

Implications to STEM Learning through the Installation of a Digital Fabrication Lab

Teton County School District #1

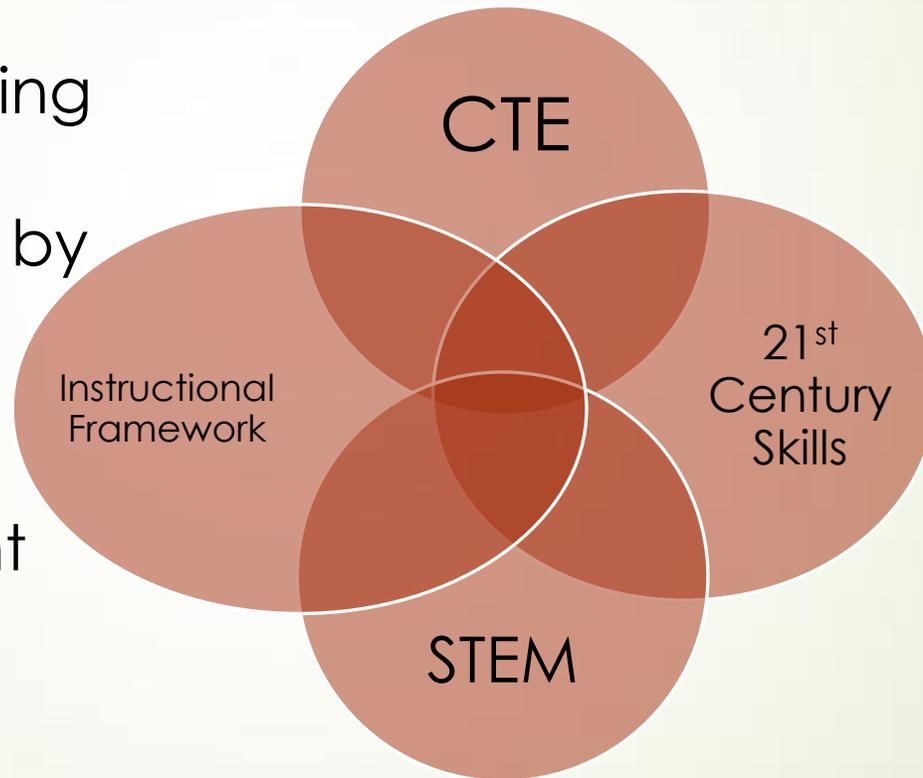
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Our goal was to develop a way to integrate CTE skills, STEM content knowledge and 21st Century Skills together...

...ideally, this was done through shifting teaching and learning practices by having groups of teachers work collaboratively on integrated content unit/lesson plans.



What is a Digital Fabrication Lab? (FabLab)

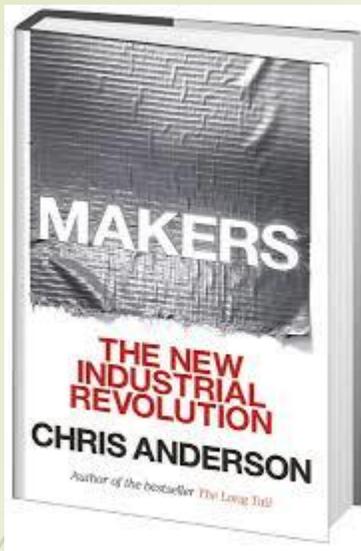
MIT

With origins at Massachusetts Institute of Technology (MIT), digital fabrication labs are places where people can use the latest in software and hardware to develop and refine inventions or ideas.

Stanford University expanded this application by putting them into schools. This fit the model we were looking for of crossing over our target areas.

