**Annotated Bibliography**

**Questions guiding my potential area of study:**

How can I weave the ADST (Applied Design, Skills, and Technology) language through my practice, utilizing it as a lens through which I motivate students and colleagues to pursue their passions and enhance their learning experiences? How do the core competencies as outlined in the BC curriculum complement the ADST curriculum and how can the two combined enhance student’s engagement in learning tasks? How can I help students access multiple modalities and opportunities through cross-curricular activities that incorporate Industrial Arts and ADST components?

**Blakemore, M. (2018). Problem scoping design thinking and close reading: Makerspaces in the school library. *Knowledge Quest*, *46*(4), 66–69.**

In recent years, makerspaces have been added to many in school libraries. This pairing naturally leads to using makerspaces to connect maker culture and literacy. In this article, Blackmore (2018) outlines her experiences with using children's literature as part of the design process, specifically to support the problem scoping phase. Blackmore (2018) directly references Tufts University for Engineering’s *Novel Engineering Project* (www.novelengineering.org), where literature is used to inspire design projects (p.66). In the article, key research on problem scoping is outlined, including reference to qualitative research that concluded that when students were given a literary context, they engaged in problem scoping with greater interest. Blackmore (2018) notes that “if we want students to more deeply practice their critical-thinking and problem-solving skills, they need to master problem scoping”(p. 68). Several examples and strategies are described where students identify and then solve problems for literary characters, including fables with primary students and Sharon Draper’s novel *Out of My Mind* with grade 5’s. In all incidences, a significant amount of time is spent on the problem scoping phase. Ultimately, utilizing children’s literature provides an ‘authentic framework’ to inspire a variety of unique design opportunities (Blakemore, 2018).

This article directly ties to my potential research questions. I believe the younger we start introducing design language to children, the more comfortable they become with the process through time. The utilization of literature makes sense because literacy is the focus of learning from the time students start school. Children as young as Kindergarten can work together to solve problems for their favourite literary characters. Problem scoping or defining the problem can be done in large group brainstorms. Many school goals, are focused around literacy; therefore, using literature to implement and practice the ADST curriculum makes logical sense. In addition, empathy is a key component to the design process and teachers frequently utilize literature to help students develop empathy skills. In BC, library's have been transforming into learning commons. Fusing makerspaces and ADST with libraries in this fashion, has the potential to make the learning commons experience even more engaging for students. In addition, it is a great opportunity to help teachers begin to implement design thinking into their teaching with the support of a teacher librarian.

**Bush, S. B., Karp, K. S., Cox, R., Cook, K. L., Albanese, J., & Karp, M. (2018). Design Thinking Framework: Shaping powerful mathematics. *Mathematics Teaching in the Middle School*, *23*(4), e1–e5.**

Over a 5-year period, in a variety of classrooms, Bush et al. worked to engage students in mathematical learning through a transdisciplinary approached utilizing the Design Thinking Framework. The Design Thinking Framework they used was developed by the Institute of Design at Stanford. The article highlights one design task where students at a rural Kentucky school designed a prosthetic arm for a Kindergartener. Key conclusions from their research included: empathy is hard for adolescents, teacher flexibility is a must, stages of the design process can be messy, and students must collaborate to achieve greater success. The Design Thinking Framework allowed the teachers to structure the task into chunks of learning. By breaking a task into the design process, there were built in explicit spots for students and teachers to reflect on where they have come and where they are going. Throughout the process, students were communicating and collaborating, which are key core competencies in BC’s curriculum. Although not explicitly mentioned, I inferred that some of the outcomes from ELA had to have been included throughout. The limitations are time, resources and training. Also, the article only highlights one case study, it would have been beneficial to see more of the examples that led to their conclusions.

“It is at the intersection of the Design Thinking Framework and transdisciplinary teaching that we believe provides a strong potential for powerful results"(Bush et al., 2018, p. e2). This quote and the findings in this article tie to my direct vision for the ADST curriculum. I saw it less as its own curriculum, but as a framework for how we approach traditional tasks in all subject areas. I also saw, that coupled with the core competencies, the two could become a common language in schools. Students, starting in elementary, would understand that all tasks can be refined and improved upon if they go through a design cycle. For example, combining literature and design thinking can help increase their understanding of the process at a younger age (Blakemore, 2018). If students have a familiarity with the language of the design process in traditional learning tasks, they should be able to transfer the process to more complex design tasks. However, the effectiveness, I hypothesize comes from a comfortability with the framework. If students are comfortable with the framework, then they will be more likely to persevere when they encounter complications.

