



**THE AGENCY *BY* DESIGN INQUIRY CYCLE:
DOCUMENTING INQUIRY AND PRACTICE
IN THE MAKER-CENTERED CLASSROOM**

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“An obvious and important question about making and its role in education is, what do youth learn through making?” –Lee Martin, 2015

Prompted by a wave of interest in the Maker Movement (Dougherty, 2012), beginning in 2012 a team of researchers at Project Zero, a research center at the Harvard Graduate School of Education, began to explore what we referred to as the promises, practices, and pedagogies of *maker-centered learning*. Throughout our study, we came to loosely define the Maker Movement as a rising interest in learning and sharing with others while working with one’s hands within interdisciplinary environments that combined a variety of tools and technologies. In turn, we simply defined maker-centered learning as the incorporation of the practices and ethos of the Maker Movement into various educational settings. The title of this initial investigation quickly came to be called *Agency by Design*—as we found the development of student agency to be one of the primary goals of maker-centered learning. This important finding formed the basis of the pedagogical framework for maker-centered learning that we later developed in concert with a cohort of educators working in Oakland, California (Agency by Design 2015; Clapp, Ross, Ryan, & Tishman, 2016).

While there has been much interest in the many frameworks for design and maker-centered learning that have emerged over the past few years (see for example, Maker Education Initiative, 2015; Stager & Martinez, 2013; Riverdale Country School & IDEO, 2015), perennial questions regarding documentation and assessment have naturally risen to the surface. As many practitioners, researchers, and advocates of maker-centered learning attest (see for example Petrich, Wilkinson, & Bevan, 2013; Yokana, 2015), accurately gauging what students are learning in the maker-centered classroom is one of the most important issues for the growing field to address. In fact, many would argue that the future of maker-centered learning may hinge on this issue.

As our initial phase of research exploring the promises, practices, and pedagogies of maker-centered learning came to a close, we approached our funders, the Abundance Foundation, with this very concern: *If maker-centered learning is going to be more than a passing trend, then we need to develop documentation and assessment strategies that measure and support the real benefits of this work.* Our colleagues at the Abundance Foundation agreed, and in the years that followed we began to forge ahead on this work. One of the primary tools that emerged from our inquiry into documentation and assessment in the maker-centered classroom is what we call the *Agency by Design Inquiry Cycle*.

The *Agency by Design Inquiry Cycle* has been designed to support educators in the processes of designing, documenting, assessing, and reflecting on maker-centered learning. This tool was collaboratively developed over time, and formally prototyped with cohorts of maker educators in two locations: Oakland, California, and Pittsburgh, Pennsylvania. Below, we loosely use the structure of the *Agency by Design Inquiry Cycle* to describe the iterative process of developing this tool, along with some suggested implications for practice. Throughout the piece, we share the experiences of our teacher partners as they grappled with this tool—tweaking, hacking, and remixing it—as they explored its potential for designing, documenting, assessing, and reflecting upon their work in the maker-centered classroom.

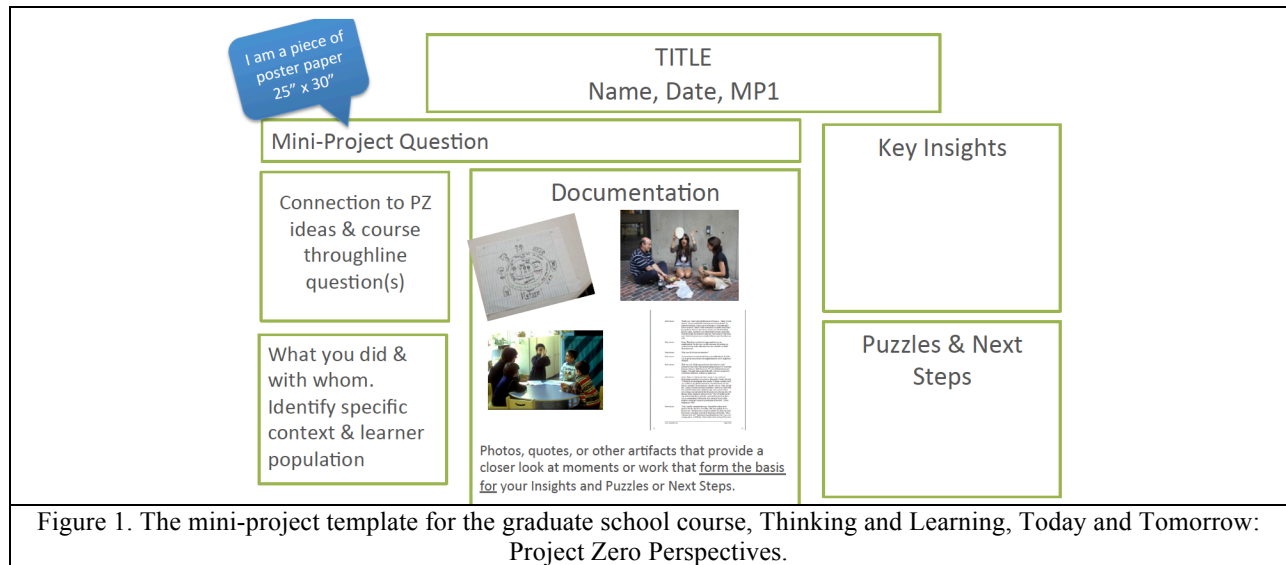
Setting the Context

Maker-centered learning is situated in a variety of spaces throughout the world of formal and informal K–12 education. In some instances a “maker” teachers are hired to work in a designated makerspace within a school, library, museum, or afterschool program. In other settings, educators are incorporating maker-centered learning into their existing practice and experimenting with how this type of learning might fit into their 10th grade history course or elementary science curriculum. From our perspective, maker-centered learning is not discipline-specific, and therefore there is no existing tried and tested maker curriculum for educators to adopt and adapt to meet their content area or grade level needs. Because of the unexplored frontier aspect of maker-centered learning, each educator traversing this terrain is quickly thrust into the role of a maker pioneer as they design experiences for their learners, test those experiences out, and redesign for improvement. For these reasons, the Agency *by* Design research team set out to develop a tool that would support a practice for educators to design, document, assess, and reflect upon their students’ learning—and their own learning—as they enter into this uncharted territory.

Varied approaches to incorporating maker-centered learning into the worlds of formal and informal education already exist, which has implications for the educators who were involved in our research. In schools that have embraced making across the curriculum, educators gathered with colleagues to plan for and reflect upon their progress along the way. However, as it was in the early days for many technology teachers, maker educators often find themselves alone and uncertain of which group to join during discipline-specific meeting times at their schools. Those who work in libraries, museums, or community makerspaces may be the lone educator (or one amongst a very small group) from their organization. This was the case for many of the educators in our study. Our team embraced the iterative nature of maker-centered learning by prototyping a tool for educators that would support reflective practice whether those educators were working alone or in a cohort. We called this tool the Agency *by* Design Inquiry Cycle.

