RESEARCH BRIEF SERIES PHASE 2

Open Portfolio Project

Maker Ed | Creativity Labs | Gordon and Betty Moore Foundation

TABLE OF CONTENTS

EXECUTIVE SUMMARY: OVERVIEW AND FUTURE VISION FOR OPEN PORTFOLIOS

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Maker Ed

Open Portfolio Project

RESEARCH BRIEF

10

Throughout our work on open portfolios, we called for openly networked, decentralized, and distributed systems in which youth can maintain control of their content and curation processes. This has implications for the way in which young makers' portfolios are considered for assessment purposes—that they present youth's interests, their experiences, as well as insights into how well youth might strive within another environment (e.g., a college or professional setting).

Open portfolios are an important form of assessment within maker education because they can showcase examples of the kind of learning that happens in making beyond numerical assessment of knowledge and skills. Instead, collections of images, videos, and sketches can facilitate the exploration of a maker's personal creative process and ways of doing beyond a one-size-fits-all model. Additionally, open portfolios can support youth taking ownership of their work and contributing to maker communities inside and outside of their own learning environments.

This Research Brief series focuses on open portfolios as a form of assessment of youth-driven making and provides a broad survey of existing assessment practices in makerspaces that builds on and advances traditional portfolio assessment. We highlight aspects that educators in a range of maker settings consider when working to integrate youth practices:

- In **Research Brief 11**, we outline the key tensions as we move portfolio assessments into makerspaces in and out of school, including aspects to consider when designing assessments that foster rather than counter the interest-driven, serendipitous, and community-centered learning of making.
- In **Research Brief 12**, we offer a close look at three prominent maker-centered learning environments to document, describe, and analyze their approaches to portfolio assessment. This sets a context to understand the practices and larger learning ecologies at work in a sample of today's maker programs.
- Our engagement with field sites consistently examined the various tensions among motivations of educators and youth for creating portfolios. In **Research Brief 13**, we closely examine some of the main motivations for youth in their portfolio creation, because often this perspective is overlooked in the broader literature on assessment and portfolios, privileging instead institutional motivations for portfolio assessment.
- In **Research Brief 14,** we take a deeper dive into the portfolio assessment practices at work in two specific maker environments servicing both elementary and high school age groups. In this work, we wrestle with what it means in these spaces to use assessment to deepen the learning process. In addition, we offer an appendix that showcases a broader range of assessment instruments not highlighted in the brief. Our hope is that future research can leverage this existing work to inform the design of new assessments.

- **Research Briefs 15** and **16** focus on in-person and online professional development opportunities for educators, as well as design workshops that support our understanding of the capturing and sharing of youth creative practices. These briefs serve as inspiration for workshops that educators may wish to adopt in their own settings.
- Our series closes with a report of our 2017 Maker Site Survey (**Research Brief 17**) that captured demographic data, program information, and assessment statistics of youth-serving makerspaces, underscoring the wide-scale support of assessment in makerspaces, the critical need to design new approaches to assessment, as well as a call to renew our core commitments to serving underserved communities through the broader maker movement.

In sum, the second phase of the Open Portfolio Project provided a platform for inquiry into the tensions around integrating traditional portfolios into maker educational settings, how these tensions are negotiated in practice, how youth are motivated to capture their work, and how opportunities for supporting these motivations can be formalized into assessments.

Status of the Field

Of course, use of portfolios in the assessment process has been a longstanding part of education in the U.S. Their use in writing and art classrooms, for example, are standard (e.g., Gardner, 1989; Wolf, 1989; Yancey, 2009). However, as practitioners come to employ portfolio assessment in the context of maker activities, there are few guidelines to steer their efforts. It would seem the nature of the work itself—the various work products that result as well as the norms and values associated with makerspaces to date—are novel enough to require some amount of re-thinking of assessment approaches. From the project's efforts, described in Research Brief 14, we know that practitioners are assessing youth work products in school and out-of-school environments, but that assessment is largely taking place amidst an absence of strong traditions and examples. In spite of that void, practitioners are moving ahead, developing their own tasks and rubrics, and modifying those that already exist.

This is as it should be. The knock-on benefits of having practitioners review student work are well recognized (Shulman, 1986); Wolf, 1989) both for student and teacher learning. And the potential for variety in what gets assessed allows practitioners to shape their assessment practices to best reflect local values and norms. On the other hand, there's significant room to improve practitioners' current assessment efforts and assessment practices within makerspaces more broadly. There's some urgency in the latter.

As the maker movement looks to continue to grow, there will be increasing pressures to provide evidence that makerspaces are effective contexts for learning. Who benefits from maker activities? To what extent? And in what ways? Investigating these questions and others will require improved assessment practices within makerspaces.

After review of the sample set of assessment tasks and rubrics collected by this Moore Foundation-funded effort, we have identified areas for additional research and development that would strengthen assessment in the context of makerspaces. First, when well designed, rubrics can convey to practitioners and learners alike the developmental nature of learning associated with maker education. This is a key function played by rubrics. They create the possibility for practitioners and learners to understand how their knowledge and skills have changed over time and how they can expect to change in the future. In the best cases, the developmental pathway conveyed by rubrics is based on empirical data. Currently, efforts to create such a portrait in the context of makerspaces is primarily theoretical, and when they're supported by observations, they're often limited to the authoring practitioners' own experiences. This impacts the reliability, validity, and bias of judgements made with the resulting rubrics.

Second, rubrics can be understood as assessment artifacts that reflect the norms and standards of a practice or community. When well designed and well used, rubrics convey these intangibles to both learners and practitioners. For learners, they become tools for shaping not only their knowledge and skill sets, but also the norms and values associated with designing and making, helping them transition along the path to expertise.

For practitioners, rubrics should also become a means for improving their pedagogical content knowledge and helping to align their own maker-related norms with those of the a broader community (Shulman, 1986; Park and Oliver, 2007). There remains an open set of questions regarding how to best design, use, and share rubrics so practitioners and learners can most effectively convey those norms to others.

Next Steps for Practitioners, Researchers, Policymakers, and Designers

We expect it won't be long before policymakers and funders become more adamant about asking makerspaces to show evidence of their impact on learners' knowledge and skills. In that case, assessment practices will be under increasing pressures to reveal changes in student knowledge and abilities. This will be a significant and important effort—to develop a set of maker projects and associated rubrics capable of supporting such evaluations—and will require action from practitioners, researchers, policymakers, and the designers of future open portfolio tools.

PRACTITIONERS

The role of practitioners in all of this work will be critical. To them, we provide the following advice:

1. *View the assessment process as continuous, or interwoven, with their instruction.* The rubrics and entailed expectations should be communicated as a part of the core, explicit instruction.
2. *Understand that the portfolio process can be used to advance their own learning as it advances their students' learning and skills.* Review of student work, particularly in concert with other practitioners, can be a fast track to improved instruction.
3. *Recognize that the interactions with learners over their work products and the associated rubrics are critical arenas* for conveying not only the technical aspects of design and making, but also the practices and norms that are held by members of the maker community, i.e., epistemic frames (Shaffer, 2006). It's expected that awareness of such practices and norms will contribute to improved student learning and success in making.
4. *Consider possibilities for portfolios to support permanence of creative projects.* This could include long-term display or storage, temporary permanence (where projects in progress remain in the open as invitations for youth to return to their projects over the course of several days), or opportunities for youth to take their work home to continue to refine and build on their projects. This contrasts to the idea of disassembling projects and returning materials to shelves and storage bins for organizational and cost-saving purposes. Where space availability can limit the amount and duration of such project (-in-progress) exhibitions, portfolios can become spaces for honoring and valuing students' creative productions, to encourage building upon prior work, and to make space for students to take ownership. This could have implications for learning because it could support learners to be emotionally and physically present within the makerspace, inflict change in the makerspace setup, inspire future projects, and strengthen intergenerational relationships.

RESEARCHERS AND POLICYMAKERS

This project has opened up areas for further inquiry that need to be considered if researchers and policymakers are to take the commitment toward portfolios as an alternative and comprehensive assessment approach for maker education seriously. As a next step, researchers and policymakers can:

1. Assess the influence of bias within open portfolios. Assessors need to consider what contextual information is relevant to consider for the application and it puts portfolio assessment into a place where the reviewers open themselves up to liability concerns. This is particularly important for portfolio assessment, as it can help detect assessment bias, for example, by investigating what kind of equipment and learning narratives are included within high-rated portfolios and how they differ from low-rated portfolios across a range of institutions that accept portfolios in relation to tone and pitch of voice, setting, and editing.
2. Investigate links between maker education and humanities. Open portfolios are inherently interdisciplinary, yet our data shows that most maker-centered efforts are positioning their programs with links to sciences, technology, engineering, and mathematics (STEM). Though more of humanities (e.g., literature and history) is integrated and woven into maker programming today, it continues to be important to show how maker education might support their disciplinary practices. Through the centrality of talk about projects, portfolios highlight the importance of rhetoric and the art of persuasion as a means to reach out to these disciplines. As all assessment is part of a larger narrative of why learning happens and how, this approach of "making an argument" increases the way we can frame portfolios as contrasting to standardized assessment, taking away from the idea of "data speaks for itself."
3. Support student ownership and control of data over a lifetime beyond the life cycle of a private corporation through data access across services and data storage as a right of every child. Inclusive of this is the importance of privacy and control of information in terms of transparency of who owns and contributes to an account and how this may be recognized. This is important for the possibilities of portfolios as a way to showcase experiences as well as to learn about data management and digital citizenship. As maker-centered learning environments serve the youngest of children, there's a need to consider how portfolio data collected across learning environments can be supported on a large scale.

DESIGNERS OF NEW PORTFOLIO SYSTEMS

Hardware documentation stations and software tools for curating and sharing personally meaningful projects are the basis for creating compelling open portfolios and require particular affordances to do this well. Yet, the tools currently being used haven't been designed for passion-driven learning where digital and tangible making frequently intersect, complicating the documentation and sharing of project work. Designing tools for capturing and sharing maker efforts is one of the salient challenges of the future for portfolio assessment. Four overarching themes will be particularly important to consider:

1. *Carefully consider the affordances and constraints of design features to guide narrative*, including the length of videos, word count, amount of projects included, as well as the possibility for editing videos (e.g., adjusting speed, annotating, etc.) without the need for third-party video-editing software. To continue to work toward differentiating portfolio assessment from standardized assessment, tool affordances and constraints need to balance between showing the richness of making and the amount of projects included in a portfolio.
2. *Scaffold the importance of self-reflections*, including finding ways for makers to share "failed" projects—thus embracing the role of iteration and failure as important to the learning process—as complementary to their showcased work.
3. *Carefully scaffold process* in a way that supports makers to identify their own personal, perhaps unique, approaches to creative practice while at the same time supporting the recognition of basic design processes within their work. This would require automatized visualizations of design practices that youth performed while making in order to see, share, and refine design cycles and personal strategies.

ASSESSMENT DESIGNERS

There has been an ongoing debate between advocates for portfolio assessment and champions of standardized tests. Both groups claim they don't trust the results of the other. In domains such as maker-centered learning environments, the case for portfolio assessment or other approaches that incorporate authentic student work products now seems self-evident. Yet as organizations look to serve increasing numbers of youth, as policymakers and funders look to evaluate the impact of makerspaces, and as the field looks to continually improve maker learning, there will be growing value in providing access to one or more uniform, scalable approaches to portfolio assessment.

But the matter is sensitive. In particular, increased standardization of portfolio assessment puts interest-driven learning at risk. Current approaches to principled assessment design (Wilson, 2004; Mislevy et al., 2015) and machine learning stand to provide one possible solution. In particular, it may be possible to design tasks that afford many degrees of freedom for youth to pursue heterogeneous designs while supporting the use of machine learning to automate and standardize assessment of student knowledge and ability.

One such effort has made use of learning analytics and tools of machine vision to automate scoring of youths' e-textiles. The automation effort yielded a set of features and a predictive model able to reproduce human judgements of the quality of youths' e-textiles. Along the way, the approach provided initial evidence for the feasibility of developing assessment tasks that allow for student choice and creativity while also allowing for comparison within and between groups (Corrigan and Bhatthacharya, 2018). Importantly, the approach is scalable.

Conclusions

The aim of the second phase of the Open Portfolio Research Brief Series has been to review and advance the current state of portfolios and assessments across an emerging national and international network of makerspaces. We know that youth are spending an enormous amount of time in interest-driven activities through their maker educational practice, and we argue in this series for the need to capitalize on these interests and connect these maker experiences to future opportunity. At the same time, youth have much to teach us about making and learning that could equally inform future assessment designs.

Building on this foundation, this brief series seeks to inspire new pedagogical practices, the documentation and analysis of existing assessments, new tools to support the documentation of making, and further research in this area. Through coordinated effort between practitioners, research, policymakers, and designers of future portfolio tools and platforms, we can open up new pathways for youth to connect their making to the broader maker community, as well as future schooling and career options.

References

Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In *Learning analytics* (pp. 61-75). Springer New York.

Gardner, H. (1989). Zero-based arts education: An introduction to ARTS PROPEL. *Studies in Art Education, 30(2), 71-83.*

Nash, P., & Shaffer, D. W. (2011). Mentor modeling: The internalization of modeled professional thinking in an epistemic game. *Journal of Computer Assisted Learning*, *27*(2), 173-189.

Park, S., & Oliver, J. S. (2008). Revisiting the conceptualisation of pedagogical content knowledge (PCK): PCK as a conceptual tool to understand teachers as professionals. *Research in science Education*, *38*(3), 261-284.

Riconscente, M. M., Mislevy, R. J., & Corrigan, S. (2015). Evidence-centered design.

Shaffer, D. W. (2006). Epistemic frames for epistemic games. *Computers & education*, *46*(3), 223-234.

Wilson, M. (2004). *Constructing measures: An item response modeling approach*. Routledge.

Wolf, D. P. (1989). Portfolio assessment: Sampling student work. *Document Resume, 351.*

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational researcher*, *15*(2), 4-14.

Yancey, K. B. (2009). Electronic portfolios a decade into the twenty-first century: What we know, what we need to know. *Peer Review, 11(1), 28.*

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INTRODUCING PHASE 2 OF THE OPEN PORTFOLIO PROJECT: ASSESSMENT IN MAKERSPACES

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RESEARCH BRIEF

11

Introduction

This brief provides a conceptually oriented analysis of the uses, challenges, and value of portfolio assessment in maker-center learning environments in order to build a common understanding of the importance portfolios can play in documenting learning in the lives of young people.

This is the first step in an important process of balancing the intrinsic techniques that youth employ to document their own making with the needs of evaluators to see evidence of learning and compare this over time and across portfolios. This investigation has immediate consequences for youth makers who, when necessary, must adapt their culturally appropriate portfolio practices to the forms requested by external authorities in the college admissions or job application process. Through this work, we seek to better understand the goals and aims of high-quality portfolio practices in makerspaces and the extent to which we can resolve its inherent tensions with traditional means of assessment, highlighting the motivations of youth and makerspaces that are fostering cultures of portfolio development.

Building on the work conducted during Phase 1 of the Open Portfolio Project (Chang, Keune, Peppler & Regalla, 2014)[1], this second phase increases focus on the use of portfolios for assessment purposes in maker-centered learning environments. We base our investigation on at least four requirements: High-quality portfolio assessment techniques need to 1) thrive both in schools and in out-of-school settings, where participation is non-compulsory and interest-driven; 2) work for a range of media inherent to making, spanning coding, visual, and nonvisual media, with less emphasis on structured writing and reflection in particular areas; 3) embrace the inherent agency that youth have in creating portfolios, often because they have a strong desire to communicate and share with external audiences; and 4) ensure that episodic commitments in out-of-school time (i.e., participation changes over time, often with concentrated periods of activity alternating with extended absences) are honored as well.

1. The Phase 1 work included a national survey of 55 makerspaces across the U.S., site visits to 10 demographically diverse makerspaces, design workshops around do-it-yourself documentation stations, and a participatory portfolio implementation that led to our first research brief series (Peppler, Maltese, Keune, Chang & Regalla, 2014) and practitioner guide (Chang, Mohammadi & Regalla, 2016). The work for Phase 1 highlighted the overwhelming interest and importance of portfolios as a way to foster youths' ownership over their learning, youth voice in the makerspace community, and the linking of learning across settings toward future job and college opportunities. At the same time, we also identified that sustained and systematic portfolio practices are rare in makerspaces, and in order for portfolios to be an effective broker of such future opportunities, there needs to be solid and scalable assessment practices in place to both validate and document learning.

This brief reviews and elaborates on our understanding or assumptions of how traditional assessment differs from assessments of making, the tensions these differences impose, and the implications these tensions have for assessment policies and practice. In the process of exploring these deeply rooted tensions in future research briefs, we share findings from site visits, interviews with youth and maker educators, and our second round of national surveys. Over the course of this process, we share ethnographic findings from spaces that have more or less successfully implemented open portfolios in order to more deeply understand the reasons and rationale behind their creation.

What We Know About Traditional Portfolio Assessment

Contemporary portfolio assessment formats originated from the historical precedent of portfolios in the arts (Gardner, 1989). They surfaced across subjects as a response to the increasing pressures of accountability as well as both a hopeful alternative to standardized testing that can subsume rich learning experience to numbers and a way to provide a fuller picture of youth learning (Niguidula, 1993; Mills, 1996). Described as a unified narrative and a consistent collection of evolving youth work, portfolios could show youth progress (Black & Wiliam, 1998) and final products. As youth capture their accomplishments and the processes of learning, portfolios become a way for learners to take ownership over their learning, as well as the evaluation of it.

Typical portfolio assessment practices in school-based settings center on (a) an adopted set of criteria that guides the development of portfolio artifacts, (b) teacher-youth conferences during which portfolios are discussed, and (c) youth self-assessment as they discuss their work and take ownership over their learning (Niguidula, 1993). This is how a coupling between instruction and assessment is established and how learning and growth can be presented in relation to a pre-designed rubric. In this capacity, portfolios can be used to inform instruction (Yancey, 1996), showcase accomplishments (Barrett, 2010), and evaluate progress toward particular learning outcomes (Valencia, 1990).

Portfolios in school contexts include a set of underlying assumptions that frame much of the possible learning that can be supported with them. First, they're created within schools, which are regularly visited by students over long periods of time, affording an opportunity to return to and pick up work previously started. Second, while portfolios are designed with the intention for learners to take ownership of their learning, the skills and knowledge being captured in the portfolios are often defined by adults in advance, so that the instruction can inform the assessment. This also means that portfolios call for skilled teaching. Third, assessment rubrics for portfolios are generally created by adults and frame portfolios toward one particular audience that generally remains the same over the course of the portfolio creation. What is being assessed and how it's captured (often through writing) is driven by adults to yield data that can help them make educational decisions that are of consequence to the learner. Fourth, traditional portfolios are created by the individual to tell their stories and to capture their skills, knowledge, and experiences as a means for educators to differentiate and separate youth achievements. Lastly, where school-based portfolios can be used within several subject areas, the structure of the portfolio is often arranged in folders replicating disciplinary structures.

An Illustrative Example of Traditional Portfolio Assessment: Arts PROPEL Writing Portfolio

Here we showcase one historically high-quality approach to portfolio assessment called the Arts PROPEL (production and reflection, perception, and learning; Gardner, 1989) Writing Portfolio as an illustration of the possibilities portfolio assessment has traditionally offered school-based settings, as well as some of the inherent assumptions that become questioned when leveraging these practices in makerspaces. We chose to highlight Arts PROPEL because it was one of the first approaches to portfolios in school-based settings and laid the basis for much of portfolio assessment today.

Arts PROPEL is a Project Zero project at the Harvard Graduate School of Education, led by Howard Gardner and Steve Seidel (see Figure 1). One of the principal components of Arts PROPEL is a comprehensive portfolio of student work, including works in progress (as opposed to just final pieces). The portfolio process begins with an introduction to reflecting on one's own expectations. Throughout the year, students collect their work and perform in-depth write-ups that reflect on single entries, compare two entries, or look across all entries within the portfolio.

Students are assisted in their reflections through open-ended questions, provided by instructors, about what they like and what they don't like about their work, and the reasons for these opinions. Teachers comment on the major achievements of students in similar ways, discussing what was done well and what may need to be improved. One complete portfolio entry includes a student's notes, drafts, the final work, self-reflection, and the teacher's comments.

Students are involved through self- as well as peer-evaluation that can be delivered orally and more formally in writing. Teachers may choose to create a shared rubric for evaluating writing based on student comments on their own work. Additionally, parents can become involved when entries are sent home and parents evaluate them through open-ended questions that are similar to the student self-reflections. As students reflect on the parent evaluation of their work, this can provide a learning experience of its own.

The Arts PROPEL portfolio process is deeply connected to and expands on an assessment system based on standards and curricular aims where the portfolio supports the improvement of classroom practice, shares evidence of student learning across stakeholders, and functions as a structured way for learners to engage in high-quality reflection. These arts-based portfolio assessments, in many respects, present starting points for open portfolio assessments, given their creative and open-ended character that supports the collection of different media types as evidence of knowledge, skills, and improved practice.

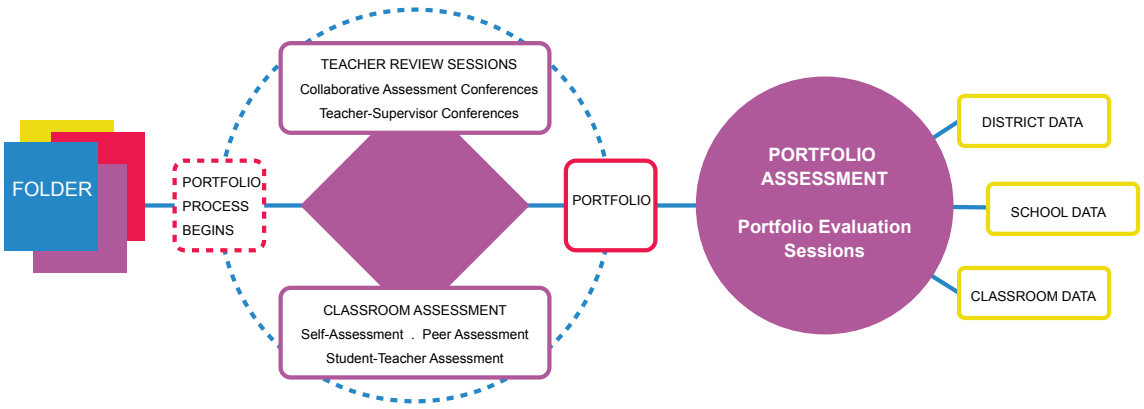

Fig. 1: The Arts PROPEL portfolio process, adapted from the original, which appeared in: Camp, R., Seidel, S., Wolf, D., & Zessoules, R. (1989). *Arts PROPEL: A Handbook for Imaginative Writing.* Pittsburgh, PA: Pittsburgh Public School System.

UNDERLYING ASSUMPTIONS

The assumption that undergirds the Arts PROPEL Writing Portfolio model is that the primary use case is for school settings, where participation can be structured over long periods of time and membership is consistent (see Table 1). A difference of the Arts PROPEL approach to portfolios in maker education may be that not all maker education happens in formal school settings, but occurs in spaces signified by intermittent time commitments, such as in libraries, museums, and afterschool settings, among many other places.

In school settings, the opportunities for systematically collecting portfolio pieces are much greater, but one constant challenge of portfolio creation is the ease in which learning is captured. Teachers may consistently need to remind students to update their portfolios; they may need to manually (and often sporadically) document learning or find ways to automate the process. This points to differences in aspects of teacher and student agency within the design of portfolio practices. The Arts PROPEL model assumes a system in which practitioners can be trained in a unified set of methods that result in high-quality and iterative learning processes. A key conceit of this perspective is that it's the teacher, as opposed to the youth, who introduces these practices into the classroom.

In maker education environments where youth have more control over the direction of their learning and therefore the artifacts they create, collect, and curate for their portfolios, the practices of portfolio creation can change. Traditional top-down structures, where teachers deliver knowledge and students receive information, are shifting, and the nature of teacher-dictated, predetermined learning outcomes for students also changes. In some ways, the role of youth is no longer just learner or student, but co-learner or co-facilitator. Then, what youth put forth in a portfolio shows not only the ways in which they exist within a classroom setting but also how they navigate, control, and utilize their experiences in informal educational settings.

One of the strengths of the traditional writing portfolio model is its focus on process rather than product. However, that model generally requires well-articulated goals and long-term, regular participation; in settings with episodic commitments, those key components are not as certain nor as important. Open portfolio models and practices must be able to leverage the rich learning that occurs in non-classroom environments, no matter how inconsistent or episodic.

In any learning environment, high-quality teaching skillfully aligns assessment and portfolio efforts with the learning of domain-specific knowledge and skills. In single-subject or single-discipline classrooms, this work has often been centered around traditional media types. Arts PROPEL has a strong emphasis on written reflections and on media that are based in more traditional visual arts, but in makerspaces, new and emerging media types – and the mix of them – may sometimes make it more challenging to recognize and measure learning as cognitive knowledge and skills of individuals. When a product is ephemeral (e.g., performances) or obscured (e.g., code), the process of documentation may be more difficult as well.

Table 1: Assumptions of Traditional Portfolios and Open Portfolios

	TRADITIONAL PORTFOLIOS	OPEN PORTFOLIOS
LEARNERS	Individuals who build skills and knowledge and can be compared and/or differentiated	Individuals and their shifting roles within communities and society
AUDIENCES	Educational stakeholders defined from the start; inside the learning environment community	Multiple and potentially changing audiences; beyond the learning environment community
AGENCY	High-quality teaching practice driven by adults; subject- and domain-specific learning	Youth agency, purposeful around distribution or sharing
TIMESCALE	Long-term commitments that follow school cycles (e.G., Terms and semesters)	Episodic commitments that are challenging to track over time
PLACE	Schools, where participation is compulsory	Schools and out-of-school settings; interest-driven
GOALS	Toward the improvement of instruction for a priori learning outcomes	Might change over time and are not always defined at the start
MEDIA/ MODALITY	Strong emphasis on written reflection; range of traditional artistic media	Mixed media; interactive arts/coding; potentially less emphasis on writing
OBJECTS	Finished projects related to disciplines	Processes and products that relate to aspects across disciplines

Tensions Introduced by Making in Portfolio Assessment

Tensions seem to stem from intrinsic differences in the purposes and audiences for any given portfolio, ranging from an assessment that serves larger administrative needs (e.g., tracking schools and student progress over time) to portfolios that allow youth to self-reflect and catalogue their learning and work. While it may be commonly thought that these two needs can be serviced at the same time, they often conflict with one another. Therefore, as we seek to use portfolios in maker-centered learning environments, we must acknowledge that the context of their use in traditional academic spaces requires a cultural shift in thinking.

As evidenced in Table 1, key tensions arise when we seek to translate traditional assessments into makerspaces to create open portfolio assessments. When fully executed, traditional portfolio assessments allow *youth* to build a collection of their work, *educators* to learn about the quality of the program or their instruction throughout the collection, and *makerspaces* to communicate their work effectively to outside audiences. At the same time, traditional portfolio assessment can present productive tensions that help us identify what must be addressed in order to build a shared set of maker-centered open portfolio assessment practices.

Toward this effort, we identified the following tensions that maker education may pose to portfolio assessment as we know it from the literature, which we introduce in this brief and further explore throughout the second phase of the project and in subsequent briefs: (1) a priori versus serendipitous learning outcomes, (2) driven by administrative policies versus driven by youth, (3) a focus on individual versus community, (4) one versus multiple audiences and timescales, (5) a focus on product versus process, and (6) disciplinary versus inter- and transdisciplinary approaches.

A PRIORI VERSUS SERENDIPITOUS LEARNING OUTCOMES

Assessment in schools asks educators to create assessment tasks a priori, so that instructions and activities could be subsequently designed to achieve the goals of the assessment, often in a lockstep and linear fashion. By contrast, activity in makerspaces holds central the tenets of tinkering and serendipitous discovery toward unknown ends. In relation to portfolios, this may mean that what is documented is the journey—the makers' process and the outcome of that process—spanning several different learning objectives frequently not anticipated at the start. What can serendipitous learning outcomes tell us about assessment of fluidly captured making?

DRIVEN BY ADMINISTRATIVE POLICIES VERSUS DRIVEN BY YOUTH

Do youth need portfolios within their makerspaces? There seems to be a spectrum of portfolios that youth create in makerspaces, which can be divided into three segments: portfolios that youth create to serve (1) their own and peer interests and purposes (not involving adults); (2) their own interests, when those interests interface with an externally created social structure (e.g., a job or school application); and (3) the interests of adults (e.g., most formal school portfolios) and only tangentially the youth's interests (e.g., for a grade).

In contrast to this range of youth-centered motivators, traditional assessment is frequently driven by the adults in the ecosystem and their high-quality practices. Assessment measures are selected in accordance with how they could best inform valid inferences about learning so educators can make sound, consequential, educational choices. This means that the processes of learning are largely driven by administrative and policy decisions, in contrast to the passion-driven learning commonly seen in makerspaces, where individuals decide on their own goals and the processes through which they are realized. Who decides on the learning objectives: a societal claim made by policymakers or the educators and the makers themselves, from the ground up?

INDIVIDUAL-FOCUSED VERSUS COMMUNITY-FOCUSED

Traditional assessment is predominantly focused on individuals, seeking to differentiate and separate youth achievements. Making, however, is often community-oriented (Peppler, Halverson & Kafai, 2016), where projects are created in collaboration with and alongside others, informing the growth of the community. This type of collaborative work is challenging the individual accountability that we want inside schools, though collaborative practices are highly valued outside schools, especially in future workspaces. As youth document not only their projects but their work in small groups and how their projects fit into the larger context of the makerspace, portfolios play a unique role in presenting how youth contribute to their communities, how they learn together with others, and how they shape what is valued within their communities. How then do we begin to assess this type of group work and approach to the community portfolio?

