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Makerspaces have been making their way into K-12 classroom instructional practices in the last ten years. Research on best practices involving Making in education have been growing in the last several years. Looking at theories of making in education and best practices surrounding that, there are connections that can be made to research in student engagement. The purpose of this research is to examine student engagement in making, and factors that either increase student engagement or diminish student engagement. Factors that were discovered in this research include teacher understandings of and beliefs surrounding student engagement in making, school culture as it relates to creating iterative classroom environments, social-relationships and interactions in classroom environments, and making experiences that are meaningful to students. These findings support continued development of making practices in classroom.

STUDENT ENGAGMENT IN MAKERSPACES: CONNECTING RESEARCH IN STUDENT

ENGAGEMENT AND MAKING IN EDUCATION

by

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CHAPTER I: INTRODUCTION

Making & Design-Based Education

When I began my teacher training, my institution began implementing Makerspaces as part of the teacher training program. I found myself more engaged as a student and a prospective teacher. As I started my teaching career, making in education and the benefits to student engagement and learning that come with it became central to my pedagogical philosophy. Sheridan et al (2014) described Makerspaces as "...informal sites for creative production in art, science, and engineering where people of all ages blend digital and physical technologies to explore ideas, learn technical skills, and create new products." Makerspaces offer a unique opportunity for students to interact with teachers, peers, and the materials they are making with (Kumpulainen & Kajamaa, 2020; Hegedus et al, 2014) in ways that other more traditional learning practices cannot always provide. Making also allows students to form-or shift- their identity (Calabrese Barton & Tan, 2020; Hegedus et al 2014; Heredia & Tan, 2021; Tan et al, 2019; Vongskullen et al, 2021), while creating more equitable opportunities for learning by inviting students to consider perspectives and positioning themselves in relation to the needs of others (Calabrese Barton & Tan, 2020; Hart, 2012; Tan et al, 2019). Making was formed out of STEM disciplines and practices but has grown to integrate other disciplines as well (Heredia & Tan, 2021; Sheridan et al, 2014) such as art (Sheridan et al, 2014), literacy (Bull et al, 2017), and social sciences (Maloy et al, 2017; Pedretti, 1997). As making in education continues to be researched and developed, there is a need for a framework for making integrated learning. Reviewing all the research and practice of makerspaces Heredia & Tan (2021) introduce these Three Tenets to Making: Maker as Learner, Making as Iterative, and Making as equitable and consequential. These three tenets will be defined and discussed more as well as what the research

says constitutes effective making in academic settings. It is the belief that making benefits engagement and learning for all students that drives my work here.

Student Engagement

As my work in makerspaces has continued and my understanding of the principles of making and design have grown, I began to see the connections to student engagement research. Student engagement is a broad topic with many components that all intersect with each other. The types of engagement that will be discussed here are behavioral engagement, emotional engagement, cognitive engagement (Fredericks et al, 2004), agentic engagement (Reeves, 2013), social-relational engagement (Conboy et al, 2014; Vickers et al, 2014), and sociocultural engagement (Wang et al, 2019). Due to the vastness of theoretical principles that underlie student engagement, there is little research that examines student engagement in its totality. It is the approach here that by connecting theories of student engagement to the three tenets of making, when looking at lessons that involve making, it allows observations of student engagement to be more encompassing of all the components of student engagement. By looking closely at the three tenets of making, the multiple types of engagement, and connecting them when observing lessons that incorporate making, it is the desire to better understand how students engage with learning while making.

CHAPTER II: LITERATURE REVIEW

Making and the Three Tenets of Making

In order to have well-rounded making experiences for students, it is helpful to think of making using the three tenets as mentioned in Heredia & Tan (2021): maker as learner, making as iterative, and making as equitable and consequential. These three tenets were formulated from years of research surrounding making in education. In this section I will define these three tenets with the literature that supports their development and implementation into Makers Education.

Maker as Learner entails that participants be able to comprehend the following ideas: understanding making and design principles, connections to scientific and technical modes of understanding, and identity development as students learn about themselves as makers and students (Heredia & Tan, 2021). A starting point for any student's experience in making is understanding how objects are built and function in that design. As Heredia & Tan (2021) point out "As children tinker with their made objects, they need to consider how changes to the structure of their design impacts its function." Knowing how the design of an object influences its function is a key element to students learning within making. This allows students to be more thoughtful and intentional about their making practices. With design and making, students are also exploring the idea of metarepresentational competence (MRC) where they "...[understand] how tools communicate an idea, when to invoke certain tools, and for what purpose." (Sheridan et al, 2014). This also supports students' ability to make connections between scientific and technical knowledge. Making in a classroom context is most effective when engineering practices and disciplinary core ideas are intertwined (Heredia & Tan, 2021). Making is more meaningful for classroom practice when design challenges not only focus on engineering and design practices but also organically connect to the curriculum of the classroom (Bull et al,

2017). Making is also a place where various scientific ideas or technical skills can all be explored within the same place and time. Students in makerspaces are working on both digital and physical products simultaneously and even have different mediums mixed together (Sheridan et al, 2014). Finally, students also learn about themselves as others around them in a making experience. As students work through making, they begin to envision who they want to be as a maker (Heredia & Tan, 2021) and can alter how they see themselves as participants within their academic environments (Hegedus et al, 2014). As students in K-12 education work through design challenges within makerspaces they are also able to form, and even disrupt who they are and how they are perceived within academic contexts (Hegedus et al, 2014; Heredia & Tan, 2021; Kumpulainen & Kajamaa, 2020; Vongkulluksn et al, 2021). In Hegedus et al (2014) students were asked to identify students who they believed to be smart students. Students' perceptions of themselves and others shifted after an engineering unit, which in turn shifted their participation in following course work. Student agency, growth mindset, and identity perceptions have also been shown to increase when students are involved with making (Kumpulainen & Kajamaa, 2020; Vongkulluksn et al, 2021). Incorporating STEM, or design processes, in education can also allow students to envision themselves as scientific, ingenuitive, and creative (Bevan et al, 2014). These design processes lead to students learning how to be iterative in making and in school.

