Engaging Rural Youth in Multidisciplinary Inquiry through Archaeology: A University-Assisted Community School Approach in Action

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Abstract

Afterschool programs for youth play an important role in stimulating a sustained interest in STEM fields (science, technology, engineering, math). While there is a demonstrated need for such informal education programs, implementing them can be challenging due to limited staffing, funding, and operational costs. University-Assisted Community Schools (UACS) initiatives offer established partnerships, support networks, and opportunities to provide informal education experiences for youth. Binghamton University's Community Schools (BUCS) is a well-established UACS initiative where families and children receive coordinated support and college students gain experiences outside the formal classroom. Using its UACS approach, BUCS joined with the Public Archaeology Facility (PAF), a research center on the Binghamton University campus, and faculty in the Department of Teaching, Learning and Educational Leadership (TLEL) to support a National Science Foundation's Advancing Informal STEM Learning (AISL) grant that funded a project entitled, *Engaging Rural Youth in Multidisciplinary Inquiry through Archaeology*. The resultant program offers a model for other communities to develop similar afterschool programs, providing youth with informal learning opportunities in STEM disciplines. The grant advanced an innovative approach to teaching STEM to youth in rural school districts using modules based on scientific concepts used in archaeology supplemented by Indigenous knowledge. This article describes the partnerships, the research aims of the program, the archaeological/Indigenous modules, and research insights and includes a graduate student's reflections on identity and the process of becoming an informal educator, mentor, and colleague. These discussions illustrate the development, implementation, and refinement of an archaeological afterschool program that supports youth, undergraduate and graduate students, and professional archaeologists as multidisciplinary STEM learners.

Introduction

Previous research suggests that interest and engagement in STEM (science, technology, engineering, math) can be triggered at a young age, and informal learning experiences play a role in stimulating this interest (Maltese et al., 2014; Maltese & Harsh, 2015). Afterschool programs are an important avenue for providing informal experiences for adolescents to engage with STEM concepts, practices, and skills. However, there are challenges in implementing such programs in rural areas including lack of access to reliable transportation, limited funding, and lack of community partnerships to sustain programs (Collins et al., 2008; Joyce et al., 2014). In this paper, we highlight a current partnership between a Binghamton University (BU) archaeological research center, a University-Assisted Community Schools (UACS) program, university-based educational researchers, and three local rural school districts in implementing a novel afterschool program focused on supporting middle school youths' participation as STEM learners using concepts embedded in the practice of archaeology. The objective of our partnership was to develop, implement, and refine an archaeological afterschool program to support and engage youth, undergraduate and graduate students, and professional archaeologists as multidisciplinary STEM learners. We contend that this partnership offers a model for collaborations with professional archaeologists in other communities to develop similar afterschool programs and provide school districts with much needed informal learning opportunities, particularly in STEM disciplines. Such partnerships also have the potential to advance a growing specialization in the field of archaeology — community engagement — which is grounded in the principle of providing a public benefit from archaeological research.

The National Historic Preservation Act of 1966 (NHPA) introduced the concept of "the public benefit" of preservation and outlined a community consultation process. The 1990 Native American Graves Protection and Repatriation Act (NAGPRA) required the highest levels of outreach and consultation with descendant communities and their representatives. Simultaneously, Black epistemologies (e.g., Blakey, 2008, 2010; Franklin et al., 2020; McDavid, 2011; Singleton, 1997), Indigenous thought (e.g., Atalay, 2012, 2019; Colwell-Chanthaphonh & Ferguson, 2008; Gonzalez & Edwards, 2020), and feminist theory (e.g., Battle-Baptiste, 2011) encourage archaeologists to incorporate various levels of community engagement in their work. A growing contingent of researchers is incorporating and centering a variety of community engaged practices in their research, ranging from public outreach and education to direct collaboration with stakeholder communities. BU's research team and the UACS initiative provided a unique partnership for assisting local middle school districts with an informal program to enhance STEM education using applied archaeological learning modules.

University-Assisted Community School Approach at Binghamton University

Binghamton University Community Schools (BUCS) is a multipronged initiative that leads local, statewide, and national efforts to implement partnerships between higher education, schools, and communities. BUCS launched in 2014 after many years of engagement between BU and local health and social services organizations and schools. The program maximizes the resources of the university to enhance student learning (for both college students and pre-kindergarten to high school students), f.u:ulty research, and community-engaged learning opportunities. As a strategy, community schools are an economically viable way to reduce the negative influence of poverty on children's ability to thrive (Bronstein et al., 2020; Williams, 2010). When universities engage as partners with community schools, they can simultaneously advance university research, teaching, learning, and service, while serving as lead partners to provide long-term engagement of faculty, staff, students, and institutional resources with the school. BUCS utilizes this strategy to implement a University-Assisted Community Schools (UACS) model in the rural communities, towns, and small cities that make up Broome County, New York.

Central to the mission of BUCS is the tenet that the partnership between higher education and schools is a mutually beneficial one, where families and children receive an array of coordinated support, and college students gain rich experiences not typically available in a formal classroom (Bronstein et al., 2020). This is facilitated in part by a notable partnership between BUCS and the Division of Student Affairs' Center for Civic Engagement, which helps to militate much of the student engagement in the local community schools.

The primary work of BUCS is carried out in three domains. First, local implementation of the UACS model is accomplished through the BUCS Regional Network. The Network brings together community school coordinators from nine school districts within Broome County for professional development, opportunities to connect with community partners, and network-building activities. Second, faculty and students from across disciplines engage in area community schools through applied research, clinically rich internship placements, and volunteer opportunities. Examples include research around financial literacy (Dzigbede & Young, 201), interprofessional education for social work., education, and nursing students to address the needs of marginalized families in community schools (Lee et al., 2017), and a full-service community school grant through the U.S. Department of Education that has expanded community schools to two rural school districts in Broome County led by faculty in the College of Community and Public Affairs. Third, through funding from the New York State Education Department and the Netter Center for Community Partnerships at the University of Pennsylvania, BUCS provides technical assistance for community school strategies in higher education in New York and New Jersey, as well as school districts, community and faith-based partners, and afterschool programs throughout New York State. BUCS provides technical assistance through universal and individualized suppon via communities of practice, webinars, toolkits, one-to-one consultation, and regional events.

