



MAKER DOCUMENTATION AND SHARING FOR AUTHENTIC AUDIENCES

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MakerEd

Open 
Portfolio
Project

RESEARCH
BRIEF

14

Within the work of open portfolio assessment in makerspaces, a constant consideration is the need to create portfolios for authentic audiences. Portfolios can be a way for youth to interface with a range of audiences, but rather than letting this be a serendipitous event, makerspaces are starting to establish formal scaffolds that provide opportunities for youth to engage with contacts who can positively impact their future in a way that is age-appropriate, preparatory, and immediately relevant.

Of particular interest is how portfolio assessment and the specific instruments they're composed of can guide these opportunities to be meaningful experiences for youth, establishing engagement with age-appropriate authentic audiences, while at the same time improving the development of their projects and skills in alignment with established standards of that audience.

In this research brief, we present two assessment approaches on the K-12 spectrum and show how two sites used portfolio assessment as a way to connect high school and elementary youth to authentic audiences. Specifically, we present:

- *High Tech Elementary Chula Vista's portfolio assessment*, which includes a practice that leads youth to iteratively refine their work as they engage with their peers.
- *Digital Harbor Foundation's portfolios for college credit*, where an out-of-school makerspace partnered with the Community College of Baltimore County to use portfolios as a way for youth to earn college credit and to improve their portfolio presentations in relation to standards by the authentic audience of the community college.

This work illustrates how portfolio assessment can be implemented to expand some aspects of learning without disrupting others. More specifically, in this Research Brief, we aim to show how the two maker-centered learning environments use portfolios to connect youth to authentic audiences and how the assessments can support aspects of agreed-upon learning and developmental progressions. In introducing two portfolio approaches in learning environments that serve youth of different ages, we share example youth projects and ways in which the assessment approaches differ depending on age-appropriateness and audience. This highlights underlying assumptions of the specific assessment instruments that each of the cases utilizes (e.g., rubrics, feedback sessions).

We close the brief with an appendix of eight additional assessment instruments that a range of maker educators across the United States have developed. This spotlights the state of the field of assessment in maker-centered learning environments, illustrating how maker educators are actively grappling with this important aspect of their work, with the aim to call attention to advancements needed in this area.

High Tech Elementary Chula Vista: Portfolios for Assessing and Connecting Youth

In an effort to support student engagement in iterative refinement and critique, one teacher at the High Tech Elementary Chula Vista (HTeCV) integrated a critique protocol that was originally designed by Chief Academic Officer at the Expeditionary Learning Outward Bound, Ron Berger, for providing peer feedback to improve the quality of elementary student work and portfolio creation (Berger, 1991). In this process, one student is the “creator” of an artifact and the other plays the “critiquer,” who provides feedback. All of the students in the class participate in this process across subjects. Students are first presented with a simple photograph and are asked to draw it as accurately as possible, focusing on one single aspect of the item (e.g., the shape, pattern, or color). As creators receive and provide feedback on each other’s drawings, they generate up to six versions of the drawing, slowly iterating toward more and more detailed representations. There are three essential rules to this process for developing peer feedback and iteration/revision skills (see Figure 1), which form the basis of the protocol and are repeated throughout the process:

- “Be kind” guides students to express appreciation about the work of others and to suggest aspects for improvement without hurting other students’ feelings.
- “Be specific” encourages students to explain their thoughts in detail and in a manner that can be understood and utilized by others.
- “Be helpful” supports students to share ideas for improvement that translate into actionable steps.

Figure 1: Ron Berger critique protocol as used by HTeCV, with more information at trevormattea.com/critique.html.

Critique

- **Be kind**
 - No hurtful comments
 - Never use “but,” “do/don’t,” or “should/shouldn’t”
 - Use “I” statements or questions
 - Balance praise with constructive criticism or provide more praise
- **Be specific**
 - No general comments, such as “It’s good.” or “I like it.”
- **Be helpful**
 - No comments that cannot be used to improve the work or were already made by another student
 - Focus on the aspects of the work that the maker wants to improve
 - Alternatively, identify the one thing you think will make the biggest change -- try not to focus on the details when something essential is missing (e.g. length of a stem vs. presence of a shadow)



Created by Remix from Sketch Project



Created by Formative Alliance from Sketch Project



Created by Woodlyndale from Sketch Project

In practice, tangible and verbal scaffolds support youth in refining the way they provide, receive, and react to critique, as well as the way in which they iterate on their efforts, as they apply feedback to their work throughout the process. For example, teachers scaffold the critique process by working individually with critiquers to offer suggestions and reminders around protocol. In addition, they facilitate classroom awareness of the process, using a Velcro-covered board where creators can post non-verbal status updates, such as “I am working on a draft,” “I am ready for peer critique,” or “I need teacher critique.” This openly visible status board displays everyone’s progress at once, allowing the teacher to keep track and the students to find partners at similar stages. In supporting critique, which includes training students to look closely, some teachers create rubrics (see Figure 2) that outline specific aspects of the drawings to examine.

Criteria	Target Met 	Almost There 	Getting Started 
Shape	The shape of my whole snake and each body part of my snake are accurate. You can tell exactly what each part is, and each part looks like my snake. The outline of my snake shape is smooth. There are no straight-lines-or-angles. My snake shape takes up the whole page.	The shape of some parts of my snake are accurate. You can tell what some of the parts are, and some parts look like my snake. Some parts of my snake are smooth. My snake shape takes up part of the page.	The shape of my snake's body parts are not accurate. It's hard to tell what the parts are. The lines are not smooth. My snake shape takes up only a small part of the page.
Proportion	The small parts are the right size compared to the large parts. The large parts are the right size compared to the whole.	The small parts are almost the right size compared to the large parts. The large parts are almost the right size compared to the whole.	The small parts are not smaller than the large parts. The large parts are not larger than the small parts.

★ Did smooth line to make the snake
some parts are Accurate

Figure 2: Example rubric that guides peer feedback. Still image from EL Education’s 2014 video, “Inspiring Excellence Part 4: Using Models and Critiques to Create Works of Quality,” licensed under CC BY-NC-SA 3.0 on Vimeo.

The process of critique also involves listening to the creator’s explanation of what they found challenging about drawing particular items. Based on this information, critiquers can point out positive aspects, areas needing improvement, and suggestions for moving forward. Then the creator uses that feedback to improve their work. Sentence frames (Figure 3) provided by the teacher help to guide the critique process even more concretely for both creator and critiquer, helping them communicate the creator’s goals (e.g., “I would like you to focus on _____.”) and the critiquer’s feedback, including praise (e.g., “I like how you _____.”) and constructive criticism (e.g., “Have you considered _____?”). The overall process supports students to appreciate each other’s viewpoints and comments, leading to improved collaboration.