What We Did... and Why

When we introduced our first prototype of the Inquiry Cycle, our hope was to understand how educators plan, document, and assess maker-centered learning in their context. The early genesis of this prototype inquiry cycle can be traced back to a course at the Harvard Graduate School of Education titled *Thinking and Learning Today and Tomorrow: Project Zero Perspectives*. In this course, taught by Project Zero researchers, students engaged in “mini-projects” to document their experiments with Project Zero frameworks in action. The guidelines for these assignments asked students to present what they did (and with whom and in what context), share documentation from their experiences, and then report on their key insights and puzzles—rooted in their documentation—while also sharing their next steps (see Figure 1).



Following the Project Zero Perspectives course, a second cohort engaged with the prototype inquiry cycle in a more formal way. These participants hailed from a seven-session, online course offered at the Harvard Graduate School of Education called *Thinking and Learning in the Maker-Centered Classroom*. The participants in this virtual learning environment worked in place-based teams that met face-to-face, but also engaged with larger online study groups made up of participants from around the world. Taking inspiration from the structure of the previous graduate course's mini-project guidelines, the designers of this online course structured their course project template around similar prompts. Participants were asked to first provide context for their home teaching and learning environment, state the unit of study they would be exploring throughout the run of the online course, and then successively respond to a series of prompts about what they did, what it looked like, and what they learned. The online course participants then proceeded to engage with the Agency *by* Design framework in a rather linear fashion, responding to the prompts in the course project template every two weeks over the course of the thirteen-week term. The goal for students' use of these course project templates was to develop an episodic narrative describing the learning that took place in each participant's home teaching and learning environment, which could then be shared with other course participants.

Seventy-five educators from around the world, each a member of a 3-5 person team from their school or informal learning environment, were the first to experiment with this format. What we learned from their early experimentation with this structure was what maker-centered learning looked like across various content areas, across various grade levels, and across varied teaching and learning environments around the world. What we also learned from these early experiences with the online course students was how the course project template could be used as a cyclical process of ongoing documentation and assessment that was embedded within the process of teaching and learning. As much as we were excited by the potential of this early structure, we also understood that the course project template would need to be expanded and tweaked in order to best function as an effective documentation and assessment tool for practitioners working outside the structure of the online course.

At the same time that we were experimenting with the course project template in the *Thinking and Learning in the Maker-Centered Classroom* online course, our research team was beginning our first full school year of collaboration with a group of 23 educators in Oakland, California. The Agency by Design Oakland Fellows included educators from libraries, after-school programs, teacher development programs, and public, private, and charter schools who worked with learners from kindergarten through adulthood. The goal of this work was to learn more about documenting and assessing maker-centered learning—and more specifically—how to document students’ ability in the three core maker capacities that are central to the Agency by Design framework for maker-centered learning: looking closely, exploring complexity, and finding opportunity.¹

During one of our first face-to-face meetings with the Agency by Design Oakland Fellows, our team offered a definition of documentation developed by our Project Zero colleagues (Krechevsky, Mardell, Rivard, & Wilson, 2013) that included four key components: “The practice of observing, recording, interpreting, and sharing through a variety of media the processes and products of learning in order to deepen and extend learning” (p. 74).

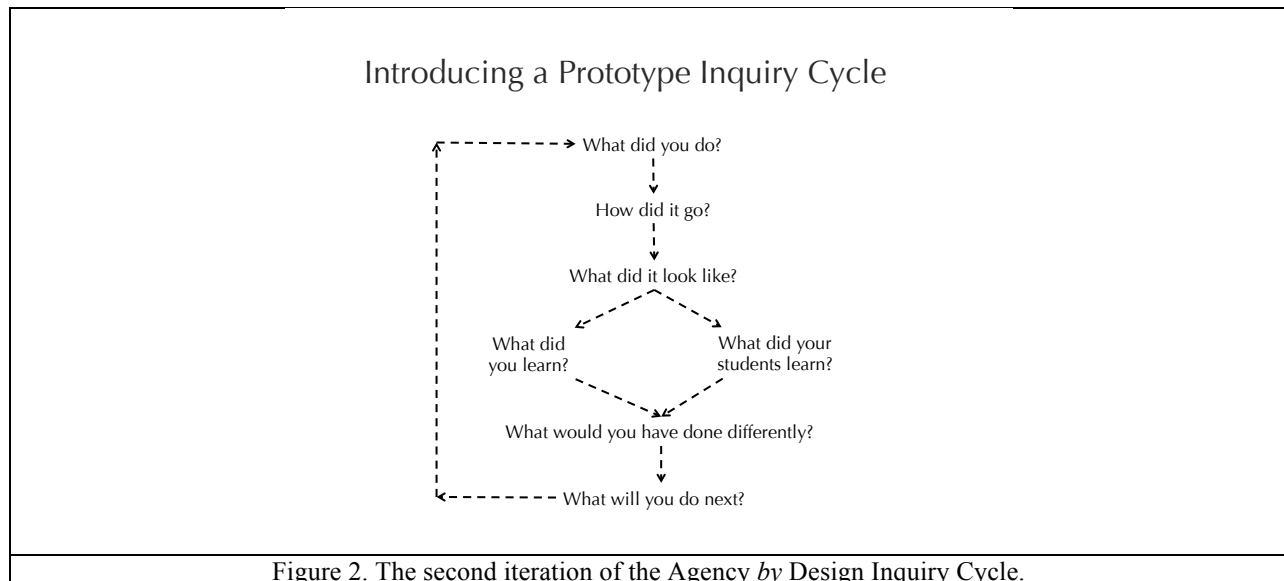
When our team reflected on some of the most prevalent approaches to documenting maker-centered learning in the world beyond our cohort, we saw no shortage of recording and sharing products—and some processes—particularly in the online sphere. A quick Twitter follow of #MakerEd will reveal a wealth of ideas for maker activities and experiences, tool use, space design, along with hundreds of images of engaged learners coding, hammering, or tinkering all shared by maker educators, families, or the students themselves. Recording and sharing are abundant on this platform, as well as on other digital venues. However, the messy processes of choosing what to observe and how to interpret the learning are less obvious in many open-sourced educator spaces.

The second prototype of the Inquiry Cycle was designed for the Oakland Fellows as a tool to provide a guide for the documentation practices of observing and interpreting. This second iteration combined what we had learned from the previously mentioned in-person and online courses, plus the four-part practice-based definition of documentation articulated by our Project Zero colleagues. We wondered if this opportunity to focus on the practices of observing and interpreting might help build a bridge between documentation and assessment. When we introduced the tool to the Agency by Design Oakland Fellows, we also shared an article by Carlina Rinaldi (2004) highlighting her views on the relationship between documentation and assessment in the Municipal Infant-Toddler Centers and Preschools of Reggio Emilia, Italy. In that article Rinaldi shares, “For us within the Reggio experience, documentation is an integral part of the learning and teaching process of the children and teachers. In the process of learning through documentation, we become aware of learning and its value; we assess it” (p.1). This article served as a discussion prompt for educators to consider the role of documentation and assessment in their own contexts.

