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Constructing Authentic and Meaningful STEAM Experiences Through University, School, and Community Partnerships

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Abstract

The aim of this article is to provide a model, an example, and suggestions for establishing and fostering meaningful partnerships to construct authentic and relevant STEAM learning experiences for preservice teachers. In order to prepare elementary preservice teachers to implement the *Next Generation Science Standards* alongside the *Common Core State Standards for Mathematics* in ways that are situated in relevant contexts and involve students in authentic inquiry-based problem solving, it is essential that PSTs actually experience modeled points of integration in their teacher preparation programs. It is our hope that this article inspires other teacher educators to develop partnerships with their university, local K–5 schools, and their community in order to best engage preservice teachers in meaningful STEAM-related learning and teaching.

Keywords: CCSSM, Interdisciplinary, NGSS, Partnerships, Preservice teachers, STEAM, STEM

The collaborative efforts described in this article are part of an ongoing partnership between a university mathematics educator and science educator in efforts to create an authentic science, technology, engineering, arts, and mathematics (STEAM) learning experience for elementary preservice teachers (PSTs) concurrently enrolled in both mathematics and science methods. These two teacher educators partnered first with each other and then formed partnerships with an innovative K–5 STEAM lab teacher, a nature center, and a water company to create a relevant and authentic context in which their PSTs could learn about both STEAM content and about interdisciplinary teaching, two identified needs in teacher preparation (Madden, Beyers, & O'Brien, 2014; Vincent & Focht, 2011). The partnership was initially formed when the two teacher educators began planning for their respective methods courses and identified an opportunity for coteaching through the context of data analysis and interpretation, an area in which PSTs need support (Roth McDuffie & Morrison, 2008). The aim of this article is to provide a model, an example, and suggestions for establishing and fostering meaningful partnerships in order to construct authentic and relevant STEAM learning experiences for PSTs.

The research literature supports the need for teacher educators to prepare PSTs to teach in ways that integrate subjects (Daugherty, Carter, & Swagerty, 2014). For instance, Frykholm and Glasson (2005) suggested the need for teaching prospective mathematics and science teachers pedagogical strategies for addressing overlapping content in these areas and drawing out the connections between the two content areas. Additionally, it has been found that when teacher education programs fail to create such interdisciplinary experiences for PSTs, they are less likely to integrate the subject areas in their own future classroom (Daugherty, Carter, & Swagerty, 2014;

Kurt & Pehlivan, 2013). We contend that in order to prepare elementary PSTs to implement the *Next Generation Science Standards* (NGSS; NGSS Lead States, 2013) alongside the *Common Core State Standards for Mathematics* (CCSSM; National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010), they must experience modeled points of integration in their teacher preparation programs. In doing so, PSTs have the opportunity to identify strong links among STEAM content while they simultaneously conceptualize how partnerships can be built to create authentic learning experiences. In this paper, we first describe the selection of STEAM content followed by the cultivation of partnerships, and then we discuss reflections from stakeholders and our own conclusions.

Selecting STEAM Content for Integration

Because elementary teachers are required to teach all subject areas, integration of content has been the central focus of much research. Specifically, the notion of STEAM (rather than just STEM) has been brought to the forefront as an avenue for incorporating the *Arts* back into the curriculum because they have been cut from many school programs nationwide over the past decade, as noted in Wynn and Harris (2012). STEAM has recently received much national attention through both the media and professional organizations such as National Science Teachers Association and the National Council of Teachers of Mathematics. However, STEAM research is still in the early stages. A new body of literature is emerging that highlights the importance of art integration into STEM to appeal to more types of learners (Ahn & Kwon, 2103; Bequette & Bequette, 2012; Wynn & Harris, 2012). Furthermore, STEAM education is important to facilitate students' interests and understanding about science and technology and to develop their abilities in integrated thinking and problem solving (Bequette & Bequette, 2012; Wynn & Harris, 2012; Yakman, 2012). Research also points to the benefits of integrating content; "By weaving big ideas and important skills from different disciplines, teachers can maximize classroom time and reinforce concepts and skills across subjects" and foster crosscurricular collaborations (Park Rogers & Abell, 2007, p. 58). Research on integration also suggests that "a number of K–12 studies sustain the notion that integration helps students learn, motivates students, and helps build problem-solving skills" (Czerniak, 2007, p. 545). Given this promising outlook on STEAM, our work focuses on STEAM integration and aims to help build this new body of literature.