Sentence Frames

WAYS TO INTRODUCE WORK:

One thing I want you to know about my work is _____.

I would like you to focus on how I _____.

One idea I had was _____.

One goal I had was _____.

One difficulty I had was _____.

I chose to _____.

I was influenced by _____.

I know I need to work on _____.

WAYS TO OFFER PRAISE:

I like how you _____.

One thing I learned from your work is _____. Next time, I can _____.

WAYS TO OFFER CONSTRUCTIVE CRITICISM:

Have you considered _____? I ask that question because _____.

Maybe you could _____ because _____.

Something that worked for me was _____ because _____.

I'm curious why you _____ because _____.

I'm confused by _____ because _____.

Figure 3: Sentence frames that scaffold the youth critique process.

One example of this process are student Nate's iterative drawings of an apple (Figure 4). Nate created six drawings of an apple during an elementary semester. He used a pencil to draw the shape of the apple and progressively refined the shape based on comments he received from other students, which were broken down into actionable steps. Iteration four (Figure 4, bottom left), for example, shows changes based on some of the comments Nate received:

Make middle wider
Dots
Big leaf
Two bumps on bottom
Make the form curvy
Curve on apple on both sides

When comparing iteration four with iteration five, it becomes evident that Nate paid attention to the feedback he received as the leaf is now larger and the apple's shape is rounder and includes bumps on the bottom. Comparing iteration five with iteration six shows that Nate carefully considered the additional comment he received about illustrating curves instead of holes. In the last version of his apple drawing, Nate integrated graphite shading to illustrate depth and curvature on the apple's surface.



Figure 4: Iterative progressions of Nate's apple drawings.

When first starting the process, teachers reported that students were mostly skilled at being kind. As the process continued and their own drawings improved, students developed comfort and skill in providing specific and helpful feedback to each other, sharing strategies with one another about how to improve their work on a technical level. The comments written on Nate's fourth and fifth iteration of the apple drawing are examples of "be specific" and "be helpful," as they point to concrete steps that Nate can follow.

In a video that the teacher created and shared on a personal website, students reported that they can apply the critique process in any subject, as well as in everyday situations and at home. Furthermore, displaying the iterations of their object drawings, side-by-side in their portfolios, was a way for students to see how much they learned and improved. One of the students wrote:

I think this project is important enough to include in my digital portfolio because it was a big strength and it was challenging. Something about this project that was easy for me was picking my background. Something about this project that was challenging for me was making the shape of my apple and all the designs on it. Over the course of this project, I learned how to make your work beautiful. I think I can use this new skill next time I color a pitcher (sic). Now, I think I want to learn more about coloring in the white space and the creation on how to draw a good apple.

Throughout this case, the teacher and peers served as audience and as critiquers for portfolio entries. For elementary students, it was important to consider how to encourage age-appropriate feedback, such as pairing encouraging comments with critical feedback, as well as presenting a simple structure that can be repeatedly practiced across projects. The assessment approach was structured through rules, sentence starters, and a public status board.

Many of the underlying assumptions of this approach align with those of open portfolios (as we outlined in Research Brief 11, “Introducing Phase 2 of the Open Portfolio Project: Assessment in Makerspaces”). The approach here assumes that learners are individuals who are part of a classroom community that hold one another accountable (e.g., through the use of the status board) and occupy shifting roles in that community (e.g., creator and critiquer). Though a teacher-led initiative, it does allow for youth choice, offering students options in their commentary and feedback. Lastly, the practice focused on the processes and products of giving and receiving critique, rather than finished products. The efforts extended beyond the classroom, too, evidenced by youth utilizing the protocol in everyday events.

Digital Harbor Foundation: Portfolios for College Credit

In an effort to support youth in their college applications and to model college-level work, Digital Harbor Foundation (DHF) established a collaboration with the Community College of Baltimore County (CCBC) that allows youth to earn college credit for the course “Digital Fabrication 101.” In this course, they’re also expected to create a portfolio of work.

Four youth at DHF participated in the first cycle of this initiative, completing projects from three DHF courses that aligned to the CCBC syllabus, including intermediate 3D design, laser cutting, CNC milling, and an independent study. All courses were open for any DHF youth members, while those enrolled for college credit also received explicit portfolio instructions, reviews, and assessments.

The CCBC college credit collaboration was eligible only for youth already enrolled in high school, excluding a majority of DHF's youth participants who are typically younger. To earn college credit, eligible youth had to create at least five portfolio entries that demonstrated knowledge and skills in the predominantly technical areas covered by the Digital Fabrication 101 syllabus (e.g., machine safety, manufacturing processes, modular and hinged 3D printing).

An important outcome of the college credit initiative was the development of the [Digital Harbor Foundation Maker Project Rubric](#) (Figure 5), which was designed to consistently evaluate maker projects and distilled DHF's approach to making and learning within a guiding frame. The rubric was created by a collaboration among makerspace and school educators, youth makers, and school students that could be used by youth to guide their practice and as a means to discuss their work with adults. The rubric covers five areas that are assessed along a progression from emerging to exemplary:

- Creativity, expressing of new and unique ideas, is considered “emerging” when youth adhere to instructions and “exemplary” when youth diverge from a set of processes and projects to explore personal ideas.
- Iteration, creating a project that changed over time, is marked as “emerging” when youth do not add to initial project demonstrations and “exemplary” when change over time is apparent.
- Initiative, problem-solving independently, is “emerging” when youth do not seek to find solutions to challenges and “exemplary” when youth independently work to address a challenge.
- Learning, engaging with and mastering new areas, is “emerging” when youth remain within their comfort zone and “exemplary” when youth explore several ways to expand their skills.
- Community, sharing learning with others, is “emerging” when youth do not share and “exemplary” when youth formalize their sharing process.

MAKER PROJECT RUBRIC

	Emerging - 1	Developing - 2	Proficient - 3	Exemplary - 4
				
Creativity	Student follows a set of directions to complete a project, but did not explore new ways to alter the idea.	Student project is original, but mostly based off of an existing idea.	Student project is explored and expressed in a fairly original way.	Student clearly explored and expressed multiple ideas in a unique way.
Iteration	Student does not attempt to iterate or make any changes on their initial design.	Student attempts to make an iteration on the design and/or aesthetic of their project, but is unsuccessful in any improvement.	Student undertakes 1 or more iterations of their product, improving the design and/or aesthetics.	Student completes their product, having improved the design and/or aesthetics over time.
Initiative	Student encounters complications with frustration and does not attempt to problem-solve independently.	Student encounters complications with frustration, but briefly attempts to problem-solve independently before seeking assistance.	Student encounters complications with a positive attitude and perseveres to problem-solve independently before seeking assistance.	Student encounters complications with a positive attitude and perseveres to problem-solve independently without needing to seeking assistance.
Learning	Student did not attempt any new learning or methodology they were not already initially comfortable with.	Student attempts 1 new avenue of learning for their project, but may not have been successful in its implementation.	Student attempts 1 new avenue of learning for their project. They demonstrate a skill they did not have at the start of the project.	Student attempts multiple new avenues of learning for their project. They clearly demonstrate a synthesis of skills they did not have at the start of the project.
Community	Student does not attempt to share their learning.	Student attempts to share their learning, but without adequate explanation or reflection.	Student shares their learning informally in a peer-to-peer fashion.	Student shares their project and learning with an authentic community in a formal manner.

