The internal evaluation for this pilot study was grounded in qualitative methods. Content analysis of modules, field notes from the afterschool program, and interviews and reflective journals with learners and educators were the main data sources utilized to assess impacts and experiences of (a) the ARCH + STEM program on middle school learners' development and participation as STEM learners; and (b) the perspectives of informal educators, including graduate and undergraduate students, on how to support the middle school participants as STEM learners. Highlights from the final evaluation report are included as an attachment.

How did the ARCH + STEM afterschool program support middle school learners' participation and identity development as STEM learners?

> The modules were developed to support middle school learners' participation as STEM learners and implemented in a manner that allowed learners to become familiar with and/or apply science and mathematics concepts and practices. Students applied scientific methods, such as hypothesis testing, observation, experimentation, and interpretation of results. For instance, in artifact analysis, they used measurements and geometric concepts, like dimensions and shapes, to hypothesize artifact usage. Through tools used by archaeologists like the total station and compass, they explored measurement, coordinates, and directional concepts (e.g., North, East), alongside negative numbers. In creating cordage and using the atlatl, practices of local Indigenous communities, students encountered physics concepts such as force, leverage, and material strength, while hypothesizing and testing their ideas.
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> Mathematical reasoning was reinforced in activities such as timeline construction and artifact sorting, or typology, which involved proportional reasoning, the metric system, and data representation through charts and averages. Additionally, Indigenous practices, such as cordage making and flintknapping, allowed students to explore engineering concepts, including material properties and angles, fostering hands-on engagement with STEM principles.
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> Students were frequently positioned as scientists and archaeologists, emphasizing collaboration, questioning, and evidence-based reasoning, particularly in developing and carrying out their own research studies. They developed hypotheses, conducted experiments, analyzed data, and presented findings through posters, combining graphical and textual data. These practices provided learners with opportunities to integrate and apply STEM knowledge in culturally and contextually meaningful ways, bridging Indigenous and Western approaches. In addition, the presentation of the posters allowed middle school learners to gain experience in scientific communication as they presented research results to peers, educators, and administrators.
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> In a post-interview, conducted approximately six months after their participation in the program, it was determined that the ARCH + STEM program had a lasting impact on students, particularly through its hands-on, naturalistic activities and integration of Indigenous cultural practices. Students frequently remembered activities such as throwing spears with an atlatl, flintknapping, and cordage-making, highlighting their enjoyment of experiential learning. Many connected their experiences to real-world applications of math

and science, such as using the Pythagorean Theorem or measuring and calculating dimensions. While students often recalled the Indigenous cultural aspects over archaeological methods, they gained insights into how Indigenous peoples used natural elements to create tools and structures beyond hunting, blending historical and scientific perspectives. They valued the freedom and equality the program fostered, feeling respected and encouraged to create and hypothesize.

In addition, learners described their engagement with STEM concepts through various identities, such as Investigator, Observer, Tinkerer, and Logician, which emerged from their participation in archaeological and Indigenous activities. As Investigators, learners described how they asked questions, examined patterns, and formulated conclusions, mirroring the scientific method. For example, during the mystery box activity, they hypothesized about unseen objects using evidence gathered through their senses. As Observers, students explored STEM ideas by closely examining artifacts and animal bones, such as comparing skeletal features during faunal analysis to draw inferences about age and origin.

Hands-on activities, like flintknapping and cordage making, encouraged students to identify as Tinkerers, exploring material properties and experimenting with tools to solve problems. Logicians applied reasoning and math, particularly during activities like constructing a 1-meter by 1-meter square archaeological excavation unit using the Pythagorean Theorem. In interviews, students highlighted these identities as ways they connected with STEM concepts, often framing them within shared activities but emphasizing different aspects, such as creativity, experimentation, and logic. These identities reflect how students integrated inquiry, observation, and practical skills to engage deeply with STEM through an archaeological and Indigenous lens.

How did participation as informal educators in the ARCH + STEM afterschool program and ongoing professional development shift graduate/undergraduate students' and archaeologists' perspectives on ways to support adolescents as STEM learners?

Ten undergraduate and graduate students were engaged as informal educators within the afterschool program. As part of the program, students also enrolled in a seminar course to reflect upon their experiences and gain an understanding of various instructional moves to support student learning. The students experienced significant tensions in their roles as informal educators, which became catalysts for their growth. They grappled with balancing when to step back versus step in, allowing exploration while providing guidance. They expressed a fear of "not knowing" archaeological content, which sometimes constrained their teaching but also positioned them as co-learners alongside the middle school learners. Many were initially timid about engaging with students, fearing rejection, or overstepping boundaries. Additionally, they navigated blurred lines between being friends and educators, struggling to establish their role as facilitators without becoming too informal or authoritative.

Despite these challenges, university students demonstrated growth in several areas. They improved their questioning techniques, learned to step back and avoid giving direct answers,

and became more flexible, adapting to student needs and interactions without rigid plans. They gained confidence in working with middle school learners and increased their content knowledge in archaeological concepts and practices. By reflecting on their actions, they recognized the importance of fostering authentic learning experiences through inquiry and student-led engagement, ultimately supporting the middle schoolers as STEM learners while developing their own skills as educators.

It was also the case that educators/archaeologists expressed areas of growth through this experience. First, educators expressed stepping outside of their comfort zone and being flexible (i.e., being prepared to not be prepared). There was a sense that going off script was okay and that it is fine to not get through all the material as it was more about the process than the product. It became important to let go of perfection and allow students to make mistakes and allow them to have more of a voice, particularly in regard to their research projects. Second, there was a shift in pedagogical practices and mindset regarding the balance and interplay of formal and informal approaches to the program. One way this was done was limiting the PowerPoint presentations and asking more open-ended questions, which transitions who is doing the talking in the space from educator to learners. This was also observed in allowing middle school learners to explore concepts before introducing them to an approach that archaeologists use. Research clearly shows that students gain more cognitively, socially, and emotionally from interacting with one another through hands-on activities and discourse than listening to others talk. Third, educators gained experience in working with a diverse group of students, behaviorally, socially, and cognitively.

In summary, the ARCH + STEM afterschool program successfully supported middle school learners' participation and identity development as STEM learners by integrating archaeological and Indigenous practices with STEM concepts. Through activities such as artifact analysis, flintknapping, and cordage making, students applied scientific methods like observation, hypothesis testing, and experimentation while exploring concepts of measurement, proportional reasoning, and material strength. Hands-on experiences encouraged learners to adopt roles such as Investigator, Tinkerer, and Logician, helping them connect STEM ideas to real-world contexts. By blending inquiry-based learning with cultural relevance, the program empowered students to develop skills in reasoning, collaboration, and creativity, bridging Indigenous and Western STEM approaches. For the undergraduate, graduate, and archaeology educators, implementing the program facilitated professional growth. They became more flexible, learned to balance guidance with exploration, and gained confidence in fostering student-led inquiry. Educators shifted their practices by prioritizing process over product, encouraging open-ended exploration, and valuing hands-on learning and peer collaboration over lecture-based instruction. These experiences not only enhanced their teaching skills but also deepened their understanding of how to support diverse learners in authentic STEM learning environments.