Although the rationale for science and mathematics integration is well supported and propagated in the literature as a best practice in teacher preparation (Berlin & White, 2010; Kurt & Pehlivan, 2013; Pang & Good, 2000), many educators worry that integration may dilute the content that could better be taught in a more concentrated manner (Park Rogers & Abell, 2007). In their review of science and mathematics integration literature, Pang and Good (2000) found that mathematics is often integrated into science instruction as an adjunct component to science content. Moreover, Akerson and Flanigan (2000) found that integration by elementary teachers often resulted in a dominant focus on one content area to the exclusion of others.

However, teachers (and in our case, PSTs) can be taught to integrate their curricula in ways that are effective and should be given opportunities to reflect on how to do so through ongoing practice and modeled experiences. Recommendations have been made to include a focus on process skills, the use of national and state standards to drive the planning of thematic units, and the use of strong and meaningful themes (Park Rogers & Abell, 2007). Some researchers have also suggested inquiry-based learning to connect science, mathematics, and the real world (Berlin & White, 1992;

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Vincent & Focht, 2011). We based our project on these recommendations by considering not only the guiding standards documents but also ways we could connect inquiry practices to authentic local contexts in ways that would effectively integrate STEAM content areas.

Our STEAM Content

We recognized a need for interdisciplinary learning in the context of data analysis and interpretation, a well-documented high-need area for PSTs (Cook & Bush, 2015; Roth McDuffie & Morrison, 2008) and an important inquiry skill utilized in all areas of STEAM. The importance and relevancy of place (and drawing on a context that is local) was also an essential element in the creation of a curriculum that allowed for a deepened connection between PSTs and the elements of STEAM around them. Rather than creating a project around a contrived or fake issue, we wanted PSTs to actively participate in authentic issues of personal and collective interest to the community.

Our chosen focal area for developing and modeling STEAM integration centered on the study of the effects of erosion on local water systems. Table 1 describes how each STEAM subject was integrated into our data analysis and interpretation project set in the context of erosion. As with other environmental issues, interdisciplinary opportunities arise when analyzing and interpreting data-based investigations to solve important community issues. Starting with a strong link between two STEAM subjects (in our case mathematics and science) built a strong content foundation in which meaningful connections to technology, engineering, and the arts could then be added.

Table 1
Integration of STEAM: The Data Analysis and Interpretation Erosion Project

Content Area	Integrated Content or Tasks
Science	Erosion & Weathering, Inquiry Process Skills
Technology	Graphing Calculators (graphing displays), Probeware (water flow)
Engineering	Water Table (design and redesign)
Art	Scale Drawing of Water Tables, Design Software
Mathematics	Fractions, Area, Units of Measure, Angle Measurement, Graphing

Our project began with PSTs visiting a creek close to campus during their science methods course to investigate effects of erosion and erosion controls (an authentic context). PSTs were placed into groups and were asked to brainstorm and investigate different variables (e.g., amount of vegetation, soil type, and degree of slope) that affect the rate of erosion. Next, in their mathematics methods course, PSTs conducted demonstrations to explore the effects of these variables. During this time, important CCSSM content was addressed, including fractions, area, units of measure, and angle measurement. Back in their science methods course, PSTs constructed water tables and conducted their water table inquiry experiments, using data tables created during mathematics methods to record the results of their trials. Using their recorded data, PSTs discussed different types of graphical displays and created a graph representing the completed data table from their experiment in their mathematics methods course. The project concluded with a gallery walk of the graphs created by PSTs and with a claims, evidence, and reasoning (CER) chart. This project provided meaningful opportunities for the incorporation of technology and art, including the use of probeware during the water table inquiry experiment and graphing calculators to explore the different types of graphical representations. The art of design was incorporated through the use of scale drawings of the water table and design software to create a water table model. Cook and Bush (2015) provide a step-by-step description of the lesson, a timeline, and alignment to CCSSM and NGSS.