Along with these elements, BUCS also co-creates coursework and credentialing about community schools in collaboration with the Departments of Teaching, Learning and Educational Leadership (TLEL) and Social Work., and has formed critical partnerships that span multiple disciplines across the university, including the Decker School of Nursing and Health Sciences and the Masters of Public Health. Additionally, BUCS contributes to the national agenda around community schools through its partnerships, advocacy work, and evaluation efforts.

The local implementation of community schools and the faculty engagement elements of BUCS provided a platform for a partnership between BUCS, TLEL, and the f.u:ulty partners associated with BU's Public Archaeology Facility (PAF). This team submitted a successful application for a National Science Foundation (NSF) Advancing Informal STEM Learning (AISL) grant designed to bring an afterschool program to three rural school districts using archaeology concepts to teach STEM components. This grant offers BU students opportunities to work with faculty and implement learning programs for middle school students, providing expanded learning opportunities for these youth, as well as valuable teaching and engagement skill-building for our university student participants. For graduate student participants, this skill-building advances their preparation for careers in community engagement, an expanding field within archaeology.

Community Outreach and the Public Archaeology Facility

The NSF AISL program awarded the BU team of researchers and educators a two-year grant in 2020. Team members began planning during the Covid-19 pandemic and ran the first in-person afterschool program in spring 2021. The program benefited from the successful relationships that BUCS personnel had established with rural schools, which facilitated the launch and delivery of the afterschool program. PAF's longstanding community outreach mission, particularly with school-aged participants, fits well with the mission of BUCS (Bronstein et al., 2020).

PAF is a research center on the BU campus that provides specialized archaeological services to clients throughout the Northeastern United States.[1] These services fall within a branch of archaeology known as cultural resource management (CRM), which operates within the context of historic preservation and public archaeology. Since PAF's establishment in 1972, community outreach and engagement have become an increasingly important part of its mission (Miroff & Versaggi, 2020; Versaggi, 2007). PAF archaeologists are committed, both personally and professionally, to engaging various community constituencies in the research they conduct. For instance, staff respond to requests for programs on archaeology and local precontact history to enhance school curricula. PAF provides speakers for community events, such as Career Days, First Fridays, and Heritage Walks. They also invite community and school groups to tour the lab facilities and, when feasible, visit ongoing excavations. In 1996, a core group of PAF archaeologists designed and implemented a summer enrichment program in response to increasing requests for ways community members could be more involved in archaeological research.[2] The Community Archaeology Program (CAP) includes three week-long sessions: Kids (grades 5 and 6), Teens (grades 7-10), and Adults (ages 16 and over). All three programs provide hands-on experiences in the classroom, field, and lab.

The success of these summer programs prompted CAP instructors to search for additional ways archaeology could contribute to schools and communities using the CAP model. PAF entered into conversations with TLEL and BUCS to see if CAP could enhance learning experiences for students in local schools through their community school initiatives. These discussions encouraged us to develop and test archaeological activities that could be used to fulfill a community need for informal afterschool programs focused on teaching STEM concepts. These conversations led to the joint proposal to NSF's AISL Pilot & Feasibility Program. The proposal focused on the overwhelming demand in rural schools for the same informal STEM programs that are available to their nearby urban neighbors. BUCS and others have found that many students in rural areas do not have opportunities to participate in athletics, music, or performing arts outside of school, revealing a high demand for afterschool activities (Snellman et al., 2015; Zaff et al., 2003). By extending CAP's summer program into the academic year and providing a more STEM-focused informal learning experience, we implemented a program that fulfills this critical need.

[1] https://www.binghamton.edu/programs/public-archaeology-facility/index.html

[2] https://www.binghamton.edu/programs/cap/

The Archaeological Afterschool Program

The purpose of the afterschool program was to advance youth knowledge of STEM through informal afterschool sessions based on the science of archaeology. The target audience was middle schoolers (grades 6-8) from rural communities, and the specific focal concepts included life sciences, technology (design and experimentation), physics, mathematics, and ecology. A key goal was to advance STEM learning by having youth formulate hypotheses and collect data from artifacts, activities, landscapes, and Indigenous knowledge. The data obtained tested hypotheses or fueled replication experiments about how precontact Indigenous people designed and used tools, acquired and prepared food, communicated without writing, practiced sustainable land use patterns, and maintained traditional ways of life into the present.

A central focus of the program was traditional Indigenous knowledge as it relates to science and the environment. A Haudenosaunee Clan Mother, a Faithk.eeper (and wampum maker), and a storyteller from the Onondaga Nation presented to the learners, supplementing archaeological concepts. Lessons included a performance by the storyteller, a cordage making demonstration and hands-on activity, and the recitation of the Thanksgiving Address in the Onondaga language. Their focus was Indigenous perspectives on the time depth of their relationship with elements of nature, and the need to treat the environment and all organisms within it with respect in order to sustain the practice of their traditional ways of life.

Archaeologists and their student assistants implemented the afterschool program twice in three rural middle schools in Broome County, New York. Each program involved two hours of informal activities per week for 10 weeks. Enrollments ranged from 10-20 youth per session. BU undergraduate and graduate students served as program assistants supporting both the middle school learners and instructor archaeologists in the classroom.

Each day, different topics in archaeology were presented that highlighted a specific STEM concept. All lessons had a hands-on component that reinforced the STEM concept. Topics and activities included: artifact identification/classification, field surveying, stone tool replication and use, faunal (animal bone) analysis, flora (plant) analysis, cordage making, spear throwing using an atlatl, wampum making (shell beads), landscape analysis, drawing to scale, hypothesis testing, diagnostic artifact typologies, and storytelling (learning about a culture from oral tradition).

An example of a lesson was landscape analysis. For this module, youth learned where people lived on the landscape thousands of years ago and where they acquired subsistence and non-subsistence resources. STEM concepts included spatial analysis, ecology, biology, and geography. This module built on previous lessons that focused on stone tool functions, floral and faunal resources, and traditional ecological knowledge. Instructors guided discussion by asking learners a series of questions:

- What are the various geographical settings (floodplain, tem.ce, valley wall, upland)?
- How did people use these various settings and what types of archaeological sites did they develop (base camp, village, temporary camp, resource procurement/processing location)?
- What factors beyond the natural environment may have influenced how precontact people selected site locations (e.g., territoriality, protection, religious beliefs, etc.)? How might this increase the difficulty for archaeologists attempting to predict where Indigenous people settled in the past?