ONE VERSUS MULTIPLE AUDIENCES AND TIMESCALES

Youth portfolios can be created for a variety of audiences and a variety of reasons (e.g., sharing work with a community or bolstering job and college applications), and the audience and purpose might not be known at the time of the portfolio's creation. With different known and unknown purposes across a cohort, educators are challenged to design evaluative rubrics that guide youth to capture the highlights of their making, repurposed for multiple audiences beyond the makerspace. This frames the value of portfolios as something that might emerge much later in life rather than immediately.

Educators need to balance potential future needs beyond the maker environment with the strength of portfolios as learning and community-building tools. Focusing on one need shouldn't mean that another need fall short. This is a potential source of procedural error (i.e., a misalignment between teacher motivations and youth purposes) and highlights the need to reconsider portfolios as unified narratives. While we discuss immediate motivations for portfolios in a later research brief, here we call for educators to consider the potential multiplicity of the portfolio audience from the beginning (e.g., serving to foster peer culture, to encourage academic or professional opportunities outside the maker education setting, and to fulfill adult interest).

When potential audiences may include teachers, the maker community, college admissions, and job applications—and these audiences may change over time—the assessment of youth work is then subject to multiple (and likely conflicting) guidelines for presentation and assessment. Whatever open solution is used to showcase youth work over the course of their lifetime, there must be opportunities for youth to customize their portfolio for different audiences and for the assessment to include the audience for which (a particular version of) the portfolio is intended.

While for traditional portfolios, learners are expected to participate in educational programs throughout the semester or term, in maker education settings, learners may drop in and follow through in more episodic ways. This may be more challenging to track and highlights the need for more dynamic portfolios. How might portfolios serve multiple audiences and multiple timescales, capturing contributions that are less consistent and long-term?

PRODUCT VERSUS PROCESS

In the world of assessment, the productions of youth—their essays, test results, art products—can be considered outcomes of youth learning and representations of their knowledge. In making, much value lies in process, including the ways in which youth go about creating their projects: the turns they took, decisions they made, challenges they faced, and mistakes they confronted along the way. These processes can be as idiosyncratic and serendipitous as the learning outcomes. This introduces a tension that may be felt strongest when portfolios are externally assessed.

What makerspace communities and learners themselves perceive as a good portfolio may contrast with what college administrators, who are seeking to fill a limited number of seats, are able to view in the short amount of time provided to them. Colleges may privilege product over process at first glance, and a finished and polished product may promote a youth's job or college application during the initial phase of the application process.

At the same time, when diving deeper into a portfolio of work that also presents maker processes of failed or less-polished products, much can be learned from the ways in which youth engage with important problem-finding and problem-solving practices, as well as the media they used to explore topics and to express their ideas. Failures or preparatory work that has been time-stamped can help frame a longer-term engagement with a medium or a topic. With a focus on processes within the making practice, how might current portfolio assessment adjust to discern distinguished makers with elaborate processes from the start? How are conventions of language expressions influencing what we consider polished products and works in progress within open portfolios?

DISCIPLINARY VERSUS INTER- AND TRANSDISCIPLINARY

Portfolios, as we traditionally know them, allow youth to include work that spans several disciplines, including language arts, art, architecture, engineering, and mathematics. While these varied works may be included, the typical digital folder structures that these portfolios follow may prevent disciplines from co-mingling and therefore impede youth from making connections across and perhaps beyond disciplines.

By contrast, maker activities rarely include a single disciplinary focus. They span disciplines and require learners to work in and bridge multiple domains, and, when using their work to generate future opportunities, learners need to be able to frame their work to audiences with different disciplinary backgrounds. Knowing this, educators—particularly school educators—need to consider the ways in which portfolio systems are structured to resist disciplinary segmentation and to provide youth with ways of questioning and articulating connections across subjects and domains. How might open portfolio assessment foster inter- and transdisciplinary links rather than compartmentalize work?

Assessing Open Portfolios: Reliability, Validity, and Bias

As portfolios become an important part of college and job applications (Byrne & Davidson, 2015), people external to the maker education activities or spaces need to draw valid inferences about youth's knowledge and skills. In fact, looking across trends of portfolios in higher education, there's a need for more data-driven research on youth outcomes based on portfolios as well as research on useful and effective platforms (Bryant & Chittum, 2013). To address these gaps requires the consideration of reliability (of the assessments), validity, and potential bias (of the implementation of the assessment) in order for open portfolios to serve as an effective system of assessment.

RELIABILITY IN OPEN PORTFOLIOS

In academic assessments, reliability can include the measurement of (a) internal consistency: how well the items on a test measure the same construct idea; (b) stability: the consistency of scores over time; and (c) alternate form: the consistency across forms (McMillan, 2011), among other measures. Depending on the kinds of claims that one is seeking to make, any of these forms of reliability may also be relevant for open portfolio assessment. In this regard, it's important to clarify the kinds of claims educators are seeking to make, what kinds of claims they would like people outside the makerspace to be able to make, and the amount of context needed for teachers, peers, and external evaluators to make those claims.

The issue of context is potentially problematic when pertaining to the reliability of open portfolio assessment. For example, generalizability theory would assert that it's possible to vary a number of facets in an assessment—the scoring rubric, the number and severity of judges, the nature of the products reviewed, and so on—all of which could theoretically contribute unwanted variation to the final judgment. If the intended outcome of a portfolio assessment is consistency across multiple judges—for example, where judgments of a student's "creativity" or "effort" is consistent whether s/he submits a textile, photograph, or steel sculpture—variation in any of these facets is not allowed to produce variation in the summary judgment offered, or else the reliability of the assessment is called into question. And yet there's a great deal of subjectivity in determining whether a robotics portfolio and a cooking portfolio show evidence of similar constructs. Given that there isn't a great deal of consistency in maker products, variation will be an ongoing challenge in assessment reliability.

However, there are good theoretical reasons to not hold too tightly to the aforementioned definitions of reliability, because they require generalized constructs like "creativity" and "effort" to be independent of the specific contexts and forms of work. This is a claim that those who ascribe to a situative or sociocultural view of learning (i.e., that performance can't be separated from context) would see as untrue. However, in viewing an open portfolio through a sociocultural lens, variation in a portfolio is fundamental to the way we understand the student who designed it. In this case, reliability that looks for consistency in spite of variation is somehow missing the point. But then again, without a unitary, consistent construct like "creativity" or "ability to design a website," it's not clear what reliability means in this case.

Moving ahead, it may be up to the field to determine the theoretical construct that best suits its needs: working toward a more school-like direction in terms of pushing for uniformity across projects and presentation or embracing assessments that may not have inherent reliability. Given that making is about wide diversity in the materials used, the final product, and the goals and aims, the traditional emphasis on reliability will be challenging to open portfolios (or vice versa, portfolios challenge traditional notions of reliability).

VALIDITY IN OPEN PORTFOLIOS

Assessments bring forth judgments regarding the knowledge, skills, or abilities (including constructs like "effort") of a learner. Those judgments may include trying to predict how that student will perform in a new school or job. In academic settings, validity of an assessment refers to whether the assessment provides evidence that supports the claims one is seeking to make. Open portfolios can be created to be viewed, talked about, and evaluated outside the context in which they were created.

However, portfolios that are submitted to the same job application or college admissions office may have been developed in different educational environments, following different portfolio processes, and for different purposes. Although these portfolios could be used as learning and community-building tools in the spaces where they were created, the portfolio platform must allow makers to curate or repurpose their portfolios in order to adhere to the specified guidelines and scoring criteria of each opportunity to which they're applying. This highlights the need to ensure that portfolio tools support equitable access to capturing and curating processes and projects of making.

More complicated is the matter of group versus individually-oriented projects, as collaboration is a central community value of many maker-centered learning environments. If one educator asks youth to create an individual e-textiles project while another educator suggests that youth work on the same project in teams, both activities will involve collaboration to some extent (e.g., by virtue of youth working alongside peers), but the portfolio pieces of the team-framed activity are more likely to reflect group engagement. (We further discuss this in a later research brief that highlights collaborative portfolios.) This possibility highlights the need to present the contexts of the learning space where projects are being created more clearly in open portfolios that are submitted for external review, including timescales of making, resources available, community projects that the portfolio owner has had at least peripheral access to, how consistent the portfolio systems and practice forms are, and how well they represent unique experiences. Open portfolios question the kind of claims about individuals that portfolios may support. Over time, portfolios may present evidence of the larger trends of a program, and individual or small group portfolios could show youth in relation to that.

BIAS IN OPEN PORTFOLIOS

Another aspect that is critical for open portfolios is potential assessment bias—offending or unfairly penalizing learners based on gender or religious, cultural, and/or ethnic background—which may result in ill-informed educational decisions and the reinforcement and perpetuation of stereotypes that limit student learning. There are several potential factors that could lead to a range of biases, including the fact that makers often picture themselves alongside their work in the documentation (unlike traditional visual arts portfolios) and reveal information about their age, gender, and race in the process.

In addition, other biases may be introduced due to the wide range of genres of making and the cultural and historical affiliations therein. For example, how might we equitably compare projects and portfolios if they range from cooking to robotics to hydroponics? Future studies should evaluate these biases specific to open portfolios. Failing to do so could unfairly penalize youth and result in making ill-informed educational decisions that perpetuate stereotypes and limit youth learning.

Additionally, given that making includes production-centered engagement that is both digital and physical, an additional bias in common assessment procedures (e.g., per-item and panel judgment) could be introduced given that youth have unequal access to space and materials. Inevitably, youth that have access to a wealth of resources, whether cutting-edge equipment or adults with time and expertise, may outperform peers with more limited access to human, social, and material capital. This could result in unfair penalization of those whose access to and comfort with opportunities to make are different.

To help eliminate this bias, visualizing the available material and overall access alongside portfolio entries could help make the context of a makerspace in relation to the process of making more transparent. Furthermore, visualizing the available resources in a makerspace lends additional information about the youth, such as whether they were able to produce ingenious work despite a lack of access to human, social, and material capital (or alternatively, evidence that a youth didn't make the most of all the tools they had access to in a more well-equipped makerspace). Future studies may wish to look at ways to potentially mitigate these biases by questioning the availability of materials at the time of the submission process.

Additionally, in youth-serving makerspaces where a significant number of youth are reported to have special needs (Peppler et al., 2014), assessment accommodations could help educators design alternative ways of creating portfolio entries for and with youth (e.g., recording a video instead of writing a response). There are a number of tasks in assembling a portfolio that may pose challenges to youth with sensory, cognitive, emotional, or intellectual disabilities. However, provided that inclusion guidelines are met by the teacher prior to and throughout the assignment of the tasks, most students have the capacity to produce a portfolio. This will likely require that formal and/or informal educators in maker-centered learning environments consult regularly with special education teachers and become familiar with youths' Individualized Education Programs (IEPs) so that the different abilities of each youth are known, appropriate goals are strived for, and the proper accommodations are applied.

Success for both the maker educator and the youth relies on creativity, an expectation of excellence based on individual ability, and the application of the three guiding principles of Universal Design for Learning (UDL; Rose, 2000):

1. Represent information in multiple formats and media.
2. Provide multiple pathways for youth's actions and expressions.
3. Provide multiple ways to engage youth's interests and motivation.

Some suggestions for how open portfolios may be adapted for youth with varied abilities are briefly outlined here but are not meant to be inclusive of all possibilities:

- Offer non-visual alternatives to visual information, evidence, and editing. For example, instead of producing a video, a youth could produce a podcast on a recording artist, singer, or musician.
- Provide youth with assistive technology/alternative means of input for using the computer and editing software (e.g., Switch Access, a feature used by people with limited mobility to allow interaction with the touch screen).
- Scaffold youths' organization of the assets they're gathering and creating (e.g., help the youth set up and label folders on the computers).
- Provide additional time to work on a project.
- Amidst portfolio production, use cues to mark the pace of working, the length of the session, and the availability of breaks.
- Allow youth the option of working in pairs or groups.
- Check in with youth frequently and inquire about their proposed next steps.

Policies of Portfolio Assessment in Maker Education

differences between school learning and learning in maker education settings and how these differences subsequently impact portfolio assessment practices and principles, it's vital to rethink assessment policies as well. Here we discuss (1) the potential increased focus on formative assessment, (2) the ways in which we traditionally interpret assessments, (3) a shift in test preparation practices, (4) a shift toward unanticipated outcomes, (5) community-based effort, and (6) a shift toward prioritizing non-cognitive factors.

An increased focus on *formative assessment*—a process for gathering information to adjust teaching and learning while an activity is in progress—could be productive (Popham, 2008). In maker learning environments, formative assessment may be especially functional by using "building blocks" (i.e., a reasonable sequence of the most important aspects that a youth needs to know to have mastered a curricular aim, such as cognitive and intrapersonal outcomes as specified by the National Research Council) as interconnected elements rather than sequentially phased discrete pieces. Similar to traditional portfolio assessment, the formative assessments that work best in makerspaces would allow for project goals and techniques to change midstream—as they often do in the creative process—while other indicators of progress are still being measured, such as increasing complexity of the work, craftsmanship, and the overall aesthetic success of the work.

Second, open portfolios shift how we think about *interpreting assessments*. Open portfolios would need to move away from the traditional standardized test measures used in schools, which use either percentiles (a learner's score in relation to a norm group), scale scores (different items calculated into one score), and/or grade equivalent scores (decimals that indicate a learner's achievement in relation to grade levels and month). While maker education pathway programs could be used as a qualitative classification, particularly in relation to years spent at a space (if space is the appropriate construct) as well as community impact demonstrated through portfolios, there's currently no way to accurately define the community impact of makers, especially since doing so may inadvertently reinforce binary divisions (e.g., people whose work has frequently been shared on social media versus people whose work hasn't been shared), and thus, potential divisions between people who only recently joined a maker community are less interested in sharing their work, or are less connected than others. This would stand in opposition to the community-oriented approaches in the maker and learning communities.

Open portfolios could further shift *test preparation*. Ethics and defensibility of test preparation practices depend on the context in which they're applied. Thinking through such practices and how they apply to maker education settings could create a nuanced differentiation, highlighting different perceptions of copying: although it's ethical and defensible for youth to share and copy within maker learning environments, this isn't directly true in traditional school classrooms. For example, sharing a successful portfolio created by a youth or adult maker to inspire and communicate the value of portfolios is ethical in maker-centered learning because the youth who are tasked with creating portfolios could build on ideas presented in the previous portfolio and interpret their own projects in relation to them. Even youth

attempting to imitate the examples could have valuable learning experiences, especially in those cases where "copying" practices may lead to new approaches (e.g., a new kind of production; Wohlwend et al., 2016). Casting out "copying" from the list of valued practices could unintentionally limit the learning that unfolds.

In academic assessment, *unanticipated outcomes* are characterized as adverse to the intended instruction, and hence, that which is evaluated hinges on what was anticipated from the start. This is problematic for open portfolios, where youth are able to carve out trajectories for themselves, resulting in unexpected learning that could potentially exceed educator expectations. Instead, we need to find ways for assessment and instruction that encourage these unintended outcomes, highlight youth agency and work, and evaluate programs. One way would be to value things like serendipitous discovery, numbers of iterations, and shifts over time. With programs largely based on interaction with tangible manipulatives (physical objects used as teaching and learning tools), the way in which these materials call for engagement seems to be an important aspect to consider. Rather than emphasizing the role of the teacher as traditional bearer of knowledge (as opposed to the role teachers often play in maker-centered learning environments, which is more centered on facilitating, coaching, and motivating) and youth achievements as something that is contingent to the quality of youth performance, it seems useful to theorize open portfolio assessment through a perspective that considers the physical environment alongside the ways that encounters within this environment bring about particular knowledge and agency.

Another important aspect of making is that it's concerned with *community-based efforts*. Much of making is based on social skills because making happens within communities and projects contribute back to the growth of these communities (Peppler, Halverson & Kafai, 2016). So, although effort and judgment-based estimates (e.g., social and study skills) shouldn't be graded because educators can't get an accurate fix on them (Wormly, 2011), what youth would be capable of doing within their maker community seems to be bound to social skills. Goal-attainment grading, a criterion-referenced method of numerically qualifying a youth's achievement of a target social behavior or academic performance (Glaser, 1963) could be an interesting starting point for considering portfolio evidence.

Lastly, *prioritizing non-cognitive factors*—such as social skills, teamwork, help-seeking, and a range of other skills that are particularly relevant to making—has an increased importance. In short, making may be more about mastery or competency instead of the content knowledge acquisition that's traditionally assessed. Closer attention to social skills, for example, could make or break the kinds of community impact youth achieve. Goal-attainment grading could also be a starting point for thinking through possible ways to put into practice such assessment policies.

Next Steps

How do we conduct assessments in maker education settings that will be accepted by adults who conform to the norms of school-based testing practices without doing harm to the unique nature of documentation inherent in maker communities? And to what extent does this necessitate changes in current practice versus current assessment theories and techniques? These questions come at a precarious time for the field, when there are many strong reasons and rationales for turning to assessment in makerspaces in order to provide evidence of high-quality learning. Yet, there's only an emergent amount of research in this area (a gap that this research brief series aims to fill). Portfolios offer one method that might be amenable to makerspaces. However, the key challenge for their use is that portfolio assessment originated within formal education and, as such, requires translation—some of it difficult—from school-based techniques to makerspaces in order to build on prior practices.

All of the aforementioned tensions explored could significantly impact the ways that assessment practices, principles, and policies are relevant for and applied in making. Working through the systematically interconnected establishment of assessment in schools in relation to the fundamentally different values that making introduces, the next stage of our research will explore these emergent tensions, exposing avenues of expansion that could help maker educators think through open portfolio assessment without "schoolifying" making. Considering these tensions from the start when designing assessments for open portfolios may not fully resolve the tensions, but it could help designers to stay on track and be aware of the opportunities open portfolio assessment affords and in which directions it could be pushed in the future.

It's also significant to point out that the maker community is not a singular entity, and it possesses within it different viewpoints around open portfolio practices. Some of these conflicting viewpoints within the maker community present tensions of their own, thus the field should approach the "best practices" of portfolio development with the knowledge that the aims of cultures of making from site to site vary. To better understand how diverse makerspaces with portfolio practices are currently using portfolios as tools for assessment, the central activities of Phase 2 include: (1) extended field site visits to selected spaces that demonstrate longer-term portfolio use, (2) in-person meetings with a national group of experts in portfolio assessment and making, and (3) a survey of youth-serving makerspaces with specific focus on assessment (portfolio and beyond) in makerspaces. Throughout the work of the second phase, we capture and share findings through this research brief series, illustrating how our field sites evolve their portfolio systems and practices over the course of our interactions and highlighting portfolio examples. Moreover, we seek to better understand the motivation behind youth and educator desires to gather and create portfolios. We dive deeper by contrasting the portfolio practices of individually owned projects versus collaborative portfolios, which capture the projects and creations of a community of makers. Furthermore, we share what we learned about documentation stations and novel practices for capturing making, including time-lapse videography and how to effectively review and analyze videos of making, and we highlight existing open portfolio assessment techniques. We showcase the practitioner guide and facilitated educator workshops as well as design cases of graduate students. The series concludes with future visions for open portfolios.

References

Barrett, H. (2010). Balancing the two faces of ePortfolios. *Educação, Formação & Tecnologias*, 3(1), 6-14.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

Bryant, L. H., & Chittum, J. R. (2013). ePortfolio effectiveness: A(n ill-fated) search for empirical support. *International Journal of ePortfolio*, 3(2), 189–198.

Byrne, D. & Davidson, C. (2015). *State of making report.* Makeschools Higher Education Alliance.

Camp, R., Seidel, S., Wolf, D., & Zessoules, R. (1989). *Arts PROPEL: A handbook for imaginative writing*. Pittsburgh, PA: Pittsburgh Public School System.

Chang, S., Keune, A., Peppler, K., & Regalla, L. (2015). *Open Portfolio Project* Research Brief Series. Available at MakerEd.org/opp/publications

Gardner, H. (1989). Zero-based arts education: An introduction to ARTS PROPEL. *Studies in Art Education*, 71-83.

Glaser, R. (1963). Instructional technology and the measurement of learning outcomes: Some questions. *American Psychologist*, 18(8), 519.

McMillan, J. H. (2011). *Classroom assessment: Principles and practice for effective standards-based instruction.* Boston: Pearson

Mills, R. P. (1996). Statewide portfolio assessment: The Vermont experience. In *Performance-based student assessment: Challenges and possibilities* (pp. 192–214). Chicago, IL: University of Chicago Press.

Niguidula, D. (1993). The digital portfolio: A richer picture of student performance. *Studies on exhibitions* (13).

Peppler, K., Halverson, E., & Kafai, Y. B. (Eds.). (2016). *Makeology: Makerspaces as Learning Environments (Vol. 1)*. Routledge.

Peppler, K., Maltese, A., Keune, A., Chang, S., & Regalla, L. (2015). Maker Ed's Open Portfolio Project: Survey of Makerspaces, Part I. *Open Portfolio Project Research Brief Series*, 47-53. Available at MakerEd.org/opp/publications
.
Popham, W. J. (2008). *Classroom assessment: What teachers need to know*. Pearson/Allyn and Bacon.

Rose, D. (2000). Universal design for learning. *Journal of Special Education Technology*, 15(1), 67.

Valencia, S. (1990). Assessment: A portfolio approach to classroom reading assessment: The whys, whats, and hows. *The Reading Teacher*, 43(4), 338-340.

Wohlwend, K., Keune, A., & Peppler, K. (2016). Design playshop. In K. Peppler, E. Halverson, & Y. Kafai (Eds) *Makeology: Makerspaces as Learning Environments*, 1, 83.

Wormly, R. (2011). Effective grading in standards-based schools. *Educational Leadership*, 69 (3), 40-44.

Yancey, K.B. (1996) Dialogue, interplay and discovery: mapping the role and rhetoric of reflection in portfolio assessment, in: R. Calfee & P. Perfumo (Eds) *Writing Portfolios in the Classroom*, pp. 83-102 (Mahwah, NJ, Lawrence Erlbaum).

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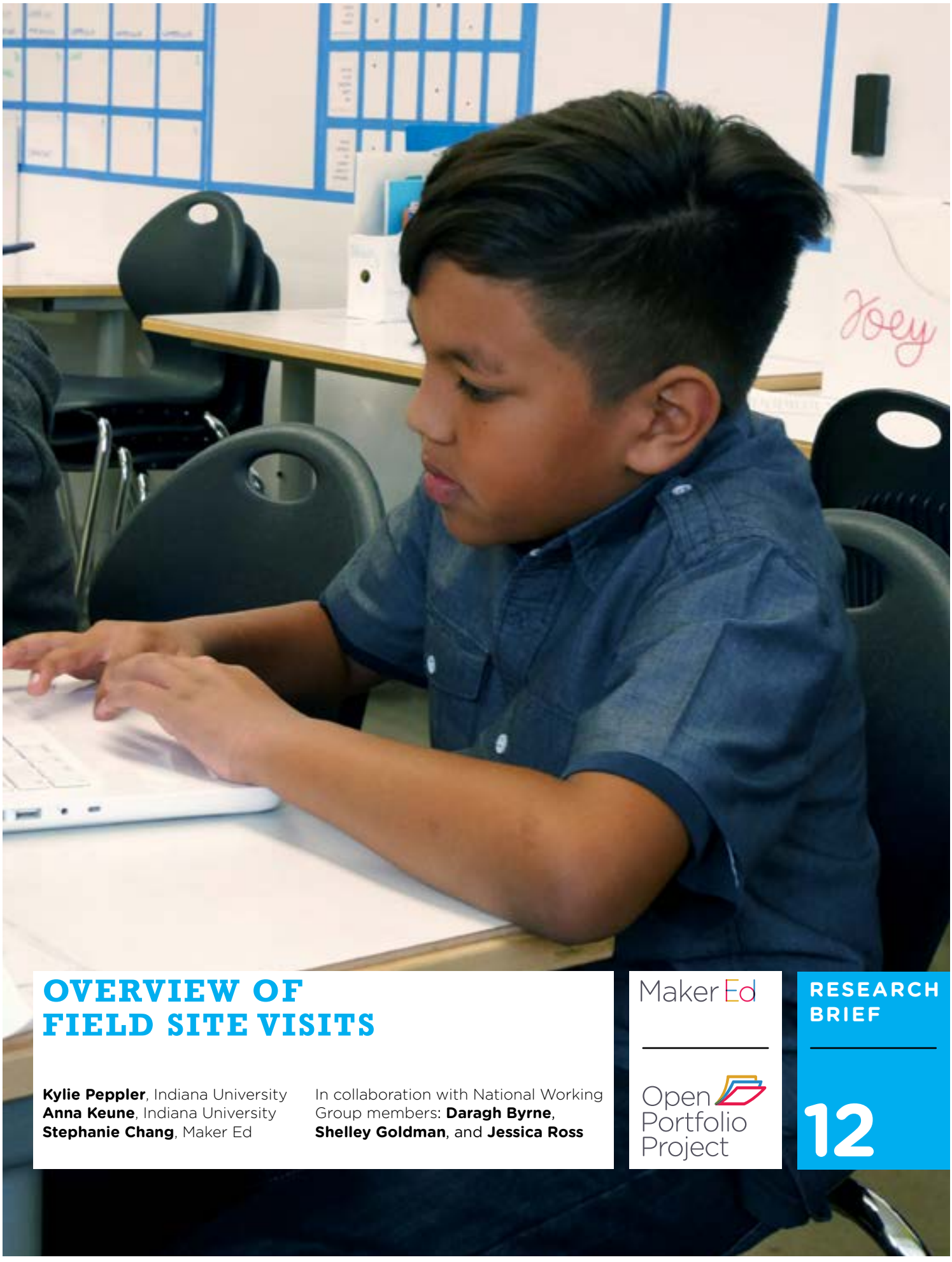

OVERVIEW OF FIELD SITE VISITS

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Maker Ed

Open Portfolio Project

RESEARCH BRIEF

12

Introduction

This research brief introduces the three makerspaces we collaborated with and provides an overview of their portfolio processes.

By makerspaces, we mean maker-centered, youth-oriented settings that focus on educational programming. The specific portfolio systems of our three sites are covered in more detail in a series of short briefs, one dedicated to each, including demographic information and descriptions of how youth capture and share their work (see Research Briefs 12A, 12B, and 12C). This series of briefs exemplifies how a diverse set of maker-centered learning environments is integrating the documentation and sharing of youth work into everyday practice; it also shares the techniques employed to balance key tensions around assessing open portfolios (see Research Brief 11, "Introducing Phase 2 of the Open Portfolio Project: Assessment in Makerspaces").

Where Phase 1 of the Open Portfolio Project (OPP) focused on surveying the landscape identifying maker education settings with portfolio practices, Phase 2 dives deeper into specific portfolio practices and compares implementations of portfolio assessment in and out of school.
The three sites featured in this series are:

1. The Digital Harbor Foundation Tech Center
2. Monticello High School
3. High Tech Elementary Chula Vista

These sites were selected for their lengthy history of portfolio implementation experiences, which complemented our out-of-school observations at school-based sites. (Two of the three overlapped from the Phase 1 OPP work.) An overview of each site is provided below.

Maker Education Settings

The *Digital Harbor Foundation Tech Center* (DHF, Figure 1) is an after-school makerspace in Baltimore, Maryland. DHF offers themed summer camps (e.g., 3D printing or digital filmmaking), open-ended member programs, foundational courses, and entry-level maker introductory courses. Over the years, DHF has been iteratively refining their portfolio practice, including providing all youth with an individual WordPress website where they're encouraged to document projects, processes, and reflections on their maker work with digital and tangible materials. Further, the site aggregates individual portfolios to reflect the most current projects of individual youth participants in one shared space and to encourage viewers to browse and explore what youth are doing at DHF.

As an out-of-school maker setting, Digital Harbor Foundation works carefully to identify youth motivations that support documentation and development of portfolio practices, particularly in an environment where membership is voluntary. DHF fosters a strong sense of community and therefore also balances its desire for youth to capture individual work with the opportunity to share its collective work as an overall community and organization. It offers opportunities for physical project display and public showcases, and it has established a youth steering committee that gives voice to youth experiences and opinions throughout the iterative refinement of its portfolio efforts.

More information about DHF's portfolio system and practices can be found in **Research Brief 12A**.

Figure 1: The Mega Lab of the Digital Harbor Foundation Tech Center, in July 2016.

Monticello High School (MHS, Figure 2) is a public comprehensive high school located in Charlottesville, Virginia, within Albemarle County Public Schools. Making is integrated into many subjects across the MHS curriculum. Since 2012, MHS has promoted a school-wide portfolio system in which all students have their own portfolios and are encouraged to document their classwork, homework assignments, and other projects and works-in-progress. This case highlights how a traditional public high school invites responses to openly shared school work while working through challenges related to administrative changes. Monticello High Schools' efforts began as traditional portfolio assessment within subject-specific learning; in the subsequent years, that integration and development of school portfolio practices have broadened. One example of this is allowing for administrative policies that can be expanded by youth and educators beyond the classroom and school walls to accommodate multiple audiences and timescales.

Further exploration of how the MHS portfolio system can be used to incorporate documentation into school-based maker activities in several different courses is discussed in **Research Brief 12B**.

Figure 2: The Open Studio Space at Monticello High School, in December 2015.