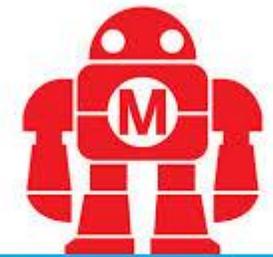


Mahtomedi High School
Mahtomedi, MN



Maker Education Initiative

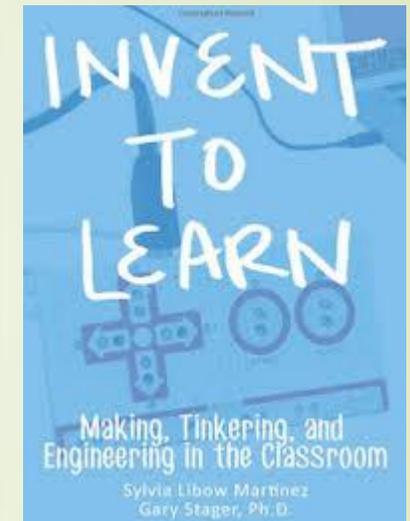
EVERY CHILD A MAKER



Maker Faire

THE MAKER MOVEMENT

AN EXTENSION OF DIY CULTURE WITH AN EMPHASIS ON **TECHNOLOGY, ENGINEERING AND FABRICATION**. MAKERS USE A COMBINATION OF HOME TOOLS, EQUIPMENT AT LOCAL HACKERSPACES, AND **ONLINE FABRICATION SERVICES** TO BUILD, PROTOTYPE, MAKE AND MANUFACTURE ALL KINDS OF THINGS. THE MAKER MOVEMENT VALUES **COMMUNITY & COLLABORATION**, OPEN SOURCE MODELS, AND A SPIRIT OF *experimentation*.



The
Maker
Movement

Typical equipment found in a FabLab?

- Laser Engravers
- Vinyl Cutters
- Large or small CNC routers (milling machines)
- 3D Printers
- Electronics
- Woodworking tools
- Art and other crafting items

Can also include:

- Metalworking
- Jewelry making
- Sewing and other textile capabilities

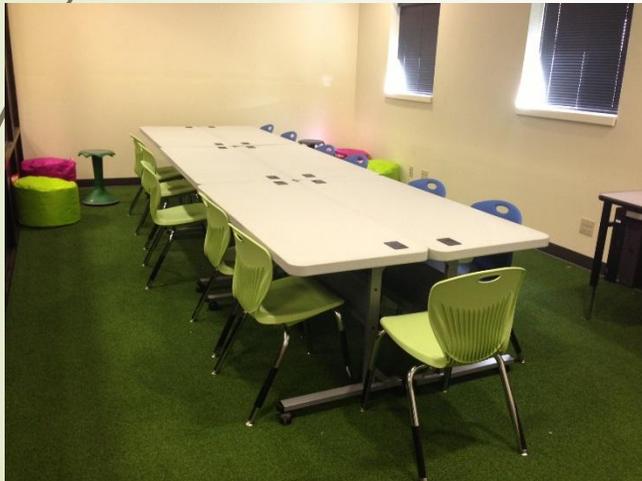


Our Spaces...

Collaboration Space: This space is our collaborative thinking space. Students, teachers and community members will find this to be a place of creativity and inspiration. Ideas and creativity should flow freely allowing you to think differently in a very flexible, adjustable space.

Digital Design Space: This space is our digital design lab where the main focus is learning how to digitally create models, objects or prototypes. The world of digital design is full of unforeseen challenges, struggles, and major accomplishments but important to include in any technology space.

Maker Space: This space is the traditional "maker space"...full of advanced technology as well as a plethora of supplies which allow a person to create almost anything he or she can think of. Culminating in an array of products that showcase the learning and making that is associated with a true "MakerSpace".



The curriculum of the FabLab consists of 12 weeks of small group projects to...



...understanding how to use all software and hardware in the lab, work on design thinking and other collaborative methods of working together including perseverance, creativity and innovation.

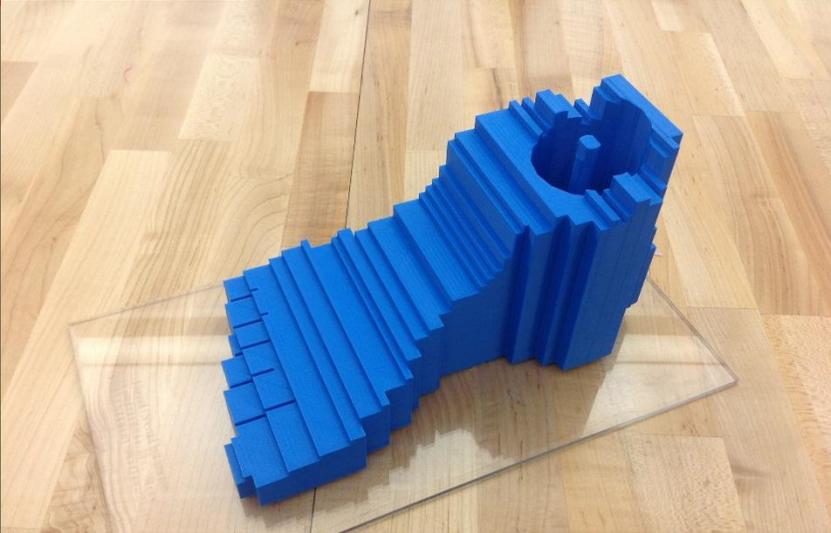
The remainder of the school year students work on projects that have been developed by high school staff in preparation for their capstone project at the end of the year.