Instructors provided topographic maps with the school's location and discussed how to read these maps and where on the map the learners would expect to find particular site types (hunting camp, fishing camp, village, etc.). Learners then went outside to view the landforms that they identified on their topo maps (e.g., floodplain, hilltop, wetlands, creek) and decided if they still thought those landforms would have been advantageous for settlement, growing crops, hunting, fishing, or other functions. They answered questions about their "site" in ArcGIS Surveyl23 and plotted the sites on an interactive map.

[1]https;/flearningpolicyinstitute.org/sites/default/files/product-files/Community_Schools_Effective_INFOGRAPHIC.pdf

These data were downloaded and a map with all their "sites" was produced. As a group, we then analyzed the landscape that housed these various "sites."

A universally favorite activity was learning to throw a "spear" (dart) with an atlatl (wooden spear throwing device). This lesson was done in conjunction with an exercise in hypothesis testing. Archaeologists introduced youth to an ancient piece of technology (a spear thrower), and the physics behind it (leverage/levers, laws of motion, etc.). Based on this, learners developed a simple hypothesis (e.g., a dart can be thrown farther with a spear thrower; or a dart can be thrown farther by hand). Learners developed methods to test their hypothesis: Will all individuals throw? How many times? Will only the farthest throw be recorded? Once they completed the experiment, learners examined the data to see if their hypothesis was supported by the data collected. If it was not, the learners, guided by the educators, discussed if there were parameters that affected the testing (e.g., wind, temperature, inexperience), or whether the hypothesis should be revised using different variables. Youth then decided how to test the new hypothesis with experiments using the new set of variables or in different weather conditions.

Around week six, learners formed groups and began their selected research project or experiment; they worked on the project at least one day a week for the remainder of the program. The end product was a printed poster created in Google Slides or a Google Slides presentation. Experiments included testing what type of tool (stone, bone, wood) cuts a root vegetable better; what method is best for making cordage and how much weight can it support; and what variables make an aclatl more effective for distance throwing (e.g., type of atlatl, person's height, dart length, person's arm length). The program concluded with a capstone event at which learners presented their projects to teachers, school staff, and their families similar to a professional conference poster session. Through these projects, youth learned an important STEM process – devising hypotheses, creating ways to test hypotheses, interpreting and presenting results, and working in teams where tasks are divided among the team members while all work to achieve a product.

The archaeological afterschool program contributed to a UACS initiative by filling an educational need for informal STEM programs for students in rural areas. Through novel hands-on activities, learners engaged with STEM concepts through archaeology. This pilot program provided educational researchers with data to assess program goals regarding how archaeological activities contribute to building a STEM identity for participating youth, and pedological advancement for the undergraduate and graduate student assistants. These will be discussed in the following sections.

Research Insights

As part of this program, we examined how the development and implementation of the program supported and engaged youth (i.e., middle school learners) in STEM learning and identity development as a STEM person. In this context, we define a STEM person as an individual who engages with STEM concepts and processes, such as hypothesizing through observation, or using principles of physics to throw a spear using an atlatl. The first aim was to understand the ways in which BU graduate and undergraduate students supported youth participation as STEM learners. The second aim was to identify ways in which a middle school student's participation in an informal STEM program shaped and shifted their identity as a STEM person.

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To study this aim, the research team utilized information collected through field notes or observations, and written reflections from the BU students themselves. Observations focused on the actions, dialogue, and interactions between the youth and the educators (including BU students), and among the youth themselves. Once the program concluded for the day, each observation was added to a two-column Google document where the research team explained our observations in greater detail. See Figure 1 for a snapshot example of the research team's field notes when learners sorted projectile points into types based on their observations.

In-Program Observations	After-Program Explanations
Educators introduced learners to the official New York State artifact typology book that archaeologists use in the field.	Educators introduced learners to the official New York State artifact typology book that archaeologists use in the field. By introducing this book to learners, they are seeing first-hand how the activities they are doing in the program are related to real-life archaeology.
Quotes from university students to middle school students: (a) "Do you notice that kind of indent on any other ones?" (b) "This is an interesting shape. What do you think it could have been used for?" (c) "Explain how you determined how to sort your projectile points." Quotes from educator to middle school students: (a) "Make types, make categories, and make sure you can explain why you put them there." (b) "You had broad categories and divided them up even farther." (c) "Try to find its side." (d) "Do you think you can break them down even farther? Maybe based on shape and width?"	BU students and educators encouraged youth to dive deeper into their typologies, providing comments and praise along the way. They let learners find their own way, and mostly allowed them to create typologies on their own. As these quotes highlight, middle schoolers were engaged as scientists as they communicated about their sorting and were challenged to consider other ways to observe the same "data."

Figure 1: Example of two-column observation field notes

The left column, entitled "in-program observations," included the actions, dialogue, or interactions we observed each week during the duration of the 10-week program. The right column, entitled "after-program explanations," corresponded with and elaborated the observation on the left. Along with the observations, BU students were asked to complete a written reflection each week where they detailed their experiences, observations, and overall feelings about the program in response to a set of questions that were subject to change. After each BU student submitted their reflections, direct responses were placed in an Excel spreadsheet where the research team created analytical memos to extract meaning from the data (Birks et al., 2008). Based on the field notes from each school site and the written reflections submitted by each BU student, the research team was able to focus on how this program supported the middle school students' participation as STEM learners. With this information, we drew connections between what we observed and what the BU student noted in their reflections.

In conjunction with the BU students, the archaeology afterschool program created an environment where youth could gain, as well as expand upon, their STEM knowledge. Based on the data collected, we identified two prominent methods that the educators of the archaeology afterschool program and/or BU students utilized to facilitate adolescents' participation as STEM learners. These methods included establishing rapport with the learners and asking them multiple types of questions.