High Tech Elementary Chula Vista (HTeCV, Figure 3), part of the High Tech High Public Charter School network, is located about 15 miles outside of San Diego, California, in close proximity to the border of Mexico. At HTeCV, students participate in project-based learning as a way to engage in disciplinary practices that are similar to those they'll experience as adults. Throughout the school, hands-on projects created by youth are simultaneously curated carefully by adults to showcase student practices.

At High Tech Elementary Chula Vista, digital and physical documentation and sharing of student work sits alongside administrative consideration of challenges around privacy and bias, as well as the scaffolding of complex documentation practices for students. This case highlights a school-driven digital and tangible portfolio practices that balance tensions between the role of learners as individuals who gain knowledge and skills and the roles they occupy within communities in the classroom, the school, and beyond.

An in-depth look at HTeCV's portfolio experience—through the eyes of a teacher with many years of experience documenting student work in portfolios—is provided in **Research Brief 12C**.

We engaged with these three sites across more than a year-long data collection process as part of the second phase of the Open

Figure 3: Hallway with curated student projects at High Tech Elementary Chula Vista, in May 2016.

Field Site Activities

Portfolio Project. Activities included conducting field site visits that included observations, semi-structured interviews with youth and educators, and design workshops; facilitating conference calls with educators and administrators; and sharing asynchronous email communication and site-specific surveys with the three sites. Our collaboration with all three sites can be segmented into four phases: (1) first round of calls and surveys, (2) first set of field site visits, (3) second round of calls and surveys, and (4) second set of field site visits. We describe the purposes of the calls and site visits below, combining the first and second round of calls, surveys, and visits.

Calls and Surveys: Regularly-recurring calls with one or two educators and administrators at the field sites helped us to understand the scale and depth of each site's portfolio practices and to surface any challenges and tensions they experienced or anticipated. The first round of calls served to establish a common ground of ideas between our team and site personnel, and to help us think about how these could be pushed forward during our visits. We used the second round of calls, after the site visits, to check our initial understandings and suggest new or additional ideas. All calls were recorded and summarized. Between calls and before the first field site visits, we asked site personnel to respond to surveys with questions about exceptional portfolios as well as youth and educator demographics.

Field Site Visits: The goal of the field site visits (each spanning 2–3 days) was to better understand the portfolio system and practices of each field site, including challenges and unique characteristics. With the focus on assessment, we were specifically interested in learning how documentation occurred and was used. The field site visits centered around (1) semi-structured interviews with educators and administrators, which asked about documentation practices and explored assumptions about learning and assessment; (2) youth portfolio walkthroughs in which youth showed us their digital portfolios and projects in space and explained how they made their project and what they learned; and (3) observations of youth making, capturing, and sharing projects.

Upcoming Briefs

The interviews, portfolio walkthroughs, and observations informed the three cases that we present in the subsequent research briefs. These cases present the use and implementation of open portfolios in in-school and out-of-school learning environments, as well as showcase how educators productively balance the tensions between open portfolios and traditional assessment. Together, these three cases offer rich descriptions that fall into different ecologies of assessment—drop-in, institutional, and classroom—all sharing techniques and examples from which anyone interested in portfolios can learn and be inspired.

Acknowledgements

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OPEN PORTFOLIOS AT DIGITAL HARBOR FOUNDATION

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Maker Ed

Open Portfolio Project

RESEARCH BRIEF

12A

This is the first of three cases of makerspaces using open portfolios. By makerspaces, we mean maker-centered, youth-oriented settings that focus on educational programming. The cases are deeper dives into the key sites of Open Portfolio Project (OPP) Phase 2 work and how each of the sites develops and maintains their portfolio assessment systems. These briefs also examine how each site balances tensions between assumptions about traditional and open portfolios.

This research brief focuses on the use of portfolios in an out-of-school makerspace and the ways that it showcases high-quality projects online. Further, this case illustrates how an out-of-school space can help promote consistent documentation of youth projects, even within an environment where participation is non-compulsory. Here we highlight the history of this site's portfolio system and practice, the challenges they faced to ensure that capturing and sharing of youth work is an authentic and meaningful activity, and the important role that its youth steering committee played in guiding the space's decisions around portfolio tools and practices.

Site Overview

Located in a former parks and recreation center, the Digital Harbor Foundation (DHF) is an out-of-school makerspace located in the Inner Harbor of Baltimore, Maryland. Opened in fall of 2013, DHF offers hands-on maker programs for youth of all ages. Apart from semester-long entry-level foundational programs (Figure 1) and more advanced and open-ended courses, DHF also offers youth summer camps to explore digital filmmaking or 3D printing. Over the summer, some of the youth are employed at the makerspace, staffing the 3D printer workstation or designing projects.

At the time of this research, DHF's programs engaged 66 youth participants from grades 6 to 11. Of these, 35% were female and 65% were male. Among the youth, 54.5% were Black, 35% were White, 4.5% were Latino(a), 3% were Asian, and 3% were of other racial or ethnic backgrounds. The physical space layout and arrangement of the out-of-school setting is in constant movement, whether this means rearranging mobile tables and tool libraries to meet the needs of diverse workshops and audiences or iteratively designing customizable furniture and workstations to suit emergent youth projects and to provide one-to-one experiences with new fabrication technologies.

Figure 1: Youth working on their digital filmmaking project during a Maker Foundation program at Digital Harbor Foundation.

DHF began facilitating makerspace-wide digital youth portfolios in early 2014, iteratively refining their process and use of tools to accommodate emergent challenges and youth needs. Moving from Evernote, an online journaling tool for creating and sharing notes, to Tackk (no longer functional), an online platform with drag-and-drop, auto-saving, and social media commenting features, DHF most recently moved to a WordPress-based custom portfolio system. This exploration of available tools across three years made it possible for DHF to pilot a range of tools and practices and to build rich experiences for youth. To capture and draw on these youth experiences, the space implemented a youth steering committee that helped align iterations of the portfolio practices to youth interests and needs.

Refining the Out-of-School Portfolio Approach

The WordPress portfolio system includes an individual portfolio page (Figure 2, left) with a separate URL for every young maker at DHF. Because the websites can be viewed publicly, youth are able to use their portfolios beyond the makerspace, sharing their URLs with anyone they choose, including colleges, prospective employers, and high schools (some of which require portfolios for admissions). Further, the portfolio system includes an umbrella page as a launching site to the youth individual pages (Figure 2, right). Here, the posts of every youth portfolio are displayed in a grid-like layout, with up to 12 portfolios per page, in reverse chronological order (the most recently updated portfolios are featured first). To help scaffold portfolio documentation, DHF's portfolio system utilizes an elaborate backend platform that features page templates, tips for effective portfolio reflections, and links to adult portfolios for youth to use as inspiration.

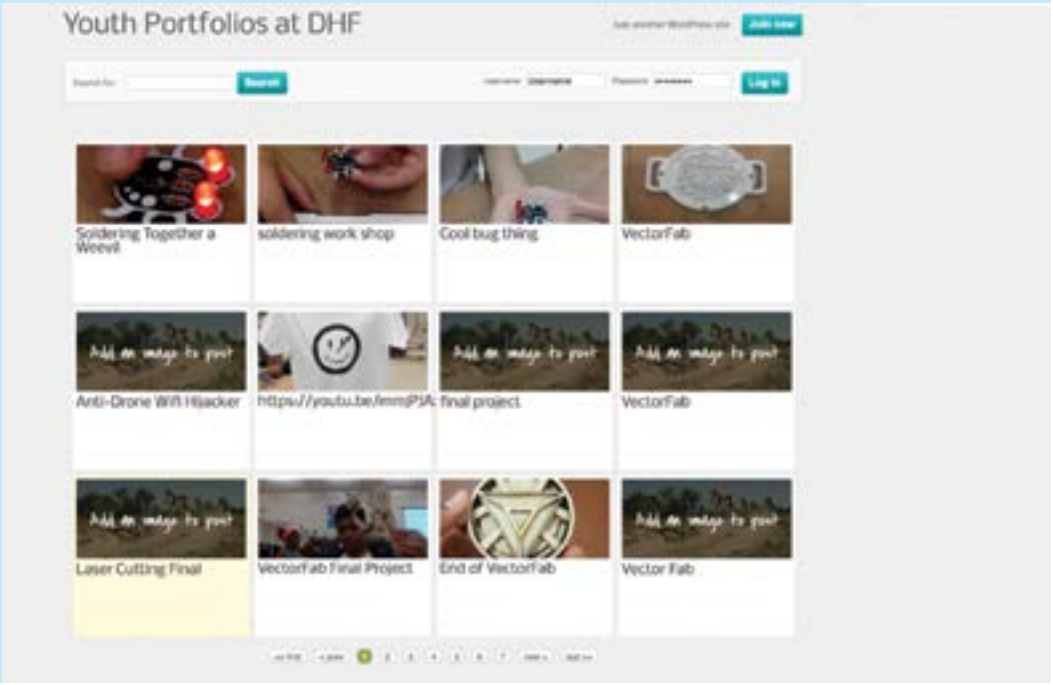

Figure 2: Portfolio of a youth (left) and the youth. digitalharbor.org landing page (right), in September 2016.

A youth steering committee plays an integral part in the iterations of DHF's portfolio design. Consisting of 11 youth who meet once a month, the committee discusses programs and practices at the space with DHF staff. This fosters leadership by making youth part of decision-making processes. At the time of this writing, the youth who were part of the committee were experienced in past and present portfolio iterations and could comment on the usefulness and value of the various practices and tools.

Three Considerations for Successful Portfolio Implementation

In the following paragraphs, we highlight three aspects that makerspace staff and youth highlighted as particularly important for successful portfolio implementation in an out-of-school makerspace: balancing community building with individual portfolio practice, incorporating material design into portfolio practice, and motivating youth to engage in consistent documentation over time.

1. BALANCE INDIVIDUAL DOCUMENTATION WITH COMMUNITY BUILDING.

Where traditional portfolios are focused on presenting the knowledge and skills of individuals, within out-of-school learning environments, it's important to foster a community where participants are aware of each other's projects and can draw on a shared pool of skills and interests. The creation of the shared WordPress website, one that highlights work done by all in the space, as well as providing opportunities to customize one's own areas of the site, is one of the first attempts to balance these needs.

To de-emphasize competition about whose work is pictured on the landing page and how often, the main page of the WordPress site features thumbnails of projects and titles but leaves off the names of the youth and the dates of the posts. The thumbnails together show a snapshot of the organizational growth of the makerspace and invite visitors and participants to click through entries and be inspired by the youth projects. Youth in the space are also encouraged by staff to comment and provide feedback on other members' posts.

Combined with individual portfolios, this method represents one way of starting to address tensions of portfolios that focus only on individuals and instead allows the space to situate the individual's role within the wider DHF community. Youth mentioned that the compilation allowed them to get new project ideas: "[It's] pretty nice because you can look through and see what other people have done and get a lot of inspiration." This indicated to the educators that the combined representation of youth portfolios was a practice that should be continued.

2. INCORPORATE MATERIAL AND SPATIAL DESIGN INTO PORTFOLIO PRACTICES.

Capturing maker projects can take time and attention away from the process and flow of making itself, exemplifying the real challenge of capturing work-in-progress. To help facilitate consistent documentation during work, DHF integrates digital with spatial presentation of youth projects to make capturing processes and projects meaningful and fluid. This includes three aspects: (1) integrating documentation through choice of tools and visual documentation, (2) connecting portfolios with showcase preparation, and (3) displaying youth projects in the space for visitors to photograph and share.

First, while working on their portfolio entries, youth use nearby laptops or tablet computers (owned by DHF) to take pictures, grab screenshots, and write posts. We also observed youth using their own phones to capture videos and images for subsequent uploading. Based on youth suggestions, DHF also started integrating documentation stations into their spatial design by asking youth participants to build these stations. In a subsequent brief, we'll discuss documentation stations.

Second, participation at DHF includes presenting work at showcases that are often open to the public, including potential funders. Before a presentation, a showcase, or other public speaking event, youth revisit their portfolios. Their portfolios spark memories, recalling details to bring up during showcases. Sandra, age 16, recalled: "They prepare you with the portfolio. They are going through with you about what the problems are, already knowing them and having the answer in your brain, the steps, and things like that.... Now I'm just so used to presenting that I can normally just think of [things] on the spot." Remembering details about a project can be challenging, especially when working on several projects at once.

Third, in addition to portfolios, DHF provides youth with opportunities and physical space to share their work, inside and beyond the walls of the makerspace, thus supporting youth in the design of personally meaningful projects over a longer duration. Displaying projects inside the makerspace in predominant locations allowed visitors to photograph and share on social media, accompanied by hashtags that link back to the makerspace (e.g., sharing photographs of events with projects in background, creating collages of snapshots that show projects and spaces, sharing selfies with the projects in the background).

At DHF, public-facing opportunities for sharing youth work include personal portfolios, local news media venues, and even nationwide panels. Some of these opportunities reach social media channels, and the information take on a mobility beyond the individual simply capturing and sharing his or her work. Combined, the diversity of possible documentation avenues through available tools, integrating documentation with presentations and public showcase events, and displaying projects in the space decentered portfolio creation from being a discrete practice that is performed at particular and predetermined moments by the project designer alone to instead integrated documentation as something that has new immediate use (e.g., for a showcase).

3. IDENTIFY YOUTH MOTIVATIONS FOR CAPTURING AND SHARING IN AN OUT-OF-SCHOOL SETTING.

Part of the inherent aspects of portfolios is that the value of capturing work in progress can often only be seen much later (e.g., when a portfolio is needed for a job or college application). To anticipate this, DHF staff originally asked youth to document and reflect after every session, introducing an administratively driven process that foregrounded consistency across individuals in terms of the amount of posts and content in relation to course progress. Staff intended to give feedback to each youth member but quickly realized that individualized feedback was too time consuming to be feasible.

In evolving their practices, the staff has created a spreadsheet that graphs upcoming blog posts and allows them to track entries from every youth. Staff then connect with individual youth when they notice that someone is falling far behind on documenting their work in progress. "Catch-Up Friday," a time set aside for pulling together fragments of documentation (e.g., screenshots, photographs, etc.) into a process narrative, helps communicate to members that documentation practices are of community value for the space. At the time of this writing, 66 youth have a mean of 10.35 posts (median 11), and there's a large variation in the number of posts per youth (minimum of 0 and maximum of 33 posts).

Further, DHF recognizes the need for administrators to seek and voice youth goals and purposes for creating and facilitating portfolio creation throughout the process of implementation. Without clearly articulated purposes and motivation, a makerspace cannot effectively communicate the value of a portfolio process to its members. To assist in this process, DHF regularly seeks the input of its youth steering committee by discussing challenges around consistently capturing work.

Some of the youth have suggested that it's motivating to receive comments as well as track statistics about how their posts perform (e.g., number of views, number of likes, and who has viewed the page). DHF has implemented some of these practices, suggesting that visitors to the makerspace peruse the online portfolios. This has led to the educators observing a piqued youth interest around portfolios, leading to a spike in the sharing of posts. DHF is currently evaluating ways to further integrate statistics data without compromising youth online safety.

To encourage more polished portfolio posts, DHF now encourages its members to collect pieces of documentation (i.e., videos, sketches, images) throughout the week and then draft a longer project post at the end of the week. Despite their experience working with portfolios and refining their process over the years, DHF considers their approach as a practice on training wheels, steadily progressing through ongoing iteration. Moving forward, plans include taking a deeper dive into the motivations of youth to capture their processes of making and learning, including how to balance long-term values and the goals of portfolios (e.g., reflecting on their personal maker practice or supplementing a college, job, or high school application) with short-term values for capturing and sharing work-in-progress (e.g., acknowledging each other's work through comments and customization).

Summary

Digital Harbor Foundation's portfolio system and practice demonstrate iterative and persistent integration of portfolios within an out-of-school makerspace. In developing the implementation of a portfolio system and practice that captures high-quality maker projects by individual youth participants, as well as their role within the developing makerspace community, DHF encountered challenges that led the staff to continue refining and improving portfolio practices to better align with youth interests and needs. These challenges ranged from identifying a portfolio tool and balancing levels of customization to grappling with how to scaffold open portfolio creation as an integrated practice for its community of members. Giving youth an official and active voice in the decision-making process is helping DHF identify portfolio practices that its youth find authentic and meaningful in the long-term.

Acknowledgements

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OPEN PORTFOLIOS AT MONTICELLO HIGH SCHOOL

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Maker Ed

Open Portfolio Project

RESEARCH BRIEF

12B

This is the second of three cases of makerspaces using open portfolios. By makerspaces, we mean maker-centered, youth-oriented settings that focus on educational programming. The cases are deeper dives into the key sites of Open Portfolio Project (OPP) Phase 2 work and how each of the sites develops and maintains their portfolio assessment systems. These briefs also examine how each site balances tensions between assumptions about traditional and open portfolios.

This research brief tells the story of the expansion and evolution of portfolio implementation within a public high school, which infuses maker-centered learning into more and more of its curricula. Portfolio practices must remain meaningful to teachers and students alike, and be leveraged for thoughtful utilization – even throughout administrative changes — while pushing on traditional assumptions where portfolios are focused on writing, curated for one predetermined audience, created within a particular learning space, and representative of the knowledge and skills of individuals only.

Site Overview

Part of the Albemarle County Public School system, Monticello High School (MHS, Figure 1) is named after Thomas Jefferson's plantation home, located close by, in Charlottesville, Virginia. Founded in 1998, MHS is one of three comprehensive public schools in the county that, in addition to core subjects and classes, offers students (grades 9–12) career and technical education (CTE) programs. These programs combine core curricular subjects and hands-on activities related to occupational skills, including television production and digital fabrication. The student body includes a predominant majority of White students (64.4%), 13.0% Latino(a) students, and 12.9% Black students. Of the overall student body, 32.4% are in the reduced meal program.

Figure 1: The entrance of Monticello High School in Charlottesville, VA.

MHS seeks to prepare students for entering professional and academic contexts outside the school with the necessary skills for effective and productive citizenship. As part of this mission, Monticello has facilitated and sustained school-wide portfolios for two years. Teachers from biology to English language arts regularly ask students to work on hands-on creative projects that are then documented in visually rich ways across multiple disciplines. As a traditional public school, Monticello discovered that weaving portfolios into their everyday practices is a challenge, especially as the school encounters obstacles related to administrative change, teacher buy-in, and technological implementation.

Expanding Administration-Driven Portfolios

At MHS, a school-wide portfolio process is housed on Google Sites, which provides every student with a unique URL to an online space that organizes school years and classes into folders. This way, students can store their assignments and projects by subject area throughout the duration of their high school experience. Students use Google documents to store their work, and teachers build portfolio assessment practices based on these tools, including how and at what frequency students should capture their work. In this setup, the portfolio system presents a guiding frame (i.e., organization by subjects) and provides freedom to create a broader range of subject-specific practices.

This system resulted from an administrative and technological revamp from the previous system that Monticello High School had implemented. Though much improved, the act of overhauling the former portfolio system, which was also based on Google Sites but worked with a less centralized identification system, created some confusion among students: some simply forgot to switch their data and logins to the new system, consequently leaving their work stuck in the previous one, and some found themselves concerned about the stability of any technological system, bringing into question the value of their time spent on documenting work and work-in-progress.

Furthermore, with a new administration, it was not yet certain which practices the school would continue to focus on at a school-wide level. To ensure that portfolios overall would continue at MHS, administrators encouraged teachers to develop their own portfolio assessment practices within the technological setup based on Google Sites and Google Docs. As practices evolved, teachers branched out beyond these platforms too.

Below are examples of how the core portfolio system put in place by administrators was effectively augmented by teachers and students, resulting in expanded thinking and shifts in existing assumptions about traditional portfolios.

Expanded Portfolio Practices Driven by Teachers

A key benefit of this organizational change was that it brought about opportunities for exploration by teachers and site-level staff. Comparing practices across subjects shows that teachers employ different portfolio practices within the Google Sites system, whether teacher or class-specific, department-specific, or grade-specific. Opportunities for increased collaboration between teachers also transpired.

One example is a capstone project, which includes interdisciplinary collaboration among teachers while students work to address a self-selected local community challenge (e.g., advocating for nursery school access for working parents by writing letters and making presentations to local government representatives). During the project, students create shared folders within Google Drive to house individual presentations, reports, and illustrations that can be shared with specific people outside of the school. Students are also able to embed all of the files relevant to their project in one personal portfolio.

Another example of a unique practice is part of an English skills class in which a teacher has designed a portfolio process that resembles the building of an interactive resume. Students are asked to select a profession for which to create a portfolio, while making use of different genres and mixed media. During class, the teacher shares a checklist to help guide portfolio development. Each portfolio must include a student-created audio-visual piece related to the profession, a cover letter, and relevant work samples.

Both examples push on assumptions of traditional portfolios. First, portfolios can reach more than one predetermined audience; that assumption is stretched when individual files or projects, as part of a larger student portfolio, are shared with targeted viewers outside of the school, as the portfolio and project simultaneously serve the intended teacher(s). The second example integrates a range of mixed media files into the digital portfolio, pushing on the idea that portfolios are predominantly focused on writing (e.g., the format of the resume shifts from a written list of skills to a place that audio-visually exemplifies concrete experiences or expertise). Combined, the range of portfolio practices widens and challenges the notion that one practice can fit all subjects, classrooms, and projects. The diversity of practices also opens up questions about curating connections across multiple formats.

Sharing Projects Publicly for Private Curation

Although the administrative setup suggests that youth sort, save, and display their work within subject-related folder structures, the underlying data structure introduces interdisciplinary connections and collaborative communities beyond the school walls. Students can share projects publicly and curate them into private portfolios for varying audiences.

Despite using a standard file structure, students have the ability to interconnect subjects and capture work across subject areas by arranging project files into fluid categories in Google Drive. Furthermore, students save videos on external and public storage sites from which they can easily embed their media files into their portfolios. For example, students can share collaboratively created music videos on one student's personal account, credit other collaborators with links to their respective profiles, and from there, embed the videos into their personal portfolio pages. On external pages, the artifacts can receive comments, likes, shares, and be consumed by a large number of people. Some MHS teachers encourage sharing on these external pages, then further disseminate the successes of their students via social media. As people leave comments on youth project pages, social spaces are automatically created where the outside community actively engages (an aspect to be discussed in more detail in subsequent research briefs).

While these practices fall outside the administration-structured portfolio system (i.e., Google Sites and Docs), they are ones developed, within the system, that seem to motivate youth (and their teachers) to continue to capture and share their work throughout their attendance at Monticello High School. In this case, these emergent practices push on traditional portfolio practices that fit within discrete subjects inside the walls of a school, and they expand upon the fact that portfolios can represent the knowledge and skills of not only individuals but also groups and other collaborations.

Capturing Making in Hallways

Traditional portfolios are often connected to or framed within particular learning spaces, but MHS recognizes the increased amount of flexible space needed for making and documenting the process of creating personally and academically meaningful projects. Often, group projects require more space than a single classroom can provide, so teachers utilize the alcove and hallway space between classrooms for making and capturing.

In an English literature course, small groups of students took advantage of the center spaces in an alcove as they made and captured the process of creating Rube Goldberg machines to represent the "Hero's Journey" story archetype (Figure 2). Early on, one small group decided to document their work by creating a video with a smartphone camera, presenting the working of their Rube Goldberg machine in one continuous shot. Throughout the activity, the students traded the camera and materials back and forth. Documentation and making were deeply intertwined as students negotiated how their portfolio piece would present the production or the final run-through of the machine. The overall shorter-term activity, facilitated between classrooms in the school's alcove, drew the attention of other students, who stopped to observe the action.

Figure 2: A small group of students is making a Rube Goldberg machine and documenting the process

Where larger projects requiring materials and space were integrated into traditional subjects, the documentation of the process required even more room to maneuver, as students had to step far enough away from their project to fully frame it within the photograph or video. Outside of the classroom, the practices were out in the open for teachers and students to see as they passed by. They invited observations and showcased a concrete example of how documentation and portfolios are integrated into school learning, especially important for inspiring uncertain students or teachers.

Discussion

The school-wide portfolio initiative at Monticello High School, withstanding the uncertainties connected to any leadership and portfolio system changes, introduces an opportunity for teachers to design portfolio practices that uniquely combine creative practices with academic content. As students travel across courses and are engaged in creative projects in more than one course, they create an open repository of work that presents practices and a collection of work that are useful across subject areas, even storing their work across different online platforms.

As such, portfolios continue to endure and remain meaningful across the school. They have become adaptable to subject- and teacher-specific practices, as well as practices that make use of tools outside the official technological system. Extending work beyond classroom walls – into actual physical space outside of the classroom – also allows for more community engagement, exemplifying concrete portfolio practices and the integration of documentation and maker-centered learning to other students and teachers.

Together, the diverse yet scaffolded practices at Monticello push on assumptions of traditional portfolios and highlight portfolios as mixed-media practices that can be curated in different ways for multiple audiences and that can function as lenses into the role of students in and out of the classroom. The MHS portfolio system and practices call us to further consider (1) how teachers can view work across subjects and classrooms if work is stored in different places that are predominantly digital, and (2) how to scaffold the portfolio process for students to identify overarching connections of learned practices. Through these new practices, Monticello is stretching the definition of what an open portfolio might mean.

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OPEN PORTFOLIOS AT HIGH TECH ELEMENTARY CHULA VISTA

Kylie Peppler, Indiana University
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Open Portfolio Project

RESEARCH BRIEF

12C

This is the third of three cases of makerspaces using open portfolios. By makerspaces, we mean maker-centered, youth-oriented settings that focus on educational programming. The cases are deeper dives into the key sites of Open Portfolio Project (OPP) Phase 2 work and how each of the sites develops and maintains their portfolio assessment systems. These briefs also examine how each site balances tensions between assumptions of traditional and open portfolios.

This research brief focuses on the digital portfolio practices of an elementary school classroom, where tangible student work, regularly and beautifully displayed within the school building, translates to individual student portfolios online, accessed via QR codes. This case also looks closely at student privacy and the complex feedback and sharing practices that are scaffolded for elementary school students.

Discussion

High Tech Elementary Chula Vista (HTeCV) is one of 13 schools within the High Tech High charter school network and is located in the Chula Vista community outside of San Diego, California, near the U.S.-Mexico border. Surrounded by desert landscapes, the school serves socioeconomically and ethnically diverse students, especially Latino(a)s, across Chula Vista, in spite of limited bus transportation. Families provide transportation, and students commute up to 30 minutes each way.

Throughout the school in hallways and open areas, student work is beautifully displayed in in collections of picture frames and behind glass cases, mimicking elegant museum exhibits. In these exhibits, individual projects are clustered together to form larger art installations (Figure 1). In one area, woven tapestries made by individual students are combined together and attached to the wall to form a flowing art piece that wraps around a corner. The walls and ceilings are preset to enable for such display, including metal hooks and shelving. The exhibition practices are guided by Jeff Robin's approach, which focuses on teachers as curators of student work to display learning through collaborative pieces.

Figure 1: Tapestry art installation at High Tech Elementary Chula Vista.

Expanding Tangible Project Exhibitions Through Digital Portfolios

In a school that already incentivizes the curation of student work in the physical space, one HTeCV 4th grade teacher is particularly enthusiastic about portfolio creation. His classroom portfolio practice extends the school-wide practice of curating tangible student work on walls of the school building with the documentation and sharing of students' digital work online. On the wall in front of his classroom, three-panel black picture frames display the work of his students (Figure 2). Each student's frame includes his or her drawing of an apple, a sketched self-portrait, a screenshot of their online portfolio pages (with nickname), and a QR code and URL that link to their portfolios. Another copy of each student's page with the screenshots, QR codes, and short URLs is displayed inside the classroom.

When it's time to work on their portfolios, 3rd and 4th grade students who don't remember the exact URLs of their online portfolios walk outside the classroom to use the URL or QR code themselves. Student and classroom work is also displayed inside the classroom. Here, too, individual student projects are grouped and displayed together; still-life drawings of apples are taped to a bookshelf and student self-portraits outline the interactive whiteboard. In addition, professionally printed exhibition posters reference whole-classroom projects, such as redesigning a school lunch program.

Figure 2: Curation of student portfolios outside Taylor's classroom.

This elementary school teacher considers digital portfolios to be consistent with other HTeCV assessment practices, including narrative-based report cards, student-led conferences, and project exhibitions. All of these practices encourage student reflection and self-directed learning, make peer feedback and review possible, and provide opportunities for sharing schoolwork with an outside audience. The interlacing of student work online (i.e., through digital portfolios) and offline (i.e., through displays of student work in the classroom) ties into the goals of HTeCV to underscore projects as more meaningful than grades alone.

Students in his class begins capturing their work in online portfolios at the beginning of each school year. They are instructed to share their work using Google Sites through *Apps for Education* accounts, a structure often used in the middle and high school classrooms. Despite the technological similarities, documentation and sharing is more scaffolded, and the teacher regularly provides instructions on how and when to capture, share, and comment on work-in-progress. One example of this is "sentence starters" (Figure 3) that students can select from when leaving comments for others. Making use of the sentence starters is a form of scripting, described as a way of starting to foster a culture of sharing and critiquing. This method seems particularly appropriate for students who are still developing comfort and familiarity with critique, and peer feedback is scheduled into the school day, typically after students have individually updated their portfolios.

Every time you read digital portfolio reflections, please leave at least one comment for the writers to let them know that they have an audience that cares about their ideas and the quality of their writing. Every comment has five parts.

1. Identify the reflection you are commenting on and praise the content.
2. Offer a connection or ask a question about the same content.
3. Offer critique to help the writer revise the reflection.
4. Offer critique to help the writer edit the reflection.
5. Thank the writer for sharing their work.

You can choose the sentence frames that work best for your comment, or you can write your own!

Identify the reflection you are commenting on and praise the content.

- As I was reading your ___ reflection, I like how you wrote about ___.