Making as Iterative is the idea that makers are always trying to improve and advance their design. Iteration is seeing making as working through the design process and focuses less on the end product or result (Ryoo et al, 2015). Timeframes for making projects can vary based on the materials used, the design, the amount and validity of the feedback, and the participants' own revelations about their design (Sheridan et al, 2014). An important part of that is that

students have access to feedback from a variety of sources: teachers/facilitators, peers, and/or other designers (Heredia & Tan, 2021). After receiving such feedback students then respond to the feedback and make any necessary improvements. It is important that as a teacher or facilitator of making, that time is offered for students to go back, and revise work as needed. Ryoo et al (2015) positioned the idea of failure in the making process, and the idea of continuous improvement of designs as valuable to making in education. How students face and overcome challenges through the design process also plays into making more iterative making (Ryoo et al, 2015). The goal is for students to see making as an ongoing process and that there always can be tweaking and improving their designs and creations (Heredia & Tan, 2021).

Making as Equitable & Consequential focuses on how the practice of making creates equitable access to learning and creating knowledge while also having students work to create solutions to problems that are meaningful to them and those within their communities (Calabrese Barton & Tan, 2020; Heredia & Tan, 2021; Tan et al, 2019). Making is more impactful for students when the students' lives are taken into account when considering what and why they are making. In order to make making a more equitable pursuit the teacher or facilitator should "...[take] into consideration the historical, cultural and social aspects of making." (Heredia & Tan, 2021). Students that are historically marginalized within academic contexts should be able to establish a rightful presence as "…[focusing] on the processes of re-authoring rights towards making present the lives of those made missing by the systemic injustices inherent in schooling and the disciplines." (Calabrese Barton & Tan, 2020). This concept redefines who is considered a maker and the significance of their making. Hegedus et al (2014) witnessed how students that were not previously considered smart or a "good student" due to many different factors, shifted their perceptions after working in an engineering unit. Students should also have the ability to

choose what they are making, why they are making, to whom they are making, and for what purpose. Socio-political issues that students face in their daily lives are important to their learning and development and should be allowed to exist within classroom making (Calabrese Barton & Tan, 2020). Pedretti (1997) examined how when social justice is applied STEM creates a more meaningful learning experience. When students were engaged in making to fix a septic tank crisis within their school, the making experience was not only becoming more enriching, but students also learned valuable lessons beyond design principles such as economics, water quality, and politics of local government (Pedretti, 1997). Consequential making also furthers students' understanding of themselves as makers and the making process. When we view "...making as a tool to support youth in creating artifacts that simultaneously support their onto-epistemological development of discipline-specific and making knowledge" (Heredia & Tan, 2021) it becomes a more enriching experience for students. When students feel as though the learning environment has created space for them and who they are, they find it easier to engage in that environment.

Multiple Types of Student Engagement

Now that the Three Tenets of Making have been examined, let's examine different types of student engagement. Student engagement has been a topic that has long been studied (Fredericks et al, 2004; Reeve, 2013; Vickers et al, 2014; Wang et al, 2019). "Because there has been considerable research on how students behave, feel, and think, the attempt to conceptualize and examine portions of the literature under the label "engagement" is potentially problematic; it can result in a proliferation of constructs, definitions, and measures of concepts that differ slightly, thereby doing little to improve conceptual clarity." (Fredericks et al, 2004). In this section I will point out six different types of student engagement-behavioral, emotional,

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cognitive, agentic, social-relational, and sociocultural-that are being used for this study. In review of the literature of these different modes of engagement for students, I will also define how these types of engagement will be looked at within this study.

Behavioral Engagement examines how students participate, attend to, focus on, and persevere through challenges in education (Fredericks et al, 2004). This can range from following teachers' directions to taking initiative in activities such as extra-curricular activities (Fredericks et al, 2004). For this study student behavioral engagement will be looking at student initiative within student-directed classroom activities. When measuring behavioral engagement, you can look at several different indicators, which can be positive or negative examples (Fredericks et al 2004). Completion of work, effort, attention, and persistence (Fredericks et al, 2004) are all behaviors that will be looked for when observing student behavioral engagement. Behavioral engagement does not mean compliance but can rather be looked at as what Engle et al (2002) called productive disciplinary engagement. Productive disciplinary engagement can look like students have constructive debates over topics, suggesting alternative ideas or procedures that benefit learning, or systematically shifting from task to task (Engle et al, 2002). It is important to note that engagement is something that can fluctuate and so I will be monitoring times where students are engaging in the activity (positive examples) and when students begin to disengage (negative examples). Both Reeves (2013) and Wang et al (2019) mention how some of the principles of behavioral engagement should be updated which they discuss in their respective ideas of agentic engagement and sociocultural engagement (both to be discussed below).

Emotional Engagement is the "positive and negative reactions to teachers, classmates, academics, and school… (Fredericks et al, 2004). With further research into Social-Emotional

learning in schools, the importance of students' emotions and that can affect their learning has become more prevalent (Yang et al, 2018). When looking for student emotional engagement signs to look for are how students' emotional reactions to situations within academic activities either increase student engagement or lead to disengagement. Parks et al (2012) pointed out the idea of student competence, autonomy, and relatedness around educational experiences and the effects of emotional engagement. Student interest and the ability to choose, were shown to lead to increased emotional engagement (Parks et al, 2012). Since student interest, especially long-term personal interest, plays an important role in emotional engagement (Fredericks et al, 2004) the inclusion of student interests supports or hinders their completion of self-directed learning should be examined. Emotional engagement is mostly measured through self-report measures such as surveys or interviews and can often be harder to observe as bystander (Fredericks, 2004), so this will have to be taken into account when thinking about ways to look for emotional engagement during an observation (to be discussed later).