www.jhhsfablab.com

Posted here you'll find samples of student work, articles and ongoing information regarding our FabLab.

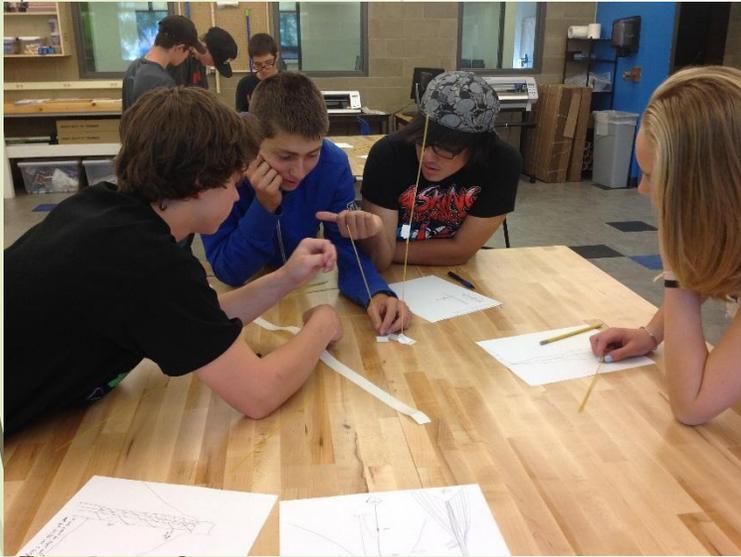
Student Projects



Examples of student capstone projects



Student Responsibilities and Sharing their Learning...



Work as a team, share ideas, listen to others...



Brainstorm, use the design-thinking process, be open-minded and creative



Present and share their findings, struggles, successes

More student responsibilities...



The screenshot shows a student's ePortfolio website. At the top left, there is a decorative graphic of a tree branch with small white flowers. The title "Shaeli's Fabulous Lab ePortfolio" is centered in a green font. To the right of the title is a search bar with the text "Search this site". Below the title is a navigation menu with several tabs: "A Little About Me and the Fabulous Lab", "Journal", "Capstone Project", "Practice Project", "Project Number One", "Project Number Two", "Extra Page One", "Extra Page Two", "Extra Page Three", and "Extra Page Four". The "A Little About Me and the Fabulous Lab" tab is selected. Below the navigation menu, the page content begins with the heading "A Little About Me and the Fabulous Lab". The text reads: "Well Hello There! I'm Shaeli! I am currently 14 years old in the 9th grade here at JHHS. My hobbies include sketching, writing, spending time with my incredible family and constantly thinking... about everything! This year I am taking a class called the Art and Science of Making. In this class, inspiration and creativity are the main motives for everything and it is absolutely awesome. In this class, students are asked to solve everyday problems in a creative, different way using advanced new technologies such as Laser Engravers and 3D Printers. In this class, the sky is the limit and that is why I love it!". Below the text is a photograph of a young woman in a dark jacket and white pants performing a backflip in a grassy field with trees in the background.

Every student created their own electronic portfolio to showcase and reflect on their projects.

[Sample Eportfolio](#)

Videos were also a common platform for students to share their learning.

Reaches out of the FabLab...

10th Grade English teacher used Aurasma to create a “talking” model of the town in “To Kill a Mockingbird”



Freshmen kicked off their Capstone Project with a visit to University of Wyoming and support from UWY Nanotech Graduate Students



FabLab Students helping others...



