autonomous learning for students through explicitly teaching skills such as self-monitoring, goal-setting, prioritizing, self-regulation, and self-assessment. I have scaffolded project-based learning and in doing so scaffolded choice. I have strived over the years to find meaningful and authentic learning opportunities for my students and I have found ways for their work to be shared with wider audiences.

I struggled with understanding why I did not use any of these good teaching practices with my makerspace class. I have already recognized that my critical thinking skills were clouded by my upholding of a very narrow definition of autonomy (complete freedom) as the key to internal motivation and thus authentic learning. This still does not explain, why I allowed this idea of complete autonomy, which I may have idealized in my youth but have never supported in my 17 years of teaching, to dictate my makerspace.

A closer look at my journals reveals that fear played a large role: fear of running a makerspace class with older alternate students; fear of trying something new; and fear of changing course midstream. This fear was also related to the fact that I did not have good grasp on what a makerspace class would look like. I did not want it to be a regular art class, home economics or shop class. I knew what makerspaces looked like in the community, but I struggled to imagine how to bring a makerspace into a classroom

setting. The combination of a new age group and an unclear vision of a makerspace class steered me into a place of uncertainty and fear.

5.1. Setting up my Makerspace Class with Fear and Uncertainty

My journal entries in late August and early September provide evidence of my trepidation with teaching makerspace in my new school. I had run a makerspace in my grade 5,6,7 class the previous year. I also had 10 years' experience teaching alternate school at the grade 9/10 level. However, this was going to be my first time teaching grade 11/12 alternate students, my first time teaching makerspace to high school-age students and my first time teaching makerspace to alternate students.

There are several entries where I wrote out my plans for the makerspace class. In my journal, there are brainstorming activities, lesson plans, and unit plans. I wrote about working towards a winter craft sale; hosting the grade 3 class from my old school and having my students lead the younger students in making activities; doing units based on various media, such as a paper unit and a wood unit; and doing problem-based design challenges. This section contains words and phrases that indicate uncertainty. For example, I used “or” between two draft unit plans. This “or” reflects that I did not know which plan I should have used. My lack of confidence is also reflected in phrase, “here’s another idea...”(Sept. 1, 2017). This journal entry was written five days before the start of school- I was still brainstorming on what to do! Two pages later, I stated, “or maybe paper is too restrictive to start....” The use of “or maybe” indicates my uncertainty on the cusp of the beginning of classes.

Despite having run a makerspace in my grade 5,6,7 class for the better part of a year, I was still struggling to understand how to import makerspaces into a classroom setting. I did not have a clear vision of a classroom makerspace. “Makerspace is applied to a wide variety of activities on the Internet, and in recently published books” (Mar 16, 2017). In a conversation with my critical friend, I criticized the book, *The Great Big Book of Makerspace Projects* (Graves & Graves, 2016) for being nothing more than a souped-up how-to craft book. I was sure that step-by-step instructions and teacher-dictated activities was not ‘makerspace,’ but rather just a repeat of traditional art class. I grappled with understanding how makerspace activities in a classroom differed from arts and crafts activities, computer science, home economics, or shop classes. In an undated Spring 2017 entry, I made a word web where I explored the similarities and differences between makerspace and traditional art, computer science, shop and home economics class. I wrote about how in traditional classes students learned by assembly style projects. These type of activities, I was convinced, offered little student choice, problem-solving opportunities or creativity. I was certain that student autonomy was the key to separating my class from a regular high school elective.

I had not been satisfied with my implementation of makerspace in the grade 5,6,7 class. I encountered many dilemmas. I had trouble finding a balance of how much front loading was necessary. For example, when we did automata, I gave them too much information and they tuned out and then everyone produced almost the same machine. Next, we tried making paper circuits, this time, I did not give enough info and most students gave up. I also struggled with finding a low enough entry point for the activities to be doable but not so low that they were boring. Always there were some students who

were not engaged, who wandered, who did homework, who tried to play video games. I grappled with the idea that maybe some students were just not interested in *my* making activities. I reasoned that people have diverse interests and that maybe makerspace should be about allowing people to find their interests, not making them do teacher-led activities.

