Archaeology Education for Children

Assessing Effective Learning

Jeanne M. Moe

In the past 30 years, archaeologists have taught children and youth about the processes of archaeological inquiry and the results of archaeological research. Since the passage of the amendments to the Archaeological Resources Protection Act in 1988, federal land–managing agencies have launched education programs to inform the public about the "significance of archaeological sites and the importance of protecting them for present and future generations" (16 U.S.C. 470aa-470mm). Other agencies and organizations, such as State Historic Preservation Offices (SHPO), state historical societies, universities and colleges, private nonprofit organizations, and many others, have launched local or statewide educational programs. Hundreds, if not thousands, of education programs have sprouted up over the years; some have endured while others have faded away. Some programs have been aimed at formal learning in

ABSTRACT

In the past 30 years, archaeologists have taught children and youth about the processes of archaeological inquiry and the results of archaeological research. Hundreds, if not thousands, of education programs have sprouted up over the last 30 years; some have endured, while others have faded away. Some efforts and programs are aimed at formal learning in school classrooms, while many others are based in informal settings, such as museums, outdoor learning centers, after-school programs, and many others. A few of these programs have been assessed for learning outcomes, but many others have not. For example, all Project Archaeology education materials are intensively assessed in classrooms and peer reviewed prior to release for their efficacy in teaching predetermined goals or enduring understandings. Additionally, the Project Archaeology curriculum was assessed for its efficacy in teaching conceptual understanding of science inquiry. Program assessment is critical for the long-term success and sustainability of archaeology education.

En los últimos 30 años, los arqueólogos han enseñado a los niños y jóvenes sobre los procesos de investigación arqueológica y los resultados de la investigación arqueológica. Cientos, si no miles de programas de educación han surgido en los últimos 30 años; algunos han perdurado mientras que otros se han desvanecido. Algunos esfuerzos y programas apuntan a un aprendizaje formal en las aulas de las escuelas mientras que otros se basan en un entorno informal tales como museos, centros de aprendizaje al aire libre, programas después de la Escuela, y muchos otros. En algunos de estos programas se han evaluado los resultados de aprendizaje, pero no muchos otros. Por ejemplo, a todos los materiales educativos del Project Archaeology se les evalúa, intensivamente en las aulas y por pares revisores, su eficacia en la enseñanza de objetivos fijos o entendimientos perdurables, antes de lanzarlos. Además, al plan de estudios de Project Archaeology se le evaluó su eficacia en la enseñanza de la comprensión conceptual de la investigación científica. La evaluación de los programas es fundamental para el éxito a largo plazo y para la sustentabilidad de la educación en arqueología.

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school classrooms, while many others are based in informal settings, such as museums, outdoor learning centers, and after-school programs, to name a few. Some of these programs have been assessed for learning outcomes, but many others have not. Very few studies have been published.

In the late 1990s, the Society for American Archaeology (SAA) sponsored a national survey to assess citizens' understanding of archaeology and their interest in the subject (Ramos and Duganne 2000). The survey showed that while the majority of respondents had positive attitudes about archaeology, approximately 95 percent conflated archaeology and paleontology; they think that the two disciplines are one and the same thing. Brain and learning research show that misconceptions, if not detected and dispelled, hinder learning or stop new learning completely (Bransford et al. 2000). Clearly, we have much work to do to change this pervasive and deeply held misconception.

Archaeology is an engaging and dynamic field, and it has much to offer to educators and their students (Davis 2000; MacDonald and Burtness 2000). However, assessment of learning outcomes is critical for the long-term success and sustainability of archaeology education. Assessment should be viewed as part of the development process for any type of project or program to bring archaeology to the public. It is impossible to create high-quality materials without feedback from the intended audiences. Furthermore, demonstrated success in learning is essential information for educators who use archaeology in their instructional venue; if there is no proof of learning efficacy, educators will not use the materials that we produce. Similarly, funders and potential funders usually require assessment data before providing continuing funding and/or new funding. Finally, assessment is essential for the continual improvement of any educational materials; education changes frequently and archaeology educators must know what educators and students need and develop materials and delivery systems accordingly.

Launched in 1990, Project Archaeology celebrated its twenty-fifth year of continuous operation and growth to 39 state and regional programs. Project Archaeology is a comprehensive national archaeology education program and is jointly sponsored by the Bureau of Land Management (BLM) and Montana State University (MSU) as a partnership. It is delivered to educators and their students through a national network of state and regional programs sponsored by a variety of partners and agencies. The program focuses on developing curricula for educators, primarily classroom teachers and their students, and delivering the materials through professional development taught by archaeology educators certified by the National Project Archaeology office.

Project Archaeology is a not-for-profit educational program dedicated to teaching scientific and historical inquiry, cultural understanding, and the importance of protecting our nation's rich cultural resources. Project Archaeology uses archaeological inquiry to foster understanding of past and present cultures, improve social studies and science education, and enhance citizenship education to help preserve our archaeological legacy. The goal of the program is to protect our shared archaeological legacy while providing educators with the tools they need to fulfill their educational standards and requirements. Education is one of the best long-term solutions for protecting archaeological sites and artifacts (McManamon 2000).

To date, Project Archaeology has reached more than 15,000 educators with curriculum guides, activity guides, and professional development. These educators reach an estimated 300,000 learners each year in classrooms and informal settings. All Project Archaeology materials are assessed for their efficacy in teaching the desired goals in their intended learning settings before they are finalized and distributed. Additionally, we rely on the research of other archaeology educators to inform our curriculum development and professional development for educators. Recently, Project Archaeology has begun to research the needs of informal educators (Fisher et al. 2011) and to develop activities and lessons for use in museums and visitor centers and on archaeological sites.

This article is not intended to be an exhaustive analysis of all educational research conducted on archaeology education programs and/or projects. It will focus on the formative assessment of Project Archaeology curricula and instruction and assessment of students' conceptual understanding of history and science through instruction in archaeological inquiry.