Cultivating Partnerships to Support STEAM Learning

There are important reasons for forming partnerships with schools. As instructors of mathematics and science methods, we have found that oftentimes, pedagogical strategies and teaching methods that PSTs witnessed or were encouraged to use in their field placements contradicted the research-based practices that were a central focus of our methods courses. This understandably caused PSTs to have conflicting views regarding the practices that they should be using as teachers, which often seemed to negatively affect the progress that we made towards supporting effective teaching strategies.

As strong advocates for inquiry-based, authentic, and relevant instruction, we realized that it was critical to better align the pedagogical practices that PSTs learned in their methods classes to the pedagogical practices used in their field placement. In other words, PSTs needed to be assigned to an exemplary classroom teacher that truly embodied the research-based practices that they were studying in their coursework. Only then would PSTs truly understand the power and possibility of teaching in a way that fostered student learning through authentic and meaningful contexts and the integration of STEAM. PSTs could begin to visualize this type of learning environment in their own classroom.

Beyond selecting an exemplar classroom for modeling STEAM education in fieldwork, we wanted to showcase multiple ways in which STEAM can fit into elementary education (e.g., as a single integrated unit or as a special area). Because we would model a STEAM unit in our methods courses, we believed that it was important to establish partnerships with local community stakeholders in an effort to highlight the local resources and supports (outside of the school) that PSTs can draw upon in their future classrooms.

We sought to form community partnerships with entities interested in the topic under study (i.e., erosion). Environmental concerns can play a versatile role in curriculum because they lend themselves to interdisciplinary instruction and can facilitate connections among local stakeholders (Cook & Weiland, 2013). As such, focusing our STEAM content on erosion in the community enabled an opportunity to invoke local surroundings and resources. According to Bouillion and Gomez (2001), science education should at least in part be "connected directly to expertise and lived experience from beyond the classroom. One way to gain leverage in this quest is through new social arrangements for schools, straightforwardly building bridges to communities beyond school" (p. 895).

In addition to creating a model in which PSTs saw in practice through their fieldwork what they had studied in their methods courses, it was important to approach STEAM learning goals (guided by the NGSS and CCSSM) by examining locally relevant issues, which is preferable to a

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context that may be more contrived to simply meet the needs of reform documents. Furthermore, engaging community stakeholders offered instructional and resource support to PSTs as they envision STEAM learning in their future classroom. Adding these components enabled PSTs to holistically visualize and embrace the idea of teaching STEAM subjects in integrative ways while learning about the resources on which they might draw in their local community.

Our STEAM Partnerships

There are several types of partnerships to consider: partnerships between university faculty (such as a mathematics and science educator), partnerships between university faculty and K–5 teachers or other K–5 school personnel, and partnerships between university faculty and STEAM stakeholders in the community (e.g., businesses, companies, organizations, or foundations). In this section, we explore these different partnerships and provide suggestions to consider.

University faculty partnerships. Partnerships formed between two or more university faculty members have three key benefits. First, they bring multiple areas of expertise together in order to create a learning experience in which PSTs benefit from different content and pedagogical expertise. To best model integration of two or more areas of STEAM, experts in as many of those areas as possible should be employed. In our case, the science educator wanted to authentically engage PSTs in data analysis and interpretation through the context of environmental science. However, she needed the help and expertise of the mathematics educator to do so in a way that clearly aligned to the CCSSM content standards (see Cook & Bush, 2015, for alignment).

Moreover, a partnership formed between two or more university faculty members has the potential to model what a partnership between two classroom teachers might look like, which can help demonstrate to PSTs the influence that such collaborative efforts can have on student learning. Such modeling may include the use of coteaching, which PSTs are increasingly being asked to implement as part of their student teaching experience.

Finally, we found that our partnership forced us to think critically about our own practice and teaching, essentially causing us to grow professionally and model to our PSTs the idea of being a dedicated lifelong learner who aims for professional growth that extends throughout an entire teaching career, as advocated in the Professionalism guiding principle of the National Council of Teachers of Mathematics' landmark publication *Principles to Actions: Ensuring Mathematical Success for All* (2014). When considering potential faculty members to partner with, care should be taken to find a partner with similar fundamental beliefs about PST learning or beliefs that complement each other. In our case, we found a common thread, which centered on the value we both placed on inquiry-based teaching and drawing upon relevant and authentic place-based contexts. Working and planning styles should also be taken into consideration. Questions to consider might include:

- What fundamental teaching philosophies do we share?
- How will PSTs be assessed on the STEAM project? How will we know if we were successful?
- How do our teaching styles differ? Do these differences create potential barriers with regards to planning, implementation, or potential PST learning?
- How will the planning, implementation, and assessment workload be distributed?