Offer a connection or ask a question about the same content (choose one).

- It made me think about ___.
- Have you heard of ___?

Offer critique to help the writer revise the reflection (choose two).

- I really like your topic sentence because ___.
- I really like your conclusion because ___.
- I thought your decision to use transitions and other words, like ___, ___, and ___ made your writing strong.
- I was impressed with how much you wrote about ___.
- Have you considered changing your topic sentence to something more like ___?
- Maybe you could change some of your transitions and other words. For example, you could change ___ to ___ to make the writing stronger.
- Have you considered writing more about ___?

Offer critique to help the writer edit the reflection (choose two).

- I was impressed that you formatted your work correctly by ___.
- I was impressed that you capitalized ___ correctly.
- I was impressed that you used the ___ punctuation correctly.
- I was impressed that you spelled ___ correctly.
- Have you considered double-checking your formatting by ___?
- Have you considered double-checking your capitalization on the word ___?
- Have you considered double-checking your punctuation after the word ___?
- Have you considered double-checking your spelling on the word ___?

Thank the writer for sharing their work (choose one).

- I enjoyed reading your reflection!
- I look forward to reading your next reflection!
- Thank you for sharing your work!

Figure 3: Sentence starters to scaffold reflection and critique for elementary students.

The classroom's portfolio system supports diverse media, such as video and audio recordings of presentations, though the majority of artifacts are generally text-heavy. The teacher also specifies the media format for each activity. Every student's portfolio includes simple biographical information: self-chosen nickname, age, number of siblings, interests, personalities, and sketched self-portraits (Figure 4). The menu bar on the left side of the student portfolio provides links to nine pages that include reflections on classroom practices and field trips, presentations of goals and how they achieved them, as well as larger project-specific pages (see Appendix for details).

Figure 4: The portfolio of HTeCV student Purple Bubbles.

Similar to the other exhibits throughout the school, student work is highlighted and valued through adult facilitation in the digital portfolios. This means that student documentation is closely tied to classroom practice and assignments and requires time and attention. The portfolio process is a high-quality teacher-led practice that has commonalities with traditional portfolios. However, teachers and student grapple with the intersection of tangible documentation and digital documentation of student projects and how to best display final work as well as work-in-progress. In addition, on a digital platform, individual pieces are less obviously tied to a larger collaborative community of student work.

Many of the youth portfolio entries link back to projects that are exhibited in the classroom. For example, students worked together on a shared classroom project on healthy lunches, where they identified ways to provide more nutritious lunch food within the school's budget. Here, physical posters and flyers (Figure 5) serve to engage people at the school-wide showcase. Augmenting the print material, the QR codes on flyers link to project videos or simulations that are posted to students' online portfolios. These portfolio posts add new and different vantage points for the classroom projects, allowing students to add personal voice and highlight specific activities. These perspectives wouldn't be apparent from viewing the final product alone.

Figure 5: Flyers of whole classroom projects with QR codes that link to project videos.

Balancing Student Privacy and Open Sharing

As with all classrooms and learning environments, privacy of students' personal information is a major concern in the design of any portfolio system. In this classroom, the goal of sharing student work is oriented towards only classmates and their parents. Each of the video clips and images that feature faces of the students are password-protected and viewable only with a High Tech school account. In addition, logging into an account is also required in order to leave comments. Students are instructed to use classroom nicknames based on their personal interests (e.g., Purple Bubbles) rather than their real names, to share a drawn self-portrait instead of a photograph, and to omit sensitive information, such as details about their homes (Figure 4; examples of student portfolios will follow in subsequent research briefs).

The teacher checks portfolios regularly to ensure that privacy is protected and asks parents and students for permission before including portfolios in a public-facing repository of current and past student portfolios. The public space is aimed at (a) broadening the audience, (b) promoting the practice in other school contexts, and (c) providing future students with examples to inspire their own portfolio creations from a more informed perspective.

Anonymity within this portfolio system serves less to avoid assessment bias—as the portfolios are assessed by the teacher only, and he knows the real identities behind each pseudonym—and more to protect youth identities outside the classroom. Understanding that the outward sharing of High Tech student work, whether tangibly or digitally, is a real possibility that would reach multiple audiences, privacy was a necessary deliberation in the initial conceptualization of the portfolio process. These best practices for student portfolios were developed by the teacher over the course of four years, in previous classrooms and while at HTeCV.

Discussion

Currently, the HTeCV school administration is aware of the teacher's digital portfolio efforts but haven't yet determined how the system can be more widely implemented across the school. Here, specifically, some of the assumptions and tensions seen elsewhere resonate in this setting as well.

The HTeCV portfolio system and practice is an interesting example of portfolios as a distinct way to bridge the presentation of tangible student work beyond the school through digital tools. The use of QR codes on physical displays (of tangible student work) that direct viewers to youth's digital work is unique. Open questions relate to how this classroom-level approach may scale to work across other classrooms within the elementary school and how it could be further refined to make it easier for youth to access their portfolios while maintaining control over privacy. There are a number of opportunities for the growth and development of portfolios at HTeCV, particularly because the charter school network's culture instills the importance of sharing and displaying student work around the school building.

Acknowledgements

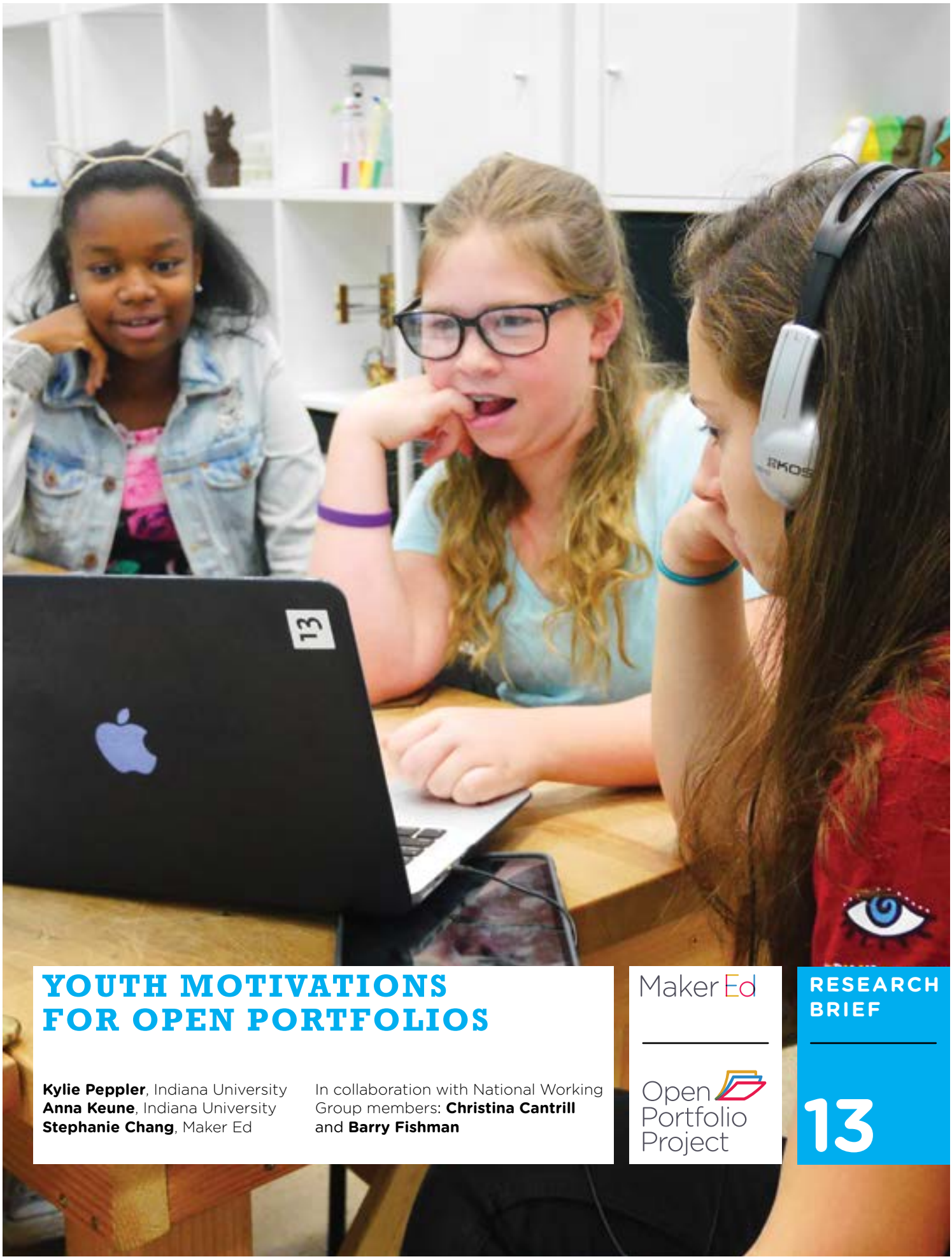
The work of the Open Portfolio Project is made possible by generous support from the Gordon and Betty Moore Foundation. The consistent conversations with and insightful feedback by our actively involved National Working Group members generated a momentum that propelled our arguments forward in ways that would not have been possible without their critical commentary.

In alphabetical order, we thank Leigh Abts, Jon-Paul Ales-Barnicoat, Daragh Byrne, Christina Cantrill, Barry Fishman, Larry Gallagher, Shelley Goldman, Jay Melican, Vera Michalchik, Chris Peterson, and Jessica Ross.

APPENDIX

The digital portfolios in the HTeCV classroom were organized into nine sections:

- Academic Reflections, where students describe their strengths, areas of growth, and interests in school subjects several times throughout the school year.
- Ask-Me-Anything, where students describe their facilitation of class discussion and how they would like to be approached by someone whom they haven't met before, as well as a video of students facilitating a discussion about themselves.
- Fieldwork Reflections, where students post every time they interact with someone outside school through digital drawings and writing.
- Goal Presentations, where students present personal learning goals, report their progress every two weeks, share notes taken during teacher-student conferences, and store video clips of their presentations.
- Math in Three Acts, a math lesson structure that shows short videos to get students engaged by asking for more information and creating drawings as representations of math challenges.
- Monthly Reflections, where students report at the end of month on their reading of choice and reflect on favorite things in school, and share what they learned.
- Oral Reading Fluency, which features audio recordings of students reading a book of their choice and a rubric for self-, teacher-, and peer-assessment of public speaking.
- Presentations of Learning, where students reflect on sharing their work in public showcases at the school.
- Project Reflections, where students reflect on their participation in whole-class projects.



YOUTH MOTIVATIONS FOR OPEN PORTFOLIOS

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Open Portfolio Project

RESEARCH BRIEF

13

Why Do Youth Share Their Work?

Portfolio assessments have typically been used in settings where adults traditionally drive portfolio construction, especially in school-based settings (Niguidula, 1993; Mills, 1996). Consequently, one of the key challenges for applying portfolio use in out-of-school settings has been the extent to which scaffolds are needed for youth to get started with a portfolio and to commit to creating and sustaining a portfolio of work over time.

Furthermore, while some youth in out-of-school settings are building large communities with thousands of followers around their online portfolios (Peppler et al., 2015), we know little about the youth's motivations for creating such portfolios, the extent to which they align with adult motivations for supporting portfolio assessments, or the extent to which we may be able to leverage these motivations in widespread portfolio assessments.

Taking a sociocultural and situative approach to motivation, which focuses on the way an activity is organized to support the engagement and participation within social circles and larger society (Hickey, 2003; Nolen et al., 2015), we examined youths' motivations for capturing and sharing work in maker education sites previously introduced in our Research Brief series. Together, this series of cases exemplifies a range of youth motivations for open portfolios across school and out-of-school settings and how these youth motivations unsettle assumptions of traditional assessment (see Research Brief "Introducing Phase 2 of the Open Portfolio Project: Assessment in Makerspaces"). We refer to open portfolios as publicly shared and youth-owned bodies of work that present the rich engagement of youth while making. By better understanding youth motivations for portfolio creation, our aim is to improve portfolio assessments in- and out-of-schools to make them more appealing to youth *and* to serve adult and youth purposes for portfolio assessment.

Uncovering Youth Motivations

In our field site visits, we asked a number of youth recommended by site educators to share with us how and why they captured their work, looking for noteworthy portfolio practices that were adult scaffolded *and* immediately meaningful to youth. Twenty-nine youth (15 girls and 14 boys) showed us their favorite projects and explained how they made them, what they learned, and how and why they captured their work. Across these cases, we identified recurring youth motivations for documenting and sharing their work, including their desire to (a) participate in and be recognized by communities outside the makerspace, (b) emulate professional production practices, and (c) try roles that could be taken on after leaving the makerspace. Youth who demonstrated these motivations consistently captured their making in exceptional ways well beyond the adult-scaffolded instructions for portfolio creation. Here, we share how these motivations were supported by design practices that can be used to facilitate similar portfolio engagement to a larger number of youth.

MOTIVATION 1: SEEKING RECOGNITION FROM COMMUNITIES OUTSIDE THE MAKERSPACE

Today's youth are acutely aware of how platforms like YouTube, Reddit, and others can be leveraged to research their interests and engage in dialogue with others who share those interests. Since one of the driving factors for this generation of youth is that they're contributing to something larger in society (Cohen & Kahne, 2011; Kahne & Middaugh, 2012), it comes as little surprise that many youth have an interest in infusing their ideas into public discourse, as well as gaining inspiration and recognition for their work. In the following, we present an example of youth motivations for seeking recognition and how this was possible through concrete design features of their portfolio practice. Table 1 provides an overview of youth motivations for seeking recognition and open portfolio design features.

Table 1: Motivations and Design Features to Increase Participation Beyond the Makerspace

YOUTH MOTIVATIONS FOR SEEKING RECOGNITION	OPEN PORTFOLIOS DESIGN FEATURES
Participate in online communities outside the makerspace.	Support and encourage the use of popular platforms that youth already use and are widely adopted.
See others recognize their projects.	Visualize feedback about portfolio engagement in real time (e.g., likes, views, comments).
Contribute to a larger project and a social cause.	Highlight how individual youth projects, or projects in aggregate, speak to larger circulating ideas.
Explore community, disciplinary, and transdisciplinary connections of projects.	Encourage and support the youth-driven use and intersection of several online spaces for sharing.

Recognizing the importance that youth placed on participating in online communities that connected them with people who were engaged with similar things, the out-of-school makerspace, Digital Harbor Foundation (DHF), encouraged and supported youth to share their work on online platforms that are commonly used in connection with certain types of media, such as deviantart.com for visual arts and graphic design.

One DHF participant, a 13-year-old named Rapha, leveraged a number of sites to showcase his work, citing that he was interested in three forms of production—graphic design, 3D printing, and robotics using microcontrollers––and he was better able to mark his progress and receive inspiration and feedback by targeting these audiences separately. In his case, he was in the process of curating portfolios across three sites: a page on Tinkercad for his 3D printing designs, a page on PicsArt, a social networking site for his graphic design, and a page on DHF's adult-scaffolded WordPress page for STEM-related projects he completed at the DHF makerspace. Rapha believed that sharing one's work "helps create and enhance a community." The reciprocal motivation for sharing suggested that he considered sharing a 3D model as a step toward and perpetuation of a larger societal cause, and that he assumed others who engaged in similar piece-by-piece sharing participated toward the same end.

One of Rapha's colleagues, Clara, leveraged existing online communities to advance a broader societal cause: the advancement of girls in STEM disciplines. Clara created a public Facebook page to "help break the gender gap" (see Figure 1, left). She started a separate page rather than share on her personal Facebook profile because she was concerned about oversharing with friends who weren't interested in the topic. Clara created a light-up prom dress that integrated a programmed LilyPad Arduino and an LED strip into the dress design. That dress was featured on popular maker-themed blogs and online sites of a youth fashion magazine as an example of a new wave of reimagining engineering and women's role in technology-related fields.

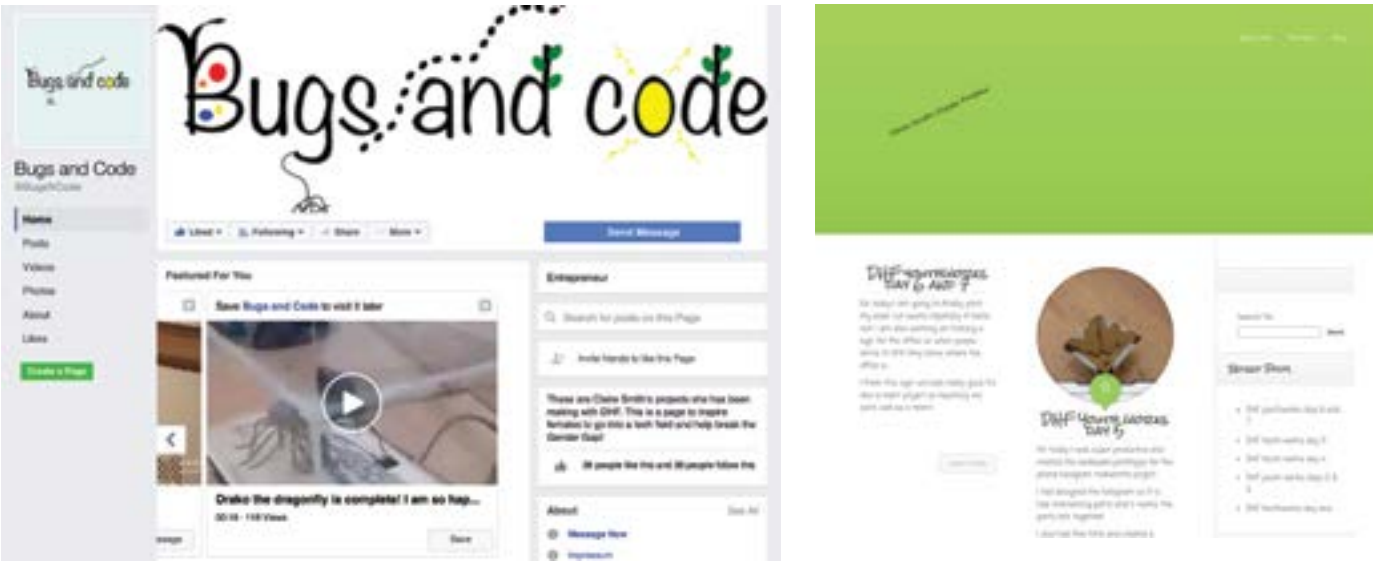

Figure 1: Clara's public-facing social media page (left) and Clara's DHF portfolio (right)

While some of Clara's projects were prompted by DHF activities and programs, she often went above and beyond expectations, using making as a way to showcase her interests and inspire others to do the same. Her Facebook page and features on popular online blogs especially demonstrated the initiative Clara took to spread her work to a broader audience and support a cause she believes in through her making. This kind of public-facing orientation to making showcases Clara's interest in building communities of girls to connect with and inspire.

Whether sharing their projects to support a social cause or targeting sites for specific feedback about a particular form of making, both cases indicate the power that a narrative plays in tying together smaller projects (e.g., a digital image) and, in accumulation, speaking to larger ideas. Highlighting and encouraging this can be motivating and a way to sustain capturing and sharing as a long-term activity. Furthermore, the use of multiple online tools for capturing and sharing projects allows youth to explore boundaries among communities and disciplines and to see how their projects speak to, disrupt, or intersect these boundaries. Design features to support this can be youth-led mixing and matching of online tools while continuing to track what youth share and where.

It's also worth noting that the prospect of engagement from others appeared to be an inherently motivating factor in terms of where and how often these youth shared their work. For instance, aiming to publish one image every day, Rapha uploaded 161 images to his PicsArt graphic design page in five months. At the time of our visit, he had a total of 313 followers, and many of his uploads had garnered thousands of views. Comparatively, on the adult-scaffolded DHF WordPress page, Rapha posted 14 entries within one year and neither received comments nor could easily determine if anyone regularly visited or followed the page.

MOTIVATION 2: EMULATING PROFESSIONAL PRODUCTION PRACTICES

For young or novice makers, scaffolding some of their earliest experiences by modelling professional work can be highly motivational and can push the boundaries of teachers' original conceptions of what a portfolio should include. Carving out a personally meaningful and interest-driven space can help them make decisions regarding how and when they publish their work, while fusing portfolio practices learned in school with youth-driven sharing moves they pick up online. In the following, we highlight a case in which this motivation was particularly salient and we present how youth motivations around this theme were supported through portfolio design features (see Table 2 for a summary).

Table 2: Motivations and Design Features for Emulating Professional Production Practices

YOUTH MOTIVATIONS FOR EMULATING PROFESSIONAL PRODUCTION PRACTICES	OPEN PORTFOLIOS DESIGN FEATURES
Explore portfolio practices in a youth-driven account and imagine new projects and ways of sharing.	Model portfolio practices that can be used across spaces for sharing (e.g., privacy, consistent sharing). Foster capturing and sharing at own pace.
Connect with authentic audiences and see examples to emulate.	Support the use of tools that connect youth to people with similar interests.
Make personal interests meaningful.	Support ways to reflect on personal interests and to integrate reflection on design processes in a final product to meaningfully connect with an audience.
Share personal interests with others as an economic means.	Introduce youth to portfolio features and platforms that could professionalize their making.

A youth portfolio case from High Tech Elementary Chula Vista (HTeCV) highlights a particular way in which a young student shared his work in school and out-of-school settings. A 3rd grade student with interests in photography and video games, Mateo captured his work in the HTeCV portfolio (Figure 2)—including videos of his goal presentations, Google drawings of field site visits, and monthly reflections—by following his classroom teacher's instructions. Mateo also used personal social media accounts to share his passion for video games through recordings of himself playing the games. Across both digital portfolio spaces, Mateo brought together the school practices of capturing learning with home culture, including everyday experiences and video game play. Mateo's capturing was motivated by the possibility of building on his personal interests.

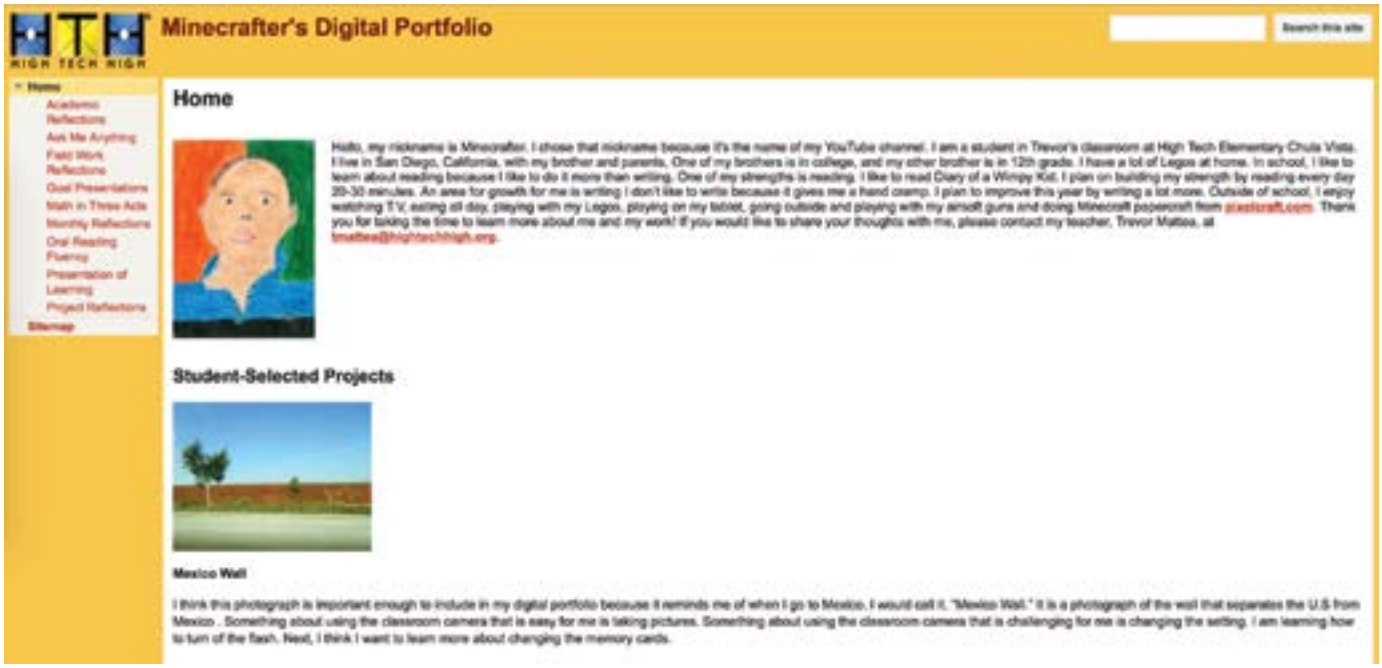

Figure 2: Mateo's High Tech Elementary Chula Vista portfolio homepage.

Beyond the HTeCV portfolio, on YouTube, Mateo shared video recordings of videogame walkthroughs with voiceovers. Since establishing this account, he uploaded seven videos with an average length of six and a half minutes. Mateo's channel had five subscribers and a total of 78 views. Mateo told us that he viewed videogame walkthroughs by others, and in his own videos, he comparatively referenced other channels.

We observed that Mateo internalized and adopted the common practices of active YouTube personalities. For example, he frequently called for viewers to subscribe to his channel. In several videos, Mateo directly addressed the audience using phrases that are common to the genre, such as anticipating comments (e.g., "I know what you guys are going to say in the comments"), greeting and signing off (e.g., "Hope you enjoyed the video. Peace out."), and editing the video to erase irrelevant aspects and to introduce humor (e.g., "So right now, I am going to cut out a bunch of footage as I am making stone so you guys don't have to watch me. I'll be right back - Guys, I am back.").

The recording of the videos is a generative practice, as it inspired Mateo to think up additional recordings he could produce (e.g., a "fails video") and alternative ways of producing them. Another aspect of Mateo's YouTube portfolio is related to sharing videos and gathering views and subscribers in order to make money. He shared with us:

> "Yeah, I put ads on them because that's how—That's like the main reason. That's how you make money. (...) you advertise things and so they pay you. They pay you a few cents when you put them, but they pay you more when people actually click on them."

Through the advertisement feature on YouTube, Mateo was aiming to utilize his personal interests and portfolio to earn money. He was aware of the mechanisms around how raising money through views works. He further told us that he learned how to implement ads on his videos by watching instructional videos. Mateo also explored other ways to gather viewers, including leaving comments on his own videos to start a discussion.

Through experimentation, Mateo also became aware of the policies and practices related to intellectual property rights and their effects on openly sharing his media online. Mateo mentioned that he didn't overlay his walkthroughs with commercial songs to avoid being flagged and removed from the site. The sharing on the site provided Mateo with an opportunity to learn about the complexities of copyright and the potential repercussions that violations would have on his own YouTube account and, by extension, his anticipated income.

In this case, Mateo appeared motivated by exploring portfolio practices in a youth-driven account and imagining new projects and ways of sharing. Furthermore, he was motivated by the possibility to connect with authentic audiences that shared examples of the kind of work he was interested in and could emulate. The way in which he was able to interact with this audience afforded Mateo the ability to integrate reflections on his design process in his final product as he connected with his audience, rather than his reflections being a separate aspect of his work disconnected from an immediate purpose.

Lastly, Mateo was motivated to further develop his portfolio through the possibility of turning the sharing of personal interests into an economic opportunity by supporting the use of features and platforms that could professionalize his making. Across the board, the capturing and sharing of work within school-based and out-of-school-based portfolios supported Mateo in meaningfully integrating his school learning with something he deeply cared about and was personally driven to do.

MOTIVATION 3: PRACTICING ROLES THAT COULD BE TAKEN ON AFTER LEAVING THE MAKERSPACE

Online, where artists with millions of followers share their work alongside aspiring young artists, youth can explore the multiple ways in which their work can be shared and represented. Many youth we spoke to were motivated by how their making is connected to their exploration of the broader media production pipeline, including post-production and cross-platform sharing, particularly those interested in the arts.

When makerspaces encourage youth to explore how artistic interests can be presented in different ways through the possibility of setting up multiple accounts, youth become motivated to explore sharing in the open and sharing semi-privately in connection with a larger collaborative effort, such as a maker collective or a band. Similarly, maintaining accounts associated to groups and individuals is a way for youth to choose how they'd like to engage with an online space and how openly to share their work.

In the following, we present cases of youth using their portfolios to practice what it might be like to be part of a production process and what this might entail for broader practices related to digital citizenship. Table 3 outlines the youth motivations for this and connects them to concrete design features of portfolio practices that can foster them.

Table 3: Motivations and Design Features for Trying New Roles

YOUTH MOTIVATIONS FOR TRYING NEW ROLES	OPEN PORTFOLIOS DESIGN FEATURES
Explore the complexity of the media production pipeline.	Support multiple accounts in professional online spaces.
Experiment with sharing both in the open and semi-privately.	Facilitate and maintain accounts associated with groups and individuals.
Be recognized as a responsible member of society.	Advocate for and amplify youth voices through transmedia productions that contain the makerspace brand.
Highlight the professional skills of all collaborators.	Support a range of modes to augment a project's message (e.g., music video for a song).

Two youth portfolio cases from Monticello High School illustrate how youth took ownership of the portfolio process. Myriam, a 10th-grade student passionate about digital music production, shared her original compositions on SoundCloud and YouTube, a common practice for most of today's recording artists. A challenge in the showcasing of her work was the often-collaborative nature of many of her productions, with her role in its creation—as musician, lyricist, songwriter, or co-writer—shifting from track to track.

Myriam has two SoundCloud accounts, one personal and one shared account for her band, which intersect in interesting ways. For example, Myriam uploaded a song to her personal account that was later reposted by the shared account. While Myriam explained that the song was not created by herself alone, the way in which it was shared on the personal account attributed the composition to her. Without access to her additional explanation, the collaborative nature of the production and how Myriam and others divided responsibilities in the creative process were neither visible on her personal nor her band portfolio.