HISTORY OF ARCHAEOLOGY LEARNING ASSESSMENT IN FORMAL EDUCATION

While long called for (Smardz and Smith 2000), assessment and evaluation of actual learning have been slow to make their way into archaeology education. Funding for educational projects often does not include professional assessment, Institutional Review Boards for Human Subjects Research (IRB) may present obstacles for working directly with children, and publishing results is time intensive.

Currently, there are no journals dedicated to research in archaeology education. By contrast, the *Journal of Environmental Education* has been published four times per year continuously since 1971, adding up to about 180 issues. Each issue contains about four articles, and approximately 720 articles have been published since 1971. There are many educational research journals such as the *Journal of Educational Research*, but without professional connections to educational research, it may be difficult to publish in these journals. It can be done (e.g., Levstik et al. 2005), and we should strive to get more of our research in front of educators. A journal dedicated to archaeology education research would provide a venue for all researchers to publish research results. While the audience for such a journal may initially be small, publishers have expressed an interest, and perhaps the journal could start online or as an annual publication.

That said, archaeology educators are beginning to make strides in the assessment of learning outcomes and program evaluation, and a few scholars are publishing their results (e.g.,

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Brody et al. 2014; Davis 2005; Levstik et al. 2005). Thus far, most research projects have taken the form of small case studies, and very little quantitative data exists. While progress is slow, archaeology educators are beginning to build a small but useful body of baseline research, paving the way for larger projects involving both qualitative and quantitative data.

Early Project Archaeology Formative Assessment

The goal of Project Archaeology is to protect archaeological sites on public lands through education while providing educators with effective tools for fulfilling their own requirements and instructional goals. Since the beginning of program development in the early 1990s, we sought information about the usability of the materials, the professional development that we offered, and the learning achievements of students in classrooms. Early peer reviews from educators and brief assessment instruments from students gave us invaluable information for improving curricular materials to better achieve our goals and those of teachers.

While developing *Intrigue of the Past: Investigating Archaeology* (Smith et al. 1992), Project Archaeology's first activity guide for Utah teachers, we gathered information on student learning through short questionnaires. Unfortunately, these questionnaires were never formally analyzed and were not saved. However, we uncovered the utility of some of the lessons and some pedagogical and content issues with other activities and revised the guide accordingly.

Intrigue of the Past is organized into four main sections: (1) Fundamentals of Archaeology, (2) Utah's First People, (3) Process of Archaeology, and (4) Issues of Archaeology. The lessons most used by teachers were the first eight lessons in Fundamentals of Archaeology and a series of three lessons on rock art in Issues of Archaeology (Moe and Letts 1998). The rock art lessons effectively demonstrated the devastating effects of vandalism on these important resources. When asked what they would remember about archaeology a year from now, many students wrote something like, "Damage to rock art sites hurts the living descendants of the people who made them." The students connected the past and present and demonstrated deep cultural understanding of the value of archaeological resources to descendant peoples. As archaeologists, we had approached the development of curricular materials from the standpoint of teaching young people to value the scientific data contained in archaeological sites. When we received the short questionnaires from the students, we realized that we had stumbled on a way to teach cultural understanding and respect for the heritage of others along with scientific inquiry.

University of Kentucky Research Projects

Gwynn Henderson, education lead for the Kentucky Archaeological Survey, and Linda Levstik, University of Kentucky history educator, have assessed student learning outcomes in archaeology education (Henderson and Levstik 2016; Levstik et al. 2005). The results of their work has informed Project Archaeology curriculum development and will continue to do so as new results are reported. In 2002, with Jennifer Schlarb, a fifth-grade teacher, Levstik and Henderson assessed student learning outcomes ($N = 74$) of a five-week unit on archaeology for fifth graders in Lexington. Project Archaeology curricula constituted a major portion of the instructional materials. The results from this project are the first published assessment of student learning outcomes in archaeology education. Levstik et al. (2005) and Henderson and Levstik (2016) found that students often thought that artifacts could tell a single "whole story" rather than offering an opportunity for multiple interpretations.

While the students in this project were clearly involved in their learning, the research results cogently revealed some of the inadequacies of archaeology education materials and instruction in the classroom. Especially relevant is the problem of interpretation of artifacts. Instead of looking for a single story, we want students to develop multiple interpretations of past lifeways based on evidence from the archaeological record.

For Project Archaeology, the Kentucky research confirmed many of our own misgivings about our existing curriculum guides and was instrumental in developing new and better curricular materials. First, we made all curricula inquiry based to guide students to evidence-based interpretations of material culture. Second, we used authentic data to better engage students in the inquiry process and to teach content at the same time. Third, we understood that teaching for conceptual understanding of both process and content is essential for obtaining desired learning outcomes. Without conceptual understanding, learning is superficial and probably will not be retained long after the learning event (Bransford et al. 2000).

Other Research Projects

Over the past 20 years or so, various master's theses and doctoral dissertations on archaeology education have been produced (examples include Eisenwhine 2000; Fisher 2000; George 2005; Krass 1995; Long 2012; Rinker 1992). For the most part, these theses and dissertations are more overviews of archaeology education projects rather than actual research on student learning outcomes. Whiting (1997), Ellick (1997), Moe and Letts (1998), and Rees (2000) collected information on teachers' perceptions of student learning through archaeology but did not assess student learning directly. The latter three research projects specifically evaluated Project Archaeology materials and their perceived efficacy for classroom teachers.