**Carroll, M., Goldman, S., Britos, L., Koh, J., Royalty, A., & Hornstein, M. (2010). Destination, imagination and the fires within: Design Thinking in a middle school classroom. *International Journal of Art and Design Education*, *29*(1), 37–53.**

This article outlines how design thinking can be used to build confidence, foster empathy, and encourage active problem solving in students. Three key questions framed the study:

"How did students express their understanding of design thinking in classroom activities? How did affective elements impact design thinking in the classroom environment? How is design thinking connected to academic standards and content learning in the classroom?" (Carroll et al., 2010, p. 38)

Their conclusions were drawn from focused observations of a group of 24 students from a grade 7 class in a semi-urban, public charter school in the San Francisco Bay Area. Adults involved included their teacher, two university design school staff members, two graduate student instructors, and graduate students who were utilized as small-group coaches. One immediate and obvious limitation is that I am only one person who does not have this many extra adults helping me. The author’s also note that the small ratio is not normal in all schools; however, the general principles are applicable if design thinking is properly implemented. Design thinking was used to teach students about geography. Three key themes emerged from their study. First, ‘Design as Exploring’, which highlighted the diverse aspect of the design thinking process. Second, ‘Design as Connecting’, where observers saw creative confidence in students and active collaboration throughout the process. Finally, ‘Design as Intersecting’, which is the relationship between design thinking and academic content, the place where the greatest potential for design thinking exists in elementary school. One of their key implications is that, “design thinking must be integrated into academic content. While it may stand alone, its power as a tool for learning comes in the ways it can support a diverse range of interdisciplinary academic content"(Carroll et al., 2010, p. 51).

There are clear connections to ADST curriculum throughout this article. In their conclusions, Carroll et al. (2018) point out that “as design thinking comes to play a more important part of educational communities, further research is needed on its role in learning” (p.52). A set of possible questions is included after this which I could explore or tie to my initial thoughts and questions, helping me refine my own focus moving forward. Furthermore, their references list is extensive, including Vygotsky’s work on the sociocultural theory of cognitive development; therefore, a great reference point for me to find more articles in this key area of my interest. This article, Bush et al. (2018) and Scheer, Noweski & Meinel (2011) reference Stanford Design Thinking Framework. Finally, the article is full of amazing quotes to support my thoughts on how ADST (design thinking) can be implemented across the curriculum.

**Jho, H., Hong, O., & Song, J. (2016). An analysis of STEM/STEAM teacher education in Korea with a case study of two schools from a community of practice perspective. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(7), 1843–1862.**

In Korea, there has been a movement towards utilizing STEAM education to increase students' interest in and understanding of science by linking it regularly to other disciplines, including the arts. Researchers initially identified that despite the increase in STEAM education efforts, the lack of materials, training, support, and opportunities to collaborate with other teachers were standing in the way of proper, sustainable implementation. The purpose of this study was to look at how STEAM teacher education led to better conditions for implementation of STEAM education in Korean schools. The researchers were government funded, and they utilized a case study approach, where they focused on two communities of teachers one from primary school and one from high school. Both communities of teachers were asked to work together to create and implement educational materials, which other teachers would eventually use in their classrooms. The research relied on participant observation, videotapes of actual lessons, documents produced during lessons, and interviews with teachers. Teachers in the communities were provided with at least 15 hours of online in-service training, with the option of further training opportunities. The key conclusions included the fact that when there is a community of teachers working together, it is easier to implement STEAM into schools. A key finding was that teachers that as a community of teachers, it is easier to work through problems and find solutions. In addition Jho, Hong, & Song (2016) note that, "to adapt to the rapid change in educational environment, teachers should hold an attitude of "self-innovation" and a community is helpful for teachers to be more innovative"(p. 1859).

As a government funded project, a critical lens is necessary, for the results may reflect what the government want reported, so it may be missing key downfalls. However, the article does reference other key researchers in this area, including from the United States. This article does stress that teachers need support if they are going to take the initiative to implement interdisciplinary lessons in their classroom. They need time and support to feel comfortable and confident. The ADST curriculum has been rolled out in BC, but the direct in-service opportunities have been limited. Teachers struggle with how to implement the ADST curriculum. As a result, they do ‘cookie-cutter’ assignments because there is a lack of mentoring and support on how to create true design opportunities. Finally, the research cited throughout this article will be useful for a further investigation on how to help teachers feel comfortable with adopting an interdisciplinary approach to teaching utilizing design thinking process, ideally with ADST as the framework. Key quote from this article to support this idea: “it is crucial that teachers cooperate with their peer teachers to develop interdisciplinary (open-ended and creative) instructions on their own" (Jho et al., 2016, p. 1844).