Figure 5: Digital Harbor Foundation Maker Project Rubric

In practice, educators considered the rubric as a way to guide the development of in-depth portfolio entries that would provide evidence of exploratory directions, elements of process iterations, comprehension through multiple media pieces, and examples of sharing with the community. Furthermore, they envisioned the rubric to function as a guide for peer-to-peer and educator-youth conversations around specific projects. It would also serve to identify and track competency or mastery before moving on to new, technically challenging courses within the makerspace, helping youth to develop portfolio pieces that could become part of their college-credit portfolios for CCBC. For example, the rubric encourages reflection related to iteration and process, as well as more concrete questions about how a design changed from an initial sketch into a 3D model. Leveraging the rubric, DHF also created prompts to support the documentation of a maker process (see Table 1).

Table 1: Progress Update and Reflection Prompts

PROGRESS UPDATE	What project is this a part of? What progress have you made? What new learning have you done since your previous update? What do you plan to do next?
REFLECTION	What was the project prompt? What is your project? Why did you make this project? How did you plan or prototype your project before starting? How did you make it? What was your process? What steps did you follow? What problems or challenges did you face? How did you overcome any challenges and solve problems that you met? What would you do differently next time? What would you tell someone else who was going to make this project? What did you like best about your project? How would you make it better?

One of the portfolios submitted for college credit was by Nalani, who identified herself as a singer and maker. Nalani shared 17 entries of projects she worked on during various courses at DHF, including the design of a music stand and 3D-printed and laser-cut projects, such as a maze and a phone case (Figure 2). For the phone case, Nalani modified the design of a living hinge case, in which she perforated rigid wood to make it bendable. In an accompanying reflection post, Nalani described her planning process and the challenges she encountered when first designing the piece:

The last two are examples of a failed living hinge, the hinge was not able to bend far and as a result it was broken. Also I made the mistake of leaving my phone size example [a digital outline line drawing of the phone] and it was cut out. When I cut it again I added more hinges and deleted the example hole but I then realized another flaw, it's too big.

Nalani underwent many iterations of product refinement, including exploration of the material's flexibility, a desire to erase planning markers, and measurement of digital models of real-world objects, before she finished a product that worked for her phone. This project is an example of how Nalani's portfolio provided evidence of learning and ongoing iteration, detailing her evolving understanding of the laser cutter, design considerations, and material science.

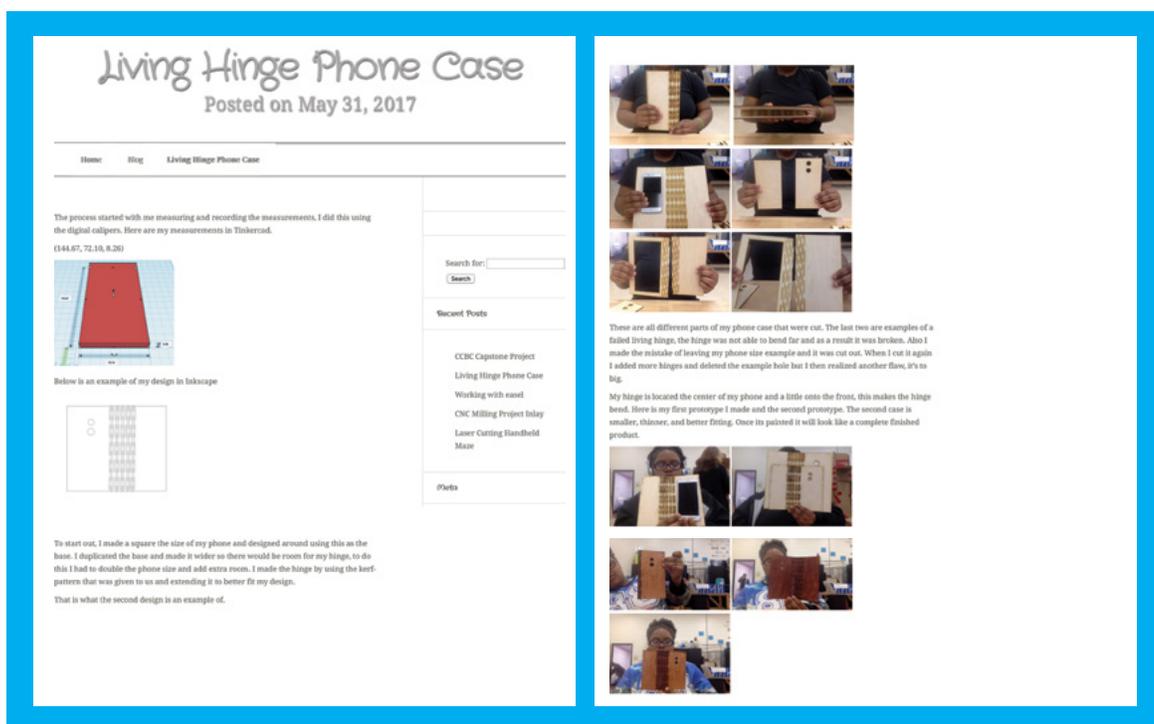


Figure 6: Screenshot of Nalani's portfolio entry highlighting her living hinge phone case.

During coursework, youth worked on their portfolios and simultaneously received intermediary feedback from maker educators and CCBC educators in order to refine their portfolio entries toward earning college credit. This feedback was presented to youth individually, and DHF educators supported them in implementing the changes, working through improvements across four 2-hour sessions within two weeks.

What stood out most was that CCBC focused on three main aspects that differed from the DHF maker rubric: (1) demonstrating knowledge and skills of different technologies, (2) understanding how the technologies are used, and (3) knowing when to use which tools and materials to best serve the designer's purpose. For example, CCBC educators commented on Nalani's phone case entry by questioning whether "this [was] a pattern she downloaded or designed" while also noting that "Screenshots are here, discusses CAD programs used, project itself looks great!"