In a seminal work, Elaine Davis (2005) studied *How Students Understand the Past* through instruction in archaeology. Her study was firmly rooted in the constructivist approach to teaching and learning (Novak 1977; von Glaserfeld 1989), which, simply put, views knowledge as a network of conceptual structures that cannot be directly transferred from teacher to student. Instead, knowledge must be built by the student by attaching new knowledge to existing hierarchies of knowledge or by differentiating between similar types of knowledge. The most important element of learning is what the learner already knows (Ausubel and Robinson 1969). All new knowledge will be attached to existing knowledge, either correctly or incorrectly, and new knowledge may not "stick" if the learner has no existing conceptual knowledge suitable for attachment. Davis (2005:119) found that the students in her study constructed historical knowledge either as narrative understanding or as logical/scientific understanding. She clearly demonstrated

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TABLE 1. Outline of *Project Archaeology: Investigating Shelter* by Enduring Understanding.

Enduring Understanding	Essential Questions	Learning Activity
		Warm-up Lesson: Thinking Like an Archaeologist
All people need shelter, but shelters are different from one another.	How are shelter the same and how do they differ? Why do they differ?	Lesson One: Knowing Shelter—Knowing People
We can learn about people by exploring how they build and use their shelter.	What does the study of shelter teach us about people? How important is this way of knowing?	Lesson Two: By Our Houses You Will Know Us
Everyone has a culture and our lives are shaped by culture in ways we may not even see.	How is culture expressed in the ways people meet basic human needs?	Lesson Three: Culture Everywhere
Using tools of scientific inquiry, archaeologists study shelters and learn how people lived in them.	How do archaeologists study the past?	Lesson Four: Observation, Inference, and Evidence Lesson Five: Classification Lesson Six: Context Lesson Seven: Every Picture Tells a Story
Studying a shelter can help us understand people and cultures.	How can investigating shelters help us understand people and cultures? How can we use what we learn about shelter in the present and the future?	Lesson Eight: Being an Archaeologist
All enduring understandings		Final Performance of Understanding: Archaeology Under Your Feet

that students' conceptual understanding of the past does not always match what archaeology educators think they will learn or understand. For this reason, constant monitoring of conceptual understanding is essential for effective learning. Memorizing details, such as the exact chronology of Southwest archaeology, is not essential, but the ability to build interpretations from evidence is essential for the goals of archaeology education.

Several other conclusions of this study (Davis 2005:119–120) are relevant for the assessment of archaeological learning:

- Relevance is essential for learners to make meaning of the past; if the past is not relevant to them then there is no reason to understand it.
- Learners become more engaged in studies of the past when they are actively involved in constructing it, and active involvement may provide some form of relevance for them.
- Objects (artifacts, buildings, features, etc.) contribute to a learner's understanding of past lifeways in a way that words alone cannot convey.
- Authenticity and accessibility to the learner (e.g., close examination of real artifacts) may greatly affect learning potential. Objects may provide personal relevance as well.
- The context of instruction is important and can be very powerful (e.g., museums, archaeological sites, classrooms, etc.), and learning outcomes in different contexts may be profoundly different.

Project Archaeology Formative Assessment Results

In 2003, we began writing new Project Archaeology curricula based on 12 years of teaching educators how to teach archaeology and learning more about their needs, our early assessments of student learning, and especially the Kentucky assessment project (see above). Additionally, we selected Understanding by Design (Wiggins and McTighe 1998, 2005) as a curriculum development model and chose three main themes for developing inquiry-based curriculum units: shelter, subsistence, and migration. We decided to use actual archaeological sites and authentic data to build these units; students would investigate an archaeological site in the classroom much as an archaeologist would.

A hallmark of Understanding by Design is the formulation of "enduring understandings." Enduring understandings are the knowledge that we want students to carry into their adult lives. Working with archaeologists and educators, we developed four overarching enduring understandings to guide the development of all Project Archaeology materials:

1. Understanding the past is essential for understanding the present and shaping the future.
2. Learning about cultures, past and present, is essential for living in a pluralistic society and world.
3. Archaeology is a systematic way to learn about past cultures.

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4. Stewardship of archaeological sites and artifacts is everyone's responsibility.

Individual curriculum units require their own enduring understandings, drawn from the overarching enduring understandings, to address specific content and learning goals. The enduring understandings for *Project Archaeology: Investigating Shelter*, our first thematic curriculum unit, are outlined in Table 1.

While developing *Project Archaeology: Investigating Shelter* (Letts and Moe 2009), the curriculum guide for the first thematic unit, we conducted formative assessment in 15 fourth- and fifth-grade classrooms. A total of 247 students were involved in the assessment process. While the curriculum guide is intended for all student audiences in grades three to five, of the 15 classrooms studied, 12 classrooms were considered to be "underserved audiences," especially in science education. Seven of the classrooms were located in San Diego, California; Kansas City, Kansas; and Washington, D.C., and involved mostly African American students. Five of the classrooms were located in Hardin, Montana, near the Crow Reservation, and served a large number of Native American students. The remaining three classrooms were located at two elementary schools in Bozeman, Montana, a small university town with an excellent education system. The selection of classrooms was governed by the requirements of a grant from the American Honda Foundation (Brody et al. 2014) and the availability of the classrooms in Hardin and in Bozeman.

Fidelity of curriculum implementation (meaning the degree to which the Project Archaeology curriculum was taught and the proximity of instruction to the prescribed procedures and assessments) was highly variable. Only five of the 15 teachers completed the entire unit before administering the assessment instrument. The curriculum was very well implemented in Bozeman and in three of the other classrooms (one in Hardin, one in Kansas City, and one in Washington, D.C.). Learning outcomes were assessed through a quasi-experimental method. The quasi-experimental approach shares many attributes of the experimental approach, but the selection of populations studied was not random, a requirement for experimental research. The assessment involved a pretest administered by the teacher before instruction and a posttest administered after instruction was completed.

Both pretest and posttest closely followed the enduring understandings developed for *Investigating Shelter* and included questions about shelter and how it is used by people, how and why shelters are different, the main job of archaeologists, and what to do or not to do when visiting or discovering an archaeological site. Additionally, students were asked to provide at least one example of the application of four archaeological inquiry tools: observation, inference, classification, and context.