For Myriam, this wasn't a matter of taking or ceding ownership. Instead, the two accounts provided Myriam with the possibility of exploring and negotiating the nuances and social implications of representing songs as part of her solo-artistic explorations or as part of a shared project. This can open up questions related to copyright, attribution, and possibly the invisible work it takes to be "internet-famous." In Myriam's case, having more than one online account on the same platform for similar kinds of creative projects facilitated the exploration of these cross-cutting conundrums.

One of Myriam's classmates, Connor, also captured his creative projects across multiple online platforms that supported different media types. A senior in high school interested in rapping and producing (under the name Sophist), he sought to increase the exposure of his tracks by posting his compositions to SoundCloud, which was cross-linked to his YouTube page for music videos and accompanying "behind-the-scenes" supplementary material (see Figure 3). Connor further disseminated links to assets on both platforms via his Twitter account.

A driving force within Connor's work was commentary on current events. In one track addressing police brutality, Connor interlaced video footage of national newscasts as well as an excerpt of a speech by President Obama into his rap verses. Framing artistic media production as an empowering way to make his voice heard, Connor took a critical and democratic stance that was purposefully directed toward showing himself as a responsible member of society.

Connor's message was that media production that is openly shared online can make voices heard that were previously not. The audience he sought to reach lay beyond the school; Connor aimed to reach people outside high school who were interested in finding a way to express themselves and their messages. Educators at Monticello supported his efforts by sharing and re-sharing posts by and about Connor's work. Monticello's academic counselor, the athletic director, the school's basketball team, and school district administrators linked to his work, praised his creative production, and shared selfies with Connor while he live-mixed event music.

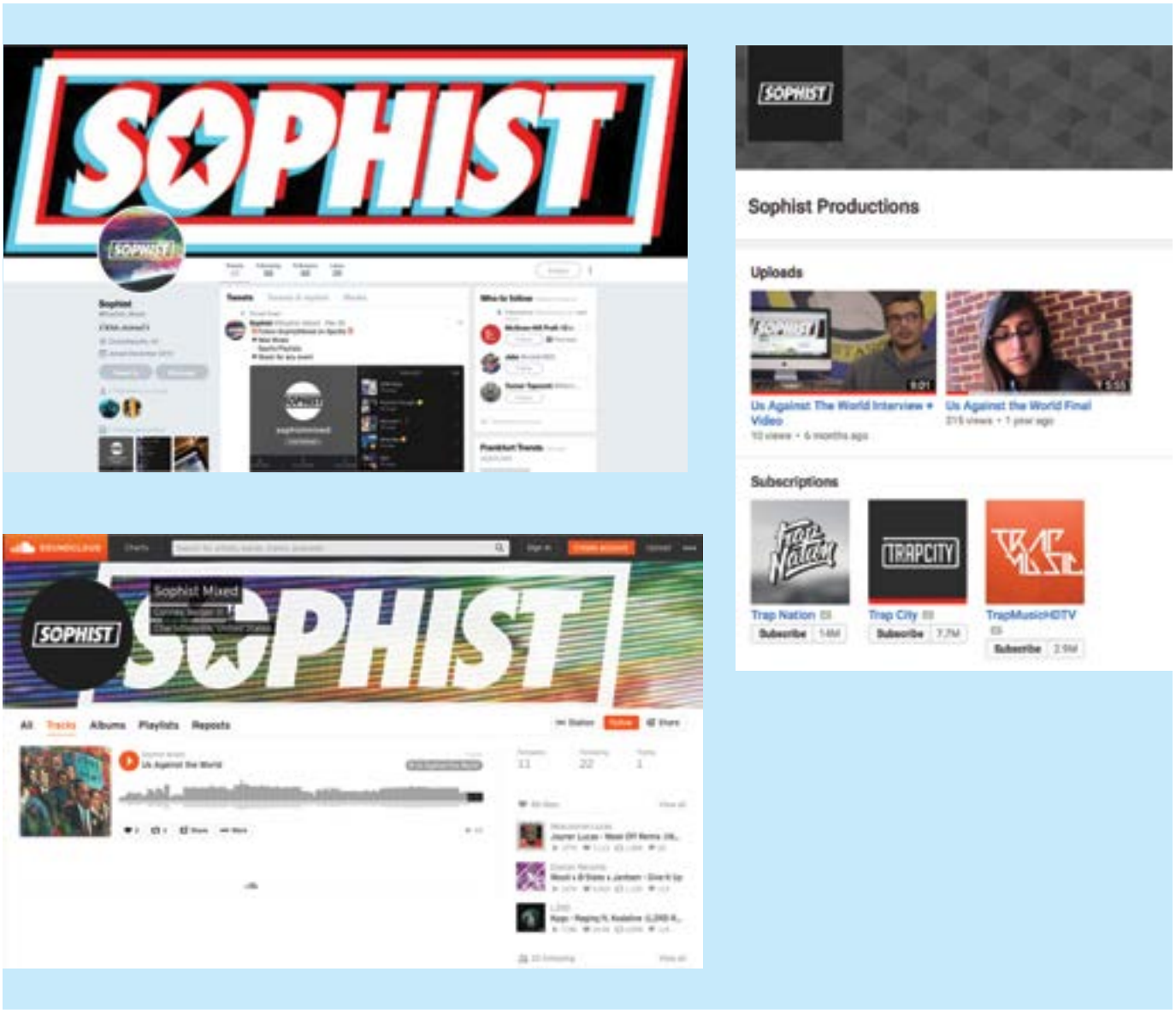

Figure 3: Connor's digital portfolio across social media accounts.

These two cases indicate that youth were motivated to document when the documentation tools afforded them recognition as responsible members of society (e.g., Connor's critical and democratic stance) and to highlight professional skills of all collaborators as a way to differentiate their skills and contributions (e.g., Myriam's shared and personal accounts). The chosen tools supported a range of modes to augment a project's message (e.g., audio recording and music video for a song). Uploading and sharing with multiple tools and different types of media supported a range of modes through which messages of one medium could be underscored and new messages could be layered onto the initial production.

When the school acted similar to a music label by advertising artists, they amplified the youth's roles in society and highlighted the school's role in producing such students. Advocating for youth voices and highlighting youth work via social media recognized youth efforts and their contributions to a larger community. Together, this afforded youth the opportunity to explore their musical identities in the open while at the same time keeping one foot in the safe, monitored makerspace.

Summary

The examples in this brief illustrate how youth were motivated to work on their portfolios, particularly when their work intersected with people and activities *outside* the makerspace environment. This helped them to try out new roles beyond the makerspace while being connected to the familiarity and security of the local setting. In out-of-school environments where participation is voluntary, this meant identifying ways to make portfolio creation immediately meaningful to making. At the high school makerspace, youth were motivated to document making when portfolios supported them trying out who they could be beyond school, including exploring copyright implications and different ways of sharing. Lastly, at the elementary school, where youth might first be introduced to sharing work online, they were motivated to capture their work in ways that strengthened connections across learning environments and to share when they could practice adult-driven portfolio principles while simultaneously earning money.

Where youth's media-production interests, such as music creation, may more easily lend itself to access to professional examples, other areas of interests, such as biology, might be less transparent outside of the makerspace. There's a need to consider how these youth motivations may be leveraged for engagement with professional examples more equitably across diverging interests. All of the portfolios highlighted here are variations on site-specific leveraging of portfolio software and practices. The variety shows how vastly different or similar individual portfolios can be in relation to the system and practice. Analyzing the inherent motivation that youth have to capture and share their work can inform future design of portfolio practices and tools that support youth in making portfolio creation immediately meaningful to their learning.

References

Cohen, C. J., & Kahne, J. (2011). Participatory politics. New media and youth political action.

Hickey, D. T. (2003). Engaged participation versus marginal nonparticipation: A stridently sociocultural approach to achievement motivation. *The Elementary School Journal*, 401-429.

Kahne, J., & Middaugh, E. (2012). Digital media shapes youth participation in politics. Phi Delta Kappan, 94(3), 52-56.

Mills, R. P. (1996). Statewide portfolio assessment: The Vermont experience. In *Performance-based student assessment: Challenges and possibilities* (pp. 192–214). Chicago, IL: University of Chicago Press.

Niguidula, D. (1993). The digital portfolio: A richer picture of student performance. *Studies on exhibitions* (13).

Nolen, S. B., Horn, I. S., & Ward, C. J. (2015). Situating motivation. *Educational Psychologist*, 50(3), 234-247.

Peppler, K., Maltese, A., Keune, A., Chang, S., & Regalla, L. (2015). Maker Ed's Open Portfolio Project: Survey of Makerspaces, Part I. *Open Portfolio Project Research Brief Series,* 47-53. Available at MakerEd.org/opp/publications

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MAKER DOCUMENTATION AND SHARING FOR AUTHENTIC AUDIENCES

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Maker Ed

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.

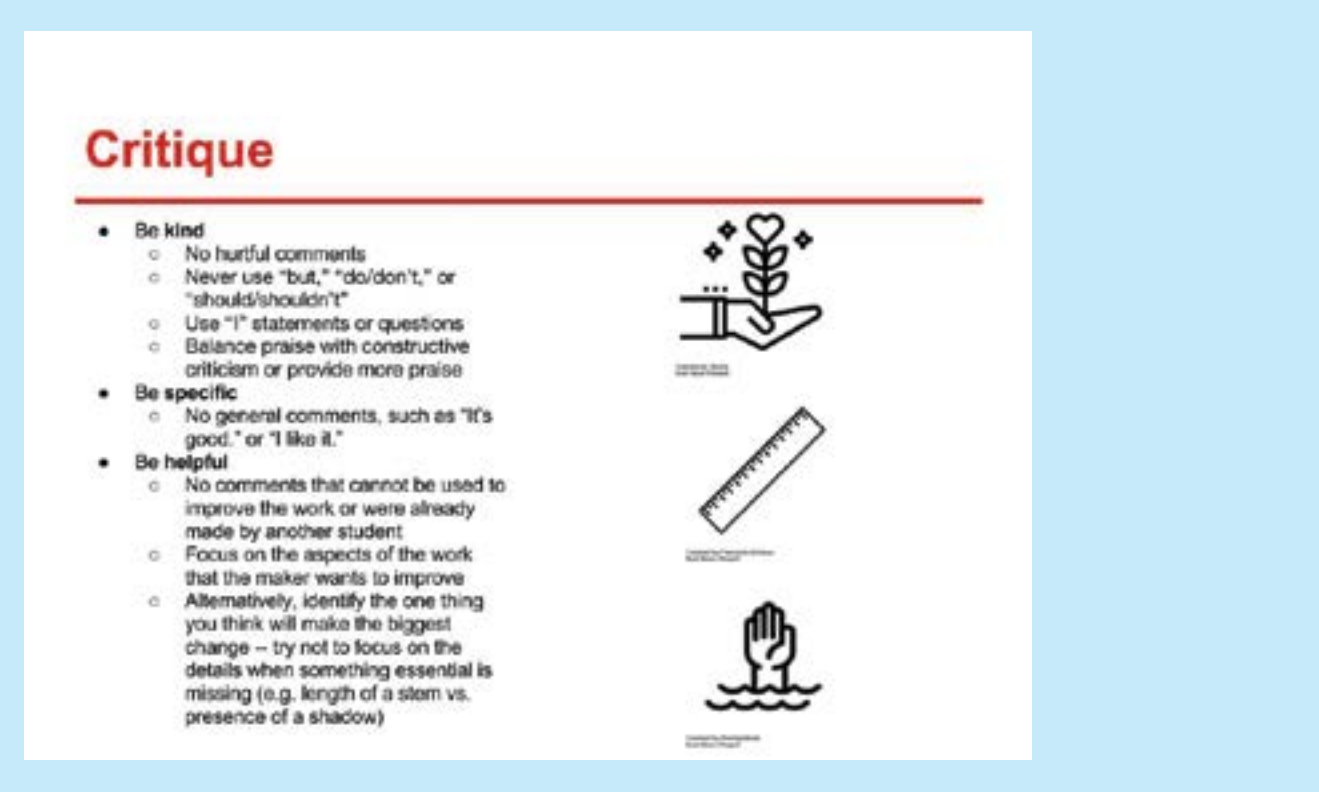


Figure 1: Ron Berger critique protocol as used by HTeCV, with more information at trevormattea.com/critique.html.

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.

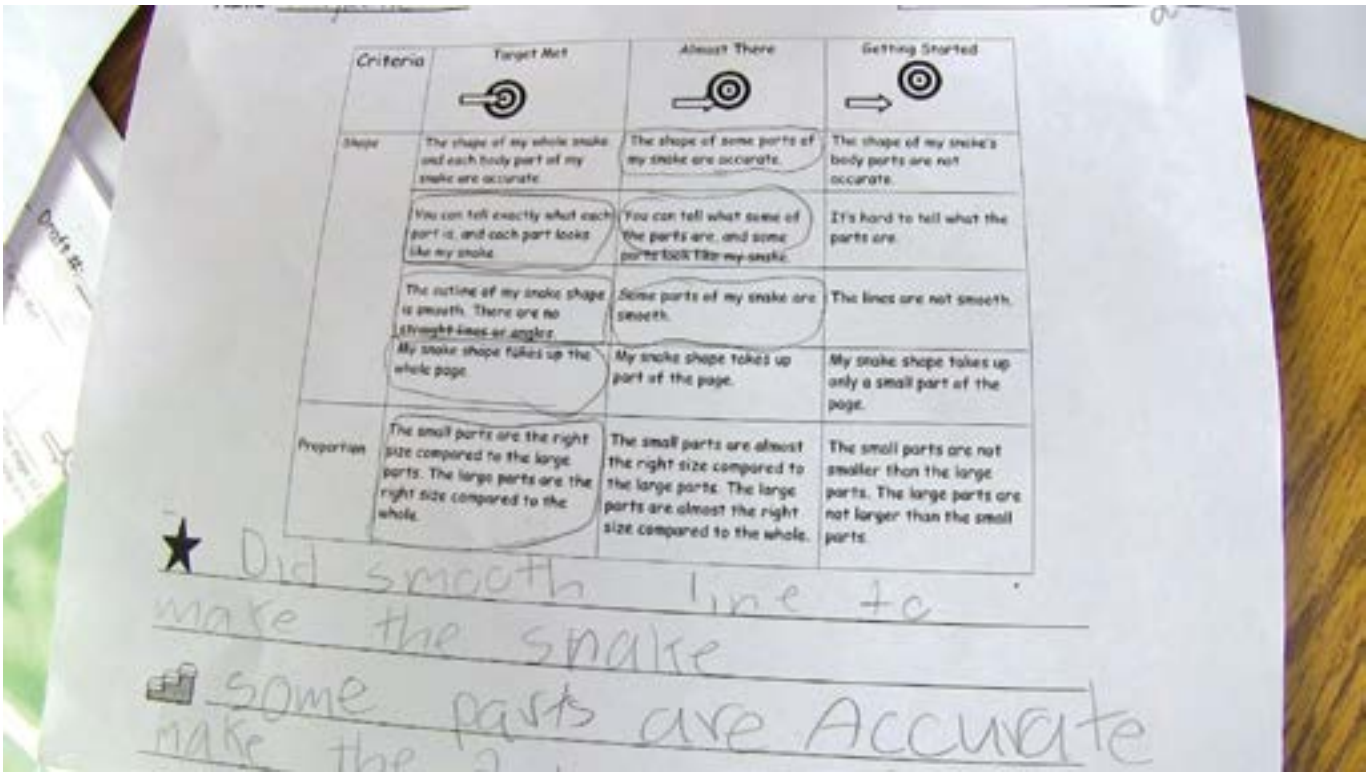


Figure 2: Example rubric that guides peer feedback. Still image from EL Education's 2014 video, "Inspiring Excellence Part 4: Using Models and Critiques to Create Works of Quality," licensed under CC BY-NC-SA 3.0 on Vimeo.

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.

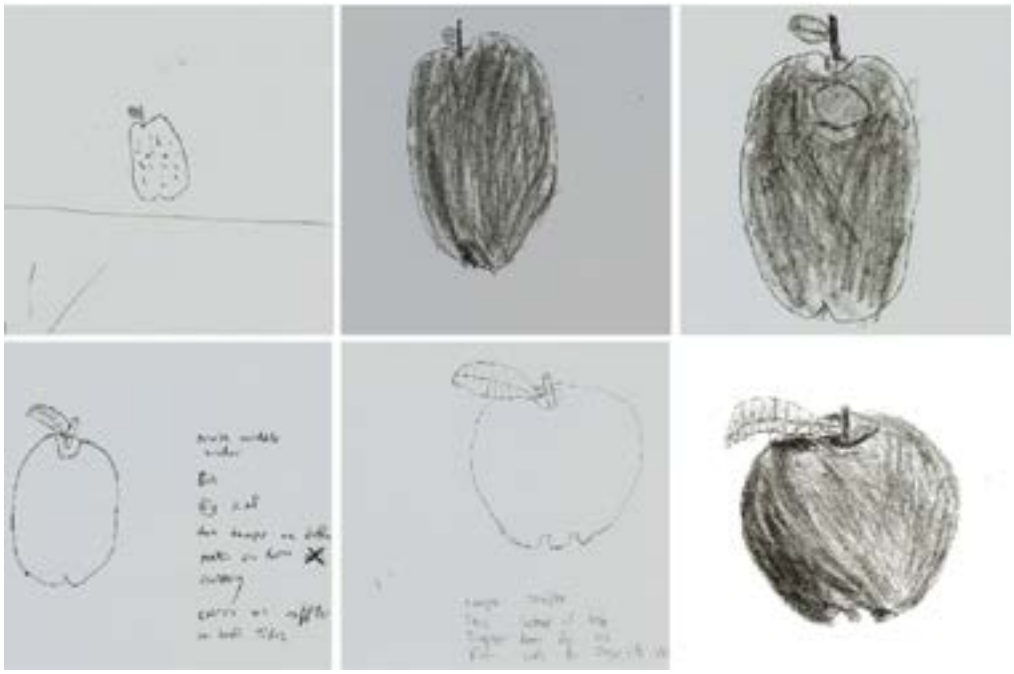


Figure 4: Iterative progressions of Nate's apple drawings.

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

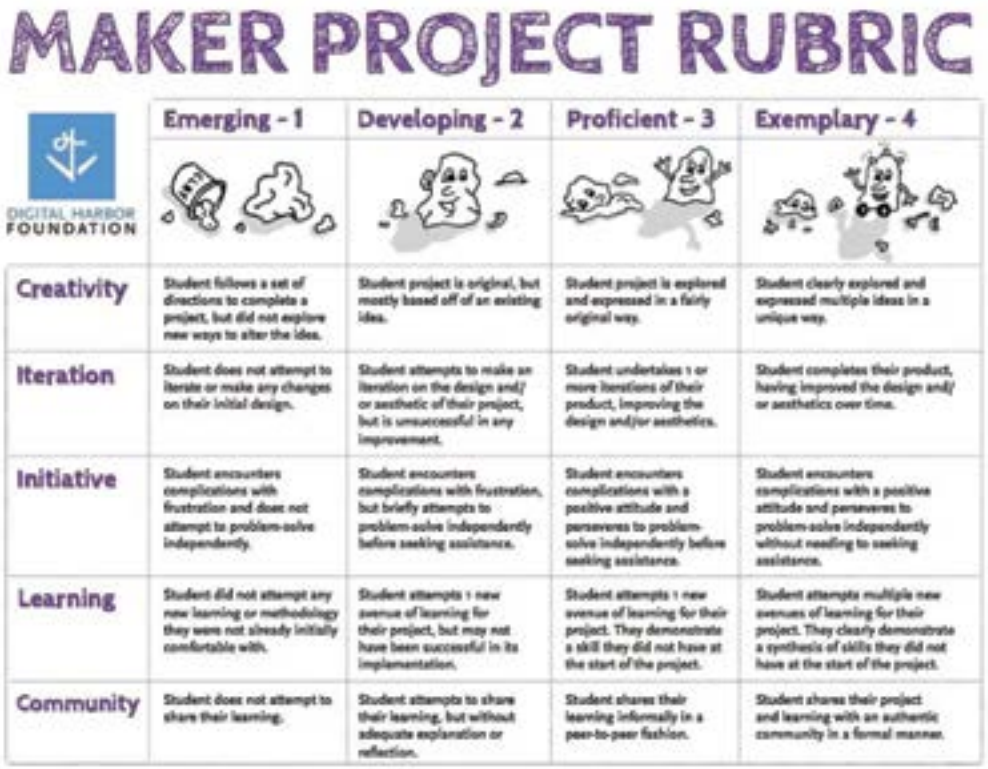
In an effort to support youth in their college applications and to model college-level work, Digital Harbor Foundation (DHF) established a collaboration with the Community College of Baltimore County (CCBC) that allows youth to earn college credit for the course "Digital Fabrication 101." In this course,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

DIGITAL HARBOR FOUNDATION

	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.

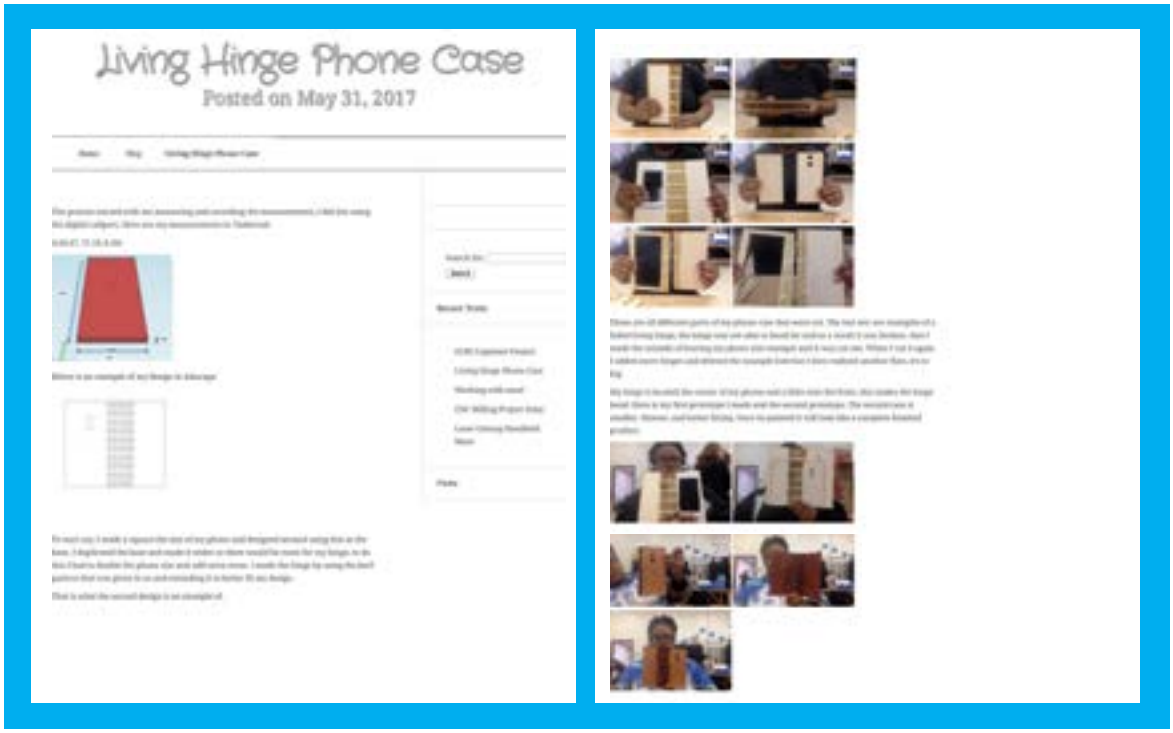


Figure 6: Screenshot of Nalani's portfolio entry highlighting her living hinge phone case.

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.

Acknowledgements

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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

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**	

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**	

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**	

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 *limited* 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	*Some* of the following elements of the process are evident: • documentation • organization • reflection • perseverance • incorporation of feedback	*Many* of the following elements of the process are evident: • documentation • organization • reflection • perseverance • incorporation of feedback	*Most* of the following elements of the process are evident: • documentation • organization • reflection • perseverance • incorporation of feedback	*All* of the following elements of the process are evident: • documentation • organization • reflection • perseverance • incorporation of feedback
MAKER MINDSET	Student does not investigate a design.	Student investigates *only one* design and does not iterate.	Student investigates multiple designs *or* iterates a single design.	Student investigates *and* iterates multiple designs.
AGENCY	Student is *not* 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) *with* 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) *without* reminders or other assistance.	Student *consistently* monitors his/her ability to benefit from and contribute to the activity (e.g.: discussion, team meeting, independent time) without reminders or other assistance.

Sonoma County Office of Education

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)

Skills and Knowledge Checklist :

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

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

Qs to help you figure our 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?

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 -Ardunio & S4A.cat		
Rasberry Pi and Similar platforms ->	PCdunio, Beaglebone, raspberry pi, etc.		
Rasberry Pi and Similar platforms ->	Basic linux		
Rasberry 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

EDUCATOR WORKSHOPS AND PRACTITIONER-FACING EFFORTS

Stephanie Chang, Maker Ed
Kylie Peppler, Indiana University
Anna Keune, Indiana University

Maker Ed

Open Portfolio Project

RESEARCH BRIEF

15

When launching Phase 2 of the Open Portfolio Project, there existed a tremendous amount of interest from educators, especially practitioners, to learn more about facilitating the creation of open portfolios by their students.

They asked about project findings, tensions in the field, tools and platforms, and the project's next steps. The vast majority expressed interest in professional development and support around portfolios. Some were looking to refine their practices and consider new questions or domains, bringing in experiences with fine arts and writing portfolios; others just wanted suggestions and resources to get started and develop practices. They all saw value in how open portfolios could capture learning and youth voice, and they were eager to find ways to situate this form of assessment and learning in their spaces, whether maker-centered classrooms, museum drop-in areas, or afterschool clubs.

In light of this interest and opportunity to engage practitioners outside of field site research, our work included numerous practitioner-facing efforts, including multiple workshops, whether standalone or as part of conferences, a published Practical Guide to Open Portfolios, an online course in collaboration with KQED Teach, engagement with Carnegie Mellon University's Learning Media Design course that leverages college student effort around similar project goals, and ongoing conversations with leaders involved in all aspects of performance-based assessment work at the technological, higher education, school district, and policy levels.

These efforts broadened the project work to bring together a wider community of participants, while ensuring that the research-to-practice and practice-to-research pathways remained open and fluid. As the momentum behind this work continues to grow, the involvement of more stakeholders leads to the possibility for greater impact and quicker movement.

A Practical Guide to Open Portfolios

The published Practical Guide to Open Portfolios is a standalone resource which distills our project's research findings and workshop efforts into an online, freely available guide. It serves as a reference and starting point, whether educators are deepening their practices or just beginning to consider their vision and goals around implementing portfolios. Our educational partners and workshop participants have contributed insights to the guide, as it's been refined, and educators have also utilized it as they formulate and iterate on their own work.

Chapters include:

- **Getting Started**
- **Purpose, Motivation, and Justifications for Portfolio Use**
- **Integration and Language**
- **Portfolio Examples**
- **Tools for Capturing**
- **Platforms for Recording, Storing, and Sharing**
- **Design Workshops**

KQED Teach Online Course

In close collaboration with KQED Teach, we launched the Digital Portfolios with Maker Ed online course in summer 2017. This course provides an overview to maker education and how to develop youth-designed digital portfolios, following a similar and shortened format to our workshops and Practical Guide to Open Portfolios. It's presented on an easy-to-use online platform in connection with KQED Teach's other professional learning offerings related to digital media production and deeper learning. The course is freely available and provides a structured, self-paced series of lessons that may help refine an educator's portfolio practices or support initial interest.

Educator Workshops

In 2016 and 2017, Maker Ed offered multiple one- or two-day practitioner-facing, in-person workshops on open portfolios. In total, almost 250 educators attended these workshops and dove into discussions, explorations, and development of practices around documentation, open portfolios, and assessment. New elementary school teachers joined museum educators, school librarians, veteran English teacher and science educators, and school principals from all over the country, reaching across subject areas, grade levels, and educational types. From hundreds of applications, the variety and diversity of educators selected for the workshops was intentional, designed to bridge informal and formal learning in a way that we hope open portfolios can, while taking into account the distinct challenges and opportunities of each.

Figure 1: Artist Nevada Lane sketched a graphical snapshot of an Open Portfolios workshop in 2017.

The workshops all followed a similar format (more details below), though each subsequent workshop was iteratively refined to be more focused and address topics that resonated most deeply. Intentionally, the workshop sessions asked participants to step back and forth between learner and facilitator to emulate and better understand the experiences we're collectively creating for youth. This purposeful workshop design was based on comments from educators at our research field sites from Phases 1 and 2: that educators themselves found it challenging to pause and capture their learning and processes, that documentation often felt like an afterthought if not intentionally integrated into the work from the very beginning, and that it was surprisingly hard to create a personal portfolio of work to use as an example!

In a similar manner to shifting between the roles of learner and facilitator, during the workshops, opportunities were also provided to work individually and collaboratively. In most learning environments, there's a need to do both, and one of the most significant tensions that we've uncovered through the Open Portfolio Project is how to effectively and adequately capture and share learning that's individually based or group-based (or a hybrid of both). Rich discussions transpired throughout the workshop sessions. Because participants represented both formal and informal educational environments, at a variety of levels and roles, the connections made between the content and skill development that occurred at each site were also conducive to overall portfolio thinking and planning.