Cognitive Engagement is the investment, or willingness to exert effort to the comprehension of situations, thoughtfulness, and mastery of difficult skills (Fredericks et al, 2004). In trying to better understand student cognitive engagement, it is necessary to reflect on how students are reflecting on their experiences and using these reflections to accomplish difficult tasks. Cognitive engagement can be defined as either being strategic or self-regulated (Fredericks et al, 2004). In strategic learning students use specific metacognitive strategies to "...plan, monitor, and evaluate their cognition in learning." (Fredericks et al, 2004). Goal-setting, and instructional discourse are observable measures of student cognitive engagement and connect to strategic learning (Fredericks et al, 2004) and so this will be monitored while students are working. Self-regulation is looking at how student interest leads to thoughtful exploration of

a topic (Fredericks et al, 2004) much like was discussed earlier with emotional engagement. I look to further explore how student interest not only assists, or prohibits, completion of an activity but also how that interest can assist students in their reflective and thoughtful exploration of a topic. "…measures of cognitive engagement such as survey items about flexible problem solving, preference for hard work, independent work styles, and ways of coping with perceived failure" (Fredericks et al, 2004) fit into self-regulated learning.

Agentic engagement is defined as "...students' constructive contribution into the flow of the instruction they receive." (Reeves, 2013). This positions students as active participants in their learning in that they can shape learning outcomes or the type of instruction that is being delivered. This requires a reciprocal relationship between student outputs and teacher instruction, whereas student output informs teacher instruction, and vice versa (Reeve, 2013). Student choice, open discussion, and individualized activities are ways in which this level of student agentic engagement can be reached. Shared control among teachers and students and student negotiation (when it comes to learning practices) has been shown to increase agentic engagement (Sökmen, 2021). With agentic engagement students are seen as active participants and producers of knowledge within the classroom by asking questions, stating preferences, making suggestions, and providing feedback (Reece, 2013). In classroom observations when looking for agentic engagement it is important to look at how classroom instruction and student work time and how students are impacting their learning, and the execution of class assignments.

Social-Relational Engagement takes into consideration the social side of education. Elements of Social-Relational engagement are how students interact with one another and their teacher (Vickers et al, 2014). Other elements that affect students' social-relational engagement are "perceived parental support for education, teacher respect at school, value coherence, …. and

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friends at school." (Vickers et al, 2014). It is important to note that these components also consider how students' perceptions of these components are impacted by those that interact with them, whether positively or negatively (Vickers et al, 2014). Conboy et al (2014) found that parent support was high among students that reported high engagement in school. Value coherence factors in a student's educational values as well as the values of their peers (Vickers et al, 2014). Friends at school weighs the balance of having friends at school and how that can support student learning and success or hinder it (Vickers et al, 2014). Having friends at school, and specifically in class, can increase student engagement if used correctly. While sometimes friends can be a hindrance to engagement (Vickers et al, 2014). It has also been examined that factors such as class size, how students are graded, relation to peers in educational settings, and interactions with peers affects student engagement (Conboy et al, 2014). Yang et al (2018) found that teacher-student relationships and student-student relationships, when positive, lead to increased social-relational engagement. The basis of Social-relational engagement for this study is how a student's engagement, and thereby their learning and achievement, is influenced by those that they interact with in academic and social contexts.

   Sociocultural Engagement factors include student coping strategies and resilience in response to stressors, emotional regulation and engagement, students' social skills, self-appraisals and motivational beliefs, and students' social contexts (peers, family, school) (Wang et al, 2019). Sociocultural factors of engagement connect to previous studies of engagement, while extending understanding of engagement or disengagement to consider the student as a whole person (Wang et al, 2019). Much of the work around sociocultural engagement stemmed from earlier work on Culturally sustaining pedagogy (CSP) from Django Paris (2012). The ideas of CSP involve students feeling as though their cultural and language practices are not only

respected but also engaged in learning experiences (Paris, 2012). When examining sociocultural engagement, all aspects of a student's identity and their cultural values and beliefs must be considered in how they affect student learning and achievement. Race and ethnicity, gender, socioeconomic status, family context, school contexts, and peers are all influences that affect the factors of sociocultural engagement that were listed earlier (Wang et al, 2019). The goal is to take into account how all these factors shape students' learning experiences, but also how to create a just system that removes barriers to learning due to these factors. Thinking about all the influences on student engagement, allows us to better understand what engages to learn and how we can provide interventions when students are disengaged (Wang et al, 2019). Paris (2012) calls for a more humanizing pedagogy where efforts are put into place so that students feel as though they can engage in learning without feeling as though they have to set aside a part of their identity, When observing for sociocultural engagement among students things that are looked for does the instruction follow a dominant-narrative of learning, are students lived experiences celebrated in the learning environment (especially among disenfranchised students), and is there equal access to learning opportunities regardless of sociocultural factors (race/ethnicity, gender, socioeconomic status, religion, sexual orientation, etc.). With a better understanding of how making can be integrated into learning and the concepts of student engagement, synthesizing these two ideas can increase student engagement in making and learning as a whole.