Establishing rapport with the middle school learners

Many of the BU students stated in their written reflections that they felt that creating a safe and comforting environment was key to getting the middle school students to participate in the activities more and more each week. The first, and perhaps the most obvious, involved getting to know the youth. Many of the BU students took time each week to ask the youth personal questions about themselves. Adina, Mandy and Maxine are exemplars.[3] Mandy noticed a learner wearing a *Marvel* t-shirt. As a *Marvel* fan herself, she asked the learner about their favorite movies as well as their favorite superheroes. After Mandy formed a bond with this learner, the young person began participating more in Mandy's groups. In many instances, they would be the first to try something. This was not a theme just with Mandy. In her written reflection for week three, Adina stated that she "was able to get to know [the students] better," which led to feeling "more comfortable asking [her] questions."

[3] Pseudonyms are used throughout this paper.

The second method was providing continuous encouragement. In their written reflections, some BU students mentioned that a few of the learners were having a difficult time engaging with every activity for a variety of reasons. Many encouraged the adolescents to participate in each activity. For example, Maxine described making a conscious effort to interact with the "lone wolves" of the program — learners who tended to work alone during activities. One specific instance occurred during the mystery box, or hypothesis testing, activity. *As* observed, Maxine noticed Eric working on the activity alone at one of the tables. Instead of ignoring this, Maxine sat with Eric and they began working on the activity together. In her written reflection for that week, Maxine commented on this interaction, stating that by sitting there and encouraging Eric throughout the activity and asking him questions, she "supported his student growth as a STEM learner." This provided Eric with the opportunity to broaden his engagement in the program. We noticed that subsequently, Eric started to work with his peers throughout the next few weeks following this encounter. When the program reached its conclusion, this "lone wolf" seemed eager to participate in a group, sitting alongside his peers. Moreover, during activities, such as the Pythagorean theorem activity, the BU students repeated phrases such as "We're gonna have fun," as well as "We're gonna do this together." In this setting, the use of the phrase "we're" created the feeling of comradery.

Asking adolescents questions

Along with being a reliable presence during the activities each week, BU students began asking the adolescents different types of questions to increase their STEM participation. These questions were either guided, open-ended, or focused depending on the scenario and the task at hand. During the faunal analysis activity (also referred to as identification of animal remains), Adina would ask the learners in her group questions in an effort to have them "figure out the answer on their own [in order to] draw their own conclusions" based on what they noticed. Another BU student, Rosie, took to asking the learners open-ended questions during the same activity in an attempt to "get them thinking again." Leading questions were used to achieve a desired answer, while open-ended questions were used to stimulate thought. Both methods of questioning allowed for the youth to apply their knowledge to the activity at hand. During the typology activity, learners were asked to "type" (sort) projectile points (the stone tips for spears, arrows, and darts) based on defining characteristics they may have noticed (see Figure 2). First, they were asked to try typing these points on their own; that is, create their own classification system based on their observations. The middle school students typed the points on noticeable traits, such as size, shape, and color. Once all the adolescents completed this task, the BU students and educators were able to ask them about their classification system. From here, the BU students asked the youth questions (e.g., "Do you notice anything else?" "Would you be able to further 'type' these points based on any deformities?") in an effort to have them expand their classifications. With the help of the BU students, the learners were able to further develop their own ideas.

In our observations, we noticed that the learners tended to demand answers when they were feeling overwhelmed with the task at hand. During the faunal analysis activity, for example, the middle school students became frustrated when they could not identify the animal their specific bone matched. Many of them approached the BU students in an attempt to find an easy answer. They demanded that the BU students "tell [them] what it is," as well as "where it's from." Instead of taking the bait, BU students turned the learners' demands into a question. They would request that the learners show them the last collection ofbones they observed

Figure 2: Image of middle school learners engaged in typology activity

(e.g., "Well, where did you leave off? Why don't we go from there?"). Next, the BU students would go table-to-table with the learner in question, working together to find the correct match to the bone (see Figure 3). By not giving the learners an answer when they demanded it, and instead working in tandem to identifY the bone, the BU students increased the youths' STEM participation. *As* mentioned earlier, they showed the youth that they do not have to struggle alone. Moreover, the BU students turned frustration with an activity into a process to help the learners think outside their current mindset.

Figure 3: Image ofBU smdent and middle school learner working together

Some of the BU students used their questions as a method to not just challenge the youth, but to get them to challenge themselves. One BU student, Rosie, stated in her written reflection for week one that she used her questions to "encourage [the middle schoolers] to think outside the box." This belief followed Rosie throughout the program. During week four's cordage activity, Rosie asked her students, "Which one would be stronger, the braid or the twist, and why?" She wanted the youth to not only come to their own conclusion, but also formulate possibilities that supported their reasoning. In other words, Rosie tried to get the learners to challenge their own current frame of mind.

Aim 2: Possible ways in which a learner,s participation in an informal STEM program can shape and shift their identity as a STEM person.

Researchers used observations (data collection described in Aim **1)** and information collected from the learners enrolled in the program to address this aim. At the beginning of the program, the middle school learners were given a booklet (referred to as student booklets) to use to write down their reflections based on their own personal experiences with the activities that day (see Figure 4).


Figure 4: Image of middle school learners' decorated smdent booklets.

Inside each booklet was a two-sided chart, as well as a place for the learners to write the date, the name of the activity, and their reflection regarding their self-selected identity from a provided list (see Figure 5).[4] One side of the booklet featured 10 "identities" along with corresponding explanations that the learners could choose from once they completed each activity (Mercier & Carlone, 2021). They were then asked to briefly explain why they chose each identity. While they were given brief descriptions of each identity in their booklets, it was possible that they formed their own interpretations of each "identity." It is important to note that the number of participants in activities and reflections varied from week to week as some joined later or left earlier in the semester or were pulled out of the program for sports or other school-sponsored activities.

[4] Definitions for the full list of "identities" can be found at https:lltinyurl.com/nvmeam32.

At the end of the program, researchers collected the student booklets for analysis. A spreadsheet was created to count which identity(ies) each learner chose for each activity. Table 1 includes the 10 "identities" along with the counts for "high" STEM activities for this table to serve as an example. We defined a "high" STEM activity as one in which we felt an outsider could clearly see the use of STEM concepts. In addition, the research team read each of the learners' one to two sentence explanations, looking for quotes that highlighted the reason they chose that particular identity. We then highlighted the top two identities for each activity.