Regardless of implementation, students in all 15 classrooms gained significant knowledge in two main areas: a conceptual understanding of archaeological inquiry and the importance of protecting archaeological sites through personal responsibility (Figures 1–5).

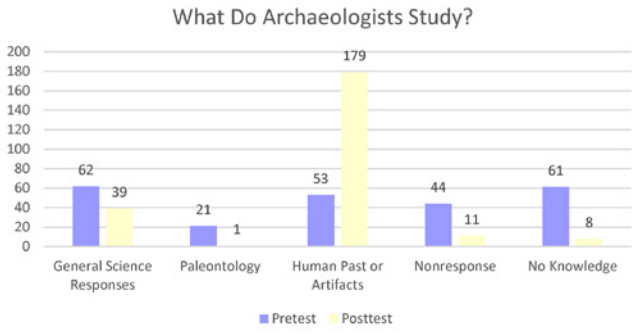


FIGURE 1. What do archaeologists study? Pretest and posttest responses for all students.

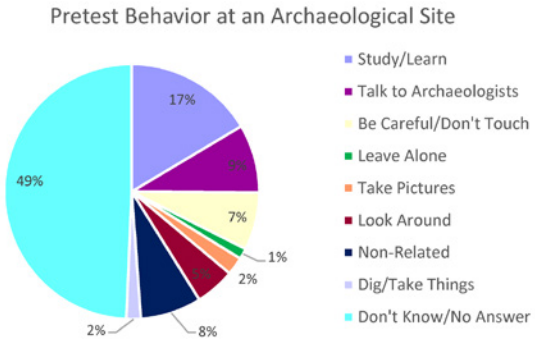


FIGURE 2. What should people do when visiting an archaeological site? Pretest responses for all students.

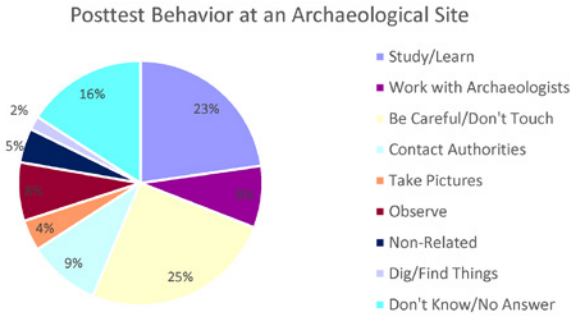


FIGURE 3. What should people do when visiting an archaeological site? Posttest responses for all students.

Students gained significant knowledge about the work of archaeologists from instruction with *Project Archaeology: Investigating Shelter*; all classrooms studied showed similar results. These data show that the curriculum and classroom instruction fulfilled two enduring understandings (see Table 1): (1) We can learn about people by exploring how they build and use their shelter; and

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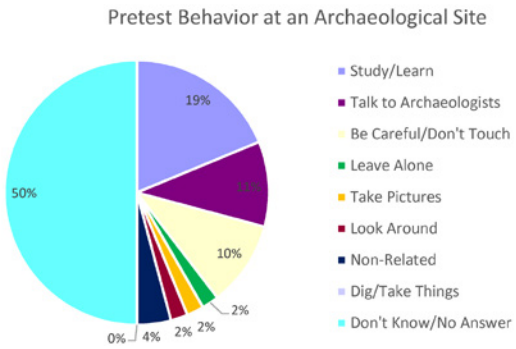


FIGURE 4. What should people do when visiting an archaeological site? Pretest responses from the Bozeman sample.

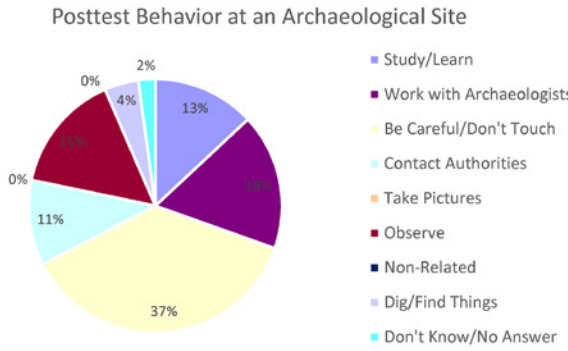


FIGURE 5. What should people do when visiting an archaeological site? Posttest responses from the Bozeman sample.

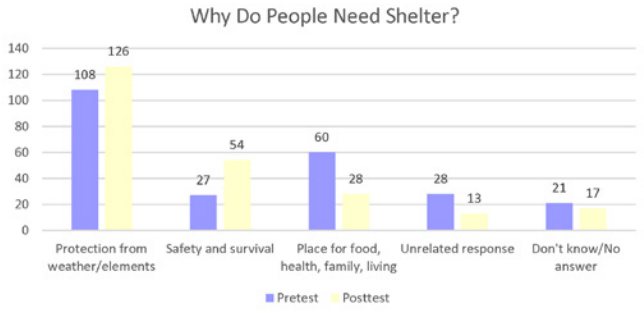


FIGURE 6. Why do people need shelter? Pretest and posttest responses from all students.

(2) Using tools of scientific inquiry, archaeologists study shelters and learn how people lived in them.

While a little less than half of the students (41 percent) already understood that archaeological sites should not be disturbed, the other half could not answer the question (49 percent). Another 10 percent answered inappropriately (dig/take things) or gave an unrelated answer.

Following instruction with *Investigating Shelter*, only 16 percent did not know, and an additional 14 percent provided non-related or inappropriate answers. The remaining students (70 percent) provided appropriate answers to the question. Overall, the percentage of appropriate answers jumped by almost 30 percent.