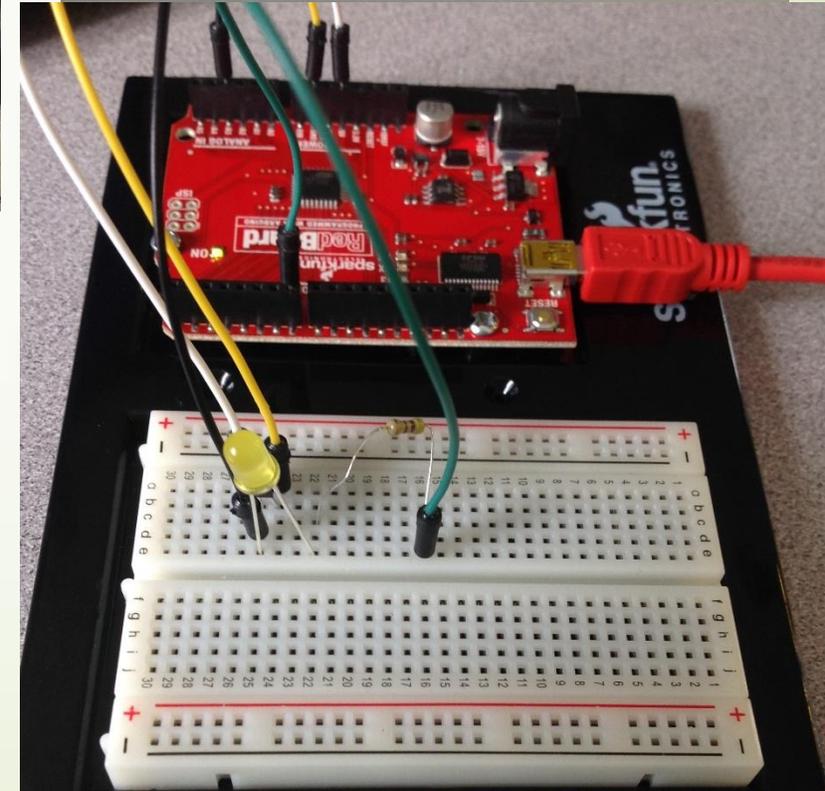
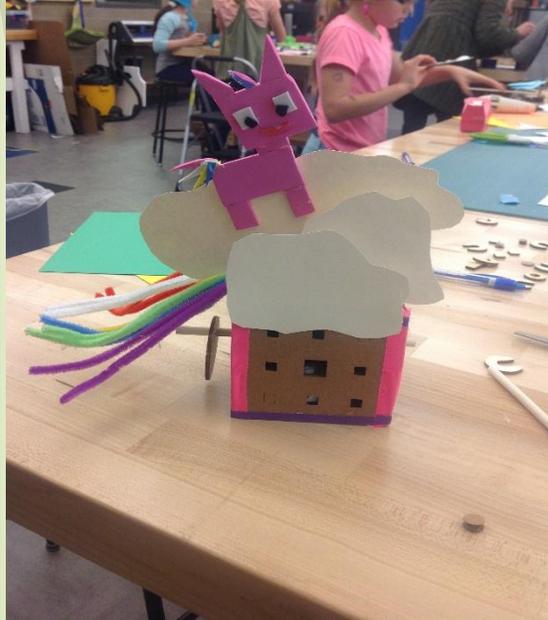
Business students and FabLab Students Unite!



Summer programming



Afterschool programming...



It's time to play!

In classroom or afterschool setting, students are given a pre and post test on circuits and electricity.

Then students are given the supplies and told to “play”.

Goal #1: Make one LED light up.

Goal #2: Make several LEDs light up.

Goal #3: Discover the difference(s) between the two types of playdough.