What resources are needed?

University faculty and K–5 school partnerships. Arguably, picking the right school partner (in our case a STEAM classroom teacher) is the most critical component. We found that one of the most imperative aspects of preparing elementary PSTs to teach STEAM subjects in an inquiry-based environment is for them to see this being done successfully in their field placement. In our case, our classroom teacher partner was a former graduate from our university who wanted to work with the mathematics and science teacher educators to establish a reciprocal partnership. When our partnership began, our K–5 STEAM lab teacher had recently started his first year as a STEAM lab teacher (a program that was new to his school) and was interested in partnering with our university for resources, ideas, and PST involvement in his classroom.

Although he was new to the field of STEAM, he had selected a curriculum (i.e., *Engineering is Elementary*) and developed several unit ideas to implement in his first year. Our initial conversations focused on what his plans were, and we provided resources that could benefit his developing curricula (i.e., journals, lesson plan ideas, research-based practices). These discussions enabled us to get a sense for his teaching style as an inquiry-based teacher and the types of relevant investigations with which students engage in his classroom. His lab is considered a special area, and over the course of the school year, he teaches every student in the school, Grades K–5. In his STEAM lab, students work on projects from start to finish and solve big problems, which are often showcased on a classroom blog. His classroom has received recognition regionally, and our partnership with him has been featured on the local news. For these reasons, it was evident that his STEAM lab was the ideal environment for our PSTs.

In addition to appropriate pedagogical knowledge, it is important that this partner have strong STEAM content knowledge, technology use knowledge, and classroom management so that PSTs can see how critical all these sets of knowledge are and how they must work in tandem to create a successful classroom environment. We suggest exploring the following avenues when trying to find a teacher who meets these criteria: former graduates of your program, stand-out teachers that have previously served as cooperating teachers for field or student teaching experiences, or recommendations from school district personnel. It is imperative that the expectations of how the PSTs will contribute and what PSTs will gain from the partnership is clear and explicit to the classroom teacher, the PSTs, and the university faculty members involved. The classroom teacher (or school member)—by definition of a partnership—should also benefit from this collaboration.

University faculty and community partnerships. A community partnership best develops from local entities that have an educational initiative. One reason that we focused on the context of environmental education is because we anticipated that there were many community entities that were stakeholders in educating children on environmental concerns. For this reason, we recommend focusing on curriculum that is of interest to local stakeholders.

For our project, we identified partners by considering who in the community is connected to water issues. The local nature center and water company were identified as key stakeholders who not only had a vested interest in educating the public about these concerns but also had established relationships with educators. Both entities work closely with the local school district (and at a reduced or no cost as part of their educative mission) and possess knowledge about the ways in which their curriculum integrates with perceived needs in the schools. Specifically for this project, we asked the education specialist at the water company to be a guest speaker in our class. This provided an opportunity for PSTs to locally contextualize what they were studying about erosion

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while also providing a broader view of how our community responds to erosion problems that affect our waterways. The nature center provided the physical space to observe erosion and related curricular materials for direct use with K–5 students (i.e., water table construction directions, formative assessment probes, and inquiry-based investigations for how to test variables affecting the rate of erosion). Both of these partners helped not only to extend learning beyond the walls of our classroom but also to provide a support for PSTs in their future teaching.

Many local entities show an interest in informal education initiatives and naturally lend themselves to opportunities for interdisciplinary learning. By definition, a partnership should be a mutual relationship in which both partners benefit. The organizations should benefit from increased awareness of PSTs and K–5 students about their efforts and through the help and expertise of university faculty and PSTs to guide or assist in their initiatives. To brainstorm potential local partnerships, we include the following questions adapted from Bush, Karp, Lentz, and Nadler (2014):

- What entity in your community might benefit from a reciprocal partnership?
- Where in your community do children learn outside of the school setting?
- Is there an entity that could benefit from a partnership in which PSTs could help with curriculum development while simultaneously learning about the STEAM content associated with that entity?
- Is there an entity in which your PSTs could help solve or contribute to solving a STEAM-related problem?
- Is there an entity in the community that would benefit from the expertise of a STEAM-field teacher education faculty member?