Project Archaeology materials are designed to guide students from questions about the human past and archaeological processes to enduring understanding of archaeological/scientific inquiry and preservation of sites and artifacts through cultural understanding of peoples past and present. When the curricular materials are implemented with a high degree of fidelity, as they were in Bozeman, the results are even more significant (Figure 4 and Figure 5). Project Archaeology staff has worked closely with the entire Bozeman School District since 2005 to pilot materials and to produce professional development videos. In 2010, after this study was completed, the Bozeman School District adopted *Project Archaeology: Investigating Shelter* as its fourth-grade social studies curriculum and is assisting with review and piloting of new Project Archaeology materials to augment its curriculum. The Bozeman pretests were similar to the entire sample ($N = 274$), while the posttests show a significant increase in knowledge about appropriate behavior at archaeological sites; only 2 percent of the students did not have an appropriate answer for the question, as compared to 16 percent for the entire sample. Similarly, only 2 percent answered with "dig/find things." While it would be inappropriate for students to dig on their own, they may have meant digging with archaeologists and did not say that they would take things.

Investigating Shelter certainly fulfilled Enduring Understanding 6 on personal responsibility for the protection of sites. While not every student supplied an appropriate answer for this question, the percentage of appropriate answers jumped substantially between the pretest and the posttest across all classrooms in the study.

Learning on the other enduring understandings was positive but not as significant. For example, the question for Enduring Understanding 1, "All people need shelter, but shelters are different from one another," the answers did not change significantly between the pretest and the posttest (Figure 6). Interestingly, when asked, "Why do people need shelter?" students were less likely to provide answers about shelter being a place for food and family living; *Investigating Shelter* emphasizes these aspects of shelter. Clearly, we need to examine this data further and address these less than optimal results in future additions of the curriculum guide.

Enduring Understanding 4, "Using the tools of scientific and historical inquiry, archaeologists study shelters and learn how people lived in them," is taught through a series of lessons on the conceptual tools of archaeological inquiry: observation, inference, classification, identifying context, and using evidence. Figures 7 through 10 show student understanding of four of these concepts (evidence was not included in this study). Students provided examples of observation, inference, classification, and context in archaeological inquiry to demonstrate their

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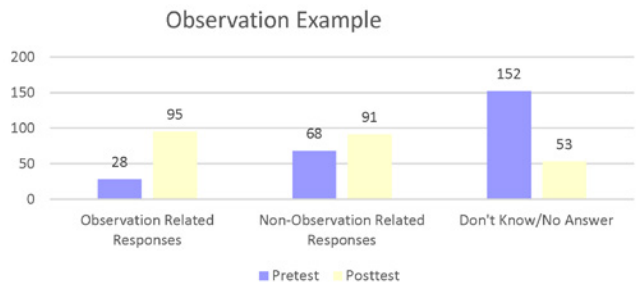


FIGURE 7. Pretest and posttest responses when asked to give an example of an observation.

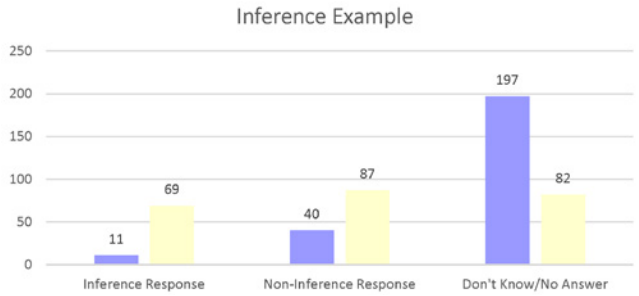


FIGURE 8. Pretest and posttest responses when asked to give an example of an inference.

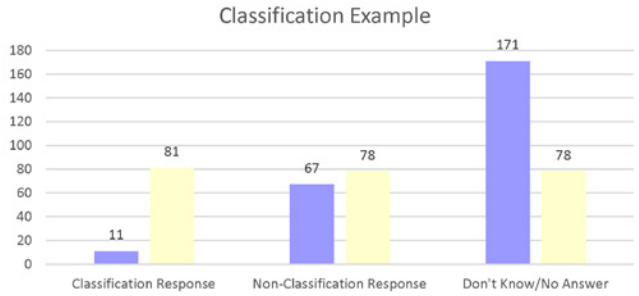


FIGURE 9. Pretest and posttest responses when asked to give an example of classification.

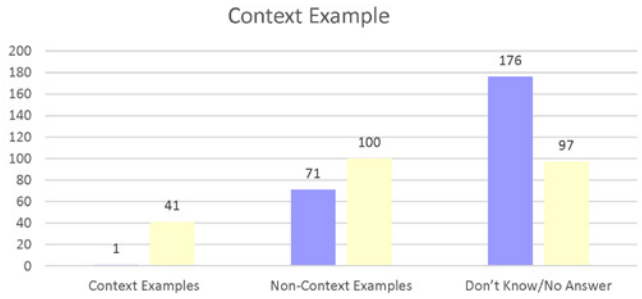


FIGURE 10. Pretest and posttest responses when asked to give an example of context.

understanding of the concept. For all four concepts, students showed consistent but only moderate gains in understanding. While general understanding of the work of archaeologists was high (Figure 1), individual understanding of the conceptual tools of inquiry was not as good.

The Project Archaeology formative assessment project did not assess student understanding of the Enduring Understanding 3, "Everyone has a culture and our lives are shaped by our culture in ways that we may not even see." Culture is a very complex concept, and we were unable to devise an effective and doable written assessment question for fourth- and fifth-grade students.

The formative assessment of *Project Archaeology: Investigating Shelter* in classrooms was instrumental in the development and completion of the curriculum guide. The results were used immediately to clarify procedures, to tweak enduring understandings and essential questions, and to provide additional background information to assist students with both content and conceptual understanding. The curriculum guide was first published in 2009. Although it had already been published, we realized that the lessons covering the conceptual tools of archaeology were inadequate and deserved further research for improving future editions of the guide and other new curriculum guides.