From the perspectives of DHF educators, Nalani's portfolio entries and overall project aligned well to the DHF maker rubric, which helped her to meet the requirements put forth by CCBC:

- *Creativity* as defined by the DHF rubric was seen in Nalani's portfolios in how she remixed and personalized the living hinge and customized the sample pattern to work as a phone case.
- *Iteration* was evident through Nalani's multiple efforts at laser-cutting the living hinge phone case, as well as her recording of the evolution of the project. CCBC focused less on iteration as a specific criterion for judging portfolio, while DHF educators suggested that scaffolding the portfolio process to focus on iteration would lead to more detailed descriptions of the use and selection of manufacturing technologies.
- *Initiative* became a focus during Nalani's intermediary review when CCBC employees commented on how her portfolio posts presented her learning and commitment to the college credit opportunity.
- Learning was evident in Nalani's portfolio when she started engaging with unfamiliar tools to complete her project. The development of skills and knowledge around new manufacturing tools, as well as providing evidence of that skill and knowledge within the portfolio, was one of the main criteria CCBC focused on.
- *Community* was apparent in Nalani's portfolio, as she was an active member of the makerspace, with the ability to use the community's key tools and materials. However, she didn't explicitly include this in her portfolio, lending less attention or formalization to the community aspect. Perhaps due to this or the fact that no collaborative projects were included in the portfolio, this aspect was not covered during the CCBC intermediary review process.

DHF educators told us that the college was more interested in seeing the projects within the portfolios rather than the assessment in relation to the rubric. At the time of writing this brief, Nalani's portfolio had been reviewed by CCBC and was approved for college credit.

While in some respects the DHF Maker Project Rubric is moving their portfolio practice closer to traditional portfolios, where learning outcomes are decided from the beginning, the rubric communicates assumptions that are explicitly aligned with making (e.g., a focus on iterative processes as well as the role of the individual within the makerspace community). Supporting multiple, and at specific times changing, audiences—that included peers and educators from both within and outside of the makerspace—broadened possibilities for youth to try out what it might mean to be a college student and to see that their work could translate into something of tangible value (i.e., college credit that usually comes with a tuition cost). While projects were created within course structures and guided by the maker rubric, youth could decide which projects to create and how to share them within their portfolios. The assessment approach allowed youth to integrate and touch upon aspects that the college educator audience cared about, while still being able to share their learning from interest-driven projects.

The Maker Project Rubric guided youth in creating portfolio entries that facilitated conversations with authentic audiences in instructionally useful ways. It also empowered youth to focus on capturing the parts of their practice that the community college cared about (e.g., materials lists and descriptions of machine use), while at the same time working on capturing their own iterative approach in all aspects of their process (e.g., selecting materials and learning how to use machines through failed attempts). The intermediary critique also helped the makerspace to continue to refine their own rubric-based guidance of portfolio entries, as they realized how their own pedagogical practices compared and contrasted to the aspects the community college focused on most.

After having used the Maker Project Rubric for some time, DHF recommends that other makerspaces wishing to adopt it should (a) focus on capturing one component of the rubric at any one time, (b) adapt their own practices to the rubric, and (c) change the rubric to match the maker practices of their own spaces. In terms of scaling the college credit initiative, currently DHF is starting the second of three iterations of the course and streamlining their approach. In the future, they hope to formalize the approach and accommodate more youth at once, as well as offer the format as professional development to support other makerspaces in establishing similar initiatives.

Conclusion

Both cases presented in this research brief demonstrate ways in which makerspaces across the K-12 spectrum establish and facilitate portfolio creation, attuned to the need to present them to authentic audiences. In our framing, these audiences must not only be genuine and purposeful but also age-appropriate and relevant.

At HTeCV, youth shared their work with their teacher and peers and received concrete feedback on their work. The timeliness of the feedback was immediately relevant to youth and led to iterative improvement. Further, the way in which critique was scaffolded and the practice repeated allowed students to practice providing feedback in helpful and respectful ways, a skill that is lifelong. Lastly, the practice was age-appropriate for elementary-age youth, specific to their own classroom communities and present in ways that had low stakes yet high utility.

At DHF, youth shared their work with educators, peers, and college representatives, receiving iterative feedback on how to improve their documentation, rather than the projects themselves. This approach was also age-appropriate, as youth were in high school and getting ready for the next phases of their lives beyond school, whether college or the job market. Connecting with college representatives and receiving feedback toward earning college credit was a way for youth to explore how they might prepare for future opportunities.

Together, these cases suggest that consideration of age-appropriateness and authentic audiences set a useful frame for the creation, implementation, and assessment of youth portfolios. In the following Appendix, additional examples of rubrics, guiding questions, and assessment techniques are included to demonstrate the variety—and commonality—in which current maker-centered learning environments are considering skill development and project evaluation.

Reference

Berger, R. (1991). Building a school culture of high standards: A teacher's perspective. In: V. Perrone (Ed) *Expanding Student Assessment*. Alexandria, VA: Association for Supervision and Curriculum Development, pp 32- 39.

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Appendix

In this Appendix to Research Brief 14, “Maker Documentation and Sharing for Authentic Audiences,” we’ve included a set of assessment instruments—many specifically for maker-centered activities, projects, and classrooms—that were created by a variety of educators in formal and informal education settings. They range from rubrics to reflection questions and other tools, and they’ve been used as a way to support iteration and improvement of youth work as well as instructor facilitation. These examples may provide inspiration to other educators who seek to integrate maker education into a range of disciplinary contexts while ensuring that creativity and authenticity remain.

The list of assessment instruments includes:

SELF-ASSESSMENT

- Weekly Reflection, Wood Middle School
- Questions Before, During, and After Activities, Viking Mars Missions Education and Preservation Project

SELF-ASSESSMENT, PEER ASSESSMENT, RUBRIC

- High Tech Elementary Chula Vista:
- Field Trip Reflection Form
- “Ask Me Anything” Protocol
- Family Meeting Notes and Feedback Form
- Classroom Success Criteria (Self-Portrait)
- Classroom Success Criteria (Field Trip)

ADULT MODELING

- Technology Education’s Assessment, CodeCreate

RUBRIC

- Maker Rubric, Sonoma County Office of Education
- Maker and Innovation Class Mindset Rubric, Mark Schreiber and Glenda Baker
- Skills and Knowledge Checklist, Mark Schreiber and Sarah Sutter
- Sample Authentic Maker Education Rubric, Lisa Yokana, Edutopia
- Coding Project Rubric, Jackson P. Burley Middle School

WOOD MIDDLE SCHOOL in Alameda, CA is using a form for weekly student reflection as a way to end the week with a record of what was done. Reflections count toward the students' participation grade. Nga Nguyen shared the assessment instrument with us.

