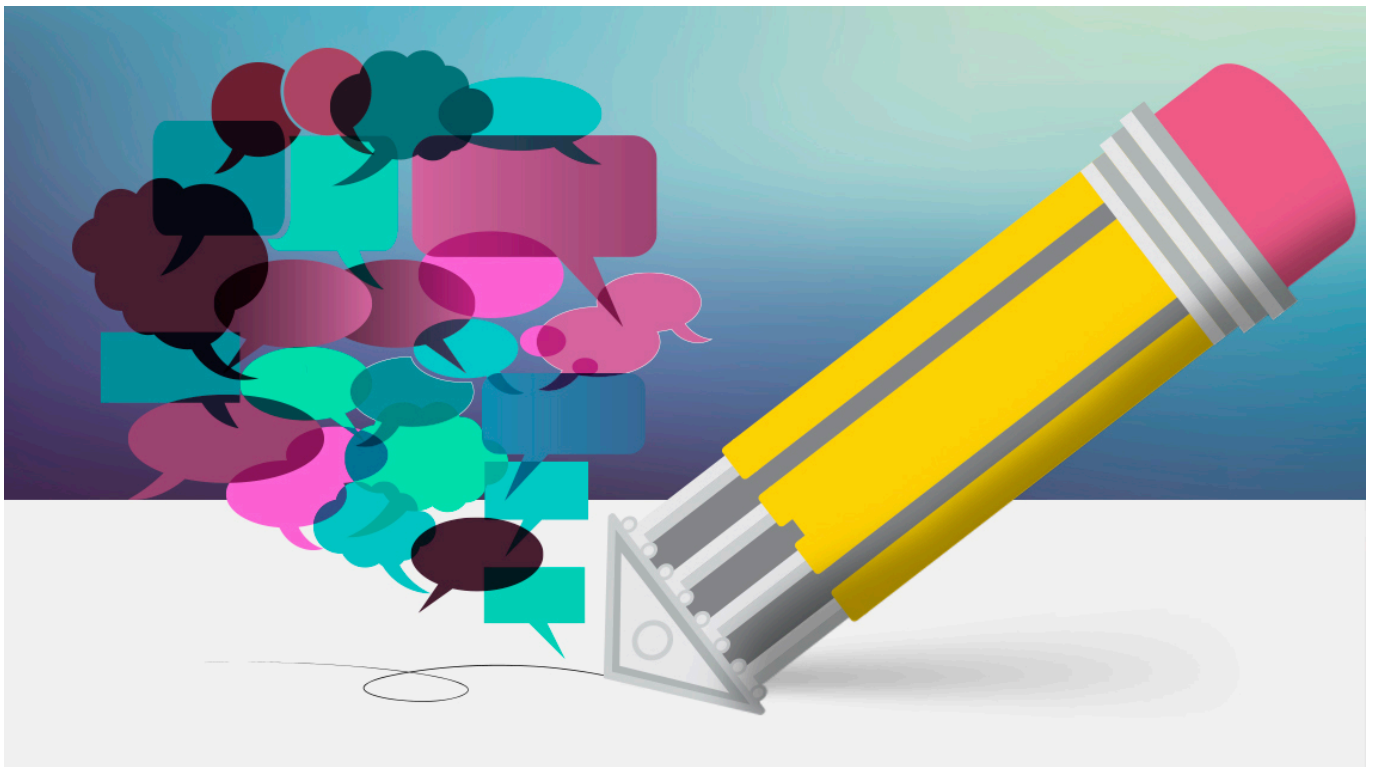


Working at the Intersections of Formal and Informal Science and Literacy Education

Author : TanyaBaker

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In this article, we invite you to expand your vision of what it means to work at the intersections of formal and informal science and literacy education by describing how educators have collaborated to create programs that blend science and literacy in schools, in museums, and across these two spaces. In 2012, K–12 teachers from the [National Writing Project \(NWP\)](#) began working with the [Association of Science-Technology Centers \(ASTC\)](#) and science museum educators in the [National Science Foundation–funded Intersections project](#), which is being evaluated by [Inverness Research](#). NWP is a [network of sites](#), anchored at colleges and universities, that serves teachers across disciplines and at all levels, from early childhood through university. NWP provides professional development, develops resources, generates research, and works to improve the teaching of writing and learning in schools and communities.