On the first day of school, before class started, I wrote that I had not yet decided what to do for makerspace. Again, I expressed uncertainty and fear, “I still don’t know who the students will be so I feel paralyzed whenever I consider planning anything” (Sept. 6, 2017). Some of this unease may be attributed to the fact that it was my first semester at a new school, with a new age group. However, I had no such problems with my other four classes. My English, Social Studies and PE classes were all organized and ready to go. I only had these hesitations with the Makerspace class. My journals indicate that my anxiety mostly stemmed from my uncertainty regarding engaging the students. I was afraid they would not be interested in the activities I had done with my younger students or any of the activities that I had planned. My next journal entry, later in the day, expresses surprise at the students’ reactions. “I was amazed by their enthusiasm and ingenuity. I was worried about a flat response but I got instead brilliant ideas and smiles” (Sept. 6, 2017). The class was an introductory class where I explained making and had them brainstorm on what constitutes making. I was inspired by the wealth of ideas the students provided for making and I decided to prioritize choice. I started the second class with the following principle: You can make anything, but you must make something. I also committed to providing students with a structured activity if they did not have a project of their own to work on. I remember justifying this open-

ended class structure to my critical friend. I argued that the older students would have little buy-in if forced to make things that were chosen by the teacher.

At the end of the first week I wrote, “it seems some of them are stuck. What is my role? Inspirator? Facilitator?” (Sept. 8, 2017). I was still struggling to figure out how to run my makerspace class. I started the second week with a lesson on electronics. In order to facilitate creative play (Martinez & Stager, 2013), I decided to let them “play” with squishy circuits. Thomas (2013) suggests that squishy circuits are a fun, tactile, malleable and familiar way for kids to creatively explore circuits. So instead of giving students loads of information on circuits, I gave quick lesson and then let them explore circuits by playing with insulating and conduction playdough, an LED, 2 alligator clip wires and a three volt battery. I asked them to try to make a circuit to light up their LED. The students showed minimal interest in this activity. Within 15 minutes no one was playing with squishy circuits and I had to have a talk with students about doing homework in class. In my reflection on the class I wrote, “I realize that lessons don’t work! People learn just-in-time, not for no reason but that the teacher made them. So what should I do next? Their own projects?” (Sept. 11, 2017).

I decided that the answer was to run the class like a community space where learning happens in a number of formal and informal ways (Sheridan et al., 2017). “Workshop style like Sheridan et al. found that learning happened formally but not coerced. Maybe I should try offering workshops with a weekly theme. If you don’t know what to do- join my workshop... Pros: provide direction and skill building, voluntary, broaden skill set of class” (Sept. 14, 2017). I committed to offering workshops and lessons to students based on their interests. I solicited ideas from the students of

workshops they would like to attend. The only suggestion put forward was to have a ukulele making workshop. I reflected in my journal that my makerspace was constrained not just by tools and materials but by a limitation of expertise available.

5.2. Running the Makerspace Class with Fear and Uncertainty

On September 12, I considered whether or not I should use reflections as I had with my grade 5,6,7 class. With the younger students, the reflection journal had been an integral part of makerspace. Every makerspace day, I had facilitated discussions on a concept that promoted making such as growth mindset, the difference and importance of both soft and hard skills and defining design. They would then do a reflection in their handmade journals. There were important differences between the two classes and what worked for one might not work for the other. I taught my 5,6,7 class full-time and had them reflect on all work. The grade 5,6,7 class was accustomed to reflections, expected them and had developed self-reflection skills. The 10,11,12 class was an art elective, a class where students did not expect to write. Furthermore, as an alternate school, there were many discouraged learners and many students with low written output. On September 12, I wrote, “I don’t want to scare them away with too much writing. I want them to be solidly into making...before I invite them to thinking about their thinking” (Sept. 12, 2017). Again, fear was at play. While it is reasonable to recognize that reflection methods I used with my 5,6,7 class might not work with the 10,11,12 class, I did not pursue any other reflection methods. I could have used non-written ways to get students using meta-cognition. Though I wrote that I did not want to scare the students, it was I who was afraid to make the students reflect.