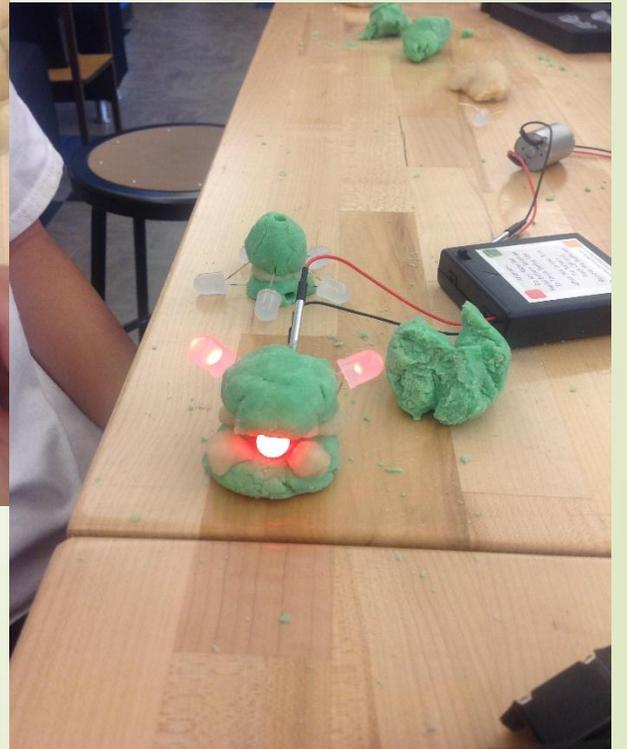
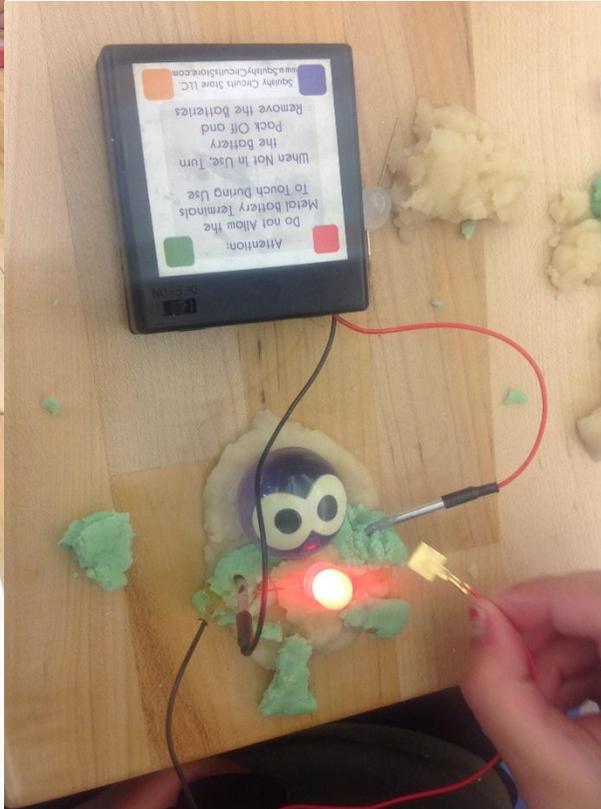
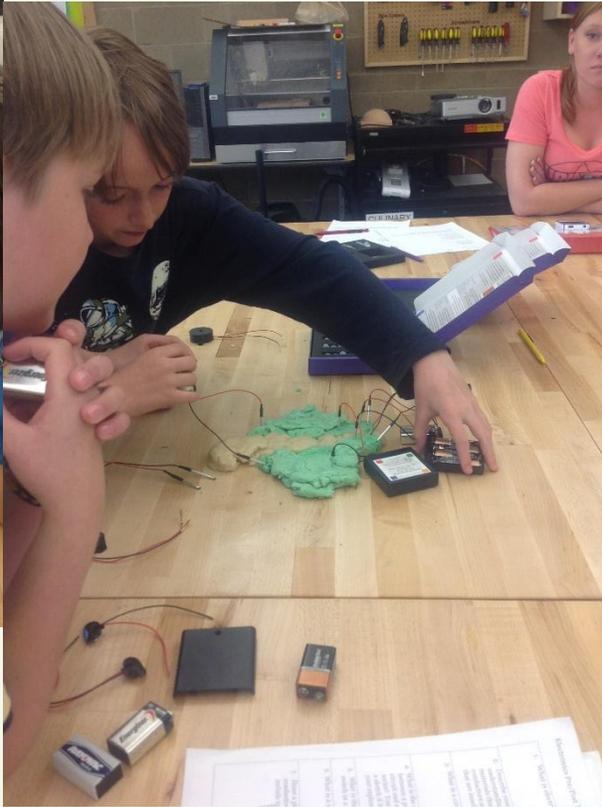
Etc....