Intersections is currently in its fourth year and is made up of 10 partnerships between NWP sites and ASTC museums, which design and implement projects at the crossroads of formal and informal education and of science and literacy learning. These partnerships also share their work across the Intersections network (which includes all 10 partnerships, ASTC, NWP, and Inverness Research), as well as beyond the NWP and ASTC communities. Intersections takes

the word *literacy* at its broadest meaning, including writing, writing strategies, writing education, professional development strategies, and digital storytelling. The project also investigates the terms *science* and *literacy* quite broadly. The project asks, “What does combining these two domains look like in professional development for formal and informal educators and in experiences for students, youth, and visitors to museums.

The project focuses on creating a network of local partnership sites, with an emphasis on partnerships first, projects second. Intersections did not set out to create a “one-size-fits-all” model for local science and literacy programming. Instead, it provides guidelines and ongoing feedback for the design and implementation of programming that fosters the partnership sites’ locally appropriate and innovative projects. The resulting 10 projects vary in their emphasis and focus: Some focus solely on professional development for formal and informal educators, whereas others include students, youth, and museum visitors as primary audiences. The range of programming is a significant result of Intersections and includes projects that focus on a variety of topics (see Figure 1).

Figure 1

Work in the Intersections

In this article, we highlight two examples of Intersections projects that involve rich formal and informal collaborations—one in San Diego, California, and one in Charlotte, North Carolina. Both examples involve:

- a professional community of educators that includes K–12 teachers, informal educators, and university faculty;
- deep dives into areas of mutual interest and need among the professional community; and
- benefits for the partnership institutions, as well as participating educators and their students.

Through their interventions and reflections on those interventions, the educators in both partnerships learned about what makes science and literacy learning more powerful in and across formal and informal spaces.

San Diego: At the Intersections of Formal and Informal Education

The bus pulled up in front of the Reuben H. Fleet Science Center as much-needed rain pelted down. Excited fifth graders poured from the bus into the rain, ready to explore. And waiting just inside was a group of classroom teachers and museum educators, ready to watch closely and think carefully about how these students’ teachers and chaperones support student learning and promote student inquiry during [a] field trip.”
—Kim Douillard, Project Leader

Members of the San Diego Intersections team—staff from the Reuben H. Fleet Science Center and the San Diego Natural History Museum, partnered with San Diego Area Writing Project (SDAWP) teachers—have spent the last two years investigating the following questions: What is the purpose of school field trips to museums? What are our goals for them? How can we best accomplish those goals? What strategies for improved literacy teaching and learning can we adopt from NWP to enhance the field trip? What can writing-project educators learn from informal educators that can inform their experiences with field trips and work in their classrooms?

In the project leaders' minds, the field trip represented an important entry point for students to form a lasting relationship with science museums and science itself, in addition to being a piece of shared work between museum and school educators. Formal and informal educators in the San Diego partnership wondered how they might improve field trips to move beyond static museum guides, which tend to assume that all students have the same background knowledge and leave with the same extended learning, to a more interactive framework that supports formal and informal educators in planning and implementing field trips that propel student learning both during and after the field trip.

To study the field trip as a shared problem of practice, leaders from the Reuben H. Fleet Science Center and San Diego Natural History Museum each enlisted five informal educators and SDAWP leadership invited 10 local K–12 teacher consultants to participate in the project. The group of informal and formal educators met for multiple four-hour sessions over the course of two years between 2013 and 2015. Much of the work of this ongoing professional learning community, especially in the first year, focused on getting to know one another and understanding the problem of practice—improving the field trip—from one another's point of view. This was no small task. One museum educator recounted leaving a first meeting with tears in her eyes to tell a colleague, "The teachers don't feel welcome at our museum." A teacher shared, "And they told us, nicely of course, that we don't take advantage of the field trip." ([Read](#) the reflections of one of the museum educators on the Intersections team.)