By October, I had recognized that my class designed around choice was not working for the majority of students. I was concerned that the students were having trouble finding things to do. I had tried to inspire them in several ways, but most were not responding. “I find it intimidating that the students won’t be able to find more things to do. Nobody has yet been inspired from the making books I have brought in. Only one student has started the printmaking based on my modeling print making” (Oct. 8, 2017). I also brainstormed ideas with them, suggested ideas and helped students search the internet for ideas. I felt that I was working hard to facilitate making, but that students were not interested in my ideas. This further reinforced my belief that the ideas needed to come from the students, that the students would inherently be interested in projects of their choosing. It also further reinforced my initial fear that the students would not be interested in my planned activities.

On October 12, I expressed frustration that the majority of students were not taking advantage of the opportunity I was giving them. I wrote that I feared that some were taking advantage of me and using the class to goof off. I noted on several occasions how little work most of them were doing.

It is very intimidating to not have my handy coercion toolbox. They could easily take advantage. Curious that I call it take advantage. But maybe it is too much to expect them to do stuff without any structure of accountability. Could I? If I wasn’t doing my masters, I wouldn’t be doing a daily practice of journal writing, even though it is good for me and I enjoy it (Oct. 12, 2017).

I recognised that there was a lack of internal motivation. I wondered if, without grades as a stick/carrot to externally motivate them, these students were choosing to do as little as possible. I was disappointed but I also was empathetic. I recognized that I too needed structure to do work. Though I knew the majority of the class was not choosing to make,

I did not change the class structure. This I attribute to fear. I wrote about my fear that changing things in mid-October would be too hard because I had set up the class one way and that it would not be fair to the students to change my expectations mid-semester.

I have always believed in fostering autonomous learning with self-regulation, self-motivation and self-direction but what am I doing to encourage these things? For the last three years, it was built into my program. This year, I am scrambling to figure out what I am doing. Maybe I need to start teaching these things explicitly. Maybe I need to do this class again and do it totally differently or maybe I can try to change things now, that might be hard because the students have expectations and I couldn't do a total course correction without possibly tipping the boat and losing trust (Oct. 18, 2017).

I recognized by this point that I had failed to scaffold autonomous learning as I had done in the past. I looked forward to starting again with a fresh slate, and I knew I needed to change the current class. I chose instead to continue with the program that was not working well. My not wanting to “tip the boat,” indicates that I feared the repercussions of scaling back the students’ autonomy and moving towards a scaffolded model. I was afraid of the students’ reactions, that they would lose trust in my leadership and subsequently, they would not easily follow my new course of activities.

5.3. Fear and Uncertainty in the Literature

When doing my data analysis, I was self-conscious about making visible my private fears. However, after reviewing published self-study research, I was relieved to find that fear is a reoccurring theme. Freese (2005) found that self-study helped pre-service teachers reflect on and face their fears of failure. Rather than allowing fear to take control, some pre-service teachers found that fear “served as a catalyst for taking more control of their actions and success” (p.71). Berry (2007) acknowledged that even

experienced teachers face issues of fear and uncertainty when trying new things: “There is a considerable amount of risk involved in exploring practices that have unknown outcomes” (p.69). Tolosa, Heap, Ovens, & Garbett (2017) argue that anxiety around trying something new (integrating technology) led to experienced teachers feeling a loss of confidence and self-efficacy. Similarly, Brandenburg (2008) found fear emerged as a theme in his journal when starting a new job. Kosnik (2005) talks about daily apprehension when trying a new teaching approach. When considering how to implement my makerspace, my journal is rife with uncertainty and apprehension. Instead of approaching the makerspace with confidence and self-efficacy, as I did my English and Social Studies classes, I hesitated and waivered. While I had never taught high school level Social Studies before, I plunged right in, my teacher toolbox in hand. However, when faced with something entirely new, I dropped my toolbox behind, and regressed to my younger ideals of education. Lighthall (2004) argues that self-study is a way of understanding and confronting fears which “left unexamined can impede one’s teaching” (p.212). My fears were impeding my ability to critically assess the situation in the present moment. It is through self-study that I have been able to identify the role fear was playing by restricting my access to my repertoire of teaching skills.