WORKSHOP FORMAT AND FLOW

Generally, all workshops followed a similar agenda, each made up of numerous sessions that were centered around a specific activity or focus, followed by time for small- and large-group discussion and reflection. Sessions addressed making and documentation, online platforms and documentation tools, sample portfolios and assessment of learning, language and integration, and finally, action planning and site-specific discussion around their unique audiences and framing.

Making and documentation: Elaborated upon in Chapter 7, "Design Workshops," of the Practical Guide to Open Portfolios, our first session of every workshop consisted of a maker-centered design challenge and hands-on engagement. The twist, of course, was that the learning and making inherent in the design challenge needed to be captured in some way. It was important to ensure that documentation of work and learning were innately embedded into the overall making that occurred. Participants were asked to not only create tangible prototypes and solutions to a presented challenge but also to capture their process and show off their documented artifacts and project portfolios.

After a mere hour or two, groups of educators presented their carefully designed, beautifully crafted, and often functional creations—with supporting images, videos, animations, and written reflections to accompany the product. Much was articulated in the reflections and discussions that followed, whether related to the difficulty of documenting while making or to the realization that so much learning occurred around a relatively simple project.

Figure 2: Educators at the workshop work together to create a solution to the presented maker-centered design challenge, capturing their efforts as they go.

Online platforms and documentation tools: Following an experience where participants engaged as learners, the next sessions allowed participants to shift between learner and facilitator. To explore online platforms and documentation tools, participants gathered in small groups to journey through a self-paced investigation of technological, browser- or app-based, online platforms, as well as new and old tools for documentation.

They considered cost, accessibility, ease of use, convenience in porting data in or out, how well the platform interfaced with other established learning management systems, and other aspects of use. Questions also arose to the stability of platforms: Will the companies creating these exist in 5–20 years? And what happens to the data? Platforms included common website-creation ones such as Weebly, alongside portfolio-specific ones such as Seesaw or Portfolium and commonly used systems like Google Classroom.

Rich discussions that ensued from these periods of exploration tackled the possibility of mixing and matching platforms, including popular social media tools. Documentation tools, whether time-lapse video, egg carton stations, or others (see "Research Brief 3: DIY Documentation Tools for Makers" were also tinkered with. Overall, the sessions revealed a long list of key factors that were important to educators, in and out of the classroom, as they considered their audiences and purposes.

Figure 3: Educators explore the online portfolio platform, Seesaw, jotting notes on ease of use, functionality, and integration with their own systems.

Sample portfolios and assessment of learning: Subsequent sessions of the workshop included additional time to investigate, reflect upon, and discuss reactions to actual youth portfolio examples. A number of online portfolios, ranging from those created by 2nd graders to those created by high school seniors, were explored in small groups, guided by both simple and complex questions, such as "Is this a portfolio?" and "Does the aesthetic of the portfolio affect your reaction to the content?"

Many focused on debating the context needed to understand a portfolio; the affordances of open portfolios in showing process versus product; and the utilization of portfolios as a vehicle for reflection and sharing, assessment by numerous audiences or stakeholders, and access toward college and career pathways. Much was deliberated as participants talked through the purpose, process, and audience of youth portfolio creation, each being unique to the youth they're engaging. We explore more around youth motivations for creating portfolios, outside of and within the context of adult-driven structures in "Research Brief 13: Youth Motivations for Open Portfolios."

Language and integration: Closely tied with conversations around the purpose, motivation, and audience for youth-created portfolios were the language and prompts that adults can design to ensure that portfolios—and the process to collect documentation, curate artifacts, and share—are relevant to the interests and motivations of youth themselves.

Workshop participants spent a significant amount of time thinking about the frameworks, language, and facilitation needed to scaffold the development of portfolio practices in their classrooms and educational environments. Some linked portfolio creation and implementation directly to college and career pathways and thought about how to frame it as such; others considered it important to situate portfolio development as a tool for lifelong learning. Still others articulated the value of portfolios as distinctly linked to formative and performance-based assessment of learning.

Action planning: Throughout the workshops and especially near the end, participants were encouraged to lay out concrete next steps. A flurry of activities and energy within professional development opportunities don't always carry through when participants return back to their respective environments, so any opportunity to thoughtfully plot out steps, however big or small, was built in. Some educators thought more about language and purpose, while others carefully dove into opportunities for integration, whether within curricula and lesson plans or with existing technological tools; others wanted to lead similar workshop for fellow educators or administrators to build buy-in, collaborate, and show the value behind the work.

Maker Ed asked participants to share their action planning via photos and social media, as a way to better understand what their takeaways were but also to help them stay accountable to thoughtful and feasible next steps. Two samples are shown below, in response to the prompt, "When I return to my institution, I'd be crazy if I didn't _____."

Figure 4: A small group of workshop participants mapped out the goals for how they envisioned open portfolios being utilized and integrated in their settings.

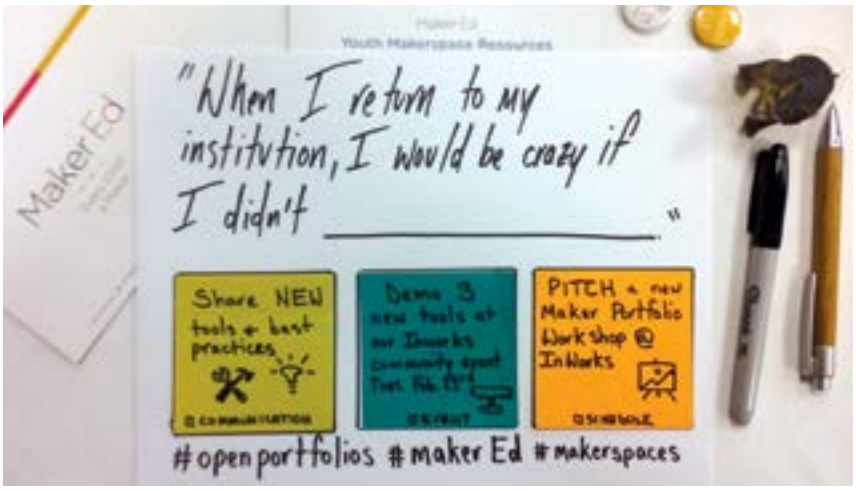

Figure 5: Participants laid out concrete and actionable steps related to the Open Portfolio workshop.

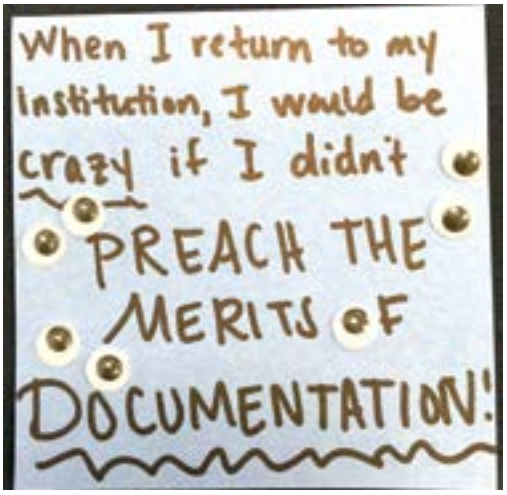

Figure 6: Some participants focused on specific parts of the portfolio process, such as documentation—and building buy-in for it.

Insights

Overall, the workshops provided a structured space for exploring some of the emerging tensions uncovered in the research, offered opportunities for thoughtfully connecting research and practice, and allowed for insight into the motivations of education for implementing open portfolios in their educational settings. In recognizing the challenges inherent in documentation and assessment of maker-based learning experiences, many of the sessions within the workshops were designed explicitly to facilitate exploration of the topic, discussion of it, and consideration of how the topic would be addressed within each educator's own environments and contexts. All topics were aspects necessary to consider when implementing portfolios with youth.

Engaging with such a strong and diverse group of educators was in no way a one-way street: Throughout the workshop and in the months that followed, the discussions and questions raised pushed on our understandings and brought important perspectives to light. The project was able to leverage the educators' deep well of classroom experiences, familiarity with fields like art and architecture, scaffolded assessment practices, and personal portfolios to ensure that the work was balanced between big-picture theory and on-the-ground applications.

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NEW YOUTH WORKSHOPS FOR CULTIVATING OPEN PORTFOLIOS

Kylie Peppler, Indiana University
Anna Keune, Indiana University
Stephanie Chang, Maker Ed

In collaboration with National Working Group members: **Leigh Abts** and **Barry Fishman**

Maker Ed

Open Portfolio Project

RESEARCH BRIEF

16

The creation of open portfolios at youth-serving makerspaces is an inherently social process where youth share projects, processes, and ideas that they've developed alongside others. In this process, portfolio development can, similar to making, be considered a creative effort that calls for aesthetic decision-making, exploration of tools and materials, and imaginative implementation.

Yet, youth don't commonly gravitate toward capturing and sharing their work on their own, perhaps because portfolio creation can easily fall into a framing that sets it up as an additional task. This suggests that there's a need to take a closer look at the design of framing portfolio creation as an integral and integrated creative practice of making, leading to the question: How can we resolve the tension between making and documenting?

While Research Brief 15, "Educator Workshops and Practitioner-Facing Efforts" covered professional development experiences for educators that explored the design and integration of portfolios into their maker programs, in this brief, we present three youth-facing design workshops that address the tension between making and documenting.
The design workshops are interventions in maker-centered learning environments, and we aimed to use these interventions as a way to frame portfolio creation as a creative practice as equally interesting as making. Thus, we explore how the workshops supported youth and educators to capture their processes, to think about documentation, and to surface implications for the future design of tools and practices.

The workshops are designed to provide ideas for how maker-centered programs can intentionally and better support youth effort around documentation and sharing. These enriching activities described can scaffold the many stages of youth portfolio creation. In turn, analyzing how youth create their own portfolios and view other's portfolios can help the community as a whole evolve and refine documentation practices over time. We conclude by presenting additional design workshop ideas that could serve as activities for makerspaces to improve their portfolio practices.

While each workshop tackles the tension among making and documenting, there are certainly other ways to address the tension among making and documenting. The described interventions are avenues for expanding how youth portfolios are made, how youth can develop personal approaches to capturing their work, and how portfolio creation is understood as a means for creative expression and artistic exploration.

Design Workshops

We created the design workshops to address three underlying tensions present when integrating portfolio creation and assessment into makerspaces and maker-centered programs: (a) curating episodic engagement for a range of audiences, (b) capturing the process of making, and (c) representing the shift of youth roles and identities in and out of a makerspace. Here we introduce three workshops that we facilitated with youth and educators during field site visits, present how participants engaged with the design activities, and describe how the activities might be useful for the larger maker education community. These are just three approaches, among potentially many more that seem promising, that lead to design implications for further development of portfolio tools and techniques, and may be considered in series or individually.

WORKSHOP 1: VISUALIZING SHARED EXPERIENCES IN A MAKERSPACE

Design Challenge: Within maker-centered learning environments, and particularly those with drop-in programs, it can be challenging to track the range of activities, as well as episodic commitments of youth over time, to represent the full engagement offered by a space to multiple diverse audiences. Furthermore, not many makerspaces have systematic portfolio practices, meaning that youth work and their processes are often unseen by outsiders. Creating physical and digital spaces for curating work in locations that are accessible to all can better illustrate program offerings, as well as youth engagement, facilitation and participation patterns, and shared experiences among youth and educators. As makerspaces offer different programs, activities, and enrichment opportunities at varying timescales, there's no one right way to represent them.

Design Response: We designed a workshop in four parts that would allow youth and educators to collaboratively curate a portfolio, representing the range of program offerings at their site. First, participants collected makerspace schedules, programs, and activities and gathered documentation of these (e.g., browser windows that displayed photographs and videos in online repositories, a list of projects exhibited in the makerspace, and camera roll folders on personal mobile phones). Second, participants browsed through the photographs, annotated memorable moments captured in still frames, and selected photographs that were most representative of their programs. Third, participants printed the selected photographs and annotations, spread them out on a large surface, and rearranged them in relation to the activity schedule (e.g., which photograph represents which activity, and how the activity related to the larger organization of the schedule). Fourth, participants decided on a structure for how the photographs and actual maker materials could be displayed, both online and in print, while considering consent and legal rights around openly sharing imagery.

Workshop Facilitation: We facilitated the workshop at the Millvale Community Library in Millvale, Pa., a close-knit community drop-in space that is seeking to design and build value-based maker-centered learning programs (Clapp, Ross, & Ryna, 2016). The workshop included participation by two educators and three youth. Most of the photographs that captured making at the library were stored in an online repository that was privately shared among the educators. We first opened all photographs on two laptops and asked participants to discuss and leave comments about the depicted engagement.

Youth comments on images were often expressed as comic observations or as ideas for humorous thought bubbles to integrate into the image. All photographs with comic annotations were printed, scattered on a long table, and rearranged with the aim to design a layout for a shared website that would map enrichment opportunities (see Figure 1). Spread across the table, the photos provided a visual representation of patterns across programs and invited thematic categorization and sorting.

Educators arranged the photographs in relation to the hand-written makerspace schedule. The educators sorted into three categories by color-coding the photographs; themes that corresponded to the schedule were blue, longer-term projects were pink, and shorter projects were yellow. The arrangement along a timeline also sparked recognition of youth participation patterns. Further, seeing how activities corresponded with the number of photographs invited conversations about factors that fostered or hindered documentation, as well as discussion around memorability of activities. Lastly, the participants created a final public collage piece, integrating the selected photographs along with actual scraps of maker project materials, including those which were depicted in the images.

Figure 1 (left to right): Students commenting on a digital photograph, a student picking up photographs and joking, and educators sorting the photographs into categories.

Design Implications: The workshop surfaced four aspects to consider for future planning: (a) showing programs on a timeline to see the density of offered activities and participation patterns; (b) presenting the depth of documentation per activity for strategizing about how to increase capturing and sharing across activities; (c) organizing, labeling, and categorizing making through keywords and groups that can then be represented and explored through visual representations in physical and digital spaces (e.g., tree structures, circular representations, density graphs); and (d) quick ways of reviewing, editing, and blurring children's faces to honor privacy across individuals and age groups.

The periodic insertion of humor created an atmosphere of enjoyment around portfolio creation that we consider important to sustain. It led to the idea of integrating speech bubbles and text annotations on top of images, where the placement, size, and font could be important ways for conveying the shared memories and collective meaning of an activity. Repurposing scrapbooking features (e.g., Shutterfly) or collage-making (e.g., PicCollage) for curating and annotating narratives of shared experiences could be a starting point. Some of these services offer the printing of personalized books that could be exhibited in a makerspace and become sources of inspiration and reference works for program development. In the process of creating books and collages, the selection and placement of photographs, as well as the addition of quotes and subtitles, were important for curating a narrative that can be told to and retold by the makerspace community.

WORKSHOP 2: CONTINUOUSLY CAPTURING THE PROCESS

Design Challenge: When implementing new portfolio practices, educators are often tempted to streamline the process by introducing one standard practice for all youth to follow. While this can be an efficient way of integrating portfolio creation and assessment, it also makes it challenging to accommodate individual needs when capturing unconventional projects. An "efficient" portfolio practice may also over- or under-represent parts of maker practices, such as focusing on turning points, characteristic improvements of a project, or failure. The authentic documentation of an entire process – and the personal learning that springs from reflecting on such a process – is critical; often though, it is less of a priority than the final product of a project, and it results in a large amount of data to process and curate.

Design Response: In order to identify avenues for youth to adapt their documentation to personal interests and to facilitate the authentic documentation of a full process, we designed a workshop in three parts. First, participants engaged in a short maker activity (e.g., integrating a circuit into an origami project) and captured time-lapse videos of their entire process using a do-it-yourself (DIY) documentation station where two modified egg cartons prop up a total of four iPads (see Figure 2 with three iPads). A time-lapse recording reduced a 30-minute maker process to a video clip of about a minute.

This documentation station is an iteration of a prior version of a DIY tool that utilized one egg carton to prop up one iPad (see "Research Brief 3: DIY Documentation Tools for Makers"). The iteration was initiated when we observed that many maker activities include collaborative and cooperative practices even in individual projects (e.g., getting up to show a project in process or leaning over to comment on a peer's work). To capture maker processes more fully requires the design of a documentation station that can capture both individual work and shared engagement. The new DIY documentation station can be set up at the center of the table and can record through four cameras. This supports documentation from a range of angles and camera views, while utilizing tools and materials makerspaces have easily access to.

Second, after the making activity, participants viewed their time-lapse recordings, took screenshots of important moments of the process, and composed animated GIFs of these screenshots that included text and graphic image layovers. This part of the workshop lasted 20 minutes. Third, participants reflected on their experience of recording time-lapses and creating GIFs by sharing their experience and contrasting it with the capturing and sharing practices they engaged with prior to the workshop.

Workshop Facilitation: We facilitated the workshop with five youth at the Digital Harbor Foundation, one of the makerspaces presented in the Research Brief 12 series. We asked youth to engage in the three-part design process by first, capturing time-lapses of an origami paper circuit activity with the iPad camera app; second, viewing and sharing time-lapses, capturing highlights, and creating GIFs; and third, sharing their experiences by comparing and contrasting capturing tools and how they might want to use them in the future. Figure 3 shows photographs taken during the design process as well as screenshots of one of the participants' animated GIFs.

Figure 2: Egg carton documentation station with three iPads.

Figure 3: Youth capturing and viewing time-lapses and creating GIFs (top), plus screenshots of an animated GIF (bottom).

What stood out most during their reflection was the way in which the workshop facilitated a comparative analysis of open portfolios tools and practices. Youth compared the two approaches to documentation: recording time-lapses or pausing to document the process of making, where one must remember to take photographs as projects progress. During the process of making, the moments that youth would have wanted to capture were the ones in which they were most engaged and in the flow. As we have often heard, documentation interrupts this engagement.

In contrast, by integrating documentation into the process of making, the time-lapse video captured the processes that youth engaged in, as well as eliminated the need to remember to pause to take pictures. Comparing the time-lapse recording to GIF creation, youth preferred to share the whole or parts of the time-lapse rather than an animated GIF that shortened the process representation. Creating a GIF required time and involved selecting which parts of the process to represent. At times, the GIF-making tool didn't save, and youth lost their work. The GIF representation also sped up the maker process in a way that eliminated transitions. GIFs also lost important aspects of process that couldn't be captured with one single frame, and they additionally required a time-consuming editing process, separate from making.

In conversation, youth brainstormed ideas for an easier-to-use time-lapse editing tool, especially one that would speed up and slow down their recordings through gesture-based interactions, rather than cropping and deleting parts of the recorded process. Furthermore, through the exploration of the tools (i.e., GIF-making app and time-lapse recording app), youth were able to better gain a deep contextual understanding of the functionality of the tools in relation to their usefulness for capturing and sharing. Getting to know the tools and the kind of media artifacts those tools can produce identified such trade-offs and built a basis for youth to make more informed decisions about which tools to use in the future and why.

Lastly, the design workshop allowed youth to reflect on the challenges in documenting making and consider the affordances of tools. They recalled the difficulty in writing reflections and portfolio entries from memory; in contrast, having visual documentation like time-lapse videos – and so seamlessly integrated into the process helped to "jog their memory" and assist in reflecting on how projects were developed.

Key to this workshop is recognizing the embedded functionality of tools and their typical and atypical uses. Exploring how tools can be leveraged to improve the capturing and sharing of youth work can help to broaden and increase portfolio creation. For example, makerspaces can build on the recommendation of the youth, take their voices into consideration when continuing to develop portfolios practices, and spur the design of portfolio tools that are uniquely suited for capturing maker processes and promoting reflective discovery.

Design Implications: The workshop was a starting point for facilitating creative exploration of both site-wide and personalized documentation. Extending this workshop into an educational curricular unit might encourage youth to consider capturing and sharing as a personal choice and artistic expression. The workshop also pointed to a need for further iterations on the design of tool that could support simplified post-production processes, like editing videos. One example of this is the further development of a time-lapse recording app that includes features of speeding up and slowing down recordings, editing, generating GIFs of parts of a video, and augmenting video with audio narrations, text, and graphic elements through a simplified user interface that emphasizes rapid production processes. Lastly, the workshop supported the supposition that automated documentation stations, like the egg carton hack, are vital for authentic documentation possibilities that shows individual and collective engagement.

WORKSHOP 3: CROSS-SITE VIEWING OF PORTFOLIOS

Design Challenge: Traditional portfolio assessment is frequently aimed toward capturing individual learning in order to connect personal achievements to concrete learning experiences. Within maker education, a strong focus on community expands upon this assumption, and portfolio practices and tools increasingly need to adapt to represent individuals and their shifting roles (e.g., novices who become 3D printing experts) within maker-centered learning communities. However, it can be challenging to identify small yet effective changes that illustrate these shifts.

Design Response: We designed an intervention that allowed participants to explore other youth portfolios and consider the roles and identities of the individual, as represented in his/her portfolio. In the workshop, participants from one site view the youth portfolios of another site and reflect on them in relation to their own documentation practices. One of these portfolios was created by a student from a school-based makerspace who had been sharing video production projects on YouTube since he was 13 years old, including

custom logo animations, music videos recorded with friends for digital media courses, and tutorials for special video effects. Some of the tutorials were speed-art recordings, time-lapsed screencasts of design processes, that showed connections with other youth who are part of a YouTube collaborative around digital video production. Many of the videos received encouraging comments and had over 9,000 views. The student then pulled together a selection of their best videos on a personal website.

Workshop Facilitation: We facilitated the workshop with four educators and five youth at the Digital Harbor Foundation. First, we provided a guided portfolio walkthrough of an example portfolio. Second, we led a conversation that asked participants to reflect on the portfolio's features and how they might translate to their own portfolio approaches. Participants highlighted the number of views, comments, and endorsements the example portfolio received. This led them to consider how community outreach and social media strategies for garnering views could be integrated as part of a unit that introduces portfolios to youth.

Similarly, participants highlighted the fact that an educator had shared some of the example portfolio's projects with their own online social network. This could help to accentuate projects exhibited at the makerspace and the youth who create them. An example of an existing practice at the Digital Harbor Foundation that bears similarities to this is the blog series "Girls in Making," in which educators share spotlight stories about female makers at the makerspace, including their projects and interests. In addition, participants discussed another way to increase community engagement, by including a "Hire from Digital Harbor Foundation" button on their main page. This button could link to the portfolios of youth who are seeking employment opportunities.

Design Implications: Reviewing portfolios of those from outside the makerspace can serve as inspiration for further developing existing portfolio practices. Seeing features of a website or a storytelling technique sparks new ideas and opportunities for how to improve their own capturing and sharing experiences. It is especially important to note how portfolios can situate youth as contributing members inside and outside of a makerspace.

Additionally, the kind of portfolio that was shared and viewed between sites mattered. Portfolios from dissimilar sites and spaces, where programs and offerings are not common to one another, can seem irrelevant and even intimidating without appropriate contextual details.

The workshop also pointed out the practices embedded within makerspaces and within portfolio tools. In some maker-centered learning environments, adults regularly shared youth projects and promoted youth via their own personal networks, and makerspaces often highlighted youth on the official website. Together, this suggests that there's a need to more carefully consider how portfolios are highlighted, shared, and promoted.

Conclusion

Creative approaches to developing improved practices around documentation and sharing are crucial to overall portfolio implementation and assessment within maker-centered learning environments. Together, the design workshops described here represent interventions for maker educators and youth to learn more about and to become more explicitly aware of how their work can be represented in relation to tools, media products, and documentation practices. Where the workshops cannot entirely resolve tensions for implementing portfolio practices within maker education, they provide avenues to address, progress, and improve documentation over time.

The picture-sorting design workshop facilitated the visualization of shared experiences of youth and educators in a makerspace by illustrating patterns across activities and youth engagement. The time-lapse and GIF-making workshop helped youth to actively consider documentation as a seamless and creative process alongside making, highlighting the need for rapid video-editing tools and improvements to prior documentation station models. Sharing the portfolios of other makerspaces helped staff and youth to recognize features that could be integrated into their own portfolio practices, highlighting the value of adults sharing youth work and fostering youth development.

There are many more interventions that could foster awareness of open portfolio practices. For example, many portfolios privilege individual representations of work over collaborative learning. To better understand how collaborative portfolios could be representative of rich learning in ways that other kinds of portfolios cannot, facilitators can ask youth and educators to engage in a shared project that is collaboratively documented. What would that documentation look like? Could it be integrated into existing platforms and how? How could this process be replicated at other sites? These types of workshops might inform the future design of new portfolio tools that can better facilitate the creation of portfolios in makerspaces.

Reference

Clapp, E. P., Ross, J., Ryan, J. O., & Tishman, S. (2016). Maker-centered learning: Empowering young people to shape their worlds. John Wiley & Sons.

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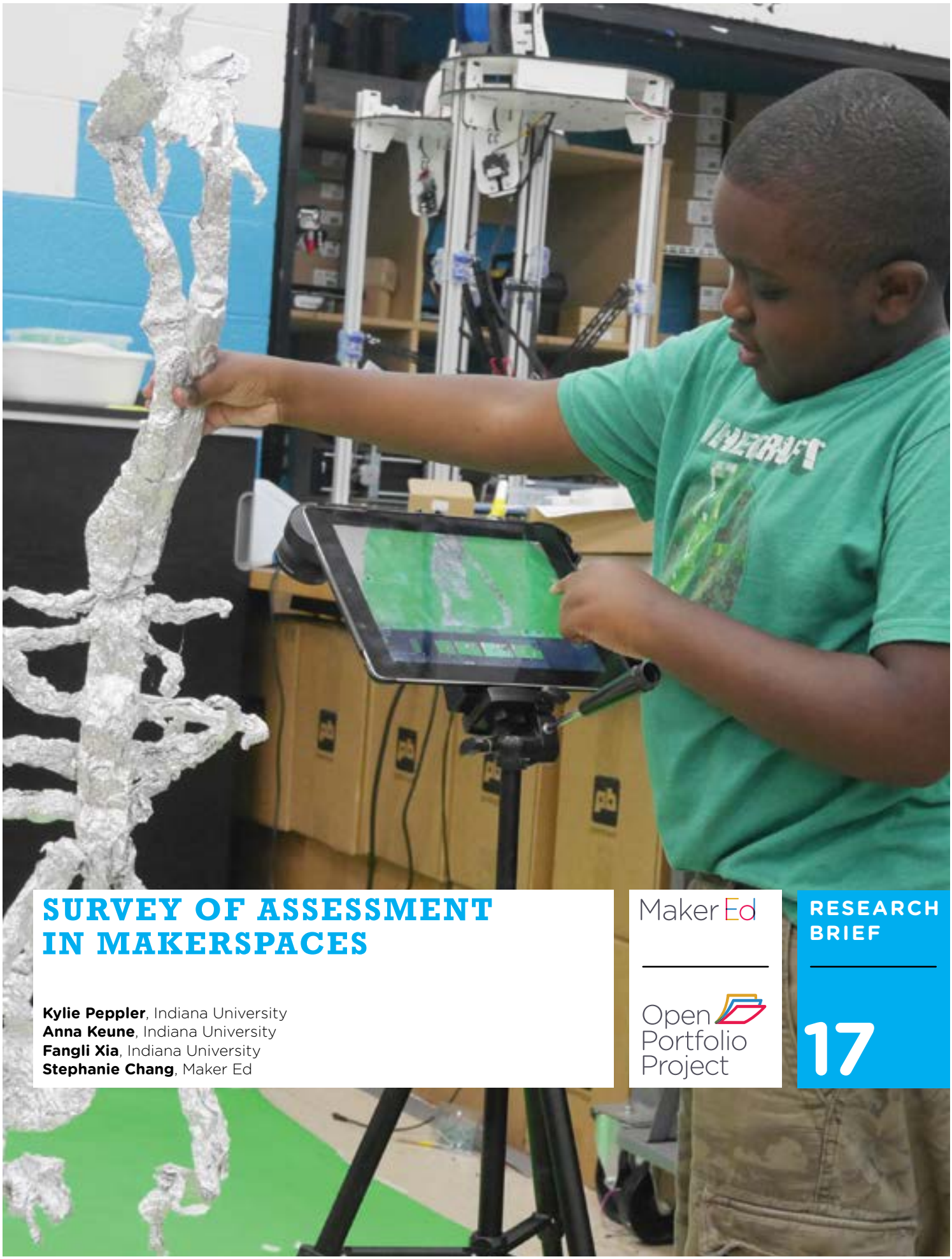

SURVEY OF ASSESSMENT IN MAKERSPACES

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Open Portfolio Project

RESEARCH BRIEF

17

Surveying Maker Education Demographics & Assessments

To understand the impact that the expanding maker movement has on the demographics of maker-centered learning environments and their assessment techniques, we invited makerspaces across the globe to tell us about their demographics, assessment practices, human/material resources, and guiding philosophies.

Our 2017 makerspace assessment survey was distributed from spring to fall 2017 via an international maker education network, generating responses from 48 sites (20 in-school makerspaces and 28 out-of-school makerspaces).

In this research brief, we share findings from this survey (see the Appendix for a full copy of the survey), which will help researchers and practitioners gain a clearer picture of the assessment practices and interest in assessment among today's makerspaces, in and out of school. In this brief, we refer to "makerspaces" as both defined physical spaces as well as integrated programming within youth-serving, educational environments.

Our survey included two broad sections:

1. Demographics, including questions about youth served, staffing, and program information;
2. Assessment, with questions about the sites' overall and portfolio-specific assessment approaches.

Common questions from our prior surveys allowed us to compare demographic and programmatic details from Phase 1 of the Open Portfolio Project, as well as investigate various trends in the broader makerspace community over time. We substantiated and triangulated findings through ethnographic observations at three out-of-school and school-based field sites (see Research Briefs 12, 12A, 12B, and 12C), selected for their history of portfolio usage.