This could have been the end of the partnership, but facilitators worked carefully to scaffold these professional conversations so that participants could remain open to hearing each other. Additionally, there was real desire on both sides to improve the field trip. That kind of shared inquiry into the work fueled the team during times of difficulty.

This team also engaged in evidence-based conversations built from its use of ethnographic tools (see examples below) to observe field trips in action. Project leaders noted the importance of formal and informal educators working as teacher-researchers during the project, testing and developing new tools for improving field trips as a first step but, more importantly, observing students in the museum trying the new tools. The teacher-researchers used (1) an action observation chart, which asked observers to note specific actions (e.g., pointing, asking a question) taken by visitors in particular rooms in the museums and (2) a map of the exhibit, which the observer could use to follow a particular youth, mark where he or she stopped and engaged, and code different kinds of engagement.

The teacher-leaders noticed that in San Diego, writing is probably the most powerful science-learning tool for improving the field trip experiences. Using the observation tools above, the team noticed a deepening of student engagement, intentionality, and understanding when they were encouraged to write before, during, and after the field trip. As a result of these findings, the

team began to eliminate complicated study guides, replacing them with “swag bags” that contained blank paper and colored pencils. The teacher-leaders also decided to substitute simple question-and-answer prompts on a worksheet with a “take five” activity, during which everyone simply stopped to write. Students returned from the museum with ideas for their own projects, inspired by something experienced during the field trip and the opportunity to write about that experience. Participating educators and students wrote blog posts about their field trip experiences. Included are links to two student blogs, one from [second grade](#) and one from a [third grader](#).

The following vignette is from an observation of one high school group’s interactions in the museum and the discussion among the teacher-leaders of what they had observed:

The students wandered in pairs or small groups through the exhibit. All teacher-researchers plus the leaders observed and recorded students' experiences. Students seem engaged in some aspects of the exhibit, less so or superficially interested in others. After about 45 minutes, some of the students wandered into other sections of the museum and answered the other, more formal questions on their handouts specifically related to an exam they would have the following day. During this time, their teacher noted that she is surprised that many of the students seem more interested in other parts of the museum [that] are less hands-on. She wonders [if it is] peer pressure? The age of the students? She said she wanted to talk to them at lunch to urge them to discover more deeply, to return to parts of the exhibit that interested them and not to be self-conscious. After the students departed, the group of educators discussed the following:

- *Student interactions and engagement and what might be impacting [these], as well as what students took away from experience that couldn't be seen or measured, [such as] comprehension from reading.*
- *How high school students were more inclined to use their phones to take photos (and how that reality could be incorporated into a visit to make it more meaningful and reflective) and how they were less inclined to engage in sustained discourse with each other and to play or to stay in one place for a long time.*
- *How the teacher sets up the visit makes a difference, [as well as] how open-ended the expectations for the visit activities are and how much the students' interests in the task ...*
- *How being able to see student work (both from the museum and from the classroom afterwards) will help both the formal and informal educators better determine the impact of the museum/field trip experience.*
- *What both formal and informal educators can do to help students figure out how to take their own initiative in the museum field trip and gain broader learning from the experience."*

One project leader noted, “[In this project,] teachers get to observe students who are not their own ... They are free to watch [students] interact without judgment, and this is powerful. They are

more apt to notice how students are engaged, are learning.” Over time, the growth and development of the educators and their ability to engage in [collective inquiry](#) was a significant outcome of this team’s work.