TAD's Week# _____ Reflection

Name: _____ Period: _____

Date: Monday - _____ / _____ / 2017

<p>Today Agenda: Write down agenda from white board.</p>	<p>Goal: What will you plan to accomplish today?</p>												
<p>Learning Objective Reflection. Use sentence starters: "I learned ...", "I wonder ...", "I think..." I'm confused about ..." (Minimum 2 sentences.)</p>													
<p style="text-align: center;">Studio Habit of Mind I used today: Circle all that apply</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 25%; text-align: center;">Develop Craft</td> <td style="width: 25%; text-align: center;">Engage and Persist</td> <td style="width: 25%; text-align: center;">Envision</td> <td style="width: 25%; text-align: center;">Understand the World</td> </tr> <tr> <td style="text-align: center;">Express</td> <td style="text-align: center;">Reflect</td> <td style="text-align: center;">Stretch and Grow</td> <td></td> </tr> <tr> <td colspan="4">Observe</td> </tr> </table>		Develop Craft	Engage and Persist	Envision	Understand the World	Express	Reflect	Stretch and Grow		Observe			
Develop Craft	Engage and Persist	Envision	Understand the World										
Express	Reflect	Stretch and Grow											
Observe													
<p>Today I learned (circle one): A lot Quite a bit Some Not much</p>													

Date: _____ day - _____ / _____ / 2017

Today Agenda: Write down agenda from white board.	Goal: What will you plan to accomplish today?
Learning Objective Reflection. Use sentence starters: "I learned ...", "I wonder ...", "I think..." I'm confused about ..." (Minimum 2 sentences.)	
Studio Habit of Mind I used today: Circle all that apply	
Develop Craft	Engage and Persist
World	Envision
Express	Reflect
Observe	Stretch and Grow
Today I learned (circle one):	A lot Quite a bit Some
Not much	

Date: _____ day - _____ / _____ / 2017

Today Agenda: Write down agenda from white board.	Goal: What will you plan to accomplish today?
Learning Objective Reflection. Use sentence starters: "I learned ...", "I wonder ...", "I think..." I'm confused about ..." (Minimum 2 sentences.)	
Studio Habit of Mind I used today: Circle all that apply	
Develop Craft	Engage and Persist
Express	Envision
Reflect	Stretch and Grow
Observe	Understand the World
Today I learned (circle one):	A lot Quite a bit Some Not much

Date: _____ day - _____ / _____ / 2017

Today Agenda: Write down agenda from white board.	Goal: What will you plan to accomplish today?			
Learning Objective Reflection. Use sentence starters: "I learned ...", "I wonder ...", "I think..." I'm confused about ..." (Minimum 2 sentences.)				
Studio Habit of Mind I used today: Circle all that apply				
Develop Craft	Engage and Persist	Envision	Understand the World	
Express	Reflect	Stretch and Grow	Observe	
Today I learned (circle one):	A lot	Quite a bit	Some	Not much

End of Week Reflection

Rate this week from 1 (bad) to 5 (good). 1 2 3 4 5	Why? Give a reason for your rating.
One thing I accomplished was	
One thing I learned was	
One thing that could be improved is ...	

Note:

Weekly reflection will be a part of your weekly participation grade. You need to fill this out and submit this by Friday of every week to receive full credit. If you are absent from class, you need to write "I was absent because ..." in the Learning Objective Reflection section to receive credit.

THE VIKING MARS MISSIONS EDUCATION AND PRESERVATION PROJECT

(VMMEPP), a 501c3 non-profit organization in Portland, WA, is asking a range of self-assessment questions to volunteers, partners, and participants before, during, and after activities. Responses are collected via email inquiries, casual video interviews, comment cards, and questionnaires. Rachel Tillman, VMMEPP Founder and Executive Director, shared the self-assessment questions with us and explained their purpose:

“This is intended to guide activity designs that are aimed at teaching and exposing youth to hands on engineering and team building activities to inspire and increase engineering and science literacy, curiosity, and leadership, and to create opportunities for real time critical thinking, systems thinking, in a hands-on team environment.”

Questions Before, During, and After Activities
Viking Mars Missions Education and Preservation Project

Questions Before Activities (for Student Volunteers)

We want this event to be meaningful and valuable to you as well as the youth and public. Please answer a few questions of you have not already. If we can, we will try to connect students with people in industry to help you as you prepare for your own “launch” into the workforce. We can’t make promises, but we do try, and we have LOTS of contacts! You can even go to my LinkedIn profile and connect with me, and once you see my connections, you can make requests of me to meet people I am connected to. I can’t guarantee their responses, but I will reach out on your behalf.

- What are YOUR aspirations in aerospace?
- What role(s) would you like to do?
- What companies are you interested in?
- What have some of your challenges been so far (reply to me only if you don’t want to disclose challenges. But do know there we understand well there are many challenges from paying student loans, school and workplace biases, to life and family changes, and we know and respect all, and Vikings themselves faced them ... you are not alone).
- Are you interested in Paid/Unpaid Internships (please indicate if you’re willing to do both)?
- What makes this event interesting and meaningful to you?
- What do you want to get from it?
- What do you know about Viking?
- What would you like to know?
- Why do you think Viking was an important mission and our work preserving Viking is important (if you agree it is)?

Questions During Activities (for Participants)

Our participants range in age from 3 years old to 80+ years old, so the questions vary depending on the participant. This is a snapshot of some of the questions we ask. We also leave anonymous comment cards for people to include information in case they are not comfortable being identified. We believe this will inspire candid feedback on areas of improvement. We also have

a mandatory check-in (with safety requirements and waiver) which asks age, name, contact, and grade. Questions the kids can answer themselves. We ask parents more detailed question when they are present and follow up in emails.

- Are you having fun? (This is basically always the first thing we ask students.)
- Would you like to do this or something like this again?
- What do you enjoy the most about the activity? Or what was your favorite thing today?
- What have you learned today?
- What is your favorite subject to study?
- What would you like to do when you grow up?
- Do you like science, math, arts, languages, history, sports... (We actually do query them like that if they don't immediately volunteer their favorite subjects, as some youth need more entry if they are not as comfortable in verbal exchange.)
- Do you have activities like this in school?
- Would you like to have activities like this in school?

Questions After Activities (for Student Volunteers)

Email: "Thank you all for taking the time out of your day to lead the #MarsMaker Event today. Because of you, kids got to enjoy this unique experience while learning about Viking. I hope you all enjoyed the event, too! Please send me your feedback on the event. What you loved and didn't care for, what you learned, if you feel our work is important, what you'd like to see us do, so we can learn and improve. And please send me all the pictures you took too, and I will add them to our gallery!"