5.3.1. Acknowledging Vulnerabilities

Larsen (2007) writes about how it is difficult to acknowledge vulnerabilities and insecurities in self-study; she argues that this emotional work can yield some important revelations. Though it has been hard for me to admit, the fear and uncertainty I have uncovered in this self-study has illuminated a long-standing internal conflict: my struggle to maintain my integrity as an anti-authoritarian and work within the school

system. Liam Brown's self-study of his first years teaching mirrors my experiences and concerns.

My greatest fear about starting this job was that I would be expected to act as an authoritarian. I do not mean to say that I was afraid to wield authority; rather, I felt (and still feel) that the rigid hierarchy of most modern school systems is hugely damaging both to students' learning and to their personal development. The world always needs more people to stand up for their beliefs, to work interdependently with their peers to achieve progress, and to summon the courage to challenge existing power structures, yet most young people spend 15 years in a system in which they have no voice and no agency. Furthermore, all of my experiences with education had shown me that true learning only occurs when the learner takes control of the process; this is certain to be a rare event when a student does not even have control over when they are allowed to go to the toilet (Brown & Russell, 2012, p.15).

In my first year of teaching, I had similar misgivings. Being informed by critical pedagogy, I valued student empowerment and saw authoritarian teaching as being in direct conflict with promoting social justice and autonomous learning. I also struggled against reproducing the traditional authoritarian teaching style I learned as a student and was witnessing as a teacher (Britzman, 1986).

In my first year of teaching I shared a class with the principal who liked to boast that up north you strung up a dead coyote on your farm to teach the others a lesson. The implication was that it was the same with students, you have to make an example of one of them at the beginning, and they won't give you any trouble (Oct. 18, 2018).

In my first year, the principal taught in the mornings with a firm authoritarian style. In the afternoons, I struggled to gain respect as a new teacher and as a teacher who wanted to establish a different tone, one of mutual respect. My style, when contrasted with the principal's, came across as permissive and, needless to say, I struggled all year with classroom management. I started to fear that the authoritarian style was the only one that worked in a classroom.

Over my years of teaching, I developed an authoritative style that relies on caring and respectful relationships with my students. This has not been without difficulties. In a system where students have often become accustomed to the teacher controlling the class through fear, bribes and punishments, it can be an uphill battle to establish a different kind of relationship. I have had some difficult teaching situations where I found myself veering towards an authoritarian style; when the line between authoritative and authoritarian has felt precariously thin. At other times, I have felt that my flexibility and care have been interpreted as permissive. When I stray towards authoritarianism or fall into the trappings of permissiveness, I feel discouraged and disappointed- my practices are not in line with my personal values.

I recognized that authoritarian teaching is particularly out of line with makerspace ideology. The root of authoritarian is author (Palmer, 1998). An authoritarian teacher is the author of the class, of the students' behavior and of the students work. The whole purpose of makerspace is to allow the students agency and authorship of their projects and therefore their learning. Authoritarianism has no place in a makerspace. However, in my fear and uncertainty of running a makerspace with the grade 10,11,12 class, I ran too far in the other direction. I gave the students full autonomy with no facilitation. This was done unconsciously and through fear of imposing my making activities on the students. My reflection on this experience has helped clarify my philosophy of education with regards to student autonomy and authoritarianism. What I have learned is that, although I am interested in working towards full student autonomy, giving students full autonomy with no scaffolding within the current school structure, with its spoken and unspoken rules and expectations, is not a viable route towards that goal.