With all of this in mind, our second iteration of the Inquiry Cycle (see Figure 2) began with a prompt that was characteristic of all of its predecessors: *what did you do?* However, before asking what the learning looked like, this new prototype of the Inquiry Cycle included an

¹ To more fully engage with the Agency by Design framework for maker-centered learning, visit [the framework page](#).

evaluative prompt: *how did it go?* Here, educators were being asked to assess the quality of their teaching and learning experiences. This tool then asked *what did it look like?* again, prompting educators to ground their assessments in documentation, before then adding two interpretive prompts: *what did you learn?* and *what did your students learn?* which were meant to be articulations of both teacher and student learning. The next prompt *what would you have done differently?* marked a movement from viewing the learning experience retrospectively, to viewing the learning experience prospectively. This prompt encouraged educators to consider how they would have changed their approach to this learning experience based on hindsight and reflection. Building on that, the final prompt asked educators *what will you do next?* Once again, this prompt took a prospective view of the learning experience and set the educator up to build off of what they learned—and what their students learned. This second prototype of the Inquiry Cycle prompted educators to engage in a cyclical and iterative practice of documentation and assessment not as separate from—but rather as integral to—the process of teaching and learning. Like the online course project template before it, this second iteration of the Inquiry Cycle was designed to be used repeatedly, and by doing so, tell an episodic story of teaching and learning in the maker-centered classroom.



How It Went and What it Looked Like

Our research team gathered 40 Inquiry Cycles from our first round of experimentation with the Agency by Design Oakland Fellows—and their counterparts from the learning community in Pittsburgh—along with verbal and written feedback about using this tool from our diverse cohort members. Below we share a small sample of excerpts that illustrates how the Inquiry Cycle tool was utilized in the contexts where our partnering educators teach, and the varied approaches they have towards maker-centered learning.

Christina Jenkins is a teacher, designer, and program director at a neighborhood makerspace called Girls Garage in Berkeley, CA. Christina used the Inquiry Cycle to document and assess her work with 9–13 year-old girls in an afterschool program at the Girls Garage (see Figure 3).



Figure 3. An excerpt from Christina Jenkins's Inquiry Cycle.

Christina used the Inquiry Cycle to share documentation from two screen-printing lessons where she used the *Agency by Design Parts, Purposes, Complexities* thinking routine with her students. In particular, she described how her students looked closely and explored the complexity of a particular tool they were using. Reflecting on her experience, Christina recalled, “I used the *Parts, Purposes, Complexities* thinking routine to invite students to carefully study the tool they chose. Through a series of drawing exercises, girls considered the tool from different perspectives, drawing on their memory and using different senses (e.g., sight, feel, etc.). Some of the girls made deeper observations as a result of this process; others appeared to commit to their first impression of the tool.” Learning from her experiences experimenting with the *Parts, Purposes, Complexities* thinking routine in one class—where students just talked through the thinking routine—Christina then tweaked her approach in another class, where she had her students respond to the thinking routine by drawing. “In one class, I invited girls to talk about, but not draw their observations,” she recalled. “In the second class, girls drew their impressions. The second class was more successful in making deeper observations about the parts and purposes of their chosen tool.”

Susan Wolf is a teaching artist and Integrated Learning Specialist who works with the Alameda County, Office of Education in Oakland, CA. Susan used the inquiry cycle to document her work with adult learners—specifically, public school educators engaged in arts integration professional development. She also engaged in a personal exploration of ways to redesign the Inquiry Cycle as an analog tool to capture her reflections. As indicated in Figure 4, Susan hacked the Inquiry Cycle by documenting her work and capturing her reflections in a one-page ‘zine.

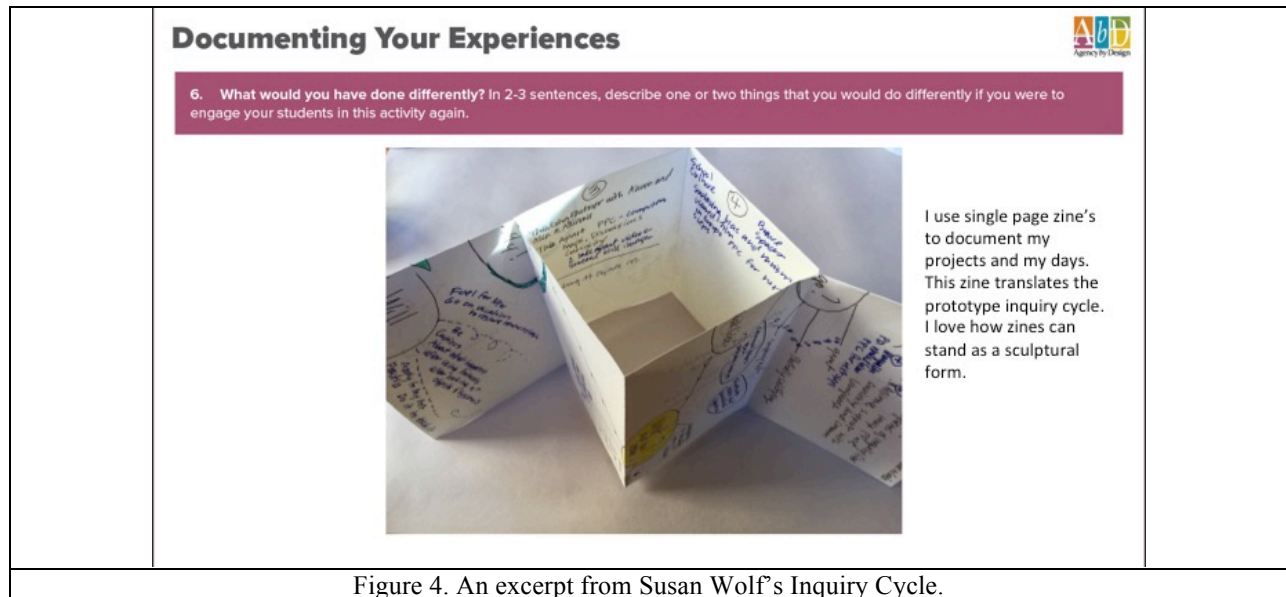


Figure 4. An excerpt from Susan Wolf's Inquiry Cycle.

In her digital Inquiry Cycle, Susan captured an image of one of her students' 'zine pages, folded into a sculptural form. But she also shared an image of the unfolded 'zine (see Figure 5). Reflecting on this artifact of documentation she wrote, "This is what the flattened 'zine looks like. I <3 how the opening runs down the center. This is a powerful metaphor for me. In this sketch I was trying to capture all of my Agency by Design related projects / thinking / work. On the back side or interior side I give a quadrant to each project with notes."