Other specific questions:

- What did you learn from the event today?
- Do you feel maker events (and hands-on learning) are valuable for youth education?
- Do you feel the activity was accessible for different ages and education levels?
- What do you think the students learned? (Did they tell you specific things?)
- Do you feel the participants (and yourself) experienced:
 - Team collaboration
 - Engineering
 - Problem solving
 - Test and failure analysis
 - Leadership
 - New use of tools and materials
 - Learned new words and terminology associated with science and engineering
- What surprised you most from the youth participants?
- What were some of the challenges you faced both in preparing for this event AND during the hands-on activity? (Please answer as separate questions.)
- What are areas you could see us improve to make this a better event for Volunteers and Participants?
- Would you like to Volunteer with us again? Check off the roles we need Volunteers for (this list varies depending on active projects).

In addition to the assessment shared in the vignette above, **HIGH TECH ELEMENTARY CHULA VISTA** in California, one of the Open Portfolio Project field sites, also utilizes:

- A **Field Trip Reflection form** to take notes about excursions related to class research topics.
- An **Ask Me Anything protocol** for youth to get to know each other by following guidelines.
- A **Family Meeting Notes and Feedback form**, as a way to integrate families into the classroom and school community around their children's work.
- **Classroom Success Criteria rubrics** that are collaboratively developed by the students and the teacher. Here we share two examples of the 41 assignment-specific rubrics that the students and the teacher created: Self Portrait Success Criteria and Field Trip Success Criteria.

Trevor Mattea shared the assessments with us.

Name: _____

Date: _____

Field Trip Reflection

On _____, _____, we went on a field trip to _____ in _____, CA.

We were trying to learn more about

_____.

Before our field trip, one thing I already knew about that topic was

_____.

After our field trip, one thing I know now about that topic is

_____.

Something I liked about our field trip was

_____.

Something I noticed on our field trip was

_____.

I still wonder about

_____.



Every day during the first week of school, and during one of our class meetings each week for the rest of the year, I make time for students to ask me anything. After we have established classroom norms, volunteers who want to sit in front of the class for 20 minutes to facilitate their own ask me anythings. Immediately beforehand, I review our classroom norms -- attentive listening, appreciations/no put downs, mutual respect, and the right to pass -- as well as past examples of low-stakes, medium-stakes, and high-stakes questions from our class meetings. As with class meetings, I ask volunteers to help facilitate the conversation by doing the following tasks.

- Maintaining a speaker's list and inviting a new person to share whenever there is a break in the conversation
- Monitoring use of the attentive listening sentence frames during the conversation, particularly the use of the "frame of the day"
- Monitoring the amount of time I am speaking versus the amount of time students are speaking in order to minimize teacher talk and maximize student talk
- Monitoring the number of times each person contributes to the conversation in order to minimize teacher talk, maximize student talk, and encourage those who normally speak to listen and those who normally listen to speak

The data collected during these conversations is tracked over the course of the day, week, and year to track trends and students' overall progress.

Attentive Listening Sentence Frames

- I have a question for [NAME]. [NAME], [QUESTION]?
- I think I have an answer to [NAMES]'s question. [NAME], [ANSWER].
- I have a comment for [NAME]. [NAME], [COMMENT].
- I made a connection with what [NAME] said. [NAME], [CONNECTION].
- I want to add on to what [NAME] said. [NAME], [ADDITION].
- I would like to respond to what [NAME] said. [NAME], [RESPONSE].
- It would help me to reword what [NAME] said. [NAME], what I thought you said was [REWORDING]. Did I get that right?
- I would like to know what [NAME] thinks about this issue. [NAME], would you mind sharing your thoughts?

We video record all of the student ask me anythings, so students can watch them later and reflect on their public speaking, comfort level with their classmates, and questions they might ask people they are meeting for the first time or trying to get to know better.

Self-Portrait Success Criteria

	Spend a lot of time looking at your picture and keep checking it to make sure your drawing matches it.
	Draw one part of the self-portrait at a time. For example, focus on the eyes before you focus on the nose.
	Make sure to draw your shoulders and arms bigger than your head.
	Make sure to draw all of the details from your clothes.
	Use lots of different colors.
	Color in all of the white space.
	Make patterns in the background, like checkerboards, swirls, stars, or zigzags.
	Draw examples of things that you like in the background, like books, fireworks, or puppies.
	Trace your pencil with a black pen.
	Erase all of the pencil underneath the black pen.

Point Montara Lighthouse Field Trip Success Criteria

	If you like something, announce it to everyone. Go and tell everyone how happy you are.
	If you don't like something, don't announce it to everyone. Go and tell Trevor how sad you are.
	Try to keep your shoes and clothes as dry and clean as possible.
	When you are doing schoolwork, stay focused.
	Never turn your back to the ocean.
	Watch your step as you run on the beach.
	Watch your step as you walk inside.
	Don't run near large rocks or climb on large rocks.
	Don't approach wild animals.
	Treat hostel materials with care.
	Clean up after yourself.
	Help clean up after others.
	Keep your voices down, especially at night.
	Be quiet after the lights go out.
	Say hello to other people at the hostel.
	Invite other people at the hostel to our talent show.
	Appreciate the people who make breakfast and dinner, play with you, help you with your writing, and chaperone during the trip.
	Before you leave, say thank you to everyone at the hostel.

CODECREATE TECHNOLOGY EDUCATION in Chicago, IL is a mobile makerspace. The makerspace captures individual development of program participants by considering evidence for gaining new perspectives, knowledge of design processes, collaboration skills, technology skills, and empathy. Jeff Sweeton shared this assessment approach with us.

Technology Education's Assessment, CodeCreate

- Evidenced by written and verbal responses, we seek a deepened understanding of disparate consumption rates and new perspectives.
- Evidenced by success in our program and youths' abilities to design their own projects, we consider knowledge of a production arch/engineering design process.
- Creativity and adaptability is considered as evidenced by both an instructor's rating of originality, variety (breadth) of solutions, discipline combinations and novelty of ideas as well as the success of collaboration in a project.
- We evaluate hard skills simply by completed successful tasks, however |we also rate increased community engagement and empathy for others by means of voluntary participation in community events.
- We also note an increased sense of empathy through demonstrated patience in considerations as well as individual behavior (avoiding social behavior).

SONOMA COUNTY OFFICE OF EDUCATION in California created a [Maker Rubric](#) that covers five broad areas related to making: (1) content mastery, (2) visibility, (3) process, (4) maker mindset, and (5) agency. All of these aspects are assessed against a scale ranging from emergent to distinguished.