**Kurti, D., Kurti, R. S., & Fleming, L. (2014). Practical implementation of an educational makerspace: Part 3 of making an educational makerspace. *Teacher Librarian*, *42*(2), 20–24.**

This is the third article in a series about the implementation of educational makerspaces. The first article is about the philosophy of educational makerspaces, the second one is about the potential tools for an educational makerspace, and this article outlines the actual implementation. All three articles focus on the school library makerspace at New Milford High School in New Jersey, a school described as ‘normal’. Kurti, Kurti, & Fleming (2014) highlight that the implementation of their makerspace went through the stages of a good maker project – always testing and refining to make it better. Therefore, just because you implement a makerspace, it does not mean that your initial ideas are going to work out. Teachers need to be flexible and reflective during the implementation process. The basis of their implementation is the idea that all students can ‘invent, tinker, create, and innovate’, but the key is to create the makerspace around the interests of the students. Subsequently, makerspaces should be tweaked each year to meet the interests of students. Budget, tools and high-tech toys do not create a perfect learning environment, instead, the tools you purchase and make available need to be of interest to the student population. Time and planning is important, not just buying a bunch of maker tools and expecting kids to make something meaningful. The article includes a visual outline of a framework for planning a successful makerspace as a cyclical process that has 5 key phases: “Understand your learners, Assess existing curricula programs, Consider global trend and best practice, Develop themes, and Order equipment and materials”(Kurti, Kurti, & Fleming, 2014, p. 23).

Several schools, including my own, ordered many tools for the makerspace, then tried to figure out what to do with them. I like how they point out the need to have a clear vision for the implementation of your makerspace, ensuring that it meets the needs of the learners in your building. In addition, I like how they encourage the cyclical nature of the makerspace implementation. Like a good design project, the space where design is taking place needs to be reflected on and refined based on changes in the student population and new technologies. Makerspaces, if planned carefully can enhance the implementation of ADST in BC schools. Furthermore, coupling them with the learning commons where a basic tool, the book, can be used to support design thinking makes logical sense(Blakemore, 2018).

**Scheer, A., Noweski, C., & Meinel, C. (2011). Transforming constructivist learning into action: Design Thinking in education. *Design and Technology Education: An International Journal*, *17*(3), 8–19.**

This article presents an empirical study, where quantitative questionnaires were used to analyze and evaluate Design Thinking as a teaching method in comparison to Dewey’s problem-solving method. Researcher’s hypothesised that a teacher would be more likely to repeat constructivist teaching in a real school scenario when applying the Design Thinking process. The article begins by outlining the history of constructivist learning, including Dewey’s problem-solving method. In addition, they outline the need for teachers to adopt a more constructivist approach to teaching to help students reach their full potential. Scheer, Noweski, and Meinel (2011) believe that Design Thinking can be ‘more digestible’ for teachers and students than the abstract nature of Dewey’s problem-solving method. They present an empirical case study that included 125 10th grade high school students in Germany and a team of 12 teachers and coaches. Half the coaches were Dewey coaches and the other half were Design Thinking coaches, with all coaches chose being of similar character, briefed to ensure their knowledge level of methods would be equal. Students were divided into 22 teams of 5 to 6 students each to face a real-world challenge. Throughout the process, students, teachers, and coaches were asked to fill out quantitative questionnaires, which are included in the article. Their findings demonstrated that Design Thinking fostered metacognitive skills and competencies, which explicitly led to motivation of both students and teachers in wanting to participate in more constructivist learning experiences. The researchers believe that, "Design Thinking can serve as the missing link between theoretical findings in pedagogy science and the actual practical realisation in schools" (Scheer et al., 2011, p. 18). They encourage future research in this area, particularly in teacher education in Design Thinking, to increase teacher confidence in this area. This recommendation directly connects to the finding of Jho, Hong, & Song (2016).

This study is based from the self-perception of a small group of teachers, making it only a small sample. However, more research in the area could further prove that the Design Thinking will help teachers feel comfortable with a constructivist approach to teaching in the 21st Century. Furthermore, this article ties to part of my research questions about how can get teachers more comfortable with taking an interdisciplinary approach to teaching while using ADST curriculum as the framework. Design Framework / ADST can help students in all subject areas, The findings in this article are echoed in other articles (Blakemore, 2018; Bush et al., 2018; Carroll et al., 2010), where student engagement in a Design Thinking model seems to be high, and students are receptive to learning being framed in this manner. This article, Bush et al. and Carroll et al. all utilize the Design Thinking Framework developed by the Institute of Design at Stanford. Finally, this article has several other key references that will be useful as I move forward. Specifically, how the Design Thinking model outlined in this article directly connects to the ADST model and how both foster the core competencies of communication, critical thinking and creativity.

Blakemore, M. (2018). Problem scoping design thinking and close reading: Makerspaces in the school library. *Knowledge Quest*, *46*(4), 66–69.

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