When first reaching out to a community entity, we suggest contacting the person who is responsible for educational outreach or coordination. Explain why you have an interest in forming a partnership. Discuss not only how they can help you and your PSTs but also what you have to offer them in terms of expertise, time, or resources.

Reflections on STEAM Integration and Partnerships

The following section highlights reflections on the STEAM integration experience from our multiple stakeholders (faculty members, PSTs, and the classroom teacher) in an effort to illuminate items for consideration for readers interested in implementing these types of experiences in their teacher preparation programs.

Reflections From Teacher Educators

The creation of this project required time and flexibility by both the mathematics and science educator. The two faculty members formed a partnership in early 2013 and spent the fall 2013 semester planning this project and pooling resources; the project was implemented during the spring 2014 semester. The course was a mathematics and science methods course for elementary teachers, and this project alternated between designated science methods course time and mathematics methods course time, spanning six class sessions. Cook and Bush (2015) provides a detailed schedule. Throughout the duration of the project, the meaning of shared terms (such as inquiry, data analysis, and interpretation) and concepts (such as erosion and weathering) were collectively honed. The science educator taught the mathematics educator about the disciplinary core content (i.e., erosion, weathering, erosion controls, human impact) and walked her through conducting portions of the labs (i.e., percolation tests, flow rate) so that students could discuss measurement and develop data tables in mathematics methods. Essentials of inquiry were also discussed explicitly to explore how the erosion unit fit within the ideals of NGSS. This required the mathematics educator to become more familiar with science content and inquiry processes so that the mathematics could be discussed meaningfully within the context of erosion. The mathematics educator also learned to teach with new materials (such as water tables and models) that she had never used before.

Concurrently, the mathematics educator taught the science educator about different graphical displays that were a focus of the elementary CCSSM agenda and worked with the science educator on important mathematical ideas and vocabulary (e.g., discreet vs. continuous data, numerical vs. categorical data, or independent vs. dependent variable). Moreover, the mathematics educator worked with the science educator to show her how students could calculate the area of the water table in square units and how the degree of the water table slope could be connected to algebraic thinking standards, both of which are topics that align well within the learning goals of the CCSSM.

After implementation of the project began, both faculty members had to make iterative changes to their methods course based on reflections from students that were discussed in weekly meetings held by the two faculty members throughout the project duration. Both faculty members used a researcher journal to document their own reflections immediately after each class session and exchanged these reflections. An example of a reflection recorded in the researcher journal is: "Upon prompting, all PSTs were able to recognize that there was a relationship [in a sample graph], but most were unsure how to characterize that relationship" (Mathematics Methods Instructor, Researcher Journal, 2/11/14). The reflections recorded in the journal served as discussion points between the two faculty members about what needed to be addressed more explicitly in subsequent class sessions. Another example showcased a time when the researcher journal led to a deeper understanding of one another's content standards. The mathematics educator wrote about a classroom discussion regarding measuring the degree of the slope of the water table:

> I started by addressing fourth grade CCSSM standard about measuring angles in degrees using a protractor. In their science notebooks, I had them all use a protractor to make a 20 degree angle. We discussed how 90 degrees would be a waterfall as far as water flow, we talked about how when thinking about the incline, the horizontal ray would be the flat ground . . . and the hill is the other ray that makes the slope. The slope group decided to use 20, 40, 60 degrees (Mathematics Methods Instructor, Researcher Journal, 3/12/14).

As well as the determination of how they would test their experimental variables from their mathematics methods class, PSTs gained experience with the use of protractors, which proved to be more challenging for PSTs than either faculty member anticipated.

Furthermore, reflections from the researcher journal at times inspired follow-up investigations, such as one that followed a discussion in the mathematics methods course regarding how to calculate area:

> Devon said, "Shouldn't you take out the area of the river first, and not count that?" Carly said only squares adjacent to the river should be counted, because the vegetation is irrelevant unless it is adjacent to the river. This led to a heated great discussion . . . and PSTs had quite a misconception about the percent of vegetation as a function of overall area of

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> the water table (Mathematics Methods Instructor, Researcher Journal, 3/12/14).

