

## Beyond Rubrics Design Principle #1

# Assessment in making should be construct driven.

While making is a process majorly driven by learners, when it comes to assessment of making in schools, the teachers who select a project idea need to initiate their assessment process by clarifying what skills, mindsets, or topic areas they intend to foster with the maker activity.

Any assessment design should start with identifying what knowledge, skills, or dispositions we want to assess (Messick, 1994). Since educators are looking for demonstrated evidence for underlying competencies, they need to consider if the students' learning experience will afford abundant opportunities to elicit evidence of their competencies. In practice, however, educators tend to prioritize exploration of project ideas, activities, themes, materials, or tools when they design activity ideas rather than starting with what constructs they value (Wardrip & Brahms, 2016). Since maker activities often enable learners to produce interesting and professional-looking products without much effort (Blikstein, 2013), both students and teachers focus too much on whether they can perform the tasks at hand while not addressing the fundamental skills and dispositions that the task allows them to develop further.

Coach A (personal communication, April 2, 2018) from the school in California touched upon the importance of creating a space for students to demonstrate their learning through making:

*[T]his learner learns best by speaking, so how can we develop an assessment that really can help them (...) versus this student's great at making videos, so how can*

*we develop an assessment strategy to make sure they can demonstrate their understanding through this, and not standardizing it across the board? And I say for all students, because all students have their own learning modalities, and giving them opportunities to demonstrate their understanding of content [is important].*

He noted that when a student appears to be underperforming, it does not necessarily mean the student lacks understanding or skills but it could be the case that the activity at hand does not allow multiple ways that the student can demonstrate their competence in the underlying skills.

This issue became salient when the team worked closely with teachers during a design workshop. For example, a teacher from Virginia had a strong interest in helping develop student agency but her original activity had limited opportunity for students to make their own choices (Teacher D, personal communications, April 12, 2019). With limited time and opportunities, students could not adequately demonstrate agency. After realizing this limitation within the activity in relation to the skills that she intended to foster, she modified the activity design to allow for students to demonstrate how well they make their own decisions. Through these insights, we learned that opportunities for teachers to think critically about the competencies they seek, as they are designing maker activities, can enable them to design assessments that specifically focused on the constructs.

Another rationale of this principle comes from the need for educators to assess broader dimensions of their students' learning beyond

content knowledge. Assessment of and focus on the standards are often prioritized over the assessment of the cognitive and non-cognitive skills being developed. Most formal classroom teachers are expected to be accountable for how a maker-centered approach can be used to “teach” certain learning outcomes, especially standards-related content topics. However, the very reason educators implement maker-centered approaches is that the approach allows them to support student learning that is not just about content knowledge but also other skills and dispositions such as agency, collaboration, and risk-taking (Clapp, Ross, Ryan, & Tishman, 2016).

The interest in assessing broader learning outcomes aligned with themes that emerged from the teacher interviews. In addition to content understanding, teachers provided a variety of learning outcomes that they are looking for in students in relation to making. Agency is one of the most frequently mentioned. Teacher C, who teaches science, described that she strives to look for students taking ownership and taking actions using their judgment: “when you see them not wait for my guidance to jump into something, it’s really when I know that something’s going right” (personal communication, November 5, 2018). Other outcomes include engagement in learning processes and risk-taking.

While teachers have a decent understanding of what these non-standards-based outcomes mean, they often do not have a clear understanding of what evidence of these skills should look like because these skills have not been explicitly addressed in current assessment practices. As a result, communicating learning outcomes with students and other stakeholders becomes a

large burden for teachers.

Our examination of conversations with teachers implies that when designing assessment in maker-centered learning, it is important to have teachers start by clearly defining what they expect their students to gain from the learning activities before starting to design the process of learning. The learning outcomes can include skills and dispositions beyond content knowledge, but teachers need to deeply reflect on what assessment might look like in the context of their learning environments.

Excerpted from Murai, Y., Kim, Y., Chang, S., & Reich, J. (2020, January 17). Principles of Embedded Assessment in School-Based Making. <https://doi.org/10.35542/osf.io/amvs2>



**MAKER ED**



This work was created in collaboration with Albemarle County School District, Portola Valley School District, and San Mateo County Office of Education. This material is based upon work supported by the National Science Foundation under Grant #1723459. It is released under [Creative Commons BY-SA-NC 4.0](https://creativecommons.org/licenses/by-sa/4.0/) license.