Benefits to participants

It seems clear to us that our process of learning together contributed to the changes in both teachers’ and museum educators’ practices when it came to field trips. The most powerful agent of change was the opportunity for educators to watch students in action with materials and practices they developed. We learned that the teacher bringing her students is often so worried about student behavior, that keeping students busy with a worksheet seems like a valuable exercise. It is when she has the opportunity to step back and see her students through her own eyes as a researcher that she is reminded of her goals for students beyond the trip itself.” —Kim Douillard, project leader

Ongoing, formative-evaluation interviews with participating formal and informal educators have shown that they liked the authentic experience of working together and trying to solve the very real issue of field trip quality and impact. In evaluation interviews, they noted the benefit of coming to know “someone from the other side.” Furthermore, teachers liked learning about the inner workings of a museum, particularly exhibit and visitor experience design, whereas museum educators said it was eye-opening to learn how addressing the diverse needs of teachers and students can have big impacts on improving museum-visit experiences. All of the educators also learned from their early toolkit-development process and observations about [what it means to design inquiry experiences](#) for students.

Students of participating educators enjoy enriched field trip experiences that are catalysts for additional learning and have better learning experiences in school. One teacher spoke about changes in her approach to taking students on museum field trips, as well as how her teaching overall has been influenced as a result of the project: “My goal for field trips has changed completely. I approach them with a more student-driven perspective, and what I ask students to do on the field trip and after has changed as a result of the project. Everything I do is different now ... I have a more open-ended stance; my questioning has changed, I give my students more choice, more flexibility, provide more opportunities for inquiry in my classroom.”

The partnership expanded the relationship and collaborative potential between the writing project and the museums. All four partnership [project leaders](#) said they would welcome the opportunity to work together again. The partnership also strengthened the ability of each institution to bridge the informal and formal worlds and to work in crosscurricular ways.

Continue Reading

UNC Charlotte: Making at the Intersection of Arts and Sciences

The Charlotte Intersections project, called Making STEAM, is a partnership between Discovery Place and the University of North Carolina at Charlotte Writing Project (UNCCWP). This project was born out of the institutions’ shared values and work history, as well as common interests

within the leadership team, all of whom believe deeply in the integration of arts and sciences. Making STEAM focused on “making” in both the school and the museum settings. As one project leader explained,

We explore ‘making’ as a concept, as way of teaching, and as a set of actions requiring literacy, science, mathematics, engineering, technologies, and creativity to engage students in the learning of science through literacy and technology-rich experiences. By ‘maker,’ we mean what Dale Dougherty in his [TED talk](#) calls ‘curious, enthusiastic amateur inventors whose tinkering habit sparked whole new industries.’ A ‘make’ in this project invites students to play with, try out, or represent ideas through physically and digitally making things and then sharing drafts in progress in various ways ([e.g.,] Google+, Twitter, classrooms, face-to-face forums). Makes in this project are science content– and literacy-rich. Makes bring science learning and literacy together by following the recursive processes of writing: launching an idea, composing, reflecting, sharing, and looping back and around.”

The project involved informal educators from Discovery Place, who teamed with pairs of teachers in three different Charlotte-area schools (a writing project teacher-consultant and a science teacher at each school). These groups of three worked in schools to guide the writing project teacher-consultant’s and science teacher’s students through *make cycles*, weeks-long activity cycles in which students, the pair of teachers, and the informal educators were engaged in making activities focused around specific themes (e.g., wonder, play, and curiosity) in both their science and language arts classes. These themes were also extended to activities completed at the museum during field trips and special events. Students then shared their collective work through an online Google+ community group that was open to all participating teachers and students, university students of UNCCWP faculty, and the members of the Intersections project network. One participating educator, Steve Fulton, explained an example of a paper-engineering activity that took place in his classroom:

Most recently, we played with paper engineering and pop-up books. The project grew out of novels students were reading in my eighth-grade ELA [English language arts] class. The novels, which all fell in some way under the broad theme of ‘injustice,’ were read by students in small book club groups, or literature circles. Toward the conclusion of their novels, students brainstormed themes and subject matter related to the text that they felt [were] important to their lives and/or community, and used this area of interest as a starting place for both research and creative writing. Building a pop-up book required students to be able to do more than write a compelling narrative; they would also need some familiarity with the mechanisms commonly employed [in] creating [pop-up books]. Robby Stanley, the informal educator from Discovery Place, collaborated with the science teacher, Mrs. Green, to transform her classroom for a few days into a paper-engineering workshop. With plenty of scrap paper, scissors, and markers on hand, the two teachers guided students as they worked through iterations of each of the four mechanisms commonly used in pop-up books: pull tabs/sliders, flaps, layers, fold-outs, and wheels. On the days ... students tinkered with paper in science class with Robby and Mrs. Green, they were finishing and sharing their creative writing pieces in my class, negotiating collaborative groups and the stories that their books would feature, and beginning to storyboard the individual pages. While all students were creating a similar form, how they crafted that pop-up book—from the story it told [to] the pop-up

mechanisms it employed [and] the ways illustrations supported and interacted with both—was up to them. What was also up to them, and perhaps the greatest challenge, was how ... to make this all happen as a group. The students created these stories that were inspired by readings in both their science and their language arts classes ... so, the content worked its way in, both in the books that they made and in the process they went through to make them. The way that they composed the books gave them experience with both doing science and doing literacy. It was the most rigorous experience with composition that has ever taken place in my classroom."

Students also participated in and facilitated [making experiences](#) for the broader community at Discovery Place and annual Maker Faires held at the local children's library. As one teacher wrote,

We brought the affordances of the science museum's informal learning structure to the formal learning environment of public schools through making, and we remade the school field trip to the science museum so that students were actively participating in and contributing to the science museum."

Benefits to participants

Ongoing, formative-evaluation interviews with participating formal and informal educators show that both benefit from the project in myriad ways. Both are learning more about making and how to integrate making into their respective education spaces. The classroom teachers become familiar with science content and the engineering design processes, project planning, and informal learning strategies from the museum educators, whereas the museum staff learn from the NWP teachers' writing strategies that they are incorporating into other museum education programs. For example, on one recent field trip, one of the formal educators participating in the project asked his students to facilitate making and science learning experiences for other visitors. Students helped demonstrate how to make stop-motion animations at a museum station; other students shared the pop-up books they had made in their science and language arts classes and facilitated pop-up engineering activities for other visitors. From observing these young facilitators, museum staff learn how to connect with and draw visitors into facilitated experiences.

Both formal and informal educators became more comfortable with implementing making projects in their settings. As one project leader noted in a formative interview, the educators apply making principles to include writing as a form of making and recognize less-obvious science and literacy intersections. For example, one participating English teacher spoke about how the interdisciplinary work, combined with a focus on making, has spread beyond the activities in the project to other areas of his teaching:

The underlying principles of making—the open-endedness, the student self-directedness—I have pulled and worked into other class assignments, too, and changed the way I teach and the way my students go about learning. When students know they have to figure things out, and I am there to support them; the whole dynamic of my class changes throughout the whole year. And when the learning that happens in science class intersects with learning in language arts class, where students can translate their

learning from one class to another, it has gotten more kids engaged. And the students take what they do when they are making and apply it in their science work and in their language arts work. When we have the space for students to make, where it isn't scripted and the notion of trying again is a big part of it, their attitude[s] change. When they have a problem in front of them in science class, they aren't as afraid of not having the right answer or not getting it right the first time. And this translates to the writing my students are doing—they are more likely to jump in and get words down on paper. So this gives the students the chance to think about how the skills they are learning through [making] are the same skills they need to be writers, scientists, and learners in general."

Many of these ideas and practices have spread throughout the museum culture as well, as “the educators who participated in this program share their learning with those who did not have the privilege,” notes Gábor Zsuppan, a project leader. Informal educators are incorporating strategies learned from their writing-project colleagues into other programs they run at the museum. For example, one informal educator said:

I am able to take what I am learning with this and apply it more directly because I am the camp coordinator and I write all of the summer curriculum. So, I am starting to bring in more literacy-based activities, like writing reflections on camp activities, to our science camps."