Connection of Three Tenets of Making and Student Engagement

While there are numerous studies on makerspaces and maker education and student engagement, not many studies have synthesized the concepts. It is the goal of this study to make those connections and see what holistic student engagement (engagement that meets multiple types of engagement) can be observed in making projects within an academic context. The tenet

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of maker as a learner, for purposes of this study, will be connected to cognitive engagement, emotional engagement, and social-relational engagement. As mentioned earlier, part of making as a learner is understanding of design principles and scientific and technical knowledge (Heredia & Tan, 2021). When students are using these physical or digital tools in learning activities, students have to be able to communicate how the tool or design represents what they are learning. As students are learning new content, the design tools should be a tool for students to model the phenomena that they are working to understand, also known as "epistemic games" (Wilkerson et al, 2018). Making has also been shown to cause students to shift their feelings and beliefs about themselves as makers and productive members of the classroom environment. Working in making has shown "...disruptions of classroom status, student positioning, and conceptions of smartness." (Hegedus et al, 2014). Hegedus et al (2014) reports that students that had previously been seen as not good students thrived while participating in an Engineering unit, and even took more leadership roles within their group while in the unit. Making also provides opportunities for students to interact with peers and even in ways that they may not have before.

Making as iterative connected more closely to behavioral engagement, emotional engagement, and agentic engagement. Studies have shown that when students have situational interest and interaction with their peers has increased motivation in design challenges (Kumpulainen & Kajamaa, 2020; Vongkulluksn et al, 2018; Vongkulluksn et al, 2021). An open environment, full of choice, and opportunities to move between individual activity and collaborative activity motivated and empowered students to complete design challenges (Kumpulainen & Kajamaa, 2020). Student engagement can also fluctuate when obstacles present themselves or when feedback becomes challenging to accept (Vongkulluksn et al, 2018).

Helping students understand the iterative nature of making, helps manage emotional and behavioral engagement.

Finally, making as equitable & consequential connects to sociocultural engagement, agentic engagement, and social-relational engagement. In making context it is important to notice what, or who's, knowledge and experiences are valued in the classrooms (Tan et al, 2019). As mentioned earlier, learning is more impactful when it takes into account students' lives and the communities around them. Making education "...ought to create conditions and provide students with the resources to work in community (and the world) as responsible and responsive citizens." (Hart, 2012). Instruction also becomes more effective when students are able to position themselves within the learning environment, but the learning also extends beyond the classroom (Hart, 2012). Making should also focus on what practices-social, cultural, and academic- that "...disrupt power differentials and conceptions of what counts as smart is in the open-ended nature of design challenges." (Hegedus et al, 2014). The three tenets of making and the types of student engagement provide natural connections to better understand how students learn and achieve in making contexts.

CHAPTER III: METHODS

A case study approach was taken to understand what engages, or disengages, students in making experiences (Malik, 2013). Field observations and interviews reflecting on experiences will be used to make generalizations about student engagement in making. An inductive thematic coding was used to create themes from both the observation and interview data.

Context

The site selection for this research was to find a K-12 institution that has an established Makerspace and is commonly used among teachers and students. Teachers that have experience with making and integrating making in education were. The site that was chosen is a 2-12 private school for neurodivergent students. Observations will be completed with a teacher maker-in-residence who teaches an elective that incorporates making. The class size for each is 5-6, with students working on different projects at different times. This course is a six-week elective course, and students are in the class for one hour four days a week. In order to have a clear understanding of factors that engage, or disengage, students in making experiences, there will be two observations done.

Observation

For the observation, an observation protocol has been developed to focus the observation on how students are engaging with making. The observation protocol takes the theoretical approach of combining the three tenets of making: maker as learner, making as iterative, and making as equitable and consequential (Heredia & Tan, 2021); and the multiple types of student engagement: behavioral engagement, emotional engagement, cognitive engagement (Fredericks et al, 2004), agentic engagement (Reeves, 2013), social-relational engagement (Conboy et al, 2014; Vickers et al, 2014), and sociocultural engagement (Wang et al, 2019). The protocol itself

is a combined product from the Reformed Teaching Observation Protocol (RTOP) (Piburn et al, 2000), and theoretical framework from Tinkering in education (Bevan et al, 2014). The observation protocol provides space for an observer and teacher to reflect on student engagement and learning in making. *Figure 1* shows the observer's reflection of the lesson while figure 2 shows the teacher's reflection.

Figure 1. Observer Reflection

Figure 2. Teacher Reflection

A. Teacher Reflection

Under each category are student or teacher actions that could occur during the making or the planning of the making. Using observations of the lesson, rate how often each element occurred on a scale of not evident to highly evident. Note: this is not an evaluation, and not every statement can be true about every lesson. This is just a reflection tool.

Making as Learning

1. The instructional strategies and activities make connections to students' prior knowledge and preconceptions

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

2. Students made predictions, estimations and/or hypotheses and devised means for testing them.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

3. Students communicated new ideas/questions about their designs and the procedures they were using to accomplish their tasks.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

4. Students demonstrated evidence of applying previous knowledge and conceptual understanding to the making.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

5. Constructive criticism, and the challenging of ideas were present throughout the making.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

6. Students communicate shifts/questions about their ideas of themselves as makers, learners, and students

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

7. Students are active participants in the learning process-asking questions, hearing ideas, providing feedback, communicating needs, etc.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

8. Students have expressions of surprise, joy, wonder, frustration, curiosity

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

Making as Iterative

1. Students set their own goals for the project and its completion

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

2. Students seek and respond to feedback and adjust their making in regards to the feedback (From peers, teacher, observers, etc.) Note: could vary depending on where students are in the making process.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

3. The teacher used questions designed to allow students to think about their designs in new ways

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

4. Students persist to achieve goals

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

5. Time is spent re-focusing work with the design challenge

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

6. Students display investment in their design by demonstrating consistent engagement towards its completion.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

7. Students showed the ability to work through frustrations/obstacles to move forward in making.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

8. Students demonstrate an understanding that designs that are not successful are not failures rather opportunities for continuous improvement of their design.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

Making as Equitable and Consequential

1. Students communicated their ideas to others using a variety of means and media.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

2. There was a high proportion of student talk about their making (Especially student to student).

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

3. Ideas from students were shared openly and received positively (from all students).

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

4. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

5. Students communicated connections between the making and their lived experiences.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

6. The teacher provided multiple entry points for students to engage in the making

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

7. The making experience was designed in ways that were purposefully equitably accessible to all students.

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

8. Students demonstrated agency, leadership towards other members (students or teachers) of their class (rather than follow typical power dynamics).