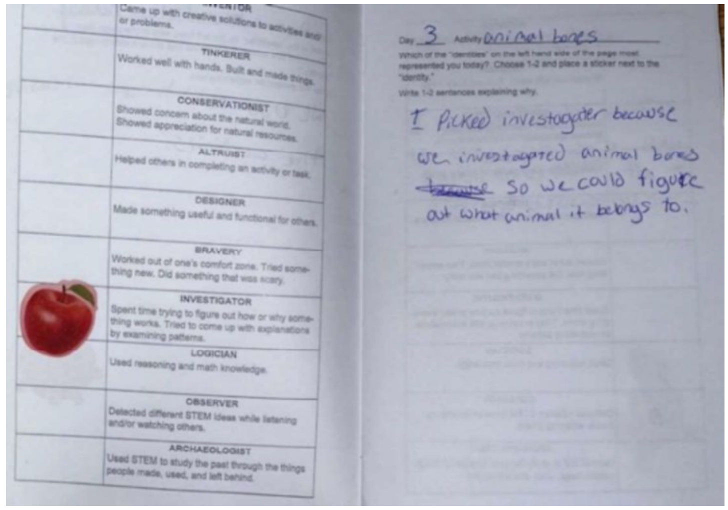

Figure 5: Inside view of student booklet

Identity	"High" STEM Activity				
	Artifact Identification	Excavation Site (Pythagorean Theorem)	Total Station	Faunal analysis	Mystery Boxes (Hypothesis Testing)
Inventor	3	3	2	5	2
Tinkerer	1	11	4	4	4
Conservationist	1	--	1	3	--
Altruist	3	5	7	1	1
Designer	2	4	1	1	1
Bravery	3	1	2	1	1
Investigator	9	1	9	16	9
Logician	4	9	10	--	--
Observer	7	3	6	4	4
Archaeologist	7	--	1	5	--

Table 1: "Identity" Count Per "High" STEM Activity

Investigator

Investigator was one of the highest self-selected identities across all the activities that learners participated in each week. It was also among the identities that had a direct connection to STEM. According to the brief description provided in the student booklets, an investigator is someone who came up with conclusions, or explanations, "by examining patterns" (Mercier & Carlone, 2021, Table 1). Being an investigator means asking questions, as well as formulating conclusions to the questions posed. In the afterschool archaeology program learners participated in many activities that required them to ask their own questions and draw conclusions.

One such activity, referred to as Mystery Boxes (Science Museum Group, n.d.), or Hypothesis Testing, featured six sealed boxes containing six different, unknown items. Middle school students were split into six groups of varying sizes. In their groups they were asked to figure out what was inside each box using all their senses except sight. Since they could not see what was in the boxes, they devised thought experiments to guess the mystery items. This process is reminiscent of a scientific method (Question, Hypothesis, Experiment, Results, Conclusion, or as we refer to it, QHERC). The learners asked questions (e.g.,"Maybe it's round. Like a ball?") in order to form hypotheses (e.g., "I think it's a rock"). From there, they tested their hypotheses. As observed, some groups dropped their box to see if the item inside would bounce. Others smelled the box to see if the item had any distinguishing scent. Once every group finished examining each Mystery Box, the learners reconvened to share their findings.

One learner, Adam, claimed he was an investigator because he "used [his] senses" to discover what was in each box. He also stated that he "got them all wrong minus two." In other words, out of the six boxes, only two of Adam's hypotheses were correct. Despite this, Adam still self-identified as an "investigator."' He used his senses to "examine patterns"' within each mystery box. As observed, Adam asked questions about the contents of each box, as well as performed experiments to support his hypothesis.

Olnerver

Like investigator, "observer" was one of the highest self-selected identities across numerous activities. According to the brief description provided in their student booklets, an observer is someone who "detects different STEM ideas while listening and/or watching others" in the program. As mentioned earlier, middle school students sometimes created their own interpretations of each identity. Instead of detecting STEM ideas through listening/watching others, for example, some learners utilized the "observer" identity when they witnessed STEM ideas in their own actions. Learners believed they were most like this identity during activities where they had to examine objects that had been presented to them, such as during the artifact identification, faunal, and hypothesis testing activities.

In particular, the faunal analysis activity required learners to examine the unknown bone given to them, looking for similarities and differences between known bones in an animal skeleton. While some did not select "observer" as one of their identities for this activity, many used this terminology in their explanations that situated them as observers. In her student booklet, one learner, Jenny, stated that she "examined a bone" that had been given to her in an effort "to figure out if it was young [or] old, what animal it was, [and] if it was tampered with." Another learner, Daria, described "looking at bones and identifying the animals." In our observations, both Jenny and Daria seemed to be aware of their *use* of the scientific method. For example, Jenny and Daria made their connections by using phrases such as "looks like" or "I think" when speaking with a BU student about their conclusions.

Bravery

Bravery was one of the least self-selected identities across all the activities but one that the educators and BU students observed being exhibited among the youth participants. According to the brief description provided in the student booklets, an individual who exhibits bravery is someone who "worked [outside of their] comfort zone, tried something new, [or] did something that was scary."' Being brave allows one to take risks they might not have done otherwise. Moreover, it allows a learner to expand their knowledge through trial and error. In the archaeology afterschool program, for example, adolescents may be working with concepts where they had little to no previous knowledge or experience. It took confidence, and bravery, to work with new concepts. They explored these new concepts in a judgment-free zone created by the educators and BU students participating in the program.

The Pythagorean theorem activity is just one of many activities in which the learners worked outside of their comfort zone. Since geometric concepts such as Pythagorean theorem are often taught late in eighth grade, it is safe to say that it may have been unknown to the learners in this program. During the activity, the educators provided the youth with a brief explanation of the concept as well as how it is used in archaeology. From there, they worked in tandem with the BU students to form a "perfect one-by-one-meter square;" that is, a square that measures one meter on each side and has a hypotenuse of "1.41 meter[s]" (see Figure 6). For the duration of the activity, the BU students questioned the learners on their thought processes in an effort to help and guide them through the unknown concept (e.g., "Why is this side not exactly a meter?").