5.3.2. Traversing Fear

Latta (2006) speaks about taking risks, instead of avoiding the fearful grounds, entering and traversing the landscape where fear resides. According to Latta (2006), fear has the possibility of being an agent of change. Latta sees fear as having ‘dynamic and transformational potential’ (p. 194). When fear or vulnerability come into play, it effects the actions of the teacher. Consciously or unconsciously one may choose any range of reactions from avoidance to blundering forward or to boldly but cautiously moving forward onto the terrain of fear (Latta, 2006). This experience has inspired me to listen to my fears: my fear of not engaging students with makerspace activities, my fear of not running a real makerspace, my fear of being an authoritarian, my fear of being seen as too permissive. Instead of avoiding these uncomfortable feelings, I need to walk across this terrain, learn about myself, and embrace this opportunity for growth. The suppression of fear means to ignore this learning opportunity. Dewey (1933) warned against unconscious fears becoming a coat of armour that can close our minds to new ideas and change. He counseled open-mindedness even if this is hard or uncomfortable.

Instead of avoiding my fear, I have confronted it. In doing so I have learned some valuable lessons about myself, my beliefs, my values, and my philosophy of education. I have also gained valuable insights into implementing makerspace in a classroom. In early November, I was tempted to close the door on makerspaces, never teaching makerspace again. I was discouraged from my experience and lost on how to make authentic makerspaces work in a classroom. I could not see past my fear to new ideas and change. By December, I was still struggling to envision a makerspace but I was beginning to show a willingness to try again.

Makerspace is a misleading term, we don't have a lot of tech stuff to do makerspace, we are limited with regards to woodwork etc... due to lack of tools and expertise- so really all I can offer is craft-based activities. But wait, I shouldn't sell myself short, we could do automata, pinball machines, programming, maybe buy/borrow a robot. I could offer a series of guided activities from textiles to woodwork to programming. There would be a mix of skill-building and design elements (Dec. 6, 2017).

Gradually, I came around and decided to offer makerspace again in the following semester. I was able to move forward with renewed confidence and a better sense of who I am and how I can run a makerspace.

5.4. Integrity

My experience with my grade 10,11,12 makerspace was not satisfactory. Throughout the term my journal reflects frustration and dissatisfaction, both with the course and myself. This was neither sustaining nor sustainable, neither my identity nor my integrity was consistently present (Palmer, 1998). I had borrowed an old identity from my youth and the chaotic class that ensued was a strain on my integrity. Because of my class format, students were misbehaving. My efforts to develop the positive relationships I have come to depend on for classroom management were sabotaged. My critical friend pointed out that it was my responsibility to provide opportunities for them to succeed. "It is my responsibility to enable them to follow the [school] rules...for example it is unreasonable for me to expect teenaged alternate students who smoke to NOT light up when working outside unsupervised" (Nov. 29, 2017). Instead of developing a classroom built on mutual respect, I found myself playing the reluctant disciplinarian. Ironically, by giving the students full autonomy, I ended up having to play the authoritarian. This role did not sit well with me, my integrity thoroughly compromised, I began to dread the class.

My integrity was also questioned by my unintended classroom structure. “I had not set out to facilitate unschooling, but that is where I ended” (Nov 29, 2017). This unexpected location was not one I was prepared or had prepared the students to deal with. Nor did I know how to save us from the disaster I had authored. In the end, the problem was solved, not by my actions but by the exodus of the school by several students. The remaining students worked on self-directed projects, some with enthusiasm some without.