## Beyond Rubrics Design Principle #2

# *Assessment in making should be seamlessly woven into the culture of the classroom and learning environments.*

In maker-centered learning, it is particularly important that assessment is embedded not only in the activity students are engaged in but also in the classroom norms and culture. Embedded in this context means “opportunities to assess student progress and performance are integrated into the instructional materials and are virtually indistinguishable from the day-to-day classroom activities” (Wilson & Sloane, 2000).

This principle emerged from conversations with several teachers who mentioned the difficulty of pausing students to ask them to document or reflect on their learning experience. One teacher from Virginia explained, “It’s hard, even for me, when I’m in the middle of doing something to stop and write a reflection about it” (Teacher A, personal communication, April 12, 2018). She admits the fundamental difficulty of stopping and reflecting while doing something, yet she also mentioned that what is missing in her assessment practice is supporting students in engaging in metacognition, by stopping and reflecting, and going back to what they could not achieve.

One reason it is difficult to stop and reflect during maker-centered learning is that maker-centered learning activities tend to have an immersive and dynamic flow rather than a series of small, linear steps. Pausing while making may require greater cognitive labor in switching back and forth between making and reflection, or may cause a loss of creative momentum. Other similarly immersive learning environments such as educational video games have been working on this

problem by utilizing digital environments that can collect performance data stealthily while learners are playing the games without interrupting the learner’s activity (Shute, Ventura, Bauer, 2009). Although assessment in in-person maker classrooms cannot be completely stealth, assessment in maker-centered learning environments needs to be embedded into the unique flow of the activity, causing minimal interruption to the process, in order to capture the authentic learning experiences of students.

As the review of assessment in other disciplines illustrated, reflecting during the creative process is not utterly impossible. In art education, for example, critical reflection is historically a part of the learning process where learners reflect on their own thought process and production process while they are engaging in art production (Gardner, 1989). As long as there is a coherent purpose and structure, pausing to document and reflect while making can be a meaningful activity integrated into the process.

Another reason why reflection might be difficult is that students are often accustomed to talking about their own and each other’s learning and progress in a constructive way. One teacher we interviewed was an art educator implementing traditional art critique practices in his maker classroom. He mentioned that students are not used to giving productive feedback to each other:

*[For a middle schooler,] getting [them] to talk about their own work, (...) I think it’s a little difficult, and it could be dangerous...because they’re all about the roasting and burning each other and you can’t allow that. So, you have*

*to be very guarded, I think, when you're talking about critiquing work (Teacher B, April 12, 2019).*

There can be several potential reasons his students made him concerned about how well they can give feedback to one another's work: students may not have a clear understanding of what qualities they need to look for, they may not have the language to describe their reasoning in a constructive way, or there may not be a norm in the classroom that students, not just a teacher alone, also help one another to produce better work.

Therefore, assessment needs to be woven into not only the learning activities but also the culture of the learning environments, including norms, language, and the behaviors students are used to and comfortable with. By creating a learning experience for such assessment, assessment activities can become accessible, transparent, and adaptable so that students can engage in all aspects of their learning and growth. If there is no culture or habit for constructive assessment practices already in place, it requires new opportunities for students to become familiar with assessment processes and approaches, terminology and vocabulary, tools, and expectations, so that they can participate in the assessment process.

Excerpted from Murai, Y., Kim, Y., Chang, S., & Reich, J. (2020, January 17). Principles of Embedded Assessment in School-Based Making. <https://doi.org/10.35542/osf.io/amvs2>



**MAKER ED**



This work was created in collaboration with Albemarle County School District, Portola Valley School District, and San Mateo County Office of Education. This material is based upon work supported by the National Science Foundation under Grant #1723459. It is released under [Creative Commons BY-SA-NC 4.0](https://creativecommons.org/licenses/by-sa/4.0/) license.

## **Beyond Rubrics Design Principle #3**

# *Assessment in making should be evidence-centered.*

Embedded assessment of maker-centered learning should also be based on several forms of tangible evidence that represent multiple aspects of learning captured throughout the process. This principle is informed by evidence centered design (ECD), a method to make inferences based on evidence about particular competencies or other types of attributes (Mislevy & Haertel, 2006). ECD enables educators and researchers to aggregate information about a learner's performance from various sources and therefore helps them understand what students can do and how they develop the particular constructs or dispositions. Although making activities are a hands-on exploratory process where students are engaged in a variety of tangible materials, a number of assessments in makerspaces still rely on traditional forms of assessment such as surveys and multiple-choice questions at the end of the activities focusing on engagement and interest (Weiner, Lande, & Jordan, 2018). Given that maker-centered learning is an exploratory process often incorporating multiple means of learning, assessment in maker environments should be based on rich evidence generated by students and teachers throughout the process of making.