Creativity is endless

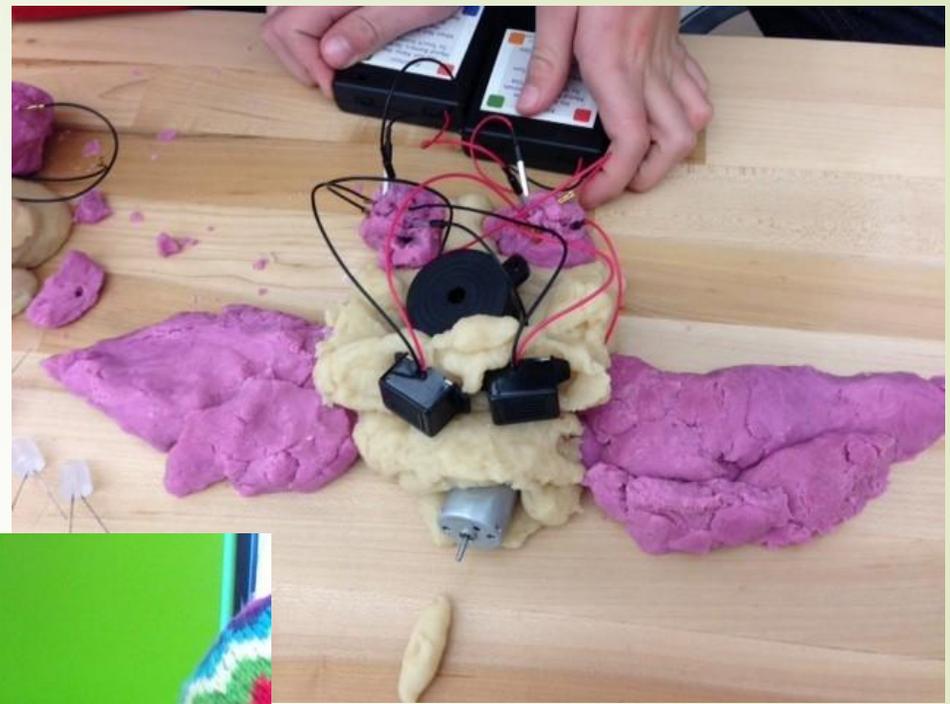
What they experience:

Fun
Hands on
Help each other



What they learn:

Insulators versus conductors
Electron movement
Short Circuits
LED
Positive versus negative
Voltage and power needs



What are our teachers doing?

- 27 teachers (middle and high school) participated in a professional development opportunity that lasted all year
- They focused on incorporating Design-Thinking into their own curriculum
- They planned units of curriculum across content and will continue to develop, refine and reflect on these units throughout the year.
- Similar collaborative units across content areas will be explored again during the 2014-2015 school year.





So...

What did we learn?

What are we now thinking?





Long term expectations are to look at the “narrative” of a student’s schedule. Some essential questions that will be the drivers of our school...

1. What groupings of courses produce the most significant impact in math and science for a student. Versus what “course” causes an impact? Taking into consideration the whole student and the entire high school experience of a student.
2. What types of practices within those courses produce the highest impact of student learning?

**A continued focus at JHHS for
2014-2015 school year...teacher
collaboration!**

A class in isolation...



**Digital Fabrication
Lab Only**



Less impactful for all

Classes/teachers across
disciplines supporting
student learning...



Earth
Science



Digital
Fabrication
Lab



Geometry



More impactful for all

Assessments!!!