Conceptual Understanding of Inquiry

Learning research clearly shows that it is essential to check for misunderstandings before learning continues (Bransford et al. 2000). Desired learning will stop if misconceptions are not identified and corrected. For example, students will learn very little about archaeological content if they persist in the misconception that archaeology and paleontology are one and the same thing.

Noting the inadequacies of the student understanding of the conceptual tools of archaeological inquiry, I designed my doctoral research to uncover student learning in this portion of *Investigating Shelter*. Research shows that conceptual understanding of science inquiry is essential for obtaining desired student learning outcomes (Keeley 2005; Keeley et al. 2007). Using the constructivist approach, I examined students' intellectual grasp of the tools of scientific inquiry in *Conceptual Understanding of Science through Archaeological Inquiry* (Moe 2011) while students were engaged in studying archaeological inquiry through instruction in *Investigating Shelter*. My main research question was "How do students understand and use science concepts through the study of archaeological inquiry?"

This study can best be described as a case study (Merriam 1998) because it is bounded by the sample, i.e., the entire fifth grade at a small elementary school. In other words, the purposely selected sample students ($N = 27$) and their experience with archaeological inquiry is the unit of study or the "case." Case studies facilitate insight, discovery, and interpretation of the phenomenon in question within a certain context, often as it unfolds over time (e.g., Brody 2005). Case studies are not tied to particular research methods and may draw from the full spectrum of data gathering techniques (Merriam 1998; Stake 1995). A case-study approach is appropriate for this study for the following reasons:

1. The case is the entire fifth grade at a small elementary school, and the students experienced a curriculum inter-

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TABLE 2. Summary of Five Inquiry Concepts Including Definitions and Archaeological Examples (Moe 2011).

Concept	Definition	Example
Observation	Recognizing or noting a fact or occurrence	Stones arranged in a circle on the ground
Inference	Conclusion derived from observations	Concluding that the circle of stones is a tipi ring and the stones mark where people pitched their conical shelters
Classification	Systematic arrangement in groups of categories	Classify stone circles by their size and infer that larger circles may represent larger family units
Context	The relationship that artifacts have to each other and to the situation in which they were found	Larger stone circles are found more often on certain landforms, such as river terraces or high bluffs
Evidence	Data used to answer a question	Radiocarbon dates or the presence of time-sensitive artifacts as evidence to establish when tipi rings were occupied

vention that is widely available nationally. While the number of participants was small, the research illuminates the larger issue of teaching science literacy. The sample of students was not diverse but generally represents the intended audience for Project Archaeology materials. Although the findings are not generalizable to the entire population, they should be transferable to similar contexts throughout the United States and, perhaps, to other countries where science literacy is an important part of education.

2. Besides the stated research questions, several additional questions were considered through this research. For example, why did the curriculum work the way it did? How could it work better in similar contexts? Would different teaching strategies change the results? Would additional learning activities or additional graphic organizers assist with learning?

3. The approach allowed me to consider a variety of variables, such as the ability of the teacher and the previous learning experiences of the students. Additionally, the relationships between variables can be considered with a bounded context. Description can be "thick" and filled with the "voices" of the participants both in written and verbal form (Geertz 1973:3–32).

Rather than providing a cursory view of each student's understanding at one moment in time, as would be obtained through a multiple choice instrument, I had the opportunity to interact with all of the students multiple times and in several different ways (e.g., reading classroom work, reading written responses to the data collection tools, analyzing verbal responses, observing a self-guided inquiry, and observing classroom instruction).

Both the teacher and her principal were very supportive of the project. The students were excited to participate in the project, and their teacher once said, "They work harder on your data collection tools than they do on anything else." I did not know any of the students before beginning the project, but I believe that they were comfortable with me and with the project. I impressed upon them that there were no right or wrong answers and that I only wanted to know what they thought and what they understood. I think that their responses were honest, and they did not tell me what they thought I might want to hear.

Using a series of formative learning assessment probes, interviews, and a performance task designed specifically for 27 fifth-grade students studying *Project Archaeology: Investigating Shelter*, I uncovered their understanding or misunderstanding of five important conceptual tools of archaeological inquiry: observation, inference, classification, identifying context, and using evidence to support interpretation. The students studied "The Poplar Forest Slave Cabin" (Heath et al. 2010) as part of a unit on American history. Table 2 shows the five conceptual tools, the definition used for each of the concepts, and an example of application of the tools in archaeological inquiry.

In my study, I separated understanding of the conceptual tools from the skill of applying the tools in inquiry. I reasoned that, while students might be able to apply the skill or tool "correctly," they may not understand the underlying concept. If the concept is understood correctly, then the skill can be applied with productive results. If the concept is not understood correctly or is misunderstood, then the application of the accompanying skill will probably not be productive. Table 3 shows the etymology of the words. All five of these tools or concepts are classified as nouns in English, but all five nouns are ultimately derived from Latin verbs (*The New Oxford American Dictionary* 2001). The English definitions for all five words include some notion of process or doing something, thus retaining some of their Latin meanings.

Lessons Four, Five, and Six of *Investigating Shelter* provide students with an example of the concept or conceptual tool of inquiry in everyday life and guide them through the use of the concept in archaeological inquiry. The teacher administered the formative learning assessment probes following each of the three lessons. I used the students' written responses to elicit further explanation of their conceptual understanding of the

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TABLE 3. Science Inquiry Concepts and their Etymology (Moe 2011).

English Noun	English Verb	Latin Root(s)	Latin Meaning
Observation	observe observing	observare (v)	to watch or to look at to attend to
Inference	infer inferring	inferre (v)	to bring in or to place on to conclude
Classification	classify classifying	classis (n) facere (v)	division; to make or to do
Context		con (p) texere (v)	together to weave
Evidence		ex (p) videre (v)	out to see

processes by which they arrived at their understanding through individual interviews. Later during the course of instruction, the students applied each concept as they investigated a shelter through authentic archaeological data, oral history, and historic documents such as diaries, census records, photographs, or artwork such as drawings or paintings, when available.