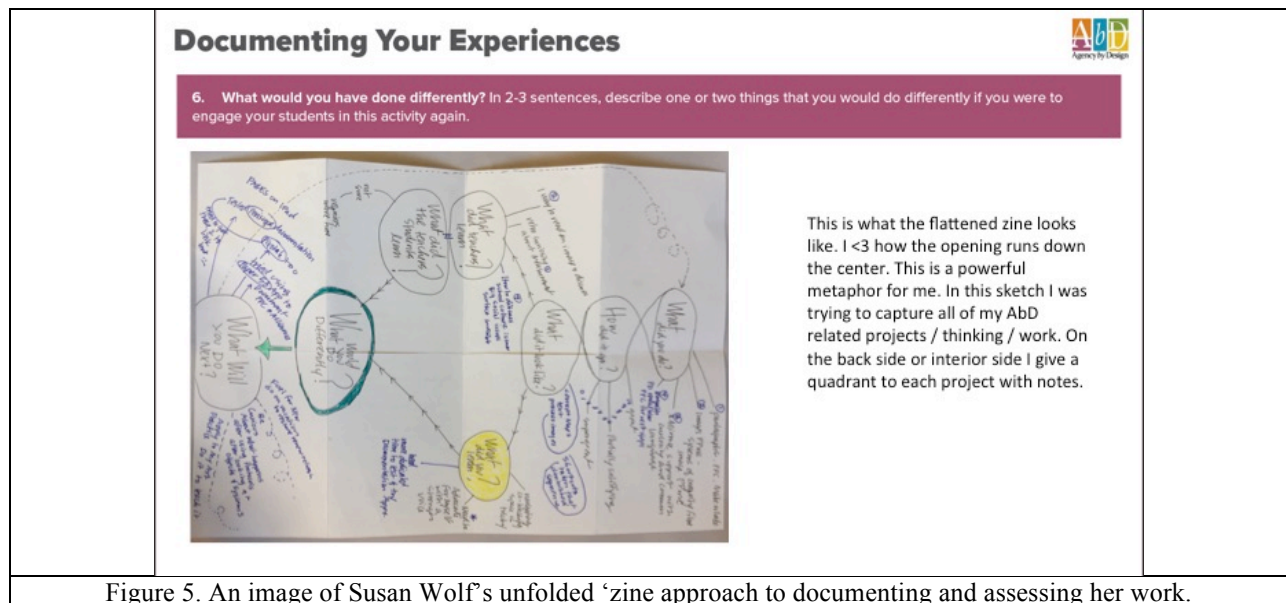



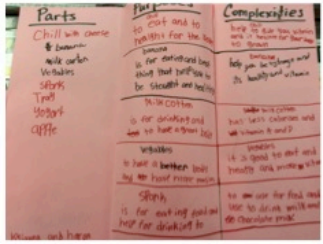
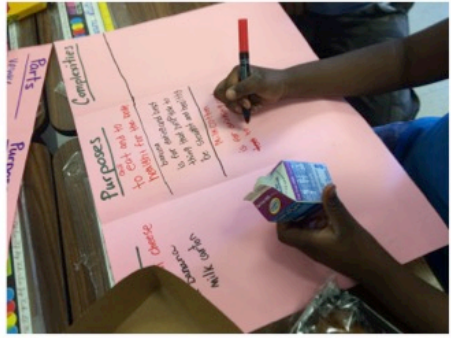
Figure 5. An image of Susan Wolf's unfolded 'zine approach to documenting and assessing her work.

Diana Culmer is a 4th and 5th grade teacher who works with special education students in a self-contained classroom at Grass Valley Elementary school in Oakland, CA. Diana used the Inquiry Cycle to document and assess her students' work as they explored the question "How can we, as agricultural scientists, create a garden that can provide healthy choices to our community?" (see Figure 6).

Documenting Your Experiences

3. What did it look like? Use 2–3 photos and/or pieces of student work or quotes from students to highlight stand-out moments from this learning experience. Be sure to add captions to each image/piece of student work you share, to place this documentation into context and emphasize any connections to the Agency by Design framework.



Students used a thinking routine to find the Parts, Purposes and Complexities of their school lunches.


Figure 6. An excerpt from Diana Culmer's Inquiry Cycle.

Like many of her colleagues, Diana introduced her students to the *Parts, Purposes, Complexities* thinking routine. She was happily surprised by her students' ability, while also being aware of what she might do differently next time to further support them. "I learned that sometimes my students can see and do far more than I imagine," she wrote. "Although I would want to introduce this thinking routine with more scaffolding [next time], my students still got very involved and were willing to take risks."

Andrea Watson is a middle school science and math teacher who works in a makerspace in a public school in Fairfax, CA. Andrea used the Inquiry Cycle to document and assess the work of 6th graders, in an elective class focused on the iterative process of the design cycle (see Figure 7). In particular, she focused on the work of her students as they considered how they might incorporate paper circuitry into the design of a greeting card.

Documenting Your Experiences

3. What did it look like? Use 2–3 photos and/or pieces of student work or quotes from students to highlight stand-out moments from this learning experience. Be sure to add captions to each image/piece of student work you share, to place this documentation into context and emphasize any connections to the Agency by Design framework.



Student quotes while using copper tape to work in creating student cards—Students had used the Agency By Design iterative framework prior to starting this process. When they actually received the materials, they experienced challenges when they did not immediately get the light bulb to light up.

Some students were easily frustrated and discouraged as evidenced by

"Help me! It's not working!"

"I want to start over and throw all of this in the trash. Can you help me?"

Others were frustrated, and yet optimistic, as was the case with this quote

"I can't do this yet... but I'll keep on trying...!"






Figure 7. An excerpt from Andrea Watson's Inquiry Cycle.

Using the Inquiry Cycle, Andrea came to appreciate the importance of intentionality in her planning with young people, especially when they were using more expensive materials. “I learned that students needed the extra time to write things down and solidify their plan prior to working with materials in an effort to increase intentionality and also work towards not being wasteful when we are using materials that are expensive (e.g., copper tape, batteries, lights, etc.).” Andrea also came to a deeper understanding of the importance of iteration in her work with young people in her school’s makerspace. “The iterative cycle was imperative to our success,” she wrote. “I learned that it is a part of the design process that absolutely cannot be skipped. It is exciting to dig in and build right away from the student mindset, but guided brainstorming helps to increase student output and articulation of designs and guide mindfulness and decrease unnecessary waste. I found that as the time I spent coaching students through brainstorming sessions increased, the level of student waste while building/making decreased. With increased planning, I observed that student work was more focused and purposeful.”