<https://www.youtube.com/watch?v=Bjk6chVqDRo&feature=youtu.be>

Participating educators have reported to evaluators—and formative-evaluation observations corroborate—that students of the formal educators have been highly engaged throughout and have benefitted, both from their integrated science-and-literacy-through-making experiences, as well as their deeper relationship with Discovery Place. Students shared how powerful they felt it was to have subjects that were normally taught in separate classrooms taught together. For example, high school students reading 18th-century novels in their English class were asked to create 18th-century theme parks based on their novels. Their projects, made from cardboard and other simple materials, highlighted one particular invention of the era and the physics or engineering behind that invention. They were assisted in this process through the coteaching of the English teacher, a writing project teacher-consultant, and an informal science educator from Discovery Place. The theme park activity was complemented by a field trip to the museum, where students explored phenomena through their interactions with exhibits that tied back to what they had been learning in physics and making in English class. As one student described:

The museum was really interesting. We walked by and there was this [museum program] on momentum and we were just doing momentum a few days ago (in physics class). We saw inventions and we were just talking about some of the inventions of the 18th century and so that kind of tied in with that and it was nice. At the Discovery Place we definitely saw connections in the things that we got to play with. A lot of those were based off of things that we learned in physics."

Another making activity students engaged in was creating a visual map of a poem in one class period (Figure 2).

Figure 2

The value of this process is described by one of the students:

When you read [a poem], and you think about it, you might pull out a few things, but when you have to actually create something, you can't just have one idea or one symbol because that is boring. So you have to pull out a bunch of different symbols and make them relate and you will find that the author does that, but you usually don't see it until you dig deeper. So it is a really cool and fun way to get you to really dig deep about the poem."

These students valued the combination of science and literacy: Another student said:

The integration of subjects has been great, because we think that subjects are very boxed, confined into their own little compartments and they don't really mingle. So we are using physics in our projects, and doing the engineering part of it, and we are writing about our projects, and we are creating and we have all of these different pieces to make this one whole ... I learned that it is difficult at first and you might not really know where to start, but once you do, you find your way and realize that it is not really 12 different subjects, it is just really one subject."

I had never done a lot like it, actually having physics in English, together ... I feel like I learned more this semester than I have in my past two years."

Lessons Learned

In its first three years of work, the Intersections project has already touched the lives of many people—nearly 300 preK–12 formal educators, over 150 informal educators, and over 700 youth have participated in these 10 projects. Formative evaluation has focused not only on gathering data about the nature and quality of these local projects and the experiences of and contributions to participants, as we have highlighted in these two cases, but also on the feasibility, strengths, and challenges of the local partnerships, as well as the work and the benefits of the network. (Summative evaluation of the program will take place in the winter and spring of 2016.)

The work and evaluation of the Intersections project show, and the two cases in this article highlight, that perhaps most significantly, the project has fostered professional learning communities on multiple levels. On a national level, the partnership between the NWP and ASTC has created opportunities for these two organizations to learn from one another about facilitating local partnerships and providing high-quality professional development. In addition, meetings and sessions at the two organizations' annual national conferences have provided opportunities for members of the broader informal STEM and literacy education communities to

learn about innovative science-literacy programming. Additionally, the two organizations' work in other areas (e.g., NWP's Educator Innovator community, ASTC's communities) has allowed the network's participants to connect into other, larger communities engaged in similar efforts.

On a local level, the partnerships between writing-project sites and science centers have engaged in and learned from designing and implementing locally appropriate science-literacy projects. These projects have fostered ongoing opportunities for leaders of these organizations and the participating formal and informal educators to inquire into many different subject areas, from place-based education to fostering youth development through science and literacy, fostering curation, and better understanding best practices in product-centered design. In some cases, they have also engaged professionals from other local schools and community-based organizations in their efforts, such as citywide science festivals, after-school programs, local poetry organizations, art museums, and libraries.