Not Evident   Somewhat Evident   Mostly Evident   Highly Evident

Any other comments that would be beneficial to reflection of the observation.

Data Collection

The data collected for the report of this study was taken from observations of a teacher leading a making lesson in their classroom. Field observation notes of learning experiences in making were used for reflection between the teacher and observer. The observer and teacher looked over observation notes to analyze student engagement in the making experience. An interview with the teacher was conducted to gather the teacher's thoughts on what happened

during the lesson(s) that was observed. This analysis of the lesson is done to better understand student engagement and how to adapt future lessons to engage students in making. Questions that were asked in the interview were: *What was the context for making? What was your thought process for planning this project? What goals did you set for student learning? (academic, procedural, personal) What were some things that students did or said that surprised you? How has using this observation protocol helped you see student engagement in making differently? What are your goals for future making with these students? (academic, procedural, or personal)*

Data Analysis

Analysis was ongoing throughout data collection. After making observations field notes were coded using Inductive Thematic Coding to match with the type(s) of engagement and which of the tenets of making that it corresponded most directly to. This was done using a table as shown below in figure 3. After the observation data is coded, initial themes will be highlighted to discuss with the teacher in later interviews.

Table 1. Example Data Coding

Field Notes	Type of Engagement	Tenet of Making
Ex: Student stops working with group members on design. There had previously observed arguments in this group on their design. Student expressed that they were frustrated because the group was not listening to their ideas.	*Emotional engagement: Student expresses feelings of frustration with group members. The student is passionate about their idea for design.* *Behavioral engagement: Student stops working after arguing with group members after arguments of the design. Student says that they were frustrated with the group for not listening to their ideas.* *Agentic Engagement: the project and their idea matter to the student* *Social-Relational Engagement: The group showed no signs of being receptive to the student's ideas, the student decides to stop working with the group rather than solve the problem*	*Making is Iterative: The group appear to not be receptive to other ideas/feedback, the student that shows frustration does not show any desire to try many different solutions and is fixated on their individual idea.* *Making is Equitable and Consequential: the design matters to the student but the group is not giving them a voice in the project*

Next this table would be used to guide the observer's reflection of the lesson using the observation protocol. Rating was used on a form of a Likert scale from *Not Evident* to *Highly Evident*. The observer would complete this reflection from their observation notes. If it was not witnessed during the observation, it would be marked as not evident. If it happened sporadically through the observation, or with only a few students it would be marked as Somewhat evident. If the statement applies to most students through the majority of the observation, with only a few student outliers then the statement would be marked as Mostly evident. If this was something

that was evident throughout the entire observation with almost all students, then the statement would be marked as highly evident.

The teacher would also complete a reflection with the same statements as the observer. Then the observer's and teacher's reflection of the making lesson were compiled together to compare the thoughts of student engagement during the making lesson. An open interview would then be conducted with the teacher to discuss their reflections of the making time, as well as the observers. Finally, the teacher was asked interview questions about the tool and how it shaped their understanding of student engagement in making. The interview with the teacher was transcribed to get their understanding of student engagement in Makerspace, and how the tool helped guide their future development of engaging maker lessons for students.

Once interviews are completed, all interview data will be coded using Inductive Thematic Coding to find how the teacher reflects on their teaching to increase student engagement in making. Coded interview data was then combined with the coded observation data to see what connections, or possible contradictions are present in the data. This analysis is used to create themes to better understand factors that support or inhibit student engagement in making.

CHAPTER IV: RESULTS

After looking through the observation data and the interview with the classroom teacher, the results were organized into the following themes: Teacher Understanding & Beliefs Surrounding Student Engagement in Making, Iteration as a School and Classroom Cultural Practice, Positive Relationships and Social-Interactions as a Driver for Engagement in Making, and Meaningful Making Practices for Students. This section will delve deeper into these themes and what was observed in the classroom or brought up in the teacher interview that brought about these themes.

Theme 1: Teacher Understanding & Beliefs about Student Engagement in Making

In the interview with the observed teacher, the question was asked to define what they believed student engagement to be or look like in the context of their classroom. The teacher's response was "Student engagement, especially in a Makerspace, should be noisy, but a productive noise. When walking into a classroom that is completely quiet, it can be alarming. Students are asking questions-to either the teacher or each other. Using the computer-or any educational tool- as a tool for learning, rather than an entertainment device." The teacher also mentioned how student engagement is such a broad term and can often be confused with other things such as behavior, motivation, or student interests. One thing the teacher mentioned as an important theme that they wanted students to take away from their class is a natural curiosity. It was discussed that school learning has become fixated around the idea of "rote learning" where students are just expected to memorize information and then recall this information when necessary. The teacher expressed concerns that this system of rote learning could diminish the ability for students to be intellectually curious. "This intellectual curiosity provides the opportunity for people to find solutions to challenges…" whereas rote learning focuses on

information that was previously acquired. It was also recognized by the teacher that students' feelings towards school at that time also affects their engagement even in making, It was noticed that with this being the end of the school year the students were more mentally checked out which affected their engagement in the course. It was observed that the later lessons in the course became more teacher directed. In the final observation, the following notes were made in the first ten minutes of the observation.