What We Learned

Through their use of the Inquiry Cycle, the educators we worked with shared information about their learners, teaching environments, programs, and some of the opportunities and constraints associated with their work. In this way, one of the most exciting things we learned from this round of experimentation with the Inquiry Cycle was that the tool provided a window into our colleagues’ learning spaces. We were further excited to see the choices educators made about documentation and how they used the Inquiry Cycle to reflect on their practice. We also learned that the tool was time consuming to use, and a bit cumbersome. Indeed, documenting student and teacher learning *is* time consuming, as is *any* reflective practice. Nonetheless, one of the biggest findings from our teacher partners was how much educators appreciated learning with and from their colleagues—and that the Inquiry Cycle was a key tool in that regard. This suggests to us that educators need structured time and tools for reflection.

In addition to concerns about time that surfaced from our first test run of the Inquiry Cycle, we also learned that the tool did not explicitly prompt educators to reflect on the maker capacities of looking closely, exploring complexity, and finding opportunity. This became a main focus of ours as we considered ways to revise the tool for future testing.

What We Did Differently the Next Time

Upon further examination of the documentation we received from the Agency *by* Design Oakland Fellows, and analysis of the feedback data we gathered, we made several adjustments for our third iteration of the Inquiry Cycle (see figure 8). In order to gain a better understanding of the learning outcomes in relation to the maker capacities of looking closely, exploring complexity, and finding opportunity, we included a prompt for the teachers to articulate their learning objectives and to specify which of the capacities they hoped to foster. Additionally, in order to strengthen the bridge between documentation and assessment, we revised the Inquiry Cycle to include a series of prompts.

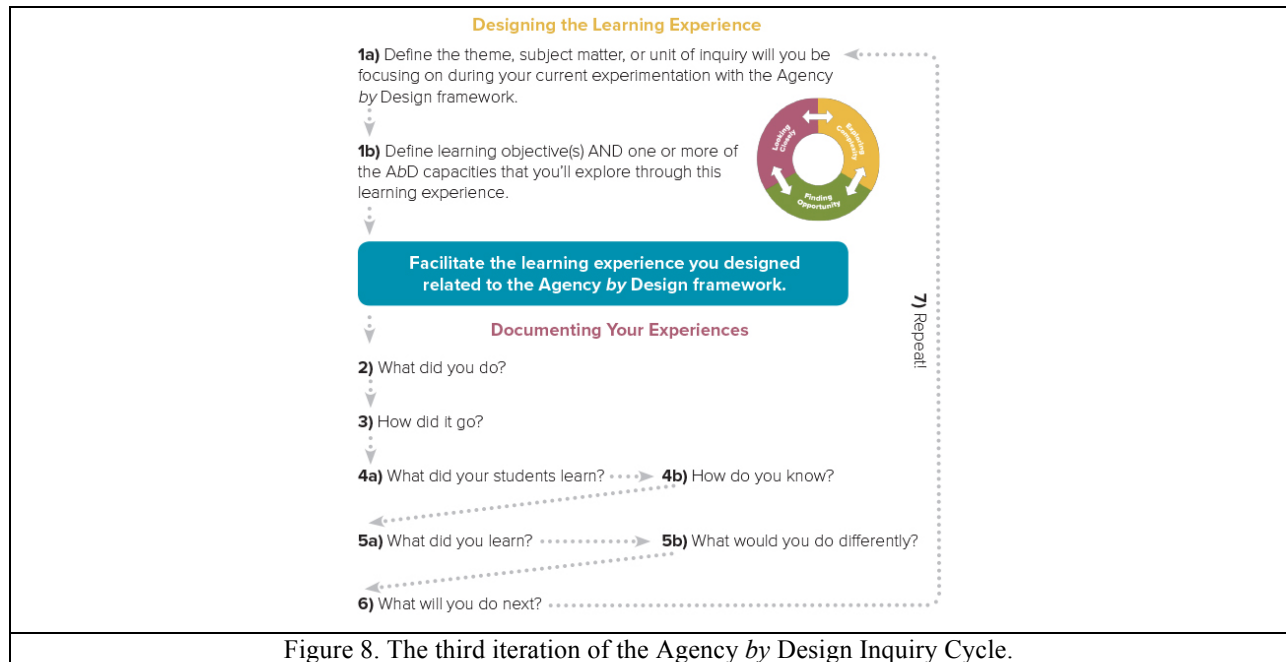


Figure 8. The third iteration of the Agency by Design Inquiry Cycle.

The figure above depicts the third iteration of the Inquiry Cycle. As you can see, there are several prompts in this iteration of the Inquiry Cycle that invite educators to assess their work—and the work of their students. In particular, the four successive prompts: *How did it go?* *What did your students learn?* *How do you know?* and *What did you learn?* All four of these prompts have evaluative components that urge teachers to assess their work and the work of their learners.

The final two prompts of the Inquiry Cycle mark a further shift from taking a retrospective approach to documentation and formative assessment, to a prospective approach towards future opportunities for teaching and learning. *What would you do differently next time?* and *What will you do next?* build on the previous retrospective and evaluative prompts that come before them.

The final prompt of the third iteration of the Inquiry Cycle, like previous iterations, invites educators to repeat the cycle and continue their process of documentation and assessment.

How did the third iteration go?

As a result of the tweaks that we made to the Inquiry Cycle, we found that our teacher colleagues were both more intentional about designing their lessons to support the maker capacities of looking closely, exploring complexity, and finding opportunity—and more detailed in their reflections on their students’ learning. Below, we share four samples of our teacher colleagues’ work, each demonstrating a more focused approach to teaching the maker capacities.

Susan Lee teaches in a full inclusion classroom in an independent K–8 school in Oakland, CA. Susan used the third iteration of the Inquiry Cycle as she worked with a class of second graders on a unit about bats. She began with an emphasis on looking closely at the design of bat houses and continued to design for and reflect upon the three maker capacities throughout her successive cycles of inquiry. Throughout the unit, Susan and her students were exploring bat houses from three different perspectives (see Figure 9). Describing her process of supporting her students in looking closely, she wrote: “We asked the class to try on 3 different ‘hats’ and to think about three questions related to the ‘hats’ they were wearing as they looked:

- Builder—how might we make another one?
- Scientist—how do bats interrelate and use this?
- Designer—how is this (bat house) made?”


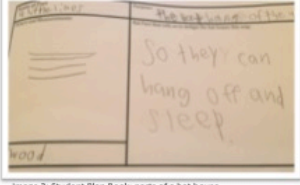
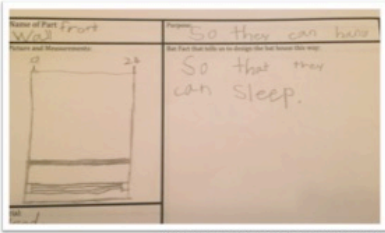
<p>Documenting Your Experiences</p> <p>4b. How do you know? Use 2–3 photographs, pieces of student work, or student quotes that serve as evidence for the learning you provided in 4a. Be sure to add captions to each photograph/piece of student work/student quote to place this documentation into context, and to emphasize any connections to your learning objectives or one or more of the three maker capacities. (Double-click below to write a response)</p>	
<ul style="list-style-type: none"> Students leaning over, crawling closer, silent room during silent looking time (Looking closely) Student questions posed during the drawing/labeling part: “What are the lines for?”, “How many lines do you think there are inside?” “What does it stand on?”, “Which way does it go?”, “I was thinking we should add that to show where it enters.”, “I was wondering how it gets in – do you think it flies in or crawls up?” (Looking closely, exploring complexity) 	 <p>Image 1: Sample Bat House</p>  <p>Image 2: Student Plan Book: parts of a bat house</p>  <p>Image 3: Student Plan Book: parts of a bat house</p> <p>“The purpose of the roof is to shelter a bat.” – Zach (Exploring complexity)</p> <p>“It also protects the bats from the weather, like when lightning strikes.” – Joseande (Exploring complexity)</p>

Figure 9. An excerpt from Susan Lee’s Inquiry Cycle.