Self-Assessment Rubric: Collaboration

Name: _____ Date: _____

	Below Standard	Approaching Standard	At Standard	Above Standard
Responsibility for oneself	~ is not prepared and ready to work with team ~ does not do project tasks ~ does not complete tasks on time ~ does not take or use feedback from other to improve his/her work ~ argues with others	~ does some project tasks, but needs to be reminded ~ completes some tasks on time ~ sometimes uses feedback from others	~ is prepared to work with team ~ does what he/she is supposed to do without being reminded ~ completes tasks on time ~ uses feedback from others to improve work	In addition to At Standard criteria... + does more than what he or she has to do + ask for additional feedback to improve his or her work, beyond what everyone has been given
Helping the team	~ does not help team solve problems; may cause problems ~ does not share ideas with team members (says nothing) ~ does not give useful feedback to others ~ does not offer to help others	~ cooperates with the team but does not actively help it ~ makes some effort to share ideas with team ~ sometimes gives useful feedback to others ~ sometimes offers to help others	~ helps team solve problems; manage conflicts; stay focused; organized ~ shares ideas that help the team improve its work ~ gives useful feedback (specific and supportive) to others so they can improve their work ~ offers to help others do their work if they need it	In addition to At Standard criteria... + steps in to help team when another is absent + encourages others to share ideas; helps clarify others ideas; connects others ideas to teams work or mission + notices if a team member does not understand something and takes action to help
Respect for Others	~ does not pay attention to what teammates are talking about ~ body language or actions indicates lack of interest or respect; negative ~ interrupts, ignores ideas, hurts feelings of others,	~ usually listens to teammates, but not always ~ is polite and kind to teammates most of the time, but not always ~ body language and actions show a general level of respect most of the	~ listens carefully to teammates ~ is polite and kind to teammates ~ body language and actions are appropriate at all times to show mutual respect for their peers, themselves and the	In addition to At Standard criteria... + encourages the team to be respectful to each other + recognizes everyone's strengths and encourages the team to use them + overlooks personality

Habits of Mind

Name: _____

Please read through each of the 16 "Habits of Mind" and rate yourself on a scale of 1 to 5...with 1 being a low score, 3 being average and 5 being the highest you could rate yourself.

Habit of Mind Description	Pre Capstone Project Rating	Post Capstone Project Rating
1. Persistence: Stick to it! Persevering in a task through to completion; remaining focused. Looking for ways to reach your goal when stuck. Not giving up!		
2. Managing Impulsivity: Take Your Time! Thinking before acting; remaining calm, thoughtful and deliberate in actions. Not wasting time on unnecessary things.		
3. Listening with understanding and empathy: Understand Others! Devoting mental energy to another person's thoughts and ideas. Make an effort to perceive another's point of view and emotions.		
4. Thinking Flexibly: Look at it Another Way! Being able to change perspectives, generate alternatives, and consider other options or ideas.		
5. Thinking about your thinking (Metacognition): Know your knowing! Being aware of your own thoughts, strategies, feelings and actions and their effects on others.		
6. Striving for Accuracy:		

Check it again! Always doing your best. Setting high standards. Checking and finding ways to improve your work constantly.		
7. Questioning and problem posing: How do you know? Having a questioning attitude or personality; knowing what data are needed and developing questions to produce that data. Finding problems to solve.		
8. Applying past knowledge to new situations: Use what you Learn! Accessing prior knowledge; transferring knowledge beyond the situation in which it was learned.		
Habit of Mind Description	Pre Capstone Project Rating	Post Capstone Project Rating
9. Thinking and communicating with clarity and precision: Be clear! Striving for accurate communication in both written and oral form; avoiding over generalizations, distortions, deletions and exaggerations.		
10. Gather data through all senses: Use your natural pathways! Pay attention to the world around you; Gather data through all senses; taste, touch, smell, hearing and sight.		
11. Creating, Imagining, and Innovating: Try a different way! Generate new and novel ideas; original; creative.		
12. Responding with wonderment and awe: Here I am figuring it out! Finding the world awesome, mysterious and being intrigued with phenomena and beauty.		
13. Taking responsible risks:		

Self-Assessment of the Design-Thinking Process

Name: _____ Date: _____

		Level 1	Level 2	Level 3	Level 4
Empathy	Goal	Understanding that other people experience things differently	Discover non-obvious insights about a situation from another's perspective	Discover deeper human centered insights or connections when exploring a problem	Discover a full spectrum of human-centered insights (individ, group, etc.)
	Skill Level	Little experience/ comfort eliciting info from others unlike themselves	Ability to explore diverse perspectives. Some experience eliciting info from others	Ability to understand multiple perspectives and experiences of others	Ability to understand others and the system/process in which they operate and ability to think like others.
Define	Goal	Pick one insight or problem out of many. Able to fill in a guided problem statement	Understand multiple insights and needs and synthesize into a single problem statement with guidance	Develop multiple deep insights and synthesize into a single problem statement with little to no guidance	Develop multiple complex problem statements with no guidance
	Skill Level	Ability to prioritize based on perceived importance of an insight or problem	Ability to synthesize info and prioritize insights based on perceived needs.	Ability to synthesize info based on needs and insights originating from multiple non-obvious internal and external sources	Ability to understand and synthesize deep insights based on a complete system