Figure 6: Image of middle school learners using the Pythagorean Theorem

When it came to the learners choosing an identity from the list provided in their student booklets, only one chose bravery. In her explanation, Diamond simply stated that she "was brave" without any further detail, leaving us to infer her motivation for this choice. While the other learners did not select bravery, the phrases they utilized in their explanations were ones that suggest this identity. Some learners used phrases such as "new math" when describing how they used their math knowledge to create a perfect square. To most, if not all the learners, the Pythagorean theorem was new. They had never seen, let alone worked with it before. Therefore, even if the middle school students did not select bravery as their identity for this activity, they still exhibited signs of bravery. Moreover, one participant, Jenny, made note of how she "kept over doing the meter" (in reference to trying to create a perfect square without the Pythagorean theorem), so she "used math to get it right." As observed, Jenny tried something new, failed, and tried again once receiving help from the educators.

Summary of Insights

Insights from the research highlight the pedagogical moves that graduate and undergraduate students utilized in supporting adolescents' participation as STEM learners, namely by fostering a safe and comfortable environment through building relationships and continuous encouragement, as well as posing different types of questions. As such, the BU students enacted the actions of informal educators and mentors, which have been shown to activate and/or increase adolescents' interest and engagement in STEM (e.g., Ko et al., 2018). In addition, learners' identities as STEM learners within the archaeological afterschool program, along with the activities in which they were most prevalent, highlight possible instances in which a middle school student's participation was shaping their developing identity as a STEM person. Prior research has documented how the development of one's identity in a STEM discipline through early learning experiences is associated with pursuing a STEM career (e.g., Dou & Cian, 2020; Godwin et al., 2016), fields that have a low number of historically excluded social identity groups (NSF, 2021).

Becoming an Informal Educator

In addition to the two aims described above, a third aim of the project addressed how participation in the informal program and professional guidance from the instructors helped graduate and undergraduate students on their journeys to becoming informal educators. The university students had a wide range of teaching experiences prior to working on the grant. Some had none, while others had only worked with college students; and a few had participated in some informal education settings. All had experience in STEM fields, but most did not have opportunities to combine STEM with informal programs. All students were on a journey to becoming comfortable and competent in this pedological experience. One graduate student, Kara, reflected on this process of "becoming" and contextualized it within their identity and experiences:

As a graduate student in Anthropology at BU, with a commitment to community engagement, this opportunity offered a way to advance my skills outside the formal university classroom. The grant provided professional development scaffolded by ongoing

[5] The Pythagorean theorem is a geometric concept which states that $a^2+b^2=c^2$ in any right triangle. Archaeologists use this theorem to create excavation squares, where solving for the hypotenuse is critical to making an exact square.

mentorship and guidance from the principal investigators whose behaviors and methods for community education encouraged my own sdfreflection in youth engagement and teachingpractia.r. Participation in the aftmchool program provided an opportunity to combine formal and informal teaching pedagogy. I wa.r particularly exa:ted for thi.r opportuntty because I bad prior experience with both end.r of this pectrum. My t/.ndeTg17lduate.rtudieJ weredim:ted toward a carn:rin pu.blic teaching while my formative experima.r a.r an arr:haeologi.rt were on public hi.rtory .rites. In thi.r section, I share my personal reflections on continuing my becoming an informal educator, mentor, and colleague a.r part of tbi.r afterscbool program.

The first reflection is on the role that identity and internal connection play.r in fostering long term engagement and learning. Identity i.r a central driver in my professional trajectory and aspirations. As a first generation university student, I've experienced the disconnect one can feel between formal edt/.Cation settings and one's own lived experience. My net/.rodivergent identity creates additional barners in formal education settings a.r I approach and interpret information differently from net/.rotypical students. Informal edt/.Cation settings allow me to draw on my skill.r and connect with tbo.re individual.r who may be 1/.ntkrserved by more formal academic experiences.

While my actions are informed by my outsider status a.r a first generation, neurodivergent researcher, t't is my queer identity that i.r tnJy central to the way I interpret and connect with the world. For a variety of reasons, I wa.r apprehensive abot/.t publicly claiming a qt/.eer identity while inoolved in tbi.r program. My personal experiences in formal education settings support a body of research that suggests that queer edUCAtors face pre.r.rure to "return to the do.ret" (Endo et al., 2010; Harris E1 Gray, 2014). Recent discourse accu.ring queer educators and their supports of "grooming" students further encourages these hostile environments, for both educators and their students (Block, 2022}. After buildz'ng connections with the learners, I am reminded of the importance for them to see queer representation in their personallz've.r.

While I have never deliberately concealed my queer identity in my carn:r, thi.r expmmce wa.r the first time I publicly di.rplayed my "theyltbemltheirs" pronouns on my name tag. During the ajterscbool sessions I participated in, multiple learners positively commented on my pronouns. In each instance, I wa.r able to build a stronger relationship with the adolescent and, hopefully, help strengthen thez'r connection to a STEM identity. It i.s beneficial for youth to see their identities reflected not only z'n popular media and thez'r history book.r, but among the community members and mentors they interact with in thez'r daily live.r (Ko.rdw et al., 2018). I did not connect with learners sokly on the men'ts of a queer identity, in fact, aside from initial compliments on my pronouns, queerne.r.r wa.rn't di.scu.rsed. Nonethele.r.r, I know from personal experience the sense of comfort that can come from sensing you are not alone. The editors of Rethinking Scbool.r argue that "a school that's a protective community for LGBTQ adults i.r a school that's going to be safe for kids" (Bt/.tler-Wallet al., 2016, p. 24). I contend that not only do we need to create a culture of protection around queer adults z'n our education .systems, but a.r queer educators we need to be vocal and vz'.rible in order to demonstrate that safe space for our students.