This enabled opportunities for the science methods instructor to address persistent misconceptions in the next class session. In fact, one of the greatest benefits of the researcher journal was that it allowed for formative exchange of information about class sessions, PSTs needs, and modifications to future class sessions. This process required flexibility by both faculty members. Based on our reflections on this process, the following is a list of suggestions for working collaboratively to create STEAM projects to use with PSTs in methods courses:

- Select a context in which PSTs can explore in an authentic setting (in our case, PSTs examined erosion and erosion controls at a nearby creek);
- Start with a strong link between two STEAM subjects (in our case, mathematics and science), and build the other STEAM subjects around that foundation in order for the project to address content in-depth;
- Consider the alignment of foundational content (see above bullet) in the project to the national or state set of standards the PSTs will use with K–5 students in order to build content knowledge and knowledge of the standards (in our case, the CCSSM and NGSS); and
- In order to establish a link between PST coursework, fieldwork, and the community, consider which school and community partners you could enlist to create the most meaningful and authentic experience possible for PSTs.

Reflections From Preservice Teachers

When asked about the importance of integrating content for teaching data analysis and interpretation, PSTs pointed to the reciprocal nature of mathematics and science and the importance for their future students. Statements such as "It goes hand in hand; you can't have one [content] without the other" (Tyson) illustrated that PSTs saw the content as mutually supportive. Others indicated the importance of teachers understanding these process skills so they can teach such skills to students. This idea was supported with reflections such as "You cannot teach students to interpret or communicate data [in science] without these math skills (i.e., how to represent data in various forms (ex. percentages) and communicate through graphing)" (Jill). One PST, Carly, stated it is not possible to understand data displays and determine relationships from the data table alone and that graphs "can reveal key relationships among data." She also noted, "They [graphs] are used sometimes by the media and marketing to mislead voters and consumers," a comment likely connected to the discussion of graphical displays (and their misuse) that took place during their mathematics methods course. Carly articulated that one of the rationales and the importance for focusing on data analysis and interpretation with students was to protect them from being misled by data displays in popular media sources—in other words, to prepare students as informed consumers.

At the beginning of the unit, PSTs exhibited misunderstandings about how to read data displays. When asked to interpret graphical images and erroneous claims, PSTs failed to recognize relationships among data. For example, after viewing a graph of temperature and carbon dioxide changes over time that included an inaccurate claim that there was no relationship among the variables, PSTs suggested that improving the graph could be done by simply (a) making the graph clearer to read (by incorporating a key), (b) reducing the time increments to better see changes in values, and (c) showcasing temperature with a best fit line rather than so many individual data points. In other words, the PSTs did not see the discrepancy between the data and the interpretation and instead focused on mechanics of graphical design. At the end of the unit, however, PSTs were asked to evaluate one another's data displays and were able to identify errors and inaccuracies. Because PSTs had multiple opportunities to discuss data analysis and interpretation as well as conduct the data collection themselves in both of their methods courses, their understanding of how to build graphical displays and analyze data became more sophisticated.

Unanimously, PSTs would return from the STEAM lab enthusiastic about what they had observed in the field and were able to identify aspects of inquiry and STEAM content that aligned with what they were learning in their methods class. Notably, PSTs were excited about implementing inquiry-based experiences with their future students. They were able to envision integrating content areas through inquiry. One PST remarked, "I plan on incorporating inquiry experiences in my classroom as often as I can. I also plan to connect it to many other content areas [besides science and mathematics]. I want my [future] students to make many connections" (Tyson). Furthermore, all of our PSTs recognized the relationship between the inquiry-based teaching of integrated content and student engagement. As one PST claimed, "It allows students to dive deeper into material and ask their own questions, often finding their own answers that mean much more to them" (Meg). As instructors, we considered this particular partnership one of the most essential elements to effectively supporting and motivating PSTs to integrate STEAM in their future teaching.

Reflections From Partnering K–5 Teacher

The K–5 classroom teacher equally valued the partnership. He not only welcomed the PSTs into his STEAM lab for observations but immediately invited them to work directly with the students—supporting and modeling the practices of formative assessment and student-led learning that are characteristic of inquiry-based teaching. He referenced his enthusiasm for our collaboration when he stated,

> I love the work you did with the teachers. It fits perfectly with the vision I've always had for STEAM—a classroom space that is student-centered, engaging and most importantly, purposeful. I've also imagined STEAM as an opportunity for current and future educators to try new things.

