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

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Open Portfolio Project

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.

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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.

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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.
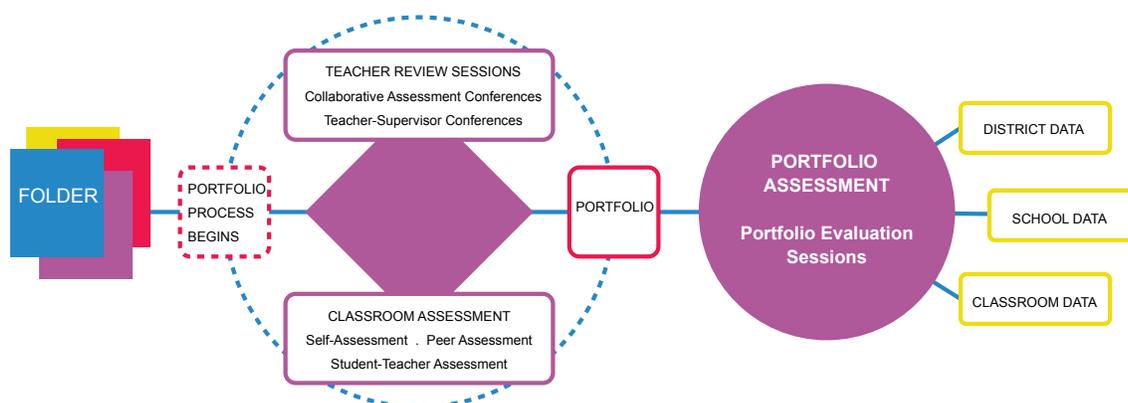
Arts PROPEL is a Project Zero project at the Harvard Graduate School of Education, led by Howard Gardner and Steve Seidel (see Figure 1). One of the principal components of Arts PROPEL is a comprehensive portfolio of student work, including works in progress (as opposed to just final pieces). The portfolio 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.

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.

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.

FOLDER

PORTFOLIO PROCESS BEGINS

TEACHER REVIEW SESSIONS
Collaborative Assessment Conferences
Teacher-Supervisor Conferences

CLASSROOM ASSESSMENT
Self-Assessment . Peer Assessment
Student-Teacher Assessment

PORTFOLIO

PORTFOLIO ASSESSMENT
Portfolio Evaluation Sessions

DISTRICT DATA

SCHOOL DATA

CLASSROOM DATA

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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.

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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.

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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?

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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?

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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?

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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.

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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.

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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.

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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.

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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.

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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.

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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.

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Acknowledgements

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