Hamilton and Pinnegar (2009) suggest that in self-study, research happens in the zone of inconclusivity, where we are becoming something different. In this study, both during the data collection segment and the analysis section, I had felt uncertainty regarding of my philosophy of education and my pedagogical practice as I negotiated my pasts, my present and my future. I found myself examining the space “between what [I] believe and how [I] act” (Hamilton & Pinnegar, 2009, p. 14). I was too afraid to change course so I justified my practice by altering my espoused theory. My espoused theory (Argyris & Schön, 1974), was not a theory I truly believed in, though I do believe in aspects of the theory of free-schooling/unschooling. I realized that I altered my espoused theory to match my practice and my theory-in-use but in reality, my practice was being controlled by my fear. Though my espoused theories waiver, my inner truth does not. I have struggled as a teacher with imagining what my actual beliefs look like in a classroom. Probably because in my heart of hearts, I don’t really believe in that education should take place in a room filled with 30 kids. I have always had to work within this incongruence between how I believe education should look like and how I can make education look like as a public-school teacher.

McGlynn-Stewart (2010) emphasized that the “strength of self-study is its capacity to surface values, assumptions, and beliefs about teaching and learning” (p. 86). This self-study has facilitated a close examination of my beliefs and values. Hildebrand (2007) suggests that self-reflexivity involves looking at four layers: pedagogical practices, observable actions; principles and metaphors, guiding rules we claim direct our practices; philosophy of subject and education; and core values. I recognize that I prize helping guide students towards autonomy because in my core values, I believe we must all learn to take responsibility for not just our learning but our conduct, our treatment of others, our choices, and our ethics. When students spend years under teachers who determine all aspects of classroom life, students risk learning passivity and apathy (Gatto, 1992). We need to learn to care not because the teacher will reward us, but because it matters deeply to us.

I also prize autonomy because I believe it is good for learning. Autonomy allows students to follow their natural curiosities driven by internal motivation. “I think it is an exaggeration, but there’s a lot of truth in saying that when you go to school, the trauma is that you must stop learning and you must now accept being taught” (Seymour Papert as cited in Martinez and Stager, 2013). In order to foster the joy children naturally have of learning, we need to find ways for students to allow students to hold onto or take back control their learning. I believe that constructionism to be an ideal way for students to learn. People learn by doing, and this learning is especially engaging if we are making something that is meaningful to us (Papert, 1991). My principles and metaphors that direct my practice are that students need varying amounts of scaffolding in their climb towards autonomy. In order for my pedagogical practices in makerspace to be in line

with my values, philosophy and signposts, I need to find a way to scaffold choice, invite creativity, encourage problem-solving and provide opportunities for design-based learning.

5.5. Restoring my Integrity

When running the Makerspace for the third time, in the January to June 2018 semester, I prepared the students for choice. In the beginning, the design challenges were limited by materials and instructions. Each group was given a box of the same assortment of items and the same goal (e.g. make an air-powered vehicle). With every new skill set, I started with a short-structured activity and step-by-step instructions. In this way, the students have learned how to build circuits, use simple machines, sew, program, use stop motion, and construct with paper maché. More importantly, the students practiced problem-solving, persistence, resourcefulness, and improvisation. Armed with some soft and hard skills, the students were ready for challenges that allowed for a higher degree of personalization. For example, after two weeks of preparatory activities, they were given a challenge to make something that moves. The only additional criterium was that it had to be different and new from the projects we had already done. They were engaged for four days building an amazing variety of new and exciting objects. I was very pleased with the engagement level, persistence, and creativity of the students. I was worried that the project might not have enough real-world application (Somanath et al., 2016) to engage them, but the whole class was engaged. Students collaborated, shared, problem-solved, used creativity and an iterative process. It

really felt like a makerspace. Also, of importance, my practice felt in line with my values and beliefs about education.

Chapter 6. Conclusion

I set out, using self-study, to understand better the implementation of a makerspace in the classroom. I used self-study because it is both improvement-aimed and contributory (LaBoskey, 2004): self-study serves both as professional development and research. I was looking for an effective professional development model because importing the makerspace promises of constructionist learning to a classroom environment requires careful consideration of the significance of culture (Brennan, 2015; Papert, 1987; Vossoughi et al., 2016), such that the students' strengths, interests, cultural values and knowledge are valued. It also requires careful consideration on how to translate the makerspace and constructionist ideals of design thinking (Brennan, 2015), play/discovery learning (Martin, 2015), easy entry points (Giannakos et al., 2017), personalized learning (Brennan, 2015) and the encouragement of creativity and imagination (Martinez & Stager, 2013) into classroom activities.