Teacher passes out a piece of PVC pipe to each student and tells them they will be using that, plus paper and scissors to build rockets today. Teacher passes out instructions and remaining materials. Teacher goes step by step with the students to create their rockets Teacher explains the role of the pressure cap-to keep the air that is being pumped into the pipe, in the pipe. Explains thrust to students. Teacher goes through the steps of making the nose cone and the fins. Teacher shows students how to take the flattened-out cone and roll it into a cone. Teacher tells students to crumple up remaining paper to put into the nose cone to give it more mass. Teacher explains how the fins help stabilize the rockets in order to reach altitude. Teacher goes around to observe and assist students.

When asked why this lesson was more teacher directed, the teacher responded that they wanted students to have a sense of success in building a model rocket since it was their last activity. This led to a discussion of how to balance teacher-centered direct instruction, and student-centered exploration and learning. The final reflection the teacher gave on student engagement was this idea of "low floor, high ceiling, wide walls". This means that the entry point for students in the learning activity is low enough that all students have access (low floor), the opportunity for the students to extend their learning to the level they can and want (high

floor), and a wide range of choices of ways students can explore (wide walls). It was discussed how this idea helps create a successful making experience for students.

Theme 2: Iteration as School & Classroom Culture

On my very first observation in this classroom the first thing I witnessed was the teacher passing back two 3D printed objects to students that were from a previous project. The students showed excitement over getting their projects back and immediately began talking with the teacher about how the objects turned out, what could be approved upon, or what they would do differently next time. There were moments in the observations where students would walk around to other students and ask about their projects and give praise or suggestions on them. One student was working on designing a digital background and wanted to take this project home and continue to work on perfecting it over the weekend. When I asked the teacher if this kind of iteration was a product of the school culture, the teacher said that how the school operates and what makes it different allows for students to feel safe to ask questions and receive feedback. It was shared that the school culture is one that focuses on building strengths to grow and learn new things. This is done through goal setting with each student, which in turn may help the students feel as though the teachers are invested in their growth and learning. The teacher believes the school culture has created an environment where students feel safe and comfortable whether that be academically, socially, or emotionally. I did notice however that in a later observation, this level of iteration was not consistent. In a later lesson where the class was building model rockets the teacher went through step by step with the students on how to build the rocket. As they were going through the process comments would be made such as "make sure there are no gaps or air will get inside and prevent the rocket from taking off", which was repeated multiple times through the process. The teacher even later mentioned that when they

launched the rockets, very few did launch correctly but since it was the end of the school year there was no time for feedback and corrections.

Theme 3: Relationships and Social-interactions as a Driver for Engagement in Making

One thing that the teacher mentioned multiple times through data collection was the role that relationships (teacher to student, and students to each other) play in establishing successful making. After the first time observing in this classroom, I asked the teacher what their goal for these students was in the previous lesson observed and their response was: "Building the relationship between [the teacher] and student. The students becoming comfortable with asking the [teacher] questions or starting a project on their own." As the teacher and I were discussing the students' engagement with the course it was pointed out that these students are brand new to this type of course, and so they are in the developing relationship stage. In this type of course, making is more personal, so the relationships help encourage making. The projects were designed to allow students to explore what the design process is like for them. Students are navigating the freedom of this type of course and staying on task. These first few days it has been about getting the students used to the space and the less structured environment (the balance of structure). Students are still navigating how to ask questions and explore new ideas. As students were working, the teacher would walk around and ask them about what they were working on but also try to make connections with students to help spark inspiration. The teacher would often talk with students about their love for space, Star Wars, and gaming, which would then lead to students creating projects that were derived from those conversations. There were times in the observations that students felt comfortable asking for assistance from the teacher or even each other. Relationships with the students and among the students is something that the teacher thought about often and mentioned often in interviews. When asked what could have

been factors for decrease in student engagement as the course continued the teacher believed that

not having a lot of time with these students was a big factor of that. The teacher noticed that even

due to the layout of the building this particular group of students do not get to see this teacher

often unless they are in this course. Some strategies that were used to try and counter this were

the conversations with the students about their interest, but also in all the observations during the

last ten minutes of class, if students completed whatever work they were supposed to be working

on, they got to work on anything they wished within the space. The openness of this time helped

the students feel acclimated to each other and the space.

Theme 4: Meaningful Making Practices for Students

The final theme that evolved from looking at the data was this idea of making projects

that are meaningful to students. As mentioned earlier the teacher valued this idea of intellectual

curiosity, and we discussed ways to create design projects that are meaningful to students so that

their intellectual curiosity takes hold and drives their work. For one of their projects the teacher

wanted the students to practice 3D modeling with TinkerCad and Icograms. It was observed that

students were reluctant to work in either of these programs. In a passing conversation with a

couple of students the teacher mentioned that apps like Icograms are used by civil engineers for

city planning as well as game animators when designing cityscapes or landscapes to use in

games. In conversations with the teacher and myself, we discussed how starting with connections

could be helpful in getting the students engaged with the making. The teacher recognized that by

doing this, the making is more meaningful for students and not just something they are told they

have to do. As we were reflecting on observations it was pointed out that students were most

engaged when they had a personal connection to their making. In the observation there was a

student that wanted to use the laser printer to create a coaster with their dad's business emblem

on it. The student went through multiple trial runs and was excited to share the products with their classmates, the teacher, and even myself. When the students were building modeled rockets, the students would make connections to NASA but also things they have learned about force and motion, there was particularly a discussion on thrust. When the teacher was asked how this experience would affect future making with the students, he discussed the possibility of offering more choices about what students would work on, and they could sign up for things they were more interested in whether that be coding and digital design, or tinkering, etc. The teacher said that his mission is for this course to be a "creative space" where students can come and explore the ideas they want to explore. The teacher is also wanting to push for more integration with other teachers and academic subjects both in and out of the Makerspace.