Ideate	Goal	To be able to come up with lots of ideas and defer judgment of others ideas.	To develop over 20 ideas off of a single well-crafted "How Might We" Prompt	Develop multiple "How Might We" prompts on your own; generate a spectrum of ideas; narrow to a few actionable ideas.	Use multiple techniques for ideation for a single insight and repeat for others
	Skill Level	Ability to generate and record ideas with others.	Ability to build off others ideas and develop unique, wild ideas, too!	Ability to lead a brainstorm session through a spectrum of ideas from low hanging to wild.	Ability to use multiple techniques to inspire a complete range of ideas with others, yourself included!
		Level 1	Level 2	Level 3	Level 4
Prototype	Goal	Create a representation of your idea that someone else can understand	Create a representation of an idea that can be evaluated by others	Create a representation that allows one to evaluate specific features of a given idea and develop multiple iterations	Create multiple representations that allow you to evaluate specific features from multiple perspectives and develop multiple iterations.
	Skill Level	Ability to make a physical or visual representation of an idea	Ability to create a physical or visual representation of an idea that can be evaluated and improved	Ability to identify variables of an idea that need to be evaluated and iterate off feedback	Ability to create more complex prototypes, addressing multiple approaches to solving a problem

Providing Feedback: Your Name: _____ Peer: _____

Providing feedback to others is an important part of improving your own work. We will be practicing this over the next few weeks as a way to hone in on these skills and become better at providing all kinds of feedback. Today, we are going to review a peer's "Project #1" in their ePortfolio. You are to read what they have written (thoroughly and completely) and fill out this simple form. Please be honest but nice, thoughtful, considerate and constructive with your remarks. If you have specific suggestions or improvements they could make then give them in the comments section (see example below).

Weak	Satisfactory	Strong	Criteria	Reader's comments:
___	___	___	Organization of ePortfolio: neat, clean-looking, simple, easy to navigate, text is organized well, photos are straight/correct size	
___	___	___	Mechanics: grammar, spelling, sentence structure, capital and lower case where appropriate, does writing make sense?, it is clear to you?	
___	___	___	Connections to rubric: empathy, define, ideation process, prototyping, testing, research. All of these parts have to be included in each project...do you see them? Are they obvious? Do you see a due date listed?	
___	___	___	Facts and Reflections: Facts about the project are present. Reflections are obvious, thoughtful and align with the facts.	
<i>Example:</i>				
__X	___	___	Mechanics: grammar, spelling, sentence structure, capital and lower case where appropriate, does writing make sense?, it is clear to you?	<i>You have made many careless mistakes. Check your spelling and watch the first word of a sentence...you have many that are lowercase. Go back and proofread your work to find your mistakes.</i>

List one thing you know you need to fix in your own ePortfolio after doing this activity:

Survey Monkey data on the skills students need to be successful in FabLab (from student perspective)



Word
It Out



Implications for Teacher Pedagogy...

- The use of an instructional framework (teaching standards) guides the teaching processes used in the digital fabrication lab. Focuses include:
 - Student questioning
 - Discussion Techniques
 - Student participation
- Formative assessment practices that focus on assessing FOR student learning vs OF student learning (during teaching-during practice vs. at the end of the lesson)
- Behavior RTI Tier One. Student behavioral expectations aligned to student learning goals.
- All in service of using an INQUIRY model in service of students owning their own learning.

Next Steps:

- ▶ Develop evening and after school learning opportunities for adults and makers in our own community.
- ▶ Integrate the Arts into our program at a deeper and more thoughtful level. (STEAM)
- ▶ Continue to develop afterschool and summer programming for younger students
- ▶ Develop specific programs for females and Hispanic populations to broaden their understanding of STEM and STEM career fields.
- ▶ The Art and Science of Making 2 begins this fall. Students will be working on community projects throughout the year...Teton County Library...Vertical Harvest
- ▶ Mobile Maker “Carts” were made at the end of last year so teachers can “make” in their own classrooms





Creativity
and Innovation.



Please contact me if you have any
questions!
ssmith@tcsd.org



INNOVATION

Sometimes it's gonna hurt.