Here, Susan used the revised Inquiry Cycle to both document and assess her students’ learning—while also designing her classroom experiences to specifically support the maker capacities.

Hannah Mintz teaches at a small, alternative public high school in Oakland, CA. Hannah saw the opportunity for the Inquiry Cycle to be a valuable tool for her students to use. And so, she decided to have the students in her elective “MakerLab” class use the Inquiry Cycle as a self-reflection tool as they designed and built furniture for the school (see Figure 10).



Documenting Your Experiences	
<p>4a. What did your students learn? In 2–3 sentences, describe one or more things your students learned in regard to your learning objectives, and one or more things your students learned in regard to the maker capacities. (Double-click below to write a response)</p>	
<p><i>Learning Objective(s)</i></p> <ul style="list-style-type: none"> • “I actually like this. I really like the drills and all that. It makes me feel powerful, like a superwoman.” • • “I feel freer in this class. I hate feeling constricted with someone telling me what I have to do. Here, I can make stuff how I want it to be. I feel like a weight is lifted off of my shoulders.” • -Alexis 	<p><i>Maker Capacity(ies)</i></p> <ul style="list-style-type: none"> • “I learned that I am a creative person and I love building things.” <p>“The most challenging thing was fixing my mistakes. Like the slots right there. I had to use a handsaw make it wider so these can fit in. It came out looking really good. I feel like I can do anything now. In the future, hope to make stuff that I need in my home” -Jose</p>
	

Figure 10. An excerpt from Hannah Mintz’s Inquiry Cycle.

Reflecting on her experience handing the Inquiry Cycle over to her students, Hannah wrote, “I learned how crucial it is to build in time for students to reflect. They seemed to really enjoy the process of reflection and I think it helped cement understanding, and create a sense of pride.”

Mallory Moser teaches 11th grade Computer Graphics at Oakland International High School, a full service community public school that provides wraparound services to first generation students, parents, and community members in Oakland, CA. Mallory used the Inquiry Cycle to document her students work as they made four different video games using the Scratch platform (see Figure 11).²

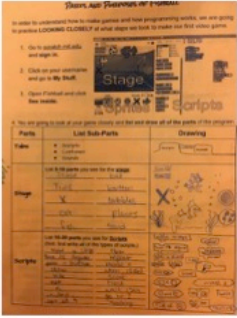
Documenting Your Experiences	
<p>4b. How do you know? Use 2–3 photographs, pieces of student work, or student quotes that serve as evidence for the learning you provided in 4a. Be sure to add captions to each photograph/piece of student work/student quote to place this documentation into context, and to emphasize any connections to your learning objectives or one or more of the three maker capacities. (Double-click below to write a response)</p>	
	<p>Exploring Complexity:</p> <ul style="list-style-type: none"> • “What’s the difference between a Sprite and a Script?” <p>Finding Opportunity:</p> <ul style="list-style-type: none"> • “Can I add two goalies?” • “Can I make Trump the goalie?”
<p>Looking Closely – labeling, drawing, listing and describing parts</p>	

Figure 11. An excerpt from Mallory Moser’s Inquiry Cycle.

² For more about the Scratch platform, please visit www.scratch.mit.edu

By using the *Parts, Purposes, Complexities* thinking routine, Mallory aimed to support her students in all three of the maker capacities. “Students had a much easier time reflecting on their own learning than I expected,” she wrote. “They were easily able to talk about the steps and processes involved in making a game but were more challenged when they had to use evidence (pictures of scripts) to explain what was happening.” She further learned that this thinking routine was particularly useful in helping her students look closely and explore complexity, but not as useful in supporting them in finding opportunity: “Moving from observation of parts and explanation of purposes is much easier than getting to finding opportunities.”

Alia Ghabra teaches middle school at a public school in East Oakland, CA. Alia used the Inquiry Cycle as a documentation and assessment tool in a 6th grade Computer Science course where her students were starting a unit on HTML web page design (see Figure 12).

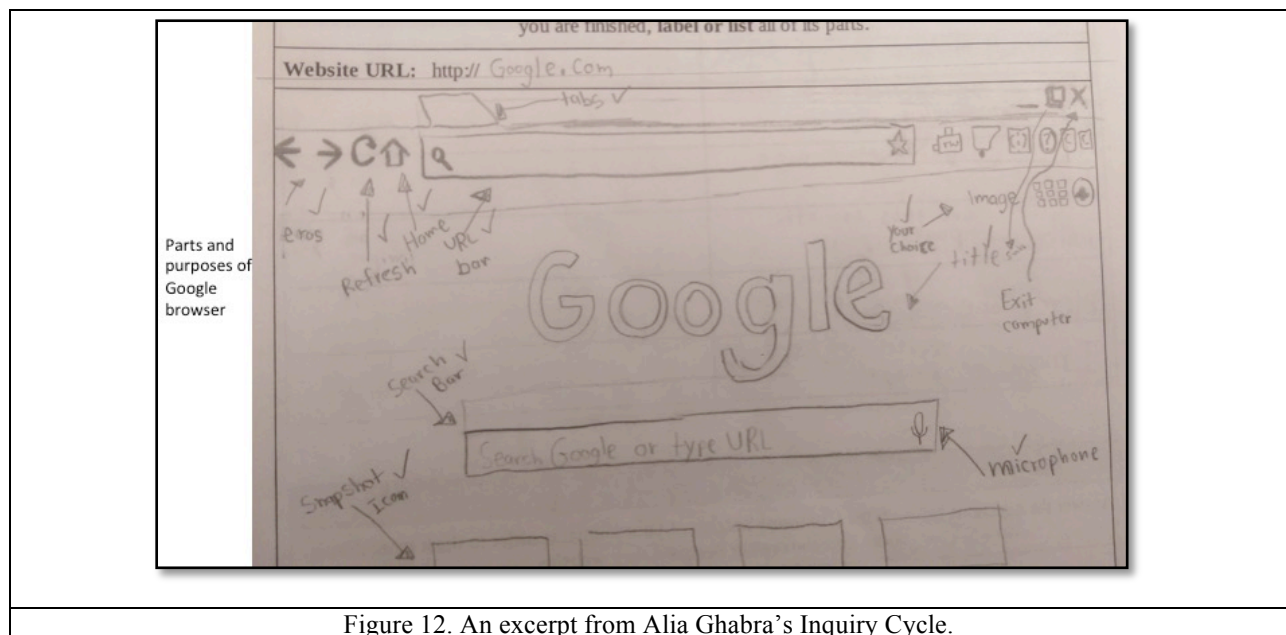


Figure 12. An excerpt from Alia Ghabra's Inquiry Cycle.