As there is little research into the application of makerspaces in classrooms (Papavlasopoulou, 2017), self-study also serves as a research methodology to enable me to explore the tensions that arise in the implementation of a makerspace in the classroom and contribute to the professional knowledge around makerspaces and formal education. While implementing a makerspace in my grade 10, 11, 12 classroom, I used journaling as form of data collection and I had ongoing dialogue with my critical friend to facilitate the reframing of my teaching practices, perceptions and beliefs (Schuck & Russell, 2005).

My findings are presented as two interrelated themes. They are 1) my privileging of choice and autonomy and 2) my fear and uncertainty with regards to implementing

makerspaces. I found, that throughout the semester, I privileged choice and student autonomy at the expense of other elements of makerspaces. I concluded that, due to my fear and uncertainty of how to run a makerspace, I neglected my teaching skills and knowledge and instead fixated on an ideal that student autonomy would lead to student-directed makerspace activities. Instead, when students were given full choice, many often chose to do non-makerspace activities, or minimal makerspace activities. I realized that full choice did not work because 1) mandatory attendance is contradictory to full autonomy, 2) my classroom lacked community of practice, and 3) choice and autonomy, like the other skills of makerspace, needs to be scaffolded and taught. I also concluded that fear and uncertainty need to be listened to, not ignored or avoided. There were many hints in my journal that I was making decisions from a place of fear and uncertainty, though at the time, I did not see it. My integrity was compromised. My beliefs and practice were out of sync. Self-study surfaced my belief that while I value student autonomy because I believe that people need to stand up for their beliefs and take responsibility for their actions, students need to be guided and scaffolded towards autonomy. By examining and traversing my fears and uncertainty, I was able to stop avoiding my problems and start identifying my mistakes. The process of self-study illuminated my internal struggle to find ways to support student autonomy within a system that often situates permissiveness as the only alternative to authoritarianism. Once my integrity was restored, I realized the potential makerspaces and constructionism have for supporting student autonomy. When choice is appropriately scaffolded, makerspaces can invite creativity, promote playful learning, encourage problem-solving and provide opportunities for design-based learning.

Through this self-study, I have learned the importance of listening to fear. When fear arises, it comes with important information. Instead of reacting to the fear, through avoidance or bold blundering, I realize that I can instead pay attention to the message of that fear and choose to react in the best way possible. For much of my makerspace class, I allowed my fear to interfere with my teaching. It was through self-study that I was finally able to accept the invitation fear was providing to explore my feelings, values, practices and philosophy of education. Now, I realize that instead of shutting out fear, or avoiding fear, I need to traverse fearful ground and find out what is behind that fear. Only with open eyes and heart, can I react appropriately to the circumstances.

My story is about maintaining integrity. Other teachers may learn from my experience when trying something new and unfamiliar, it is important to keep one's values and beliefs around education close at hand. They are not our compass and map. Compasses always point north but values and beliefs around education can shift and change through experience. A more accurate metaphor is that one's values and beliefs are a cipher to help one make sense of the new situation. Check your cipher from time to time, make sure you are using the current code and not some outdated philosophies, values or practice.

My story is about courage, I hope that my insights with regards to fear will help other teachers face their trepidations, uncertainties and worries and ask what this feeling is telling them, accept the invitation to explore and traverse their fears. I think as teachers, we too often avoid trying new things when instead, we could discover new possibilities for our practice.

Finally, my story is about implementing makerspaces in the classroom. I hope my journey will start a conversation about the ways in which we can bring making into the classroom. Every teacher needs to figure out for themselves what fits with their practice and values. By sharing my rich experience, I will give other teachers the opportunities to take short cuts on their own journeys to bringing this valuable learning opportunity to their students.

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