Second, while I have experience in both formal and informal edUCAtion settings, this was the first tt'me I felt comfortable and con.folent enough in my skill.r to provide mentorship to my peers. My preowus experiences a.r an educator led some of the other BU students to confide in me about their apprehensions and succe.sse.r when interacting with our STEM learners. For many, thi.s wa.r their first experience a.r an informal educator, if not their only expen'ence a.r an edt/.Cator. Informal education requires a different skill.ret from traditional education settings and I tried to guide my peers t'n becoming more confident in engaging with the learners: giving advice on when to allow "off topic" conversations to continue and when to steer them back to our lesson, how to position yourself a.r a mentor to support youth learning rather than an authority figure, and how to relate the complex topics of our expertise to the interests and identities of our audience. While first surprised, these moments filled me with confidence in my abilities. Following these experiences, I made an rjfort to ojfor adoice and mentorship to other teaching assistants in my department, many of whom do not have prior experience or training in education. In addition to "talking shop" about grading, a.r.re.r.rment wn'ting, and le.r.ron planning, I al.ro tried to open discussions about teachz'ngphilo.rophies and how to orient our preparation and practice to better accomplish our teaching goals.

Upon reflection, I can see how much I have learned since the beginning of my career. I can also see plenty of areas for growth and can imagine new horizons in my future that are not yet visible. In future experiences, and as I eventually develop and implement my own programs, I intend to practice nuanced methods of engagement with the public such as developing my skills in capitalizing on moments to encourage critical thinking and creativity, engaging with youth and the public in ways that promote personal connections with new content, and providing accessible opportunities of public engagement that support the growth of a common community. I hope to carry this openness and bravery throughout my career; taking opportunities to challenge myself while also opening doors for others to engage in new experiences. Moving forward in my career, I hope to develop and implement my own public programs centered around archaeology, culture, and history. While I have had previous experiences where I helped to administer established programs, experiencing the birth of a program and learning more about my becoming as an informal educator, mentor, and colleague are reflective practices and lessons that will benefit me along my future career paths.

Future Steps

Binghamton University's UACS initiative provided a novel approach to applying university resources to address a need for afterschool STEM programs in rural middle schools. Supported by BUCS, evaluated by TLEL faculty, and led by archaeologists from PAF, this pilot program used the science of archaeology to deliver hands-on STEM modules to youth learners. Indigenous representatives discussed their own perspectives on science, including the depth of their relationship with nature and commitment to protecting the environment. Their presentations enhanced the STEM learning modules and added a new dimension to student learning and the practice of pedagogy.

This pilot project offers a viable model for future partnerships between archaeologists, or other science professionals, and educators to assist local schools with critical educational needs. This informal afterschool program offers concrete practices and strategies that enhance and inform science education in middle school classrooms. There is promising potential to replicate this model in other rural schools and urban school districts in need of STEM learning opportunities. Such partnerships between universities and schools also have the potential to advance a growing specialization in the field of archaeology and community engagement, which is grounded in the principle of providing a public benefit from archaeological research. Lastly, as noted from our research, the program affords an opportunity to support middle school youth as STEM learners, as well as support post-secondary students interested in pedagogical practices.

Future initiatives would expand our afterschool program to more school districts and to other regions. The pilot grant focused solely on rural school districts. A next step would be to develop the program within urban areas, and possibly Indigenous school systems. New initiatives would also allow us to train teachers to implement similar programs, in both middle and high schools, thus accessing broader participation.

Implementing this project in partnership with BUCS offered a unique and critical support network that contributed to a successful informal education experience for youth in rural schools. Middle school youth learned from the diverse array of science modules, while archaeologists and educators advanced their own skill-sets in community-engaged informal education.

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References

Atalay, S. (2012). *Community-based are'hl#eology: Roearch with, by, and for buligentJW alltllocai commtmititJ* (1st c:d.). University of California Press. https·//doi org/10 1525/j.ctt1pn9dj

Atalay, S. (2019). Can archaeology hdp decolonize the: way institutiow think? How community-based research is transfunning the archaeology m.iningtoolbox and hdping to transform !IIJ5titutions. *Arch4eologieJ,* 15(3), 514-535. https://doi.org/10.1007/s11759-019-09383-6

Battle-Baptiste:, W. (2011). *Black &minist Arch.-Jogy.* Roudcdgc:.

Birks, M., Chapman, Y., & Francis, K. (2008). Memoing in qualitati'YI: research: Probing data and *pro=ses. Jotmt4l of Rest: Arch in Nursing.* 1.3(1), 68-75. http:l/doi.org/10.1177/1744987107081254

Bbkc:y, M.L. (2008). An ethical epistemology of publicly c:llg2gCd biocultural research. In J. Habu, C. Fawcett, & J. M. Matsunaga (Eds.), *Evalr ating Multiple NAmztiues: Beyond NationAlist, Colonialist, ImperiAlist Arcbaeologic* (pp. 17-27). Springer.

Bbkc:y, M. L (2010). Afrkan burial ground project: PandJgrn for cooperation? *M"-«Um lntmwional,* 62(1-2), 61-68. https·//doi org/l0.11111j.1468-0033.2010.01716.x

Block, M. (2022, May 11). Accusations of "grooming" are the: latc:st political atack-With homophobic orig!IIJ5. NPR. https://www.npr.org/2022/05/11/1096623932/accwations-grooming·political-attack-homo.phobic-origins

Bronstein, L., Kida, L., Garton, M., & Simpson, A (2020). BU Community Schools: Building univ=ity·assistc:d communityschools in small cities, rowns and rural communities. *UniiN!r.rititJ and Community Schools,* 10(1), 18-33.

Budc:r-Wall, A., Cosier, K., Harper, R. L. S., Sapp, J., Sokolowc:r, J., & Tempel, M. B. (2016). Quc:c:rlng our schools. In K. Cosier, R. Harper,]. Sapp. J. Sokolowc:r, M. B. Tempel, & A Bucler-Wall (Eds.), *Rethinking Smsm, Gmdo; and Sau4lity* (pp. 22-26). R.c:thinlring Schools.

Collins, A., Bronte-T"mkew, *].,* & Logan, C. (2008). Strategies fur improving out-of-school prograrw in rural communities. *Child Trmds, 18,* 1-8.