Like her colleagues, Alia used the *Parts, Purposes, Complexities* thinking routine to support her students in developing the three maker capacities—and in becoming more sensitive to design. In her Inquiry Cycle, Alia reflected on how she employed this thinking routine differently than she had in the past—and to great effect. “We had used the Parts, Purposes, Complexities thinking routine with objects before, but we had not yet used it with something like a website,” she wrote. “They definitely understood by the end that every little icon on a website has a purpose. They also started to learn about their own sensitivities to style and design.” Alia also noted that her students developed further questions to explore—and that they began to find opportunity to develop their own websites with specific audiences in mind. “Through this activity, they ended up with way more questions than answers,” she wrote. “Most of their questions were around the functionality of different designs (why do they need to copyright?), and thinking about why designers made the choices they made—which in turn had them thinking about the intended audience for their web pages as well.”

Experimenting with the Inquiry Cycle in Another Set of Contexts

While our colleagues in California were engaged in their experiments with the Inquiry Cycle, our research team also began collaborating with a cohort of 28 educators in and around Pittsburgh, Pennsylvania. Much like their California counterparts, this group of educators hailed from a variety of teaching and learning environments that spanned the pre-K-12 spectrum, including public, private, and charter schools as well as libraries, museums, and after-school programs. Known as the Pittsburgh Maker Educator Learning Community, these educators began experimenting with the Inquiry Cycle work as we were launching our third prototype in Oakland, CA. At this time, the Pittsburgh Maker Educator Learning Community was exploring how they could take a value-based approach to documentation and assessment, that our team had introduced to them (Sachdeva, 2016), but which they developed further by incorporating the work of Steven Covey (Evancho, Wardrip, & McNamara, 2017). The cohort hacked the Inquiry Cycle by adding a prompt to include the values-based lenses they looked through as they documented the work in their classrooms. A value-based approach can help educators identify and focus on the behaviors and qualities of mind and heart they most value for students. The additional prompt for this cohort read: “In a few sentences, describe the value-based lens you chose to look through as you documented. Why did you choose this lens? How did it play out in your work (or not)?” Through their Inquiry Cycles, educators from this cohort reported on a wide range of values including: joy, resourcefulness, collaboration, and curiosity—among others. Below, we share some examples of how our colleagues in Pittsburgh employed the Inquiry Cycle.

Scott Caplan teaches a STEAM class in a public middle school in Bridgeville, PA. Scott used the Inquiry Cycle during an engineering unit where his students were creating conceptual and physical models of shelters that had to meet certain design parameters including water resistance and durability (see Figure 13). The value-based lens that Scott brought to his work was *persistence*.

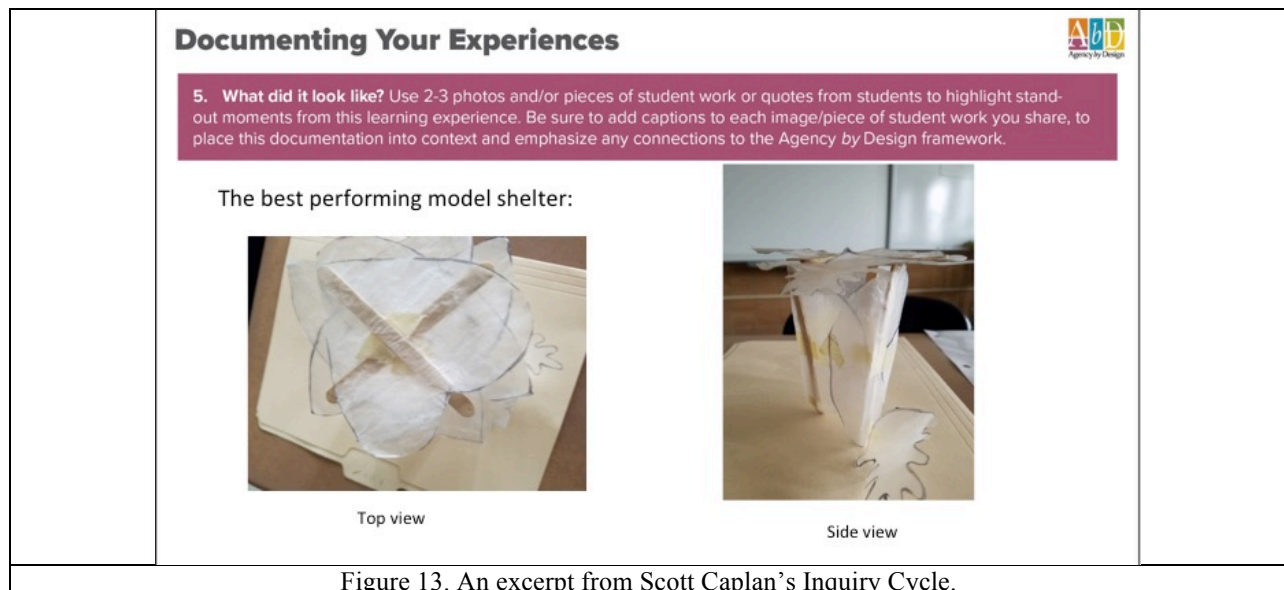


Figure 13. An excerpt from Scott Caplan’s Inquiry Cycle.

In his Inquiry Cycle, Scott noted what his students did, and how they persisted through their work. “Each group was able to go through the design process and create a model shelter,” he wrote. “As a class they were able to come up with a fair test (good experimental design) that would determine if the shelters were water resistant and durable. The students did have trouble accepting that failure is expected and is part of the learning. They wanted their shelter to ‘win’ even though it wasn’t a contest.” Following the design process, Scott used modified prompts from the Inquiry Cycle to engage his students in a self-assessment conversation. “We went over this in the redesign phase when they were asked how they would design their shelters if they could do it again. We also went over evaluating the test itself and not just the shelters. I was pleasantly surprised at their insights on how to improve the testing to make it a more realistic test.”

Vanessa Garcia works with youth ages 14-19 years old in an after-school program in the East End of Pittsburgh. She used the Inquiry Cycle while teaching a bridge-building unit cycle as part of a team building activity and to also introduce students to the STEAM focused curriculum of the program (see Figure 14). The value-based lens that Vanessa brought to her work was *student agency*.