Collecting evidence of learning is not straightforward because many of the learning outcomes in maker classrooms are hard to measure. Maker-centered learning provides students an opportunity to develop a variety of knowledge, skills, and attitudes (Clapp, Ross, Ryan, & Tishman, 2016). The teachers we interviewed also mentioned various

learning outcomes they wish to see through maker activities. However, the connection between what students are making and those constructs are often not visible in classrooms. For example, agency, collaboration, and engagement are the three most frequently mentioned desired learning outcomes from our interviewees, but they are not necessarily visible by just looking at what students are making. It requires careful observation of how students are making. One teacher described that she notices and takes mental notes of each student. However, such method rarely works at scale or for novice teachers.

Another reason for the difficulty to collect evidence in maker-centered learning is that it often takes complex and non-linear paths where students explore different materials and tools through a series of trial-and-error and social interaction. Learning activities often involve varied extents of open-endedness where students are given the freedom to decide what to make or how to make it. As a result, each student tends to take a unique and complex approach to achieve the instructions given to them. A single assessment method at the end of a learning activity is often not comprehensive enough to fully capture and understand students' diverse learning experiences.

Teacher G (personal communication, November 5, 2018), who teaches English at the school in California, talked about how difficult it is to understand the students' learning outcomes:

*With writing, it's just so straightforward that it's pretty easy [to see] whether or not they're meeting the standards. [But*



*for maker projects,] am I going to have to go through every kid, and take the standards and say, "Okay, did you master this one, did you master this one?" How is that going to look?*

While asking each student is one way of gathering evidence, it is a time-consuming approach and also fails to give a complete picture of how students are growing their competencies.

The teachers we interviewed also faced the challenge of sharing the learning outcomes with parents and other stakeholders. One teacher observed, "we as educators can pick out the learning, because we're trained to do that. But, how do you then convey to a parent, who has no experience?" (Teacher F, personal communication, November 5, 2018). For students, parents, and other stakeholders who without the expertise to understand student performance, it is not easy to gain a comprehensive view about learning outcome. In addition, signs of learning in maker-centered activities are often witnessed in the process of making and it's difficult to capture concrete evidence in the moment. Collecting visible and tangible representation of those indicators in real-time is essential for sharing evidence of learning that is highly time- and place-specific with people who were not there to see it themselves.

Tangible evidence can help students and teachers alike to recall and reiterate the experience more accurately specifically with parents and administrators who are attempting to understand the full scope of what students are learning in maker-centered classrooms. For these reasons, embedded assessment for maker-centered learning needs to help students and teachers generate visible and tangible evidence that can be used to convey learning beyond

just "the thing they created." Collecting a variety of visible and tangible pieces of evidence that provide multidimensional perspectives on students' performance at multiple points during maker activities is an alternative approach to capturing such complex learning experiences. For example, written documentation can be combined with photographs or videos to incorporate different mediums; descriptive documentation can be combined with a quantitative record of the number of times certain behaviors happened; or observational notes and reflections by students can be combined with observational notes by teachers. By collecting a variety of types of evidence, both students and teachers gain alternative ways of looking at their performances. This may also open up an opportunity for students who are not competent in one type of medium (such as writing) to express their understanding through different mediums (such as drawing).

Excerpted from Murai, Y., Kim, Y., Chang, S., & Reich, J. (2020, January 17). Principles of Embedded Assessment in School-Based Making. <https://doi.org/10.35542/osf.io/amvs2>



**MAKER ED**



This work was created in collaboration with Albemarle County School District, Portola Valley School District, and San Mateo County Office of Education. This material is based upon work supported by the National Science Foundation under Grant #1723459. It is released under [Creative Commons BY-SA-NC 4.0](https://creativecommons.org/licenses/by-sa/4.0/) license.

## **Beyond Rubrics Design Principle #4**

# *Assessment in making should involve students as active participants in the assessment process.*

In maker-centered learning environments, students should be empowered as the assessor of their own learning and choose and collect evidence for their own learning to construct a multidimensional and comprehensive account of their learning experiences. Historically, assessments have been conducted by teachers to and for students in order to assess students' abilities and compare students with one another, often relying on summative assessment after the learning activity. Most of the time a universal measure is used to assess student learning, even though it may not guarantee equal access to learning for students with diverse economic, cultural, and academic backgrounds.