Who Were the Survey Respondents?

Forty-one of the youth-oriented makerspaces responding to our survey hailed from across the United States, in addition to six sites responding from European countries (Finland, Germany, Ireland, Italy, the Netherlands, and Romania), with one makerspace responding from Colombia, South America. The sites reported serving a mean of nearly 6750 participants annually, with a wide range—25 to 200,000—of annual participants. See Figure 1 for a visual map of the locations of the makerspaces participating in the survey and their relative sizes.

Figure 1: Survey respondents from North America and South America (left) as well as Europe (right). Both maps are not at the same scale.

The respondents identified as being located in one or more physical spaces, including 42% in schools, 10% in after-school programs, 23% in community-based organizations (e.g., libraries and museums), and the remaining 25% in a range of other settings (e.g., mobile makerspaces). Respondents represent a greater percentage of school-based makerspaces than our 2014 survey, reaching 42% of total respondents, compared with 35% from those surveyed in Research Brief 6 (see Figure 2). For the purposes of this brief, we examined some of the differences between in-school and out-of-school makerspaces and report on key differences whenever found.

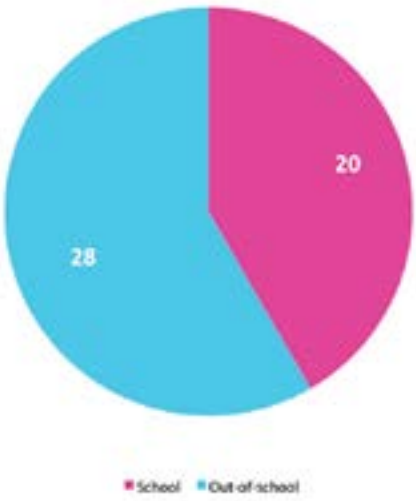


Figure 2: Proportion of out-of-school and school-based makerspace respondents.

Respondents have provided maker-oriented programming for an average of 5.1 years, an average of 6.5 years in out-of-school settings (1.4 years longer than the overall average), and 3.2 years in in-school settings, suggesting that in-school makerspaces are generally more emergent in the landscape.

WHOM DO MAKERSPACES SERVE?

Across all surveyed sites, we sought to identify the average diversity in relation to race and ethnicity, age, socioeconomic status, abilities, and gender of youth participants served. We also wanted to know more about makerspace staff diversity, in relation to their ethnicity, age, education, and gender. Unsurprisingly, there was a large variation across respondents; thus, we provide here a proportional (not weighted) average across sites.
Racial and Ethnic Diversity

Across all makerspaces surveyed, 45.5% of program participants were White, 21.6% were Black/African-American, 8% were Asian, 0.3% were Native American, 1% were of Hawaiian or Pacific Islander descent, 6.7% were of more than two races, and 16.8% didn't fall in the given categories. Of all participants, 18.9% were Hispanic/Latino(a). While these represent the mean across all respondents, the sites vary widely in the populations they serve (see Table 1).

As a common measure of identifying market diversity, we utilized diversity indexes calculated with the Herfindahl-Hirschman Index (HHI), which takes the sum of each of the reported percentages into squares and divides it by 100. This index is a common measure of identifying market diversity (Rhoades, 1993) and has been applied to study policy and program diffusion (Napoli, 1999), effects of ethnic and racial leadership diversity on financial performance (Hunt, Layton & Prince, 2015), and the representation of the interests of ethnic minorities on television programs (Fowler, Hale & Olsen, 2009), among other uses.

HHI is a suitable measure for understanding diversity of various demographic aspects within complex educational settings, especially makerspaces, which often strive to broaden participation in disciplinary areas for traditionally underserved populations. In this case, a HHI score closer to 100% indicates a less diverse space. In our analysis for racial diversity of maker-oriented program participants, HHI includes all race-related variables, and we report on ethnicity separately.

Race diversity across all makerspace respondents was 57% on average, and this is the same as the racial diversity of participants in out-of-school and in-school settings. We compared the results of this year's survey to the one administered in phase 1 of the Open Portfolio Project to determine if there were any noticeable shifts in the demographics of the survey respondents over time. We should note that this analysis is based on two independent samples (i.e., respondents weren't exactly the same at both time points). And, given the wider breath of international programs represented in this year's survey, we've isolated comparisons of race diversity to the US respondents in this comparison to closer match the sample demographics from our prior findings.

Table 1. Racial and Ethnic Diversity of Makerspaces

	MEAN	MEDIAN	STANDARD DEVIATION
HISPANIC/ LATINO	18.9%	10.0%	22.7%
AMERICAN INDIAN & ALASKA NATIVE	0.3%	0.0%	1.0%
ASIAN	8.0%	4.0%	10.6%
BLACK/ AFRICAN-AMERICAN	21.6%	15.0%	23.4%
HAWAIIAN AND PACIFIC ISLANDERS	1.0%	0.0%	2.5%
WHITE	45.5%	50.5%	31.1%
TWO OR MORE RACES	6.7%	3.0%	8.2%
OTHER	16.8%	0.0%	33.8%

Using an independent t-test to determine whether a difference existed between the means of race diversity in the 2014 survey (M = 36.4%, SD = 26.7%) and in the 2017 survey (M = 54.2%, SD = 21.5%) in the US sites, we found that there were significant differences between the two time points: t (83) = -3.368, P = .001. These results indicate that the mean of race diversity in the 2014 survey is statistically significantly lower than that in the most recent survey, indicating that there is significantly less diversity in the current sample in the US sites.

While this could be due to very different sites responding between the two time points or the small sample size of respondents, this may also be due to the influx of new school sites and makerspaces opening more easily in affluent, predominately White settings. The results could also be due to sites who identify themselves more as STEAM or innovation spaces and opted to not respond to this particular maker site survey. Further work should look at policies to preserve the overall commitment to minority or non-dominant groups in makerspaces.

AGE DIVERSITY

The most common age of youth served across both out-of-school as well as in-school makerspaces was between 11–15 years old (constituting above 42% of overall population). Over half of the youth in school makerspaces are within this age range, rendering the age diversity of these spaces as low. By contrast, the age diversity of youth within out-of-school makerspace participants is more stratified, serving over 26% of their overall youth population at 6–10 years old. Across all makerspaces, age diversity was at just over 56% on average. Figure 3 shows the age groups served across all surveyed sites.

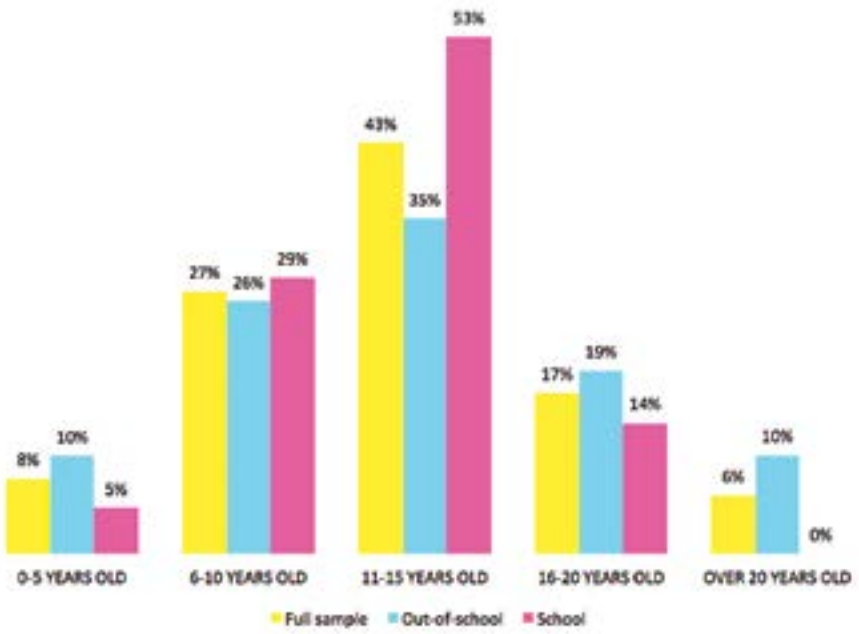


Figure 3: Average age diversity of makerspaces.

Serving Individuals with a Range of Abilities and Economic Backgrounds
All surveyed makerspaces serviced an average of approximately 11% of youth with disabilities and 35% of youth who classified for free and reduced-price meal programs. On average, schools served more diverse populations in terms of ability (14% on average) and economic background (40%, on average, receiving free or reduced-price meals). The difference of population diversity in relation to ability and economic backgrounds may be in part due to the general role of schools, and by default, the populations represented, within society, though both in-school and out-of-school makerspaces play an important role in advancing larger equity initiatives within maker education. Future surveys may also wish to break out learning and physical disabilities to better understand a range of abilities in makerspaces and how makerspaces are working to serve those needs.

GENDER DIVERSITY

Gender diversity among out-of-school and in-school makerspaces was nearly equal, with 1.6% of the makerspaces reporting to serve youth who don't conform to a binary gender definition (see Table 2). The gender diversity index calculation includes responses about non-binary and unidentified gender of youth participants. Overall, makerspaces serve a slightly larger amount of male youth (52% on average) than female youth (44% on average). This is similar across in-school and out-of-school spaces. Still, the less-than-10%-difference in gender participation among male and female youth in today's makerspaces is an important finding in comparison to the gender representation in STEM fields, which is traditionally much more lopsided (e.g., Beede et al., 2011; Riegle-Crumb, King, Grodsky, & Muller, 2012). It begs the question of how STEM initiatives do or do not closely align with makerspaces and their programming.

Table 2. Average Gender Diversity Across Makerspaces

	MEAN	MEDIAN	STANDARD DEVIATION
HHI INDEX	54.4% Full sample 55.5% Out-of-school 52.9% School	50.4% Full sample 50.5% Out-of-school 50.0% School	13.4% Full sample 14.8% Out-of-school 11.4% School
MALE	52.2% Full sample 51.4% Out-of-school 53.2% School	50.0% Full sample 51.5% Out-of-school 50.0% School	18.8% Full sample 21.6% Out-of-school 14.5% School
FEMALE	44.2% Full sample 43.2% Out-of-school 45.6% School	47.0% Full sample 45.0% Out-of-school 49.5% School	18.3% Full sample 21.2% Out-of-school 13.7% School
NON-BINARY	1.6% Full sample 2.0% Out-of-school 1.1% School	0.0% Full sample 0.0% Out-of-school 0.0% School	3.8% Full sample 4.6% Out-of-school 2.3% School
OTHER	2.0% Full sample 3.4% Out-of-school 0.1% School	0.0% Full sample 0.0% Out-of-school 0.0% School	8.7% Full sample 11.2% Out-of-school 0.4% School

Collectively, this continues to paint a picture that stands in stark contrast to the adult demographics (i.e., predominantly middle-aged, White males) attending U.S. Maker Faires or subscribing to Make: magazine (Maker Media, 2012, 2013a/b) that has been subject to a great deal of recent scrutiny (Buechley, 2013). The reported adult demographics may also not be representative of the youth who engage in making in their educational settings, outside of Maker Faires or branded opportunities. Continuing trends from our 2014 survey, this new generation of makers looks to be more diverse and holds a great deal of transformative potential, a point to consider as we think about supporting these young makers across their lifespan.

DIVERSITY OF MAKERSPACE STAFF

Out-of-school makerspaces employ, on average, 10 staff members, whereas in-school makerspaces employ, on average, 12. School staff have a higher age diversity than out-of-school staff. In both types of spaces, staff members tend to be more frequently female (54%, on average, in out-of-school and 61%, on average, in in-school makerspace). Of the surveyed population, the largest number of out-of-school employees is between 36 to 45 years old (31% on average), while the highest age group of in-school makerspace employees is between 46 to 55 years old (38% on average). Within out-of-school and in-school makerspaces, the level of education is approximately equal, with educators having experienced, on average, 16.5 years of education, which is equal to the number of years required to earn a bachelor's degree.

Race diversity is low in both school-based and out-of-school makerspace employment, with White employees comprising 50% of staff in out-of-school makerspaces and over 80% in school makerspaces and Black/African American

employees comprising 12% in out-of-school and 5% in school-based spaces. For both out-of-school and in-school sites, on average 9% of the employees are Hispanic. This presents a wide margin when compared to the higher race and ethnic diversity of youth in both types of makerspaces. There's obviously a need to diversify staff, thereby providing youth with role models who look similar to them. Some out-of-school makerspaces are building pathway programs that provide opportunities for former youth participants to become employed at the makerspace, working toward decreasing this diversity margin between adult staff and youth participants (Keune & Peppler, under review).

Makerspace Programming

We asked survey respondents to tell us about the programming they offer by selecting all that apply from a list. The most frequently mentioned programming includes courses and classes for youth (79% out-of-school, 85% school-based), community events (71% out-of-school), educator training and professional development (70% school-based), open studio time for youth (65% school-based), youth workshops (61% out-of-school), and summer camps (61% out-of-school, 25% school-based).

Comparing the programs offered across out-of-school and school-based sites reveals an interesting pattern that professional development is more frequently provided in school-based makerspaces and that out-of-school makerspaces adopt the kinds of formats that are often associated with school learning (e.g., workshops and classes). Table 3 highlights the most- and least-frequently mentioned programming offered.

Table 3. Programming Offered Across Makerspaces

	FULL SAMPLE (N=48)	OUT-OF-SCHOOL (N=28)	SCHOOL (N=20)
COURSES OR CLASSES	81.0% ↑	79.0% ↑	85.0% ↑
COMMUNITY EVENTS	63.0% ↑	71.0% ↑	50.0%
OPEN STUDIO TIME	60.0% ↑	57.0%	65.0% ↑
PROFESSIONAL DEVELOPMENT	56.0%	46.0%	70.0% ↑
WORKSHOPS	52.0%	61.0% ↑	40.0%
DROP-IN PROGRAMS	48.0%	46.0%	50.0%
SUMMER CAMPS	46.0%	61.0% ↑	25.0% ↓
EDUCATOR MEETUPS	35.0%	32.0% ↓	40.0%
PROGRAMS FOCUSED ON GIRLS	33.0%	32.0% ↓	35.0%
OTHER	**25.0%** ↓	**21.0%** ↓	30.0%
WINTER/SPRING CAMPS	17.0% ↓	21.0% ↓	10.0% ↓
MEMBER PROGRAMS	8.0.0% ↓	14.0% ↓	0.0% ↓

Note: Bolded percentages indicate most ↑ and least ↓ common responses.

MOST FREQUENT ACTIVITIES OFFERED ACROSS MAKERSPACES

We asked sites to report the activities that presented their flagship offerings, meaning those activities and materials that characterized their makerspaces and were frequently facilitated. Respondents could select up to three choices from a provided list of topics and report other topics that weren't mentioned in the list. Overall, in out-of-school and in-school makerspaces, the most frequently reported activity was "Other" (42% on average), followed by robotics and 3D printing. Out-of school makerspaces added other activities, including tinkering, exploratory play, paper art, engineering, recycled materials, CNC milling, language, and literacy. In-school makerspaces mentioned rockets and exploring recyclable materials. For both types of spaces, the least frequently reported activities included metalworking and sound design. Table 4 shows the average frequency of the activities offered across sites.

Table 4. Most Frequent Activities Offered Across Makerspaces

	FULL SAMPLE (N=48)	OUT-OF-SCHOOL (N=28)	SCHOOL (N=20)
OTHER	42.0% ↑	61.0% ↑	15.0%
3D PRINTING	29.0% ↑	21.0% ↑	**40.0%** ↑
ROBOTICS	27.0% ↑	25.0% ↑	**30.0%** ↑
2D DESIGN	21.0% ↑	18.0% ↑	**25.0%** ↑
FIBER ARTS	15.0%	14.0%	15.0%
INTERACTIVE ART	15.0%	11.0%	20.0%
LASER CUTTING	15.0%	7.0%	25.0% ↑
PHYSICAL COMPUTING	15.0%	18.0% ↑	10.0%
WOODWORKING	15.0%	11.0%	20.0%
MUSIC	13.0%	14.0%	10.0%
PROGRAMMING	13.0%	11.0%	15.0%
FASHION DESIGN	10.0%	14.0%	5.0%
SCRATCH (PROGRAMMING)	10.0%	11.0%	10.0%
GARDENING	8.0%	4.0%	15.0%
FILMMAKING	6.0%	11.0%	0.0% ↓
THEATRE ARTS	6.0%	7.0%	5.0%
WEB DESIGN	6.0%	4.0%	10.0%
E-TEXTILES	4.0%	7.0%	0.0% ↓
VIDEO GAME DESIGN	4.0%	4.0%	5.0%
COOKING	2.0%	0.0% ↓	5.0%
GAME DESIGN	1.0% ↓	4.0%	5.0%
METAL WORKING	0.0% ↓	0.0% ↓	0.0% ↓
SOUND DESIGN	0.0% ↓	0.0% ↓	0.0% ↓

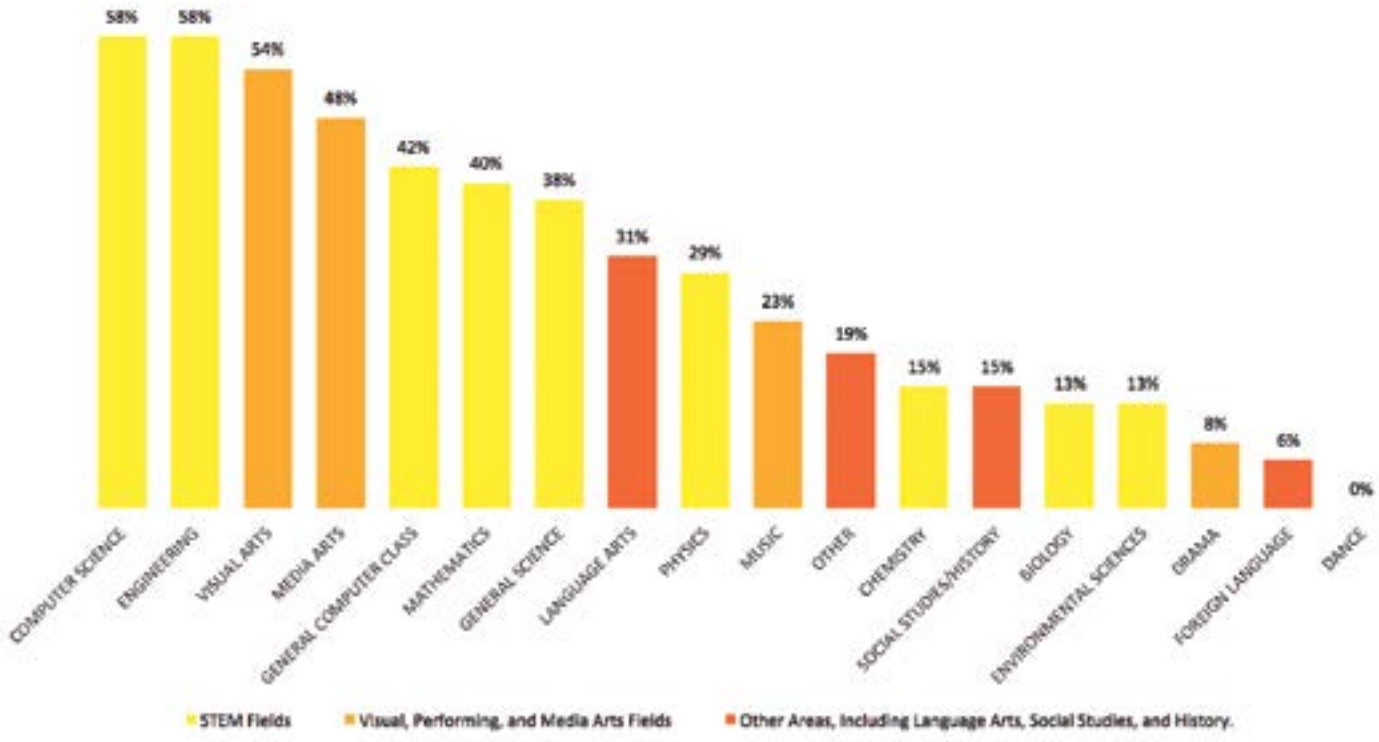
Note: Bolded percentages indicate most ↑ and least ↓ common responses.

SCHOOL SUBJECTS TO WHICH MAKERSPACES ALIGN THEIR PROGRAMS

Overall, makerspaces reported that their programming aligns with an average of five school subjects. The school subjects that out-of-school makerspace respondents aligned most frequently with were engineering (61%), computer science (57%), media arts (57%), and visual arts (57%; Figure 4). The subjects least aligned with their maker programs were foreign languages (0%), dance (0%), and biology (4%). School makerspaces aligned their programs most frequently with computer science (60%), engineering (55%), mathematics (55%), and visual arts (50%). The subjects they reported as least frequently aligning with their program were dance (0%), drama (10%), environmental sciences (15%), and foreign languages (15%).

Comparing the alignment among out-of-school and in-school spaces shows that there's a larger divergence among media arts (57% out-of-school, 35% in-school) and general computer science (46% out-of-school, 35% in-school) that is, on average, more frequently aligned with out-of-school makerspace programs. In contrast, language arts (21% out-of-school, 45% in-school), music (18% out-of-school, 30% in-school), chemistry (11% out-of-school, 20% in-school), social studies/history (11% out-of-school, 20% in-school), biology (4% out-of-school, 25% in-school), and foreign language (0% out-of-school, 15% in-school) are, on average, more frequently aligned with school maker education programs. Across the board, it appears that there are many subjects to be explored within the context of maker-centered learning and room for improvement across disciplinary domains, in order to support a broader spectrum of interests and possibilities for engagement.

Figure 4: Alignment of maker programs with school subjects.



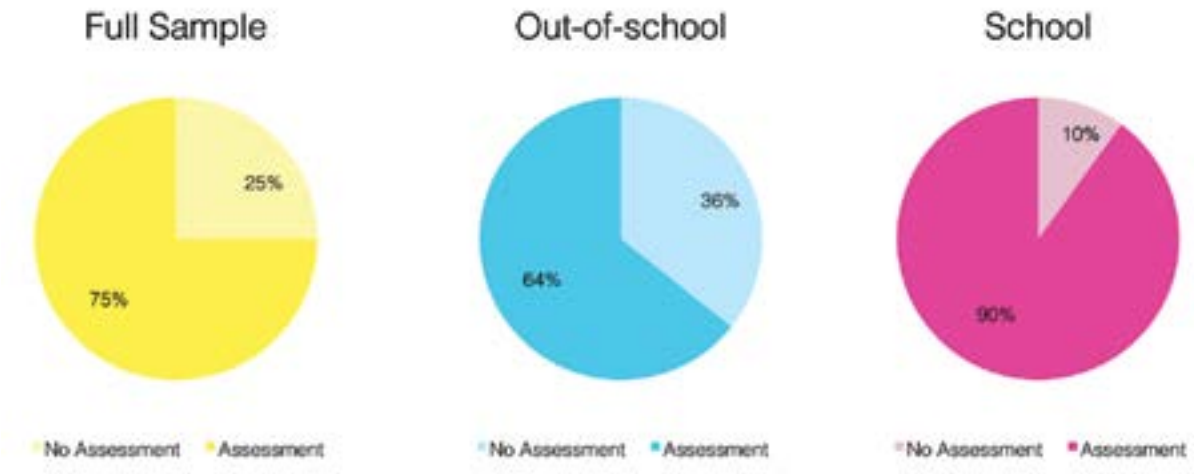
Comparing these findings to the prior survey administered in 2014, we can see shifts in alignment. Today, makerspaces most closely align their program offering with STEM fields, whereas they previously aligned their programming most closely with visual, performing, and media arts fields (i.e., digital media arts and visual arts). For example, while survey respondents aligned their programs, on average, 72% with digital and media arts and, on average, 70% with visual arts in 2014, this alignment changed to 48% for media arts and 54% for visual arts in 2017. Alignment with computer science remained similar (58% in 2017 and 57% in 2015), while alignment with engineering increased by over 50% and with mathematics and social studies/history decreased by over 10%.

Overall, this seems to suggest that makerspaces are aligning themselves with the STEM policy movements, including an increased emphasis on computer science for all, as well as engineering. However, the data analysis may also indicate that, in 2014, the sites early to embrace making were already engaged in media making in the realm of digital and visual arts, matching the attention and funding toward digital media at that time. In the years since, STEM-focused funding and widespread growth has opened up the subjects to which maker education connects.

Assessment in Makerspaces

Across all makerspaces, three-quarters of survey respondents reported having assessment measures in place. However, there was a notable difference between in-school and out-of-school makerspaces, with 90% of school-based spaces integrating assessment, which might be due to curricular integration into other subject areas and/or pressures to grade youth work for demonstrable learning outcomes. By contrast, only 64% of out-of-school makerspaces reported the use of assessment in their programs (see Figure 5). Across both types of sites, the use of assessment seemed much larger than anticipated, revealing the size of the demand for high-quality maker assessment. At the same time, it also demonstrates that practice is ahead of research; despite researchers not providing a firm answer on how makerspace learning can be measured, educators in and out of school are moving forward to meet the practical realities.

Figure 5: Assessment in out-of-school and school makerspaces.



ASSESSMENT TYPES

Of those out-of-school makerspaces that incorporated assessment into their programs (N=36), the most frequent approaches are youth self-assessment (i.e., a one-time reflection activity at the start or end of a program or accompanying each project; 36%), exit survey (i.e., a form presented to youth at the end of a program or activity that asks questions about their learning experiences; 32%), and peer assessment (i.e., critique or guided comments by a fellow youth participant; 29%).

In schools, the most frequently reported assessment types were self-assessment (65%), rubrics (60%), and portfolio assessment (55%). It's not surprising that schools report portfolio assessment more frequently considering this approach historically emerged as a school-based assessment alternative to numeric representations of student achievement (see Research Brief 11, "Introducing Phase 2 of the Open Portfolio Project: Assessment in Makerspaces"). Furthermore, rubrics are far more likely to be used in school-based settings than out-of-school settings presumably because they require a priori planning and likely stress common outcomes among makers, while out-of-school settings typically allow for more divergent and emergent outcomes.

It's important to note, too, that the least prevalent assessment types used across in-school and out-of-school contexts are those most heavily stressed in standard assessment measures—such as multiple choice, matching item, and essay questions—likely because they're a poor match to the types of learning occurring in makerspaces. See Table 5 for more detailed information on assessment types used and their usage among makerspaces. Examples of self-assessments, peer assessments, rubrics, and adult modeling are included in the Appendix of Research Brief 14.

Table 5. Assessment Types Utilized Among Makerspaces

	FULL SAMPLE (N=48)	OUT-OF-SCHOOL (N=28)	SCHOOL (N=20)
SELF-ASSESSMENT	**48.0%** ↑	36.0% ↑	65.0% ↑
PORTFOLIO ASSESSMENT	35.0% ↑	21.0%	55.0% ↑
EXIT SURVEY	33.0% ↑	32.0% ↑	**35.0%**
PEER ASSESSMENT	33.0% ↑	29.0% ↑	40.0%
RUBRICS	29.0%	7.0%	60.0% ↑
SHORT ANSWER QUESTIONS	21.0%	18.0%	25.0%
ADULT MODELING	17.0%	4.0% ↓	35.0%
PRE/POST-TESTS	10.0%	11.0%	10.0% ↓
ESSAY ITEMS	6.0% ↓	4.0% ↓	10.0% ↓
MATCHING ITEMS	2.0% ↓	0.0% ↓	5.0% ↓
MULTIPLE CHOICE	2.0% ↓	4.0% ↓	0.0% ↓

Note: Bolded percentages indicate most ↑ and least ↓ common responses.

Given the emphasis in both settings on self-assessment by youth, 33% of all responding makerspaces (7 out-of-school, 9 school-based) reported employing sentence starters to assist in youth's reflections. The prompts and sentence starters covered 18 aspects of making, among which learning, tools and materials used, project descriptions, challenges/failure, and proposed changes were the most frequent. Prompts included, "I had difficulty when...," "I solved my challenge by...," and "Did you use a new tool? Which one? How was it used to make your project?"

PORTFOLIOS AND ASSESSMENT

Nearly a quarter of out-of-school makerspaces (21%) engaged in portfolio assessment, whether it be of publicly available or internally stored work, as compared to the 53% of school-based makerspaces that did (see Figure 6). Of the spaces that engaged in portfolio assessment, 75% of school-based makerspace respondents considered portfolio assessment at least "very important," compared with 42.8% of out-of-school makerspaces (see Figure 7). None of the schools thought that portfolios were "not at all" important, though five out of 28 out-of-school makerspaces did.

Overall, portfolio assessment was considered less important by out-of-school makerspaces than by in-school makerspaces, which also explains why a lower number of out-of-school makerspaces perform portfolio assessment in comparison to in-school makerspaces. This data suggests that portfolio assessment may not be a one-size-fits-all solution to assessment in makerspaces and may have greater perceived value to school-based than out-of-school settings.

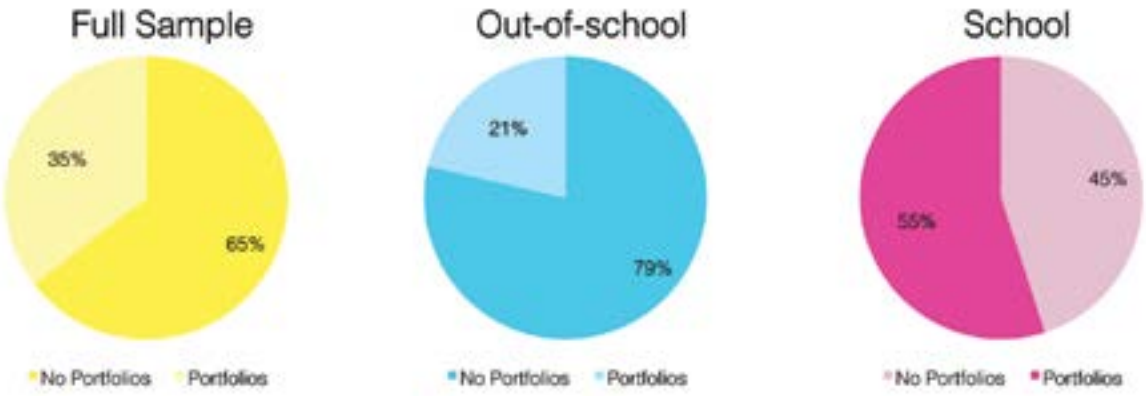


Figure 6: Portfolio assessment in out-of-school and school makerspaces.