CHAPTER V: DISCUSSION

In this research study, the teacher being observed enjoyed the opportunity to reflect on their practice and how they were engaging students in the classroom space. It was recognized that student engagement is a broad subject and there are many factors that contribute to high student engagement and low student engagement. It was also noticed that when combining the different parts of student engagement with carefully planned out making activities that are conscientious of the Three Tenets of Making (Maker as a Learner, Making as Iterative, and Making as Equitable & Consequential) that it becomes easier to reflect on student engagement and build activities that lead to better student engagement. The goal of this research was to find commonalities between research on student engagement and research on design and making in education. With the connection of these two fields of research it is my belief that both areas could benefit from being discussed in tandem with each other. It is the hope of this research that student engagement becomes a topic that is better understood by researchers and teachers to benefit student learning. It is also the hope that making in education (in many different forms) is seen as an avenue to explore different strategies on increasing student engagement.

Since this research was focused on design principles in education, I would be remiss to not apply those principles to my research. One of the components of design is being iterative by nature and always looking for feedback and improving upon what is being created. When I asked the teacher what is something that could be improved on with the Observation Protocol that was compiled for this research, it was discussed to think more about the school culture and how that affects student engagement in making. As I continue to develop my own understanding of factors of student engagement in making, I will have to continue to think of ways that evidence of the influence of school culture in student engagement presents itself in student learning activities. I

also notice the need to continue to think of concrete evidence for student engagement in making to create a well-designed observation protocol.

It is also important to note limitations of this research, and how that affects further research. First the population size of students that were observed and the time in which to observe them. Since the classroom that was partnered has a smaller class size than most typical classrooms that affects the amount and validity of data that can be collected. There was also limited time to observe these students since this was only a six-week course there was not ample time to observe student engagement over longer periods of time. With further research it is imperative that different populations and population sizes be observed to create better validity among results. More time with the students would also be more beneficial to the kinds of results that would be produced.

CHAPTER VI: CONCLUSION

Making in education is something that is being researched and developed more for formal classroom learning environments. It is in making that there exists the potential to increase student engagement as well as better understand student engagement from a research perspective as well that of the classroom teacher. By combining the ideas of meaningful making practices and student engagement it can increase the understanding of both topics. Connecting the ideas of making and student engagement could lead to increased learning for students, students' identity development as students and people, and provide students with learning experiences that are meaningful to them.

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Student Engagement in Making Education
Researcher Observation Protocol

The Student Engagement in Making Education (SEME) Observation Protocol was created to observe patterns of student engagement, or disengagement, with making. The observation protocol takes the theoretical approach of combining the three tenets of making: maker as learner, making as iterative, and making as equitable and consequential (Heredia & Tan, 2021); and the multiple types of student engagement: behavioral engagement, emotional engagement, cognitive engagement (Fredericks et al, 2004), agentic engagement (Reeves, 2013), social-relational engagement (Conboy et al, 2014; Vickers et al, 2014), and sociocultural engagement (Wang et al, 2019). The protocol itself is a combined product from the Reformed Teaching Observation Protocol (RTOP), and theoretical framework from Tinkering in education (Bevan et al, 2014). More about the three tenets of making, and the multiple types of engagement will be discussed below.

Three Tenets of Making
1. Maker as Learner- Participant understanding of making and design principles, connections to scientific and technical modes of understanding, identity development and students learning about themselves as makers and students. (Heredia & Tan, 2021)
2. Making as Iterative-Access to feedback and responding to the feedback. Seeing as making as an ongoing process and always tweaking and improving designs and creations. (Heredia & Tan, 2021)
3. Making as Equitable and Consequential- Taking into consideration the historical, social, and cultural components of making (Heredia & Tan, 2021). Making where students can apply design principles and disciplinary knowledge to disrupt typical narratives of power (Heredia & Tan, 2021).

Types of Engagement
Behavioral Engagement-the ability to focus, attend, and persevere in a learning environment.
Emotional Engagement-How students specifically feel about themselves and their learning within the context of the learning environment.
Cognitive Engagement-Students ability to apply cognitive strategies and the connections they make through the learning process.
Agentic Engagement-Students see what they are learning as important, meaningful, and purposeful, what they are learning extends beyond the classroom.
Social-relational engagement-what students learn about themselves, their peers, and the world through the social interactions within the learning context.
Sociocultural engagement-recognizing and celebrating differences and perspectives within the learning context, design of learning environments/experiences that allow for equitable access to knowledge formation and expression.
Observation Field Notes
Take note of student and teacher actions during the observation of the making process. Pay close attention to how students are engaging with making, and what factors either facilitate

or prevent engagement with making. (Note: Depending on where students are in the making process could affect observable practices. Could be helpful to ask students or teacher what previous steps were taken and what the next steps will be.)

Coding Field Observation

After making field observations look at your notes and code them to the types of engagement and which tenet(s) of making that is part of. An example table of how-to code field observations is below.