Maker activities involve many exploratory and complex interactions in more or less open-ended environments that can lead to varied outcomes. Not only can the product and learning goals vary between students but also the process taken to reach learning goals can as well. In order to understand what students gained through the activity, assessment needs to capture learning that occurs during the process of making. About half of the teachers described that they wished to have better ways to holistically capture students' learning processes. Teacher A from the school in Virginia mentioned, "we miss a lot when our assessments just show an endpoint, and they don't show the growth experience." and continued, "'The journey is more important than the destination,' is true in learning, I think, as well" (personal communication, April 12, 2018). She emphasized that she believes

that assessment lies in the process of students getting from point A to point B. Another coach mentioned that they focus greatly on reflection on the learning process rather than the project itself, such as lighting up a circuit (Coach B, personal communication, Apr 2, 2018). The importance of looking at the process of maker-centered learning was shared among many interviewees that we talked to.

However, observing and collecting learning evidence in the process requires teachers to pay attention to multiple students at the same time, documenting multifaceted and dynamic learning outcomes throughout the class period. This is nearly impossible to achieve, particularly for teachers who do not have the privilege of having another teacher or assistant in the classroom. Empowering students to collect learning evidence and self-assess their progress is, therefore, not only compatible with the values of making, but also a practical solution in maker-centered classrooms.

In addition, involving students in the assessment process can provide an opportunity for students and teachers to create a shared understanding of when and how learning occurs with making. Since the making process is complex and highly contextualized, teachers may be able to capture limited moments of each student in the class. Relying solely on teachers, therefore, eliminates the opportunity for both students and teachers to coherently understand students' full learning experiences.

A number of interviewees answered that one

of the qualities of assessment that matters to them was that the assessment helps students understand and be on-board with it. Coach C described his idea of a good assessment:

*I think a good assessment is one that students understand why they're doing it, students understand what they're doing, and then what it leads to. What's the next step on this, if there is the next step? Who's the audience of this thing that I'm doing? (personal communication, April 12, 2019)*

By having students document their own learning, explaining and communicating their learning experience, students can deepen their understanding about their learning experiences while teachers can also gain more understanding about what students got out of the class activity.

There are several conditions that are necessary for truly engaging students in the assessment process, as mentioned by a teacher from the school in Virginia: "I think we need a system for having kids capture that [emphasis added]." (Teacher E, personal communication, November 5, 2019). First, students and teachers need to build a shared understanding of what they are assessing. For example, if how students define collaboration differs from how the teacher defines it, they cannot collect consistent evidence that shows how students are collaborating with one another. It is important that students and teachers take time together to share how they understand the construct and agree upon what it might look like in their classroom context.

Second, the series of skills to assess learning—i.e., noticing the signs of learning, documenting it, understanding what it means, and communicating about it with other stakeholders—is not a skill that is universally

shared among students. Students need to learn assessment and practice it before they can begin assessing their own learning performance in a real context.

Third, the design of the assessment should be inviting and accessible to students for them to openly and sincerely participate in the assessment process. Teachers, administrators, and researchers tend to use specific words when they talk about assessment that are not necessarily understandable to students, from general assessment terms like construct and disposition to educational terms such as intention and scaffolding. It is important that facilitation of assessment and materials use plain language that students are familiar with, and involve engaging activities for students to take part in.

In sum, we learned from the interaction with teachers that it is important that embedded assessment in making should position students as active and empowered participants in the assessment process, collectively noticing, capturing, understanding and communicating learning experiences, paying attention to the conditions described above. This would help not only teachers but also students themselves build deeper understanding of the learning experiences that are taking place.

Excerpted from Murai, Y., Kim, Y., Chang, S., & Reich, J. (2020, January 17). Principles of Embedded Assessment in School-Based Making. <https://doi.org/10.35542/osf.io/amvs2>



**MAKER ED**



This work was created in collaboration with Albemarle County School District, Portola Valley School District, and San Mateo County Office of Education. This material is based upon work supported by the National Science Foundation under Grant #1723459. It is released under [Creative Commons BY-SA-NC 4.0](https://creativecommons.org/licenses/by-sa/4.0/) license.