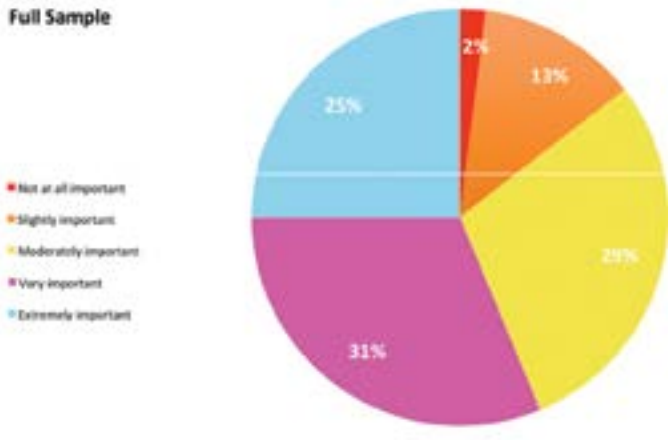


Figure 7: Importance of portfolio assessment for out-of-school and school makerspaces.

On the whole, about 40% of sites reported that they publicly post portfolios online for broader audiences. However, this was an area of stark difference between in- and out-of-school makerspaces. For example, 46% of the out-of-school makerspaces reported that they published portfolios and documentation of youth projects online, while only 20% of the in-school makerspaces shared youth projects openly beyond the makerspace or school community (see Figure 8). Of those, 66% of the responding sites (12 in-school spaces, 20 out-of-school spaces) reported sharing youth projects on a collective total of 27 platforms. The most popular platforms for this purpose included YouTube (27% on average), Facebook (25% on average), Instagram (23% on average), and Google Drive (16% on average). (See also Research Brief 13, "Youth Motivations for Open Portfolios.")

Figure 8: An open portfolio by a teen from the Digital Harbor Foundation in Baltimore, MD, including posts across three pages that are all openly available to the public.

A total of 91% of the respondents reported that they exhibit projects in their space. Sites mentioned a total of 15 ways of displaying projects in physical locations. Among these, the most frequently mentioned were display cases and special shelves; on top of cabinets and shelves; wall installations; during exhibitions, showcases, and gallery walks; in public and community locations; as well as everywhere throughout the makerspace where space was available. One space reported that youth projects become part of the furniture used in the makerspace, and three spaces reported displaying youth projects on screens in the space as well as published in local newspapers. See Figure 9 for more information.

Portfolio implementation seems to be fueled more by youth documentation practices than by staff practices around documentation and display. This suggests that when a venue adopts a portfolio system, a large component of its success involves engaging youth in self-driven documentation to help ensure that it becomes a more sustainable practice of the community. The implications are that the intentional development and dissemination of documentation practices need to be cultivated in makerspaces over time, which can lay the foundation for higher quality assessment practices. This is represented through the correlation matrix (see Figure 9), which shows that portfolio assessment and youth documentation practices correlate more so than portfolio assessment and staff practices.

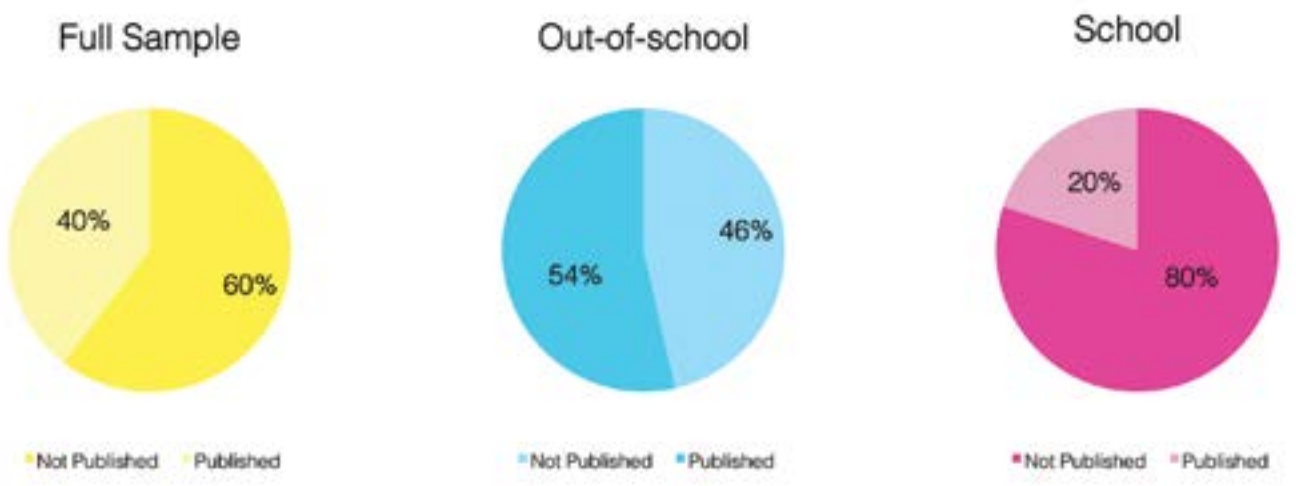


Figure 9: Portfolios published beyond the makerspace and portfolio assessment correlation matrix

	Portfolio Assessment	Youth Capturing	Staff Capturing	Project Display
Portfolio Assessment	1			
Youth Capturing	**0.4947**	1		
Staff Capturing	0.2893	0.2652	1	
Project Display	0.2405	**0.4862**	0.3223	1

BARRIERS TO PORTFOLIOS

On average, neither the out-of-school nor the school makerspaces reported that portfolios were difficult to adapt into maker education, disagreeing with the notion that documentation takes time away from making, that it's challenging to integrate documentation with making, that making is mobile and documentation is stationary, and that documentation interrupts the flow of making. However, a number of spaces reported other barriers to documenting making, such as access to dedicated technology for documentation (23%), privacy concerns (e.g., sharing youth work, collecting consent and release forms, data security; 14.5%), and lack of youth motivations to capture making (14.5%).

Other barriers mentioned were youth insecurity to share unfinished work (4%), youth forgetting to capture work (4%), and youth—particularly young makers—having the requisite skills for capturing (4%). This echoes the barriers makerspaces mentioned in our 2014 survey. Resources, including software, hardware, and staff support, continue to be a challenge for integrating portfolios into maker education settings. Furthermore, these barriers speak to the need for larger policy issues, as well as the need to resource makerspaces to capture their making well and cultivate practices that are well aligned with youth motivations (see Research Brief 13, "Youth Motivations for Open Portfolios").

REASONS FOR PORTFOLIO ASSESSMENT

In order to better understand the rationale for investing in portfolios and assessment systems, we thought it helpful to gain a grounded perspective of the adult motivations. For out-of-school makerspaces, the most predominant reasons for portfolio assessment were self-reflection (86%), development of community inside of the makerspace (57%), and using portfolios for youth to develop community outside of the makerspace (54%; see Figure 10). Surprisingly, reasons that related to college preparation, college applications, and career development were the least mentioned among out-of-school makerspaces.

For in-school makerspaces, the most predominantly mentioned reasons for portfolio assessment were self-reflection (95%), program development (70%), and community development inside of the makerspace (55%). The first two responses mentioned by schools aren't surprising, as these are the main reasons for portfolio assessment mentioned in the literature.

In terms of portfolio assessment rationale, there were two key differences between school-based and out-of-school spaces: out-of-school makerspaces were far more likely to desire connections to communities through youth portfolios (54% vs. 35% for in-school spaces), potentially to support the youth themselves and/or to fundraise or promote the space. In comparison, school-based makerspaces were more likely to use portfolios to further their program development (70% vs. 36% for out-of-school spaces). In out-of-school spaces, the predominant adult motivations, in supporting community development, resonate with what we uncovered in regard to youth motivations (see Research Brief 13, "Youth Motivations for Open Portfolios"). Youth found it motivating to create portfolios when it led to increased engagement with and growth of the community in- and outside of the makerspace.

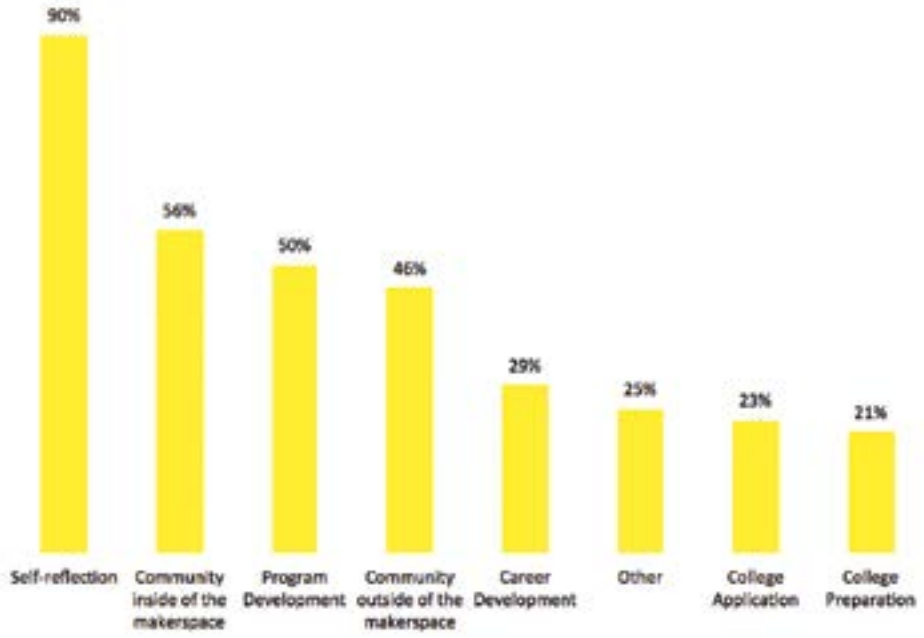


Figure 10: Reasons for portfolio assessment in out-of-school and school makerspaces. (Makerspaces could select multiple responses.)

The degree to which youth assessment data shaped administrative decision-making for the makerspace also varied across spaces. Across all respondents, 33% of the makerspaces reported that their assessment informed decisions on instructional design, 16% reported that their assessment informed decisions on future programming, 8% stated that it informed funding and administrative decisions, and 8% reported professional development improvements based on assessment. Other decisions informed by assessment included educational research, outreach, featured online programs, modes of communication with students, strategies for broadening gender equity, and the purchasing of materials. This echoed the need in prior survey as well; in addition to technology resourcing, there's a need for ongoing professional development to support work on portfolio assessment in makerspaces.

FUTURE PLANS FOR IMPROVING DOCUMENTATION

A total of 36 makerspaces reported that they have plans to increase portfolio assessment. The most frequently mentioned aspects for improvement included increasing the number of projects that were being captured, improving the technical setup of documentation, increasing youth capturing, and making portfolio assessment more interest-driven by, for example, supporting a range of possibilities for capturing opposed to only one portfolio practice and increasing the number of educators who were facilitating portfolios within courses and programs of the same makerspace. Several makerspaces also asked for professional development, including in-person workshops, online courses, and publications. This is part of the rationale for the creation of the Maker Ed Practical Guide for Open Portfolios, as well as the continuing professional development offered through Maker Ed.

Conclusions

Our survey continued to track the emerging demographics of the maker education network. While overall makerspaces seem to be continuing to serve diverse populations in terms of ability, age, and gender, the race of youth participants in the US sites in 2017 is significantly less diverse compared with that of participants in the 2014 survey. As the network shifts over the years, this finding serves as a reminder to renew our commitments to underrepresented groups within the larger maker movement. In addition, this research increases our understanding of the extent to which portfolios and assessment practices are taking place amongst the network and the reasons and rationales for doing so. Furthermore, this work helps to inform future research and practice to respond to the demonstrable need amongst the network for high-quality portfolio and assessment practices.

References

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011). Women in STEM: A gender gap to innovation. U.S. Department of Commerce Economics and Statistics Administration, 04 (11), 1-11.

Buechley, L. (2013, October). Thinking About Making. Keynote speech presented at FabLearn Conference, Stanford University.
Fowler, E. F., Hale, M., & Olsen, T. D. (2009). Spanish-and English-language local television coverage of politics and the tendency to cater to Latino audiences. The International Journal of Press/Politics, 14(2), 232-256.

Hunt, V., Layton, D., & Prince, S. (2015). Diversity matters. McKinsey & Company, 1.

Keune, A. & Peppler, K. (under review). Materials-to-develop-with: the Making of a Makerspace.

Maker Media (2012). Maker Faire Bay Area Attendee Study. Online. Available at http://cdn.makezine.com/ make/sales/maker-faire-bay-area-survey-09-2012.pdf

Maker Media (2013a). Maker Faire Bay Area Attendee Study. Online. Available at http://cdn.makezine.com/ make/sales/MFBA%202013%20Survey%20.pdf

Maker Media (2013b). World Maker Faire New York Attendee Study. Online. Available at http://makermedia.com/wp-content/uploads/2013/01/WMFNY-2014-deck_ FOR-PRINT.pdf

Napoli, P. M. (1999). Deconstructing the diversity principle. Journal of Communication, 49(4), 7-34.

Rhoades, S. A. (1993). The herfindahl-hirschman index. Fed. Res. Bull., 79, 188.
Riegle-Crumb, C., King, B., Grodsky, E., & Muller, C. (2012). The more things change, the more they stay the same? Prior achievement fails to explain gender inequality in entry into STEM college majors over time. American Educational Research Journal, 49(6), 1048-1073.

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Appendix

Open Portfolio Project Maker Site Survey 2017

Thank you for agreeing to participate in the Open Portfolio Project Maker Site Survey 2017. The data collected through this survey will inform research and general understanding of the demographics and assessment practices within maker education programs and sites.

It should take between 20 to 30 minutes to complete this survey. Once started, you may leave your survey and then re-enter where you left off when you click the survey link again. This works by placing a cookie on your browser that keeps track of the survey progress. The survey will close on June 16th, 2017.

By starting this survey, you consent to participate. Your responses will remain strictly confidential. This research is conducted by Dr. Kylie Peppler at Indiana University in collaboration with Maker Ed. Please direct any questions or report a research-related problem to Dr. Kylie Peppler at kpeppler@indiana.edu or (812) 856–8381.

RESEARCH PROCEDURES – This survey is conducted to inform research and general understanding of the demographics and assessment practices within maker education programs and sites. If you agree to participate, you will be asked to complete an online survey that will take between 20 to 30 minutes.

RISKS AND BENEFITS – There are no foreseeable risks for participating in this research. There are no benefits to you as a participant other than to advance research on demographics and assessment practices within maker education programs and sites.

CONFIDENTIALITY – The data in this study will be confidential. Identifying information will not be disclosed in any publications that result from this study. Only the research team will have access to the data collected during this study. Survey data will be stored on a password-protected external hard drive, which will be maintained in a locked office at Indiana University. We will keep the data for five years following the study, at which point all data will be erased from the hard drive.

PARTICIPATION – Your participation is voluntary, and you may withdraw from the study at any time and for any reason. If you decide not to participate or if you withdraw from the study, there is no penalty or loss of benefits to which you are otherwise entitled. There are no costs to you or any other party.

CONTACT – If you have any questions regarding your rights as a research subject or your participation in this research, please contact the Indiana University Human Subjects Office at (800) 696–2949 or (812) 856–4242. This research has been reviewed according to Indiana University Human Subjects Office procedures governing your participation in this research.

By clicking the box below, you indicate that you have read and understood the above Informed Consent statement and you agree to participate in this survey.

Thank you again for your participation!

Please provide consent to participate. *

☐ I have read and understand the above Informed Consent Statement and agree to participate in this survey.

MAKER EDUCATION PROGRAM OR SITE: PLEASE PROVIDE INFORMATION ABOUT YOUR PROGRAM

Program or site name *
Program or site location (City, State, Country) *
- City
- State
- Country

When did your maker education program first start? Please provide the month and year. (We realize that you may identify your programming more with STEM, STEAM, innovation, invention, or other.) *
- Year (YYYY)
- Month (MM)

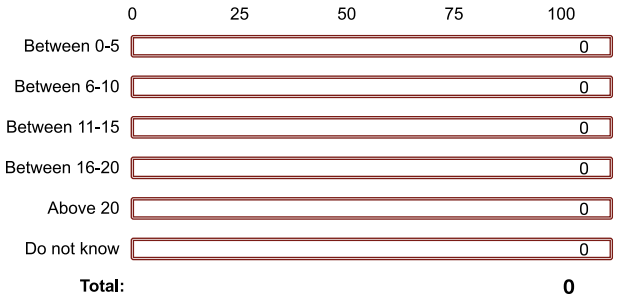
What type of setting is your maker education program part of? Please select the one that best fits your setting. (The responses to this question will help us in the response recruitment process.) *
- School
- Museum
- Library
- Mobile (e.g., bus)
- After-school clubs and activities
- Pop-up shop
- Other

MAKER EDUCATION PROGRAM DEMOGRAPHICS: YOUTH PARTICIPANTS – PLEASE PROVIDE DEMO

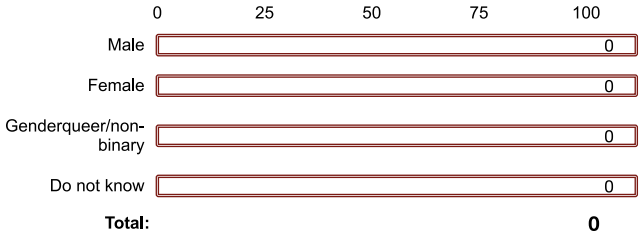
How many youth participate in your programs? Please estimate the unique number of participants in your programs during a typical day, week, and year. *

- Youth participants per day
- Youth participants per week
- Youth participants per year

What is the age range of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *

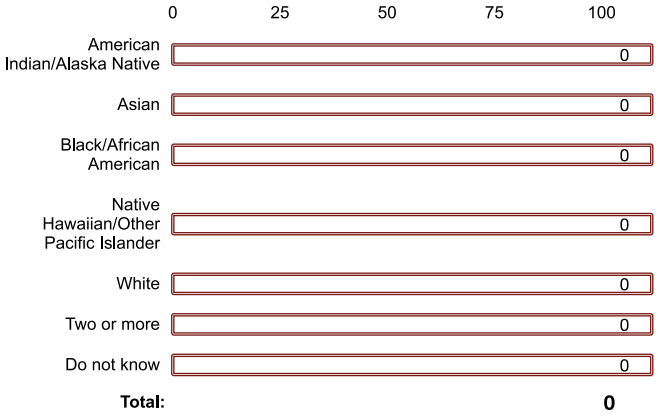


What is the gender distribution of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *

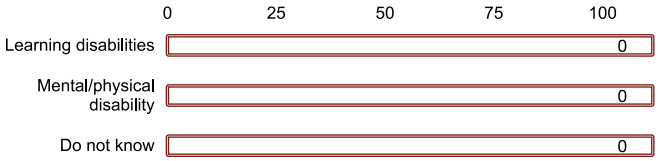


What is the ethnicity of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *

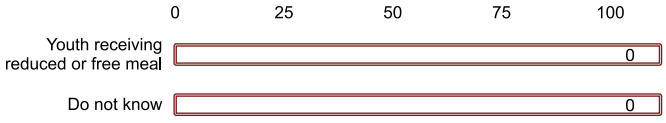
What is the race of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.)



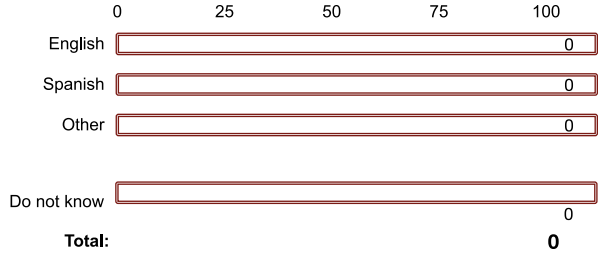
If applicable, what are the disability types of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown.



What percentage of youth are eligible for a free or reduced meal? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown.



What is the dominant household language of your youth participants? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *

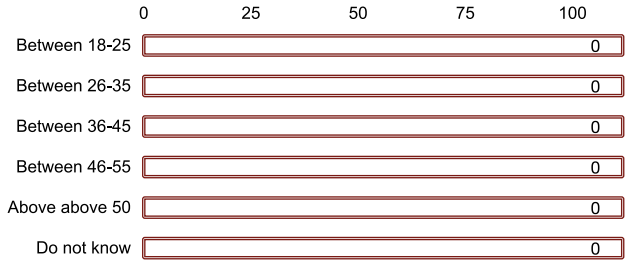


MAKER EDUCATION PROGRAM DEMOGRAPHICS: STAFF MEMBERS – PLEASE PROVIDE DEMOGRAPHIC INFORMATION

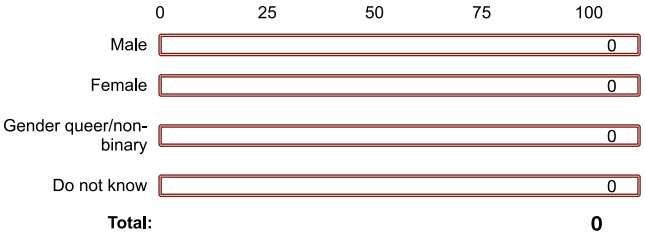
How many staff members does your maker education program employ? Please include both educators and administrators. Please estimate the number of staff in the program per day and year. *

- Daily staff members
- Yearly staff members
- Overall staff members

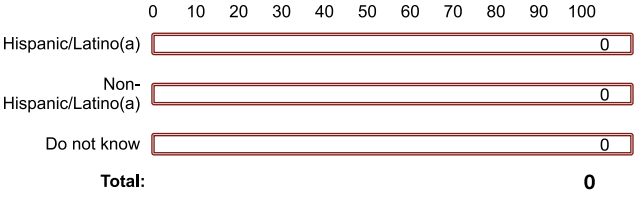
What is the age range of your staff members? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *



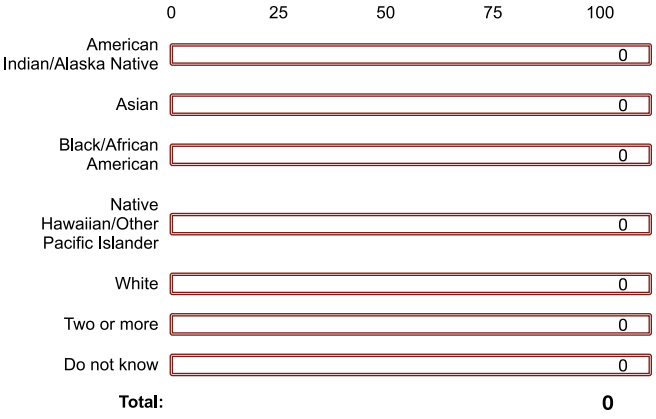
What is the gender distribution of your staff members in percent? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *



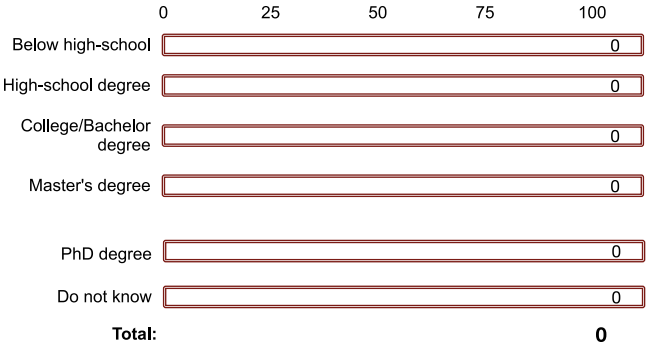
What is the ethnicity of your staff members? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *



What is the race of your staff members? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100.) *



What is the highest level of education of your staff members? Please use the most recent full/regular week of your program as a reference to provide an estimated percentage breakdown. (Total sum must be 100). *



MAKER EDUCATION PROGRAMS

What are the formats of the programs you offer? Please select all that apply. *

- Community events
- Courses or classes for youth workshops
- Drop-in programs for youth Educator meetups
- Educator training or professional development
- Member programs
- Open studio time for youth Youth programs focused on girls
- Youth summer camps
- Youth winter or spring camps Youth workshops
- Other

What topics or areas best describe your flagship offerings? Please select 1-3 choices. *

- 2D design (including graphic design)
- 3D printing
- Cooking
- E-textiles
- Fashion design
- Fiber arts (e.g., knitting, weaving, sewing)
- Filmmaking
- Game design
- Gardening
- Interactive art
- Laser cutting
- Metalworking
- Music
- Physical computing
- Programming Robotics
- Scratch programming
- Sound design
- Theatre arts
- Video game design
- Web design
- Woodworking
- Other
- Other
- Other

If your site or programs were to be offered during the school day, in which of the following subject areas or disciplines would they most likely be offered? Please select all that apply. *

- Biology
- Chemistry
- Computer science
- Dance
- Digital or media arts
- Drama
- Engineering Environmental science
- General computer class
- General science
- Language arts
- Mathematics
- Music
- Physics
- Foreign language
- Social studies/history
- Visual arts
- Other

GENERAL ASSESSMENT

We are interested in the kinds of learning assessments used in makerspaces including forms of recording the process and products of making. Do you assess the maker work of your youth or evaluate maker activities at your maker education program or site in any way? *

- Yes
- No

What kind of assessments do you use? Please select all that apply. *

- Adult modeling
- Essay items
- Exit surveys
- Matching items
- Multiple choice items
- Peer assessment
- Portfolio assessment
- Pre and post-tests
- Rubrics
- Self-assessment
- Short answer questions

Specific to your program or site, what decisions do the above assessment inform? These can include, for example, instructional design decisions or administrative decisions. Please describe by providing examples.

PORTFOLIOS

How important is it for you and your maker education program or site to have youth document the maker activities that they take part in? *

- Extremely important
- Very important
- Moderately important
- Slightly important
- Not at all important
- Why do you consider it important to document and capture the process of making for youth, educators, and administrators? Please select all that apply. *
- Career and job opportunities
- College admissions
- College preparation
- Community building inside the maker education program
- Community building outside the maker education program
- Development of instruction Learner self-reflection Other

YOUTH PORTFOLIO PRACTICES

Do youth capture their making at your maker education program or site? *
- Yes
- No

How often do youth document and capture making? Please select one option. *
- Once a day
- Multiple times per day Once a week
- Multiple times per week Once a month
- Multiple times per month
- Other

We would like to learn more about the online content that your youth publish. Please share examples of youth documentation, if available (e.g., URLs to their portfolios or other documentation).

Do you provide youth with prompts or sentence starters for documenting maker education activities? *
- Yes
- No

Please share any prompts or sentence starters you provide to youth for documenting maker education activities.

Do youth publish or display their work online, outside of the site/platform that your organization uses? *
- Yes
- No

Which platforms do youth publish on apart from the tools provided by the makerspace? Please select all platforms that you have seen youth use. *
Adobe Voice Behance
- Blogger
- DIY.org
- Dropbox
- Evernote
- Facebook
- Flickr
- Freshgrade
- Github
- Google Drive
- Google for Educators
- Hackpad
- Instagram
- Instructables
- Jellycam Jing
- Pathbrite
- Pinterest
- Portfoliobox
- Screencast-o-matic
- Seesaw

- Shadow Puppet Edu
- Snapchat
- Soundcloud
- TACKK
- Thingiverse
- Tumblr
- Twitter
- Ubersnap
- Vimeo
- Weebly
- Wix
- Wordpress
- YouTube
- Other

STAFF MEMBER PORTFOLIO PRACTICES

Do staff members document youth projects, processes, or practices? *
- Yes
- No

How do staff member document at your maker education program? Please briefly describe the process of documentation including the tools used (software and hardware), and any other special practice (e.g., videos of themselves or their friends making, process pictures, reflection text, music etc.). Please provide as many details as possible.

CHALLENGES AND FUTURE PLANS

To what degree to you agree or disagree with following statements related to documentation? Please select responses for all options. *

	Strongly Agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
Documentation takes time away from making	◎	◎	◎	◎	◎
It is challenging to integrate documenting with making	◎	◎	◎	◎	◎
Making is mobile and documentation is stationary	◎	◎	◎	◎	◎
Documentation interrupts the flow of making	◎	◎	◎	◎	◎

Are there any additional reasons that prevented or stopped youth, educators, and administrators from documenting their maker work? If so, please describe the reasons.

Are there plans for your maker education program to increase or improve documentation of making in the future? *
- Yes
- No

What are potential plans to increase or improve documentation of maker education practices in the future?

MAKER EDUCATION LEARNING ENVIRONMENT

Are youth projects displayed in your maker education environment? *
- Yes
- No

How are the projects displayed? Please describe the projects and how they are presented.

We are working on an online platform to view 360° photographs of maker-educational learning environments: www.360makerspaces.com We found that these pictures can be useful and inspiring for educators to identify material design aspects that they would like to include into their own makerspace setups. We warmly invite you to participate in this initiative. If you would like for your space to be featured on our website, please provide your contact information (e.g., email address) so we can follow up with you with instructions on how to participate.

Do you have anything else you would like to add, or do you have any questions you would like to direct to us?