Colwell-Chanthaphonh, C., & Ferguson, T.J. (2008). *Collabonztion in areh.-logiad practice: Engaging de.rr:mt:lant rommunitia. Rowm11n Altamira.*

Dou, R., & Cian, H. (2020). The rdevmcc: of childhood science talk as a proxy fur college students' STEM identity at a Hispanic serving institution. *Re.searehin Science Eiluution.* Advanced online: publication. https://doi.org/10.1007/slll65-020-029211-8

Dzigbede, K. & Young. S. (2012). Determining access to financial services among the young and poor in American communities.]o.tm .J*of Public M UJ Jptzent Social Policy, 26{2),* Article 11.

Endo, H., Reece:-Miller, P.C., & Santavicca, N. (2010). Surviving in the trenches: A narrati'YI: inquiry into queer teachers' experiences and identity. *Teaching alltl Teacher EducAtion,* 26{4), 1023-1030. doi.o!W'10.10161j.tatc:.2009.10.045

Franklin, M., Dunnavant,]. P., Flc:wellc:n, A. O., & Odc:wale, A. (2020). The Future is now: Arch:aeology and the eradication of anti-Blackness. *lnkrnationtd]otmt4l of Historical. ArchAeology,* 24(4), 753-766. https://doi.oig/10.1007/s10761-020-00577-1

Godwin, A., Potvin, G., Hazar!, Z., & Lock, R. (2016). Identity, critical agency, and enginc:c:rlng: An alfc:ctivc: model for predicting enginc:c:rlng as a career choice. *journal of Engineering EducAtion, 105(2),* 312-340. https·//doi.oig/10 1002/jce 20118

Gonzalez, S.L., & Edwards, B. (2020). The intc:rsc:ction of Indigenous thought and archaeological practice: The field methods in Indigenous archaeology field school.]ourn.J *ofCommtmity Arch4eology HmU.g*7(4), 239-254. bttps·//doi org/10 1080/20518126 2020 17 2.4631

Harris, A., & Gray, E. (Eds.). (2014). *Queer teachers, identity and performativity.* Springer.

Joyc:e, H.D., Wade-Mdivanian, R., Anderson-Butcher, D., & Gibson, A. (2014). Aftc:rschoolsustainability.]ourn.J *of Youth Devdopment,..*9(4), 61-76.

Ko, A.J., Hwa, L., Davis, K., & Yip, }.C. (2018). lnformalmentoringof adolescents about computing: Rclatiowhips, roles, qualities, and impact. *Proceedings of the 4!Jth ACM tecbnic.J symposium rm compuur .rdmaeducation* (pp. 598-603).

Kosciw, J. G., Greytak, E. A., Zongrone, A. D., Clark, C. M., Truong, N. L., & Gay, L. (2018). *The 2017 National Jchool dimatt survey: The experi=oflesbi.n, gay, bisexw.J, t/Unsgmtkr, alltlqueeryouthin our nationschools.* Gay, Lesbian and Straight Education Network (GLSEN). Rc:tric:Yl:d from http://www.glsen.org

Lee, Y., Quaranta, J., & Anderson, E. (2017). Fostc:rlng intc:tprofc:ssional collaboration through a family-cc:ntc:rc:d program for grandparent hc:adc:d *funilies. Journ.J oflnterpro.fossional Care, 31,* 550-552. httpJ:LL doi.org/10.1080/13561820.201Z1296420

McDavid, C. (2011). From "public archaeologist" to "'public intellectual": Seekingengagement opportunities outside traditional archac:ological arenas. *Historic.JArr:bt«rJlogy,* 4'5(1), 24-32. hnps://doi.o!W'10.1007/BF03376818

Maltese, A V. & Hanh, J. A (2015). Pathways of entry into STEM across K-16. InK. A Renninger, M. Nieswandt, & S. Hidi (Eds.), *Inte=t tnd the Stif in K-16M tthematics and Scima: Learning.* Washington, DC: American Educational Research Association.

Maltese:, A V., Mc:lki, C.S., & Wiebke, H.L. (2014). The nature of expc:ric:nces responsible for the generation and maintenance of interest in STEM. *Science Eiluution,.*98(6), 937·%2. https://doi.o!W'l0.1002/sce.21132

Mercier, A., & Carlone, H.B. (2021). ldenti-beads and identi-badgc:s as strategies to encourage STEM identity work. *Connected Science Learning. 3(*4). Retrie'Yl:d from https://www.wta.o!W'connectc:d-scic:ncc:-lcarninglconnc:ctc:d-sciencc--learning-july-aug.ust::2021/identi-bc:ads-and-idcn.ti

Miroff, L. E. & Versaggi, N. M. (2020). Community archaeology at the trowd's edge. *Adwmw in Arch4eologiclll Pr-actice,* 8(4), 398-408. hnps://doi.o!W'10.1017/aap.2020.28

National Science Foundation [NSF]. (2021). *Women, minorities, and Jl"SOns with di.14bilitic in JCinl« And engineering.* Retricvtd from hnpi;LL ncscs nsf govlpubs/nstl1321

Science Museum Group. (n.d.). *Mystery bo=.* R.etricvcd from l.wning-resolll'CC5.scicna:museum,org.uk

Singleton, T. (1m). Facing the challenges of a public Afrlcan-Amerian arcl=:ology. *Historical Arr:hAeolorJ,* .31(3), 146-152.

Sncllman, K., Silva,]. M, Frcd.crick, C. B., & Put, R.D. (2015). The engagement gap: Social mobility and extracurricular participation among Amerian youth. *The Annals of The American Academy, 657,* 194-207.

Vcf82ggi, N.M. (2007). Partners in preservation: The BU Community Archaeology Program (CAP). In J. H. Jamison, Jr., & S. Baugher {Eds.), *PastMeets Pr=nt: PartnershipJ in the PublicInterpr«Ation uf Archaeology* (pp. 203-217). Springer Press.

W!lllams, D. (2010). *The rural Mlution: How CtJmrnsmity .rchool.l Clln rrinvigol'llrrmJ edw:ation.* Rural School and Community Trust; Center for Amerian Progress.

Zaff, J. F., Moore, K. A., Papilla, A. R., & Williams, S. (2003}. Implications of extracurricular activity participation during adolescence on positive outcomcs.]mmw1 *UJ Adole.ra:nt R.exarch, 18(6),* 599-630. https·//doi oxg/10.1177/{)743558403254772