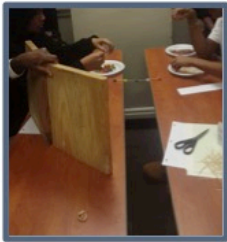

	<p>Documenting Your Experiences</p> <p>4. How did it go? In 2-3 sentences, describe the degree to which this learning experience met your expectations or learning objectives. Did it go well, not so well, or have an outcome you would have never anticipated?</p> <div data-bbox="375 1005 600 1245">  </div> <p>It went great! The students met the learning objectives and design specifications. I didn't expect the students to get as competitive as they did among groups, and I also didn't expect a student to ask if he could "facetime his brother who works in construction for help."</p>	
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Figure 14. An excerpt from Vanessa Garcia's Inquiry Cycle.

Vanessa reflected, “Students learned that learning isn’t just working on a worksheet or out of a book. They also learned different ways to approach problems to solve and they learned how to work together efficiently or in some cases what didn’t help their design/team effort. When I do this activity again, one thing I would do differently is have the students do some pre-building reading to learn about bridges and explore different bridge design concepts. I would also incorporate a ‘budget’ to charge students for materials and incorporate math/financial literacy/planning.”

Hacking the Inquiry Cycle

What we learned from working with the Pittsburgh Maker Educator Learning Community was that, in order to be most effective, the Inquiry Cycle had to be hackable to suit the specific needs and interests of educators. Having learned this, we returned to our teacher colleagues in Oakland to see how they might alter the Inquiry Cycle to best suit their learning environments and their curricular goals.

In our last few months of work with the Agency *by* Design Oakland Fellows, the cohort members broke into small focus groups to engage in mini investigations of some of the tools we had explored throughout the year. One focus group dedicated this time to further investigation of the Inquiry Cycle. This focus group experimented with the Inquiry Cycle as both a student self assessment tool and a peer assessment tool. They also used the Inquiry Cycle as a tool for narrative documentation and assessment to tell the story of student learning—a suggestion we offered to the group early on in our work with them.

Alejandra Utrera teaches a design/build course for high school students in Berkeley, CA. Alejandra used the Inquiry Cycle as a visual narrative during a unit on food justice that included design and construction of a greenhouse. Kimberly Padua and Miriam Leshin are middle school educators who teach at different schools in Oakland, CA, but they joined forces to hack the language of the Inquiry Cycle to be more student-friendly for their multilingual students. To meet this goal, they added sentence starters to help their students engage with the Inquiry Cycle and further their learning. In another student-focused hack, Leah Jensen, a teacher librarian in Oakland, CA, redesigned the Inquiry Cycle as a student reflection guide at the end of an arc of learning. Similarly, Sarah Purdy, a high school Humanities teacher in Oakland, CA, tweaked the Inquiry Cycle so that she could use it as a student feedback tool. Each of our colleague's experimentation with the Inquiry Cycle demonstrated the flexibility of the tool and its ability to be used in different ways, by different people, to fulfill a range of purposes (see Figure 15).



Figure 15. An excerpt from Alejandra Utrera's Inquiry Cycle

While many of our teacher colleagues came up with exciting hacks of the Inquiry Cycle, what we found was that some essential qualities of the Inquiry Cycle had to be maintained in order for tweaks to the tool to be successful. In particular, we found that the cyclical, narrative-based, evidence-rich, and retrospective/prospective structure were necessary aspects of the Inquiry Cycle—as was the tool's focus on what students learned and what educators learned.

Why Use an Inquiry Cycle in a Maker-Centered Setting?

We created the Inquiry Cycle to provide educators with a documentation and assessment tool that they could use over time to tell a story of teaching and learning and develop maker-centered learning experiences for their students. Making this tool a *cycle* was intentional. It is our hope that the cyclical nature of the tool will serve as a formative documentation and assessment instrument that supports teachers in designing their learning experiences by reflecting on where they have been, what their students have learned, what they have learned, and what they might do next. In the case of our educator cohorts from Oakland and Pittsburgh, we have seen this potential for the Inquiry Cycle to generate content for a larger narrative of teaching and learning, including documentation that further illustrates these stories, and a method to routinize the practice of documentation and assessment.

Ultimately, the Inquiry Cycle is intended to support teacher and student learning—and to make that learning visible—all the while exploring the capacities associated with the Agency by Design framework for maker-centered learning.

Suggestions for Practice

Having worked closely with various educators on the development of the Inquiry Cycle, we have learned that using this tool takes a little practice—and benefits from support from others. Some specific suggestions for using the tool that our colleagues have suggested include the following:

Do it Together—While the Inquiry Cycle can easily be applied by a lone educator in a particular setting, the potential of the Inquiry Cycle is amplified when educators share their work with one another. In this regard, we recommend that educators using the Inquiry Cycle seek out a community of diverse colleagues that frequently meet or connect with one another either online or face-to-face. Sharing Inquiry Cycles within a community of practice is a great way to offer one another feedback and learn from one's peers.

Make Time to Reflect—While utilizing the Inquiry Cycle tool becomes routinized and therefore easier over time, we have learned from our teacher colleagues that contributing to an Inquiry Cycle on a regular basis takes a good amount of time and effort. Teachers are often busy people, and time is a precious commodity within most every learning environment! Making the time to reflect upon one's work is no easy feat, but our teacher colleagues have found it to be valuable in the long run.

Hack It!—The Inquiry Cycle that we have presented here has been very deliberately designed, but we expect that it will not perfectly fit each educator’s needs without alteration. To this end, we encourage educators to hack the Inquiry Cycle to suit their needs, best serve their students, and be responsive to the demands of their unique teaching and learning environments.

Experiment and Take Risks—The Inquiry Cycle deliberately prompts educators to try something out, reflect on how it went, and then try it out again. This is a process of tweaking one’s practice over time, experimenting with new approaches, learning from those experiments, and then experimenting again. Risk taking is a natural component of experimentation. It is our hope that the Inquiry Cycle helps scaffold educators as they take risks in their classrooms in a manner that supports experimentation, reflection, and further learning.

Celebrate—We have found that great stories of teaching and learning have emerged from educators’ use of the Inquiry Cycle. And while learning is its own reward, it is also something to celebrate! In that regard, we encourage educators and learners to use the Inquiry Cycle in exhibitions to celebrate their work.

Conclusion

One of the biggest—and most important—questions in the field of maker-centered learning is how to effectively document and assess what students learn in the maker-centered classroom. We have developed the Inquiry Cycle as one of many possible responses to this question. In doing so, we hope to encourage an approach to documentation and assessment that is formative, narrative-based, qualitative in nature, and grounded in the maker capacities of looking closely, exploring complexity, and finding opportunity. True to the spirit of the maker-centered classroom, we have designed this tool with great intention and purpose—and carefully considered its structure—but at the same time, we intend for it to be flexible, hackable, and adaptable to suit various needs and purposes. We are eager to hear, see, and experience the many stories of teaching and learning that the Inquiry Cycle helps to tell, as educators in maker-centered classrooms from around the world apply it to their unique settings.

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