As evidenced here, our K–5 teacher partner envisioned this collaboration as an opportunity for our PSTs to grow in their development as prospective teachers in addition to having their support and assistance in his classroom, which fosters the reciprocal nature of a partnership.

Our K–5 teacher partner also shared our passion about the integration of subject matter and how the authentic combining of disciplines in STEAM enables students to deepen their inquiries. As claimed below, science and mathematics skills are a necessary component of the projects that students were completing in his classroom:

> Integrating authentic math into science is difficult (while also tackling NGSS), but I think we have something unique happening [here]—What you don't see [in students' final projects] is the week or two of design work and research that goes into developing the projects—the science and math content required to fully understand the skill, the iterative nature of the work, even the collection of data as students quantify themselves as learners (analyzing their own data—they keep data notebooks in their regular classes).

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Although he recognized that his classroom was not a typical field placement for elementary PSTs, his approach to inquiry-based teaching brought about a need for natural integration to support content learning and skill building.

Beyond this, his passion for STEAM teaching extended to a moral imperative for teaching: "We work to imbed needed foundational science and math skills while showing students that math and science mastery allows them to obtain knowledge and, thus, capital." In essence, our K–5 teacher partner envisioned his work as an educator to be centered on empowering students and prospective teachers. In other words, he truly works to prepare his students for the future jobs they will have as adults (some of which don't yet exist) and to be productive, self-sustaining citizens. Based on our reflections of collaborating with our K–5 teacher partner, consider the following list of suggestions as important guiding questions when embarking on a partnership:

- How does the curriculum and pedagogy implemented by the K–5 teacher partner align with the curriculum and pedagogy being promoted in the methods courses?
- How will PSTs fit into this environment? When or how often should they spend time in this classroom in order to benefit all stakeholders (including K–5 students)?
- What research, lesson planning, curriculum work, or resource gathering can be done by the faculty partners and PSTs to help the K–5 teacher partner?
- Does the K–5 teacher partner privilege specific areas of STEAM? If so, are there ways faculty partners can help find a balance while keeping the curriculum authentic and meaningful?
- What opportunities are there for coteaching between the different stakeholders (K–5 teacher partner, faculty partners, and PSTs)?

Concluding Remarks

The partnerships discussed in this article showcase the benefits of collaborating with stakeholders in order to create authentic and meaningful opportunities for PSTs that have the potential to fundamentally change how they envision their future classrooms. Our PSTs were grateful for this holistic experience and viewed their time spent in the K–5 STEAM lab as one of the most meaningful experiences of their semester. Their experience aligned with the recommendation made by Park Rogers and Abell (2007), which states that national and state standards, in our case the CCSSM and NGSS, should drive the planning of thematic units, and also aligned with the best practice of inquiry-based learning that connects science, mathematics, and real-world models (Berlin & White, 1992; Vincent & Focht, 2011). Having a field experience that truly embodied the heart of the message we were sending in our mathematics and science methods courses was invaluable.

Moreover, our teacher partner was grateful for the opportunity to share his K–5 STEAM lab with PSTs while at the same time obtaining the help PSTs were able to provide. Because his lab was a STEAM lab, there was greater buy-in from K–5 students and our PSTs, as artistically-inclined students, were intrigued by the ways the art of design could be integrated with mathematics, science, engineering, and technology. Our partnership with the nature center and water company created the critical connection to our community.

In our attempts to integrate STEAM content, we found that centering our inquiry on environmental concepts enabled PSTs to explore relevant science content while collecting and analyzing authentic data from which they could offer potential solutions to local concerns. Although we began this endeavor with a primary focus on the science and mathematical concepts at play, we found that this experience could naturally bring in the arts (i.e., use of graphic design software, scale model drawings) and technology (i.e., use of probeware, graphing calculator).

It is our hope that this article inspires other teacher educators to develop partnerships at their university, local K–5 schools, and community in order to best engage PSTs in meaningful STEAM learning and teaching. This experience has and will continue to have a substantial effect on the growth and development of our PSTs as well as our growth and development as teacher educators.

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