Field Notes	Type of Engagement	Tenet of Making
Ex: Student stops working with group members on design. There had previously observed arguments in this group on their design. Student expressed that they were frustrated because the group was not listening to their ideas.	*Emotional engagement: Student expresses feelings of frustration with group members. The student is passionate about their idea for design.* *Behavioral engagement: Student stops working after arguing with group members after arguments of the design. Student says that they were frustrated with the group for not listening to their ideas.* *Agentic Engagement: the project and their idea matter to the student* *Social-Relational Engagement: The group showed no signs of being receptive to the students' ideas, the student decides to stop working with the group rather than solve the problem*	*Making is Iterative: The group appear to not be receptive to other ideas/feedback, the student that shows frustration does not show any desire to try many different solutions and is fixated on their individual idea.* *Making is Equitable and Consequential: the design matters to the student but the group is not giving them a voice in the project*

Reflection of Observation Notes

After coding field observations to connect to the theoretical framework (Maker as Learner-emotional engagement, cognitive engagement, social-relational engagement; Making as Iterative-Behavioral engagement, emotional engagement, agentic engagement; and Making as Equitable and Consequential-agentic engagement, social-relational engagement, sociocultural engagement), go through each section and rate how evident the statement applies to the observation. Rating was used on a form of a Likert scale from *Not Evident* to *Highly Evident*. It should be noted that this is not an evaluation of teaching practice. Rather, a snapshot of student engagement in a lesson. Depending on where students are in the making process not all factors will be present.

Observation Notes

A.   Initial Reflection of Observation Notes

Under each category are student or teacher actions that could occur during the making or the planning of the making. Using observations of the lesson, rate how often each element occurred on a scale of not evident to highly evident.

Making as Learning

1. The instructional strategies and activities make connections to students' prior knowledge and preconceptions.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

2.   Students made predictions, estimations and/or hypotheses and devised means for testing them.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

3.   Students communicated new ideas/questions about their designs and the procedures they were using to accomplish their tasks.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

4.   Students demonstrated evidence of applying previous knowledge and conceptual understanding to the making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

5.   Constructive criticism, and the challenging of ideas were present throughout the making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

6.   Students communicate shifts/questions about their ideas of themselves as makers, learners, and students.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

7.   Students are active participants in the learning process-asking questions, hearing ideas, providing feedback, communicating needs, etc.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8.   Students have expressions of surprise, joy, wonder, frustration, curiosity.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Making as Iterative

1. Students set their own goals for the project and its completion.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

2.   Students seek and respond to feedback and adjust their making in regard to the feedback (From peers, teacher, observers, etc.) Note: could vary depending on where students are in the making process.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

3.   The teacher used questions designed to allow students to think about their designs in new ways.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

4.   Students persist to achieve goals.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

5.   Time is spent re-focusing work with the design challenge.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

6.   Students display investment in their design by demonstrating consistent engagement towards its completion.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

7.   Students showed the ability to work through frustrations/obstacles to move forward in making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8.   Students demonstrate an understanding that designs that are not successful are not failures rather opportunities for continuous improvement of their design.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Making as Equitable and Consequential

1. Students communicated their ideas to others using a variety of means and media.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

2.   There was a high proportion of student talk about their making (Especially student to student).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

3.   Ideas from students were shared openly and received positively (from all students).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

4.   Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

5.   Students communicated connections between the making and their lived experiences.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

6.   The teacher provided multiple entry points for students to engage in the making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

7.   The making experience was designed in ways that were purposefully equitably accessible to all students.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8.   Students demonstrated agency, leadership towards other members (students or teachers) of their class (rather than follow typical power dynamics).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Any other comments that would be beneficial to reflection of the observation.

Student Engagement in Making Education
Teacher Observation Protocol

Teacher Reflection Notes (optional)
This space can be used for you to make any notes about the lesson. This can be done from memory after the lesson or by looking at video of the lesson.

## A.	Teacher Reflection

Under each category are student or teacher actions that could occur during the making or the planning of the making. Using observations of the lesson, rate how often each element occurred on a scale of not evident to highly evident. Note: this is not an evaluation, and not every statement can be true about every lesson. This is just a reflection tool.

Making as Learning

1.	The instructional strategies and activities make connections to students' prior knowledge and preconceptions.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

2.	Students made predictions, estimations and/or hypotheses and devised means for testing them.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

3.	Students communicated new ideas/questions about their designs and the procedures they were using to accomplish their tasks.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

4.	Students demonstrated evidence of applying previous knowledge and conceptual understanding to the making.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

5.	Constructive criticism, and the challenging of ideas were present throughout the making.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

6.	Students communicate shifts/questions about their ideas of themselves as makers, learners, and students.

Not Evident　　　　　*Somewhat Evident*　　　　　*Mostly Evident*　　　　　*Highly Evident*

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7.   Students are active participants in the learning process-asking questions, hearing ideas, providing feedback, communicating needs, etc.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8.   Students have expressions of surprise, joy, wonder, frustration, curiosity.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Making as Iterative

1. Students set their own goals for the project and its completion.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

2.   Students seek and respond to feedback and adjust their making in regard to the feedback (From peers, teacher, observers, etc.) Note: could vary depending on where students are in the making process.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

3.   The teacher used questions designed to allow students to think about their designs in new ways.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

4.   Students persist to achieve goals.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

5.   Time is spent re-focusing work with the design challenge.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

6. Students display investment in their design by demonstrating consistent engagement towards its completion.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

7. Students showed the ability to work through frustrations/obstacles to move forward in making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8. Students demonstrate an understanding that designs that are not successful are not failures rather opportunities for continuous improvement of their design.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Making as Equitable and Consequential

1. Students communicated their ideas to others using a variety of means and media.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

2. There was a high proportion of student talk about their making (Especially student to student).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

3. Ideas from students were shared openly and received positively (from all students).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

4. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

5.   Students communicated connections between the making and their lived experiences.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

6.   The teacher provided multiple entry points for students to engage in the making.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

7.   The making experience was designed in ways that were purposefully equitably accessible to all students.

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

8.   Students demonstrated agency, leadership towards other members (students or teachers) of their class (rather than follow typical power dynamics).

Not Evident   *Somewhat Evident*   *Mostly Evident*   *Highly Evident*

Any other comments that would be beneficial to reflection of the observation.