Figure 11 shows an assessment probe on observation and inference, as an example of the five assessment probes developed for the study. Following instruction on these two tools of inquiry, students chose observation or inference for each of the statements and explained their reasoning in writing. I interviewed all of the students about their written probes to draw out further information about their understanding. Generally speaking, their oral explanations were better than their written explanations; I gleaned most of my data from transcripts of the interviews.

Out of 158 possible incidences of misconception or misunderstanding, I detected 56 among the 27 students, or approximately one-third of the total possible (Figure 12). Only three of the students showed no evidence of misunderstanding (Figure 13).

While the bar graph looks like a perfect bell curve (Figure 13), it is important to know that student understanding was idiosyncratic, and I could find no way to group students based on their responses. Interestingly, the rate of misconceptions dropped significantly on the Performance Task, which was completed after the students had finished their investigation of an archaeological site using authentic data from a slave cabin in Virginia. The investigation gave the students a chance to apply the tools of inquiry and to hone their inquiry skills. When the students conducted an independent inquiry using a map and artifacts from a Pawnee Earthlodge in Kansas, only four misconceptions surfaced among all 27 students.

While all 27 students obtained a basic understanding of each of the five tools of inquiry, misconceptions were still quite prevalent (Moe 2011:164). For example, most of the students were able to differentiate between the five tools of inquiry most of the time, but a few students conflated context and classification and did not have a clear understanding of either (Figure 12). Similarly, some students did not demonstrate a complete understanding of the difference between observation and inference or the difference between evidence in science as opposed to evidence in legal contexts. One of the most common misconceptions occurred on Learning Probe 5: Observation and Inference (Figure 11). Almost all of the students selected the correct answer for statements A–E. Eleven of the students selected "observation" for statement F, when the statement is clearly an inference. Even though they seemed to have a good grasp of the two concepts, this statement tripped them up.

From a curriculum development standpoint, this study provided our best insight into student understanding of archaeological inquiry and content and on how to improve our materials to achieve deeper understanding. The research clearly indicated inadequacies in differentiation of understanding between the fundamental tools of archaeological inquiry. Because of the study, we will provide the learning assessment probes in future additions of the *Investigating Shelter* curriculum guide for teachers to use to check for understanding before continuing instruction. Actually, misconceptions provide an excellent opportunity to expose flaws in reasoning and help students understand the differences between the concepts (Bransford et al. 2000; Wiggins and McTighe 2005). In short, these misconceptions, if detected by the teacher, provide "teachable moments" that could be remediated through additional instruction and checked again for increased conceptual understanding.

Based on this study, we intend to include some additional activities to differentiate between the conceptual tools of inquiry in the second edition of *Project Archaeology: Investigating Shelter*. For instance, a card sorting activity with examples of context and examples of classification may help students to understand the difference between the two. Similarly, a card sorting activity with examples of evidence in legal contexts versus scientific or historical interpretation may help students better identify the types of evidence needed for scientific inquiry. A simple class discussion about the differences between observation and inference might help students solidify their understanding of each concept and how they work together. Two of the students in the study corrected their own misconceptions about observation and inference during their interviews through self-dialogue. After examining the statement more thoroughly, they both changed their answers to inference. A guided classroom discus-

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Learning Probe 5: Observation and Inference
(Adapted from *Intrigue of the Past: A Teacher's Activity Guide Fourth through Seventh Grades*, Smith et al., 1996).

An Ancient Coin: This coin was found in an archaeological site. The drawings below show both sides of the coin. Look at the coin carefully and decide if each of the statements below is an observation or an inference.



Place an "O" before statements that are observations and an "I" before statements that are inferences.

_____ A. There is a picture of a face on one side of the coin. Explain your answer.

_____ B. The coin tells us that these were deeply religious people. Explain your answer.

_____ C. The words "We Trust the Gods" are printed on the coin. Explain your answer.

_____ D. On one side of the artifact is a drawing of leaves. Explain your answer.

_____ E. We can tell from the artifact that these were peace-loving people. Explain your answer.

_____ F. The face on the coin is picture of the nation's king. Explain your answer.

FIGURE 11. Example of formative learning assessment probe differentiating observation and inference (from Moe 2011).

sion would probably enable most students to better understand the differences between these two tools of inquiry.

Importantly for this article, the research clearly guided us toward effective ways to improve our curricular materials, gave us effective tools to help teachers detect misconceptions or misunderstandings, and showed us how to make teachers aware of common misconceptions in the study of archaeology and how to correct them. From a curriculum development standpoint, detecting and measuring student understanding is critical to achieving the goals of archaeology education: conceptual understanding of the discipline and its importance as a way of knowing about the past and other cultures and reasons for protecting archaeological sites for the scientific information that they contain.

Further Assessment of Project Archaeology Curricula

While we assess every Project Archaeology curriculum that we produce, we also depend on the assessments of other researchers on our materials and on other aspects of archaeology education. For example, in 2014, the Kentucky Project Archaeology program received funding from the U.S. Army Corps of Engineers in the form of alternative mitigation for damage to archaeological sites on the shores of Lake Cumberland (Levs-

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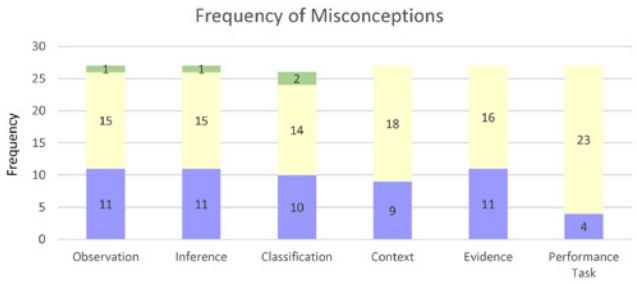


FIGURE 12. Bar graph of the frequency of misconceptions per conceptual tool.