Maker Rubric

	EMERGING	APPROACHING	PROFICIENT	DISTINGUISHED
CONTENT MASTERY	Student demonstrates <i>limited</i> understanding of curricular content.	Student demonstrates understanding of curricular content.	Student demonstrates understanding of curricular content and its applications. Student can articulate how his/her design relates to curricular content.	Student demonstrates understanding of curricular content and its applications. Student can articulate how his/her design enhances others' understanding of curricular content.
VIABILITY	Product does not work/function as intended.	Product does not work/function as intended, but student can explain why and has a plan for revision.	Product works/functions as intended.	Product works/functions as intended and student can provide rationale for design choices.
PROCESS	<p><i>Some</i> of the following elements of the process are evident:</p> <ul style="list-style-type: none"> documentation organization reflection perseverance incorporation of feedback 	<p><i>Many</i> of the following elements of the process are evident:</p> <ul style="list-style-type: none"> documentation organization reflection perseverance incorporation of feedback 	<p><i>Most</i> of the following elements of the process are evident:</p> <ul style="list-style-type: none"> documentation organization reflection perseverance incorporation of feedback 	<p><i>All</i> of the following elements of the process are evident:</p> <ul style="list-style-type: none"> documentation organization reflection perseverance incorporation of feedback
MAKER MINDSET	Student does not investigate a design.	Student investigates <i>only one</i> design and does not iterate.	Student investigates multiple designs <i>or</i> iterates a single design.	Student investigates <i>and</i> iterates multiple designs.
AGENCY	Student is <i>not</i> yet able to monitor his/her ability to benefit from and contribute to the activity (e.g.: discussion, team meeting, independent time).	Student is able to monitor his/her ability to benefit from and contribute to the activity (e.g.: discussion, team meeting, independent time) <i>with</i> reminders or other assistance.	Student is able to monitor his/her ability to benefit from and contribute to the activity (e.g.: discussion, team meeting, independent time) <i>without</i> reminders or other assistance.	Student <i>consistently</i> monitors his/her ability to benefit from and contribute to the activity (e.g.: discussion, team meeting, independent time) <i>without</i> reminders or other assistance.

DESIGNCASE.CO developed two rubrics for assessing making in a school context. The first rubric focuses on Maker and Innovation Class Mindset and centers on four aspects: (1) Creative Confidence, (2) Effective Use of the Design Cycle, (3) Maker Mindset, and (4) Communication. These criteria are evaluated on a three-point scale ranging from Developing Mastery to Mastery. The second rubric is a Skills and Knowledge Checklist, which lists classroom activities alongside space for status updates, as well as scaffolding questions that support students in selecting a project and the skills they want to focus on developing. Glenda Baker, Mark Schreiber, and Sarah Sutter led the assessment instrument design.

Maker and Innovation Class Mindset Rubric:

Criteria	dt	Developing Mastery	dt	Approaching Mastery	dt	Mastery
1. Creative confidence						
1.1		Unsure of next steps in the design process. Needs support to take risks and process setbacks.		Relies heavily on outside sources for inspiration with limited modification of ideas from resource materials. May need some support to take risks and process setbacks.		Demonstrates confidence and independence in the design process. Deals with fails and setbacks with resilience.
1.2		Settles on ideas quickly with limited input from others.		Ideation results in very few options with limited variety. Incorporates input from others and outside sources in a literal / direct manner.		Curious and seeks inspiration from others to create new and original solutions and/or build on others ideas.
1.3		Relies on same approaches to finding a problem and solving it. May not be uncovering most of a user's real needs.		Occasionally varies approaches to problem finding / problem solving. Uncovers and incorporates surface user needs.		Uses a wide range of strategies to uncover and develop empathy for less obvious user needs. (Seeks new ways to do so.)
2. Effective use of the Design Cycle						
2.1		Waits for prompts on which phase of the design cycle to work in to move a project forward. Requires more direction from the teacher to engage in rounds of refinement.		Uses all phases of the design cycle with confidence. Engages in rounds of refinement but may stop short without direction or support from the teacher.		Knows how to move a project forward by engaging in multiple rounds of refinement, testing and prototyping that results in greater clarity and resolution about the final product.
3. Maker Mindset						
3.1		Uses limited structures and strategies during projects.		Uses a range of structures and strategies to help manage projects when suggested by the teacher.		Uses a wide range of structures and strategies to efficiently manage projects, collaborate with others and successfully meet deadlines without prompting.
3.2		Experiments with materials and ideas when prompted.		Experiment with materials when directed but are somewhat timid about risk-taking for discovery.		Self-initiation and risk-taking in the tinkering process.
4. Communication						
4.1		Drawing and visualization skills limit the potential quality of the final objects.		One or more technical competencies in drawing and visualization needs further development.		Uses drawing/visualization skills to conceptualize, and effectively turn ideas into tangible objects.
4.2		Documents when prompted by the teacher and often to show snapshots, end-points. May not grasp the reason to document in terms of collaboration and open source.		Documents to show snapshots, end-points. To be more meaningful for collaborators and open source community documentation needs to include more attention on process and insight.		Documents and shares process and results in a way that others can utilize and build on for future communal results. (Open source model)

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Skills and Knowledge Checklist :

Core Skills	Status	date	date	date	date
-Fundamental Understanding of Electronics and Circuits- <i>Student understands and can demonstrate how to create basic parallel and series circuits as well as switches in the creation of an electric circuit.</i>	Skill Complete				
	Not quite there yet				
	No Attempt				
-Basic Soldering- <i>Student is safe and effective soldering iron operation.</i>	Skill Complete				
	Not Quite There Yet				
	No Attempt				
-Basic Arduino Programing and Board Use- <i>Student understands how to program an Arduino board for use in their various projects.</i>	Skill Complete				
	Not Quite There Yet				
	No Attempt				
-Basic Vector Drawing Software- <i>Student has enough software proficiency to create function vector line drawings. (Program examples- InkScape and/or Illustrator)</i>	Skill Complete				
	Not quite there yet				
	No Attempt				
-Independent Laser Cutter Operation- <i>Student is able to safely operate the laser cutter to output digital files with correct power settings, frequency, and speed for varying materials and thicknesses.</i>	Skill Complete				
	Not Quite There yet				
	No Attempt				
-Orthographic Projection <i>Student is proficient in technically representing objects in a 3-view orthographic model.</i>	Skill Complete				
	Not Quite There Yet				
	No Attempt				

Core Skills	Status	date	date	date	date
-Basic Operation of 2D CAD Software- <i>Student has a level of CAD knowledge that allows them to design and output files for 2D fabrication.</i>	Skill Complete				
	Not Quite There Yet				
	No Attempt				
-Basic Form and Function- <i>Student has the needed background knowledge that allows them to create final objects with both good form and good function</i>	Skill Complete				
	Not Quite There Yet				
	No Attempt				

Qs to help you figure out your final project(s) and what skills you might need to make the project a reality.