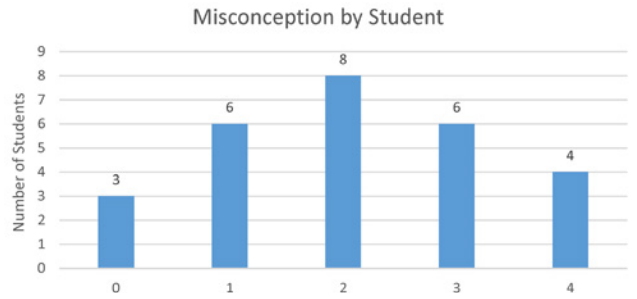


FIGURE 13. Bar graph of the frequency of misconceptions per student.

tik and Henderson 2015; Stottman and Henderson 2015). The project included *Project Archaeology: Investigating Shelter* and "Investigating a Shotgun House." Fourteen teachers from the Lake Cumberland area attended a five-day institute and learned how to use the materials and how to integrate them into their history and social studies curricula. They also received extensive information about the lives of blue-collar workers and their families who lived in Davis Bottom in Lexington, Kentucky. Some of the teachers agreed to pilot both *Investigating Shelter* and "Investigating a Shotgun House" in their classrooms during the 2014–2015 academic year. The researchers assessed student learning outcomes, which will be used to improve "Investigating a Shotgun House" and future editions of *Investigating Shelter*.

All Project Archaeology curricular materials are tested in classrooms while under development and peer reviewed by educators and archaeological content experts. Formative evaluation is routinely built into all curriculum development budgets as much as possible. For example, *Changing Land, Changing Life: Investigating Archaeology in the Absáalooke Homeland*, a curriculum based on the archaeological excavation at the Absaroka Agency or second government agency for the Crow Nation, occupied between 1875 and 1884, was tested in three classrooms: one in Livingston, Montana; one in Bozeman, Montana; and one in Crow Agency, Montana, with Crow children. Similarly, *Investigating Fort Meade* was tested in three third-grade classrooms in Sturgis, South Dakota, before it was finalized and widely distributed. Our next major curriculum unit, *Project Archaeology: Investigating Migration*, will be extensively tested and modified for classroom usability before completion. When no assessment funding is available, we test materials in Bozeman School District classrooms to the greatest possible extent; in return, we provide materials and professional development to the district at reduced rates. It is more difficult to find funding for summative evaluation, but we know that the materials are classroom friendly and achieve the desired enduring understandings before they leave the Project Archaeology office.

CONCLUSIONS

While research results on learning outcomes is still scant, archaeology educators have begun to build a body of research data. These studies will serve us well as we develop larger and more comprehensive assessments and program evaluations in multiple contexts. Only large quantitative assessments of student learning will enable archaeology education to be implemented widely across the nation (Tamela Eitle, personal communication 2016). Research showing the effectiveness of an intervention attracts both educational publishers and high-level educational administrators, a necessary step for widespread distribution. We hope to obtain a series of research grants from the Department of Education, Institute for Educational Sciences (IES), using archaeology education as an intervention to show that students who experience high-quality archaeology education exhibit deeper conceptual understanding of science and history and will perform better on performance-based examinations. Grants from IES allow the recipients to develop and test materials qualitatively and, finally, to implement them widely through broad, randomized experimental assessment. Once this research work is complete, we stand a far better chance of distributing archaeology education to a much wider audience than we are able to reach now.

In a formative assessment project while *Project Archaeology: Investigating Shelter* was under development, we learned that the curriculum guide is very effective in teaching two important things, even when it is not implemented well. It teaches students about the work of archaeologists and is effective at helping them differentiate between archaeology and paleontology. Pretests showed that students had very little idea of what archaeologists do, and posttests showed a significant leap in their knowledge about archaeology.

Project Archaeology: Investigating Shelter also teaches students what to do when visiting an archaeological site. While pretests showed that a good percentage of students indicated that they should respect an archaeological site and not disturb it, the posttests showed significant gains in appropriate and proactive behavior when encountering an archaeological site.

Because *Project Archaeology: Investigating Shelter* is designed for teachers, we want to strengthen the educational components, especially instruction for the conceptual tools of inquiry. The second edition of the guide will provide teachers with formative learning assessment probes modeled on the probes developed for research in 2009 to check for conceptual understanding and additional instructional materials to remediate gaps in understanding.

While it is difficult to control learning in informal venues and even more difficult to assess learning outcomes in these places, museums, archaeological sites, and other venues are excellent places to engage the public in archaeology education.

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Particularly powerful learning may occur in these informal settings; hence, we must work to improve both our informal programming and the assessment of learning outcomes in informal settings. In our experience, students get the most out of field experience after they have experienced Project Archaeology instruction in their classrooms.

Assessment of learning outcomes is essential for the sustainability of archaeology education. Without demonstrated success, we cannot rely on continued funds or find new funding sources. Similarly, our intended audiences will not be interested in archaeology education unless the materials and professional development that we provide assist them with their teaching jobs. Many other better-funded education offerings are available to teachers and other educators; our materials must be at least as good, if not better, to compete for a place in the nation's educational system. Finally, our vision of a well-informed citizenry engaged in historic preservation will not be achievable without the highest-quality materials and professional development for educators.

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Data Availability Statement

All research reported in this article was conducted with the permission and guidance of the Montana State University Institutional Review Board (IRB). The data were gathered from children under the age of 18 and are subject to confidentiality, per the IRB guidance. Recorded interviews were erased. Written pretests, posttests, and transcripts of interviews are stored in a locked cabinet at Montana State University and cannot be viewed by any researchers except those on the original IRB applications.

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