- What object would you want to make for your final project?
- What skills and knowledge would you need to attain to make this object a reality?
- What interests & hobbies do you have that could help focus you towards a specific project?
- If you could give someone a gift, who would that person be and what would be the gift? Could you make a version of your own?

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Tier 2 Skills to Pick From: Pick 5 specific skills from the list below for your level 2 skills and then pick 1 of these 5 skills to go even deeper in (your level 3 skill)

Skill Categories	Specific Skill	Tier 2 Skills- (pick 5 and write them here)	Tier 3 Skills (pick 1 and write here)
Basic Electronics ->	Building small circuits		
Basic Electronics ->	Fundamental concepts of electricity/electronics		
Basic Electronics ->	Microcontroller programming		
Basic Electronics ->	Advanced circuits and soldering		
Robotics and Physical computing ->	Intermediate Arduino Usage		
Robotics and Physical computing ->	E-textiles		
Robotics and Physical computing ->	Basic programming -Arduino & S4A.cat		
Raspberry Pi and Similar platforms ->	PCduino, Beaglebone, raspberry pi, etc.		
Raspberry Pi and Similar platforms ->	Basic linux		
Raspberry Pi and Similar platforms ->	Other distros		
Drawing Software ->	Intermediate Vector- (Inkscape or AI)		
Drawing Software ->	Intermediate CAD program use		
Drawing Software ->	3D drawing program		
Tools & Techniques (safety & use) ->	3D printer		
Tools & Techniques (safety & use) ->	Vinyl cutter		
Tools & Techniques (safety & use) ->	Precision Milling/routing (CNC)		
Tools & Techniques (safety & use) ->	Large Scale Milling (CNC)		
Tools & Techniques (safety & use) ->	Sewing machine (embroidery, etc)		
Arts & Crafts	Basic Sewing skills		
Arts & Crafts	Crafting techniques		
Arts & Crafts	Sample processes such as silk screening, etc.		
Mechanical/construction processes	2D vs. 3D design and fab -joinery of structures		

EDUTOPIA published the Sample Authentic Maker Education Rubric for assessing six broad aspects of making: (1) technique/concepts, (2) habits of mind, (3) reflection and understanding, (4) craftsmanship, (5) responsibility, and (6) effort. These aspects are assessed based on a four-point scale that ranges from unsatisfactory to distinguished. Lisa Yokana designed the rubric.

Sample Rubric

By: Lisa Yokana /// @lyokana59

	UNSATISFACTORY	COMPETENT	PROFICIENT	DISTINGUISHED
TECHNIQUE/CONCEPTS	Work lacks understanding of concepts, materials and skills.	Work shows some understanding of concepts, materials and skills.	Work reflects understanding of concepts and materials, as well as use of skills discussed in class.	Work shows a mastery of skills and reflects a deep understanding of concepts and materials.
HABITS OF MIND	Student passively attempts to fulfill assignment without much thought or exploration of possibilities. Student refuses to explore more than one idea.	Developing exploration of possible solutions and innovative thinking. Student has more than one idea but does not pursue.	Student explores multiple solutions and innovative thinking develops and expands during project.	Consistently displays willingness to try multiple solutions and ask thought provoking questions, leading to deeper, more distinctive results. Student fully explores multiple ideas and iterations.
REFLECTION & UNDERSTANDING	Student shows little awareness of their process. The work does not demonstrate understanding of content.	Student demonstrates some self-awareness. Work shows some understanding of content, but student cannot justify all of their decisions.	Student shows self-awareness. Work demonstrates understanding of content and most decisions are conscious and justified.	Work reflects a deep understanding of the complexities of the content. Every decision is purposeful and thoughtful.
CRAFTSMANSHIP	Work is messy and craftsmanship detracts from overall presentation.	Work is somewhat messy and craftsmanship detracts somewhat from overall presentation.	Work is neat and craftsmanship is solid.	Work is impeccable and shows extreme care and thoughtfulness in its craftsmanship.
RESPONSIBILITY	Frequent illegal absences, tardiness, disrespect for classmates and teacher. Disregard for materials and work such as refusal to clean up or throwing out work.	Student is sometimes illegally absent, tardy, or disrespectful. Must be persuaded to assist in clean up and to take work home.	Student is most often present, on time, and respectful. Usually participates willingly in clean up and takes pride in work.	Student is consistently present, punctual, and respectful of classmates and teacher. Self-directed clean up and ownership of work.
EFFORT	Work is not completed in a satisfactory manner. Student shows minimal effort. Student does not use class time effectively.	Work complete but it lacks finishing touches or can be improved with a little effort. Student does just enough to meet requirements.	Completed work in an above average manner, yet more could have been done. Student needs to go one step further to achieve excellence.	Completed work with excellence and exceeded teacher expectations. Student exhibited exemplary commitment to the project.
edutopia				

JACKSON P. BURLEY MIDDLE SCHOOL in Charlottesville, VA created a rubric for their process-driven math curriculum, which focuses on documentation of media-rich iterative progressions of projects. Other areas covered in the rubric are: math, reflective practice, cooperative learning, and dealing with challenges/failure. Ranging from “exceeding” to “not met,” students can earn a total of 15 points per project. Peter Fiddner shared the rubric with us.

Jackson P. Burley Middle School’s Coding Project Rubric

	Exceeds (4)	Meets (3)	Nearing (2)	Not (0)
Documentation of Progress	Numerous entries in portfolio with both visual and written components (all 3 sections- beginning, middle, and end)	Multiple entries in portfolio with both visual and written components (all 3 sections- beginning, middle, and end)	Multiple entries in portfolio with both visual and written components (in 2 of the sections- beginning, middle, and end)	Not Observed
Math	Student can understand and show the math necessary to complete the projects.	Student can understand the math necessary to complete the projects.	Student shows partial understanding of the math necessary.	Not Observed
Reflective Practice	Student can express areas of weakness and has overcome obstacles.	Student can express areas of weakness.	Student does not understand where the obstacles are.	Not Observed
Cooperative Learning	Student implements the suggestions of others and offers suggestions to others..	Student implements the suggestions of others.	Student is in the group, but is a passive member.	Student works in isolation or requires frequent redirection.
Dealing with Challenges/ Failure	Student attempts multiple strategies to fix problem(s) and can document why attempts might have worked or not	Student attempts multiple strategies to fix problem(s) and can explain why they those chose given strategies	Student attempts a strategy or two to fix problem	Student gives up with no attempt to solve challenge

_____ out of 15