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# STEAM vs. STEM: A Study and Program Proposal for Monticello

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**Abstract**

STEM (science, technology, engineering, and mathematics) and art programs have long been struggling for dominance in the education system. This fight overshadows the fact there are synergistic educative capabilities when these two schools of thought are combined, allowing scientific and artistic persons to work in tandem and be exposed to a wider variety of problem-solving options and opinions. This study aims to focus on museum education practices specifically and how implementing STEAM programs (science, technology, engineering, arts, and mathematics) versus STEM could raise the perceived value of arts in society, as well as create a more enriching educational experience by using more holistic and interdisciplinary measures within their curriculum. This study will focus on the historical site Monticello and its current educational programs and expand on how these programs may be adapted to become STEAM programs that appeal to both artistic standards and scientific/technological standards.

*Keywords*: American history, curriculum planning, historical site, museum education, museum studies, public education, STEAM, STEM

## Introduction

There has been a long-standing push for STEM (science, technology, engineering, and mathematics) fields and programs, and a diminishing amount of support for liberal arts programs as more and more liberal arts universities are being shut down (Henchinger Report Contributor). This is especially evident (and concerning) in light of the recent proposal to eliminate funding for the National Endowment for the Arts—which was rejected, at least for now (Deb). To save the arts and humanities and continue a well-rounded school of thought in STEM fields (that is, challenging preconceived notions by learning outside of one's primary discipline), a marriage of art and STEM, or STEAM, must be implemented. STEAM may be one of the few things that can convince administration to keep the arts and humanities healthy. This is especially true when one considers the countless reports that support the legitimacy and benefits of the arts, which apparently are not enough of a positive argument to convince arts and humanities' validity (Mowlah). I want to make clear that this is not an attack on STEM or an elevation of arts and humanities over STEM, rather an argument to create equilibrium between the importance of STEM and the arts and humanities.

First and foremost, this study will promote the concept of STEAM (science, technology, engineering, arts, and mathematics) as opposed to STEM, which incorporates the arts as a means to improve scientific studies and approaches instead of presenting art as lower form of study than standard STEM fields (Ali). For more concrete purposes, this study will focus on developing STEAM academic and/or extracurricular programs within historically significant sites. This study will specifically focus on the historical site Monticello, the home to the third President of the United States, Thomas Jefferson. Situated in the mountains of Charlottesville, Virginia, it is a place of beauty and opportunity—a perfect site for which to propose a program for visitors. To provide a more local connection, I will reference Sauder Village, a living historical site in Archbold, Ohio, roughly an hour northwest of Bowling Green, Ohio.

To create a STEAM program, this study will establish links between scientific studies and artistic practices, such as chemical processes in metalworking and environmental science and biology in botany/agriculture. Ideally, two specialists or trained tour guides will present site-focused information about the topic, and then continue by explaining scientific processes within preexisting tour stops and/or pieces in the house collection. These STEAM programs will be more efficient as individualized family programming, but for the sake of adaptability, both tour integration and standalone programs will be explored in this study.

**Literature Review**

Although the push for an increase in STEM education and a decrease in liberal arts education has been endorsed for a long time now, perhaps the latter issue most recently came to a head in 2018 when there was a proposal to eliminate funding for the National Endowment for the Arts—which was rejected, at least for now (Deb). This battle will perpetuate unless the equal value of both sides is finally acknowledged, and they are presented at the same level of importance. To save the arts and humanities and continue a well-rounded school of thought in STEM fields (that is, challenging preconceived notions by learning outside of one's primary discipline), a marriage of art and STEM, or STEAM, must be implemented. STEAM may be one of the few things that can convince administration to keep the arts and humanities healthy. This is especially true when one considers the countless reports that support the legitimacy and benefits of the arts, which have not been thus far effective in retaining arts funding or in convincing the validity of arts and humanities ("The Value of Arts"). Again, I want to make clear that this is not an attack on STEM or an elevation of arts and humanities over STEM, rather an argument to create equilibrium between the importance of STEM and the arts and humanities via museum programming. In order to create an immersive, healthy environment for critical thinking, one ought to use both hemispheres of academics in tandem.

The source that are the driving force of this study is *Excellence in Practice: Museum Education Principles and Standards* published by the American Association of Museums (2005). This source reflects current standards in museum education and clearly outlines the main goal of museum education: to combine "intellectual rigor with the inclusion of a broader spectrum of our diverse society" (Fortescue 2). This resource explains the necessity of creating a learning environment that appeals to a diverse range of learners, allows for multifaceted ways of viewing and understanding materials, and overall allowing respectful growth of knowledge and opinions within the institution. This drives home even further the idea that there should be an integration of arts and sciences when presenting information to create a more diverse presentation as a whole, especially if the ultimate goal is wide spectrum inclusion.

As accessibility, both monetary and physical, is also a key component to museum programming, the addition of augmented reality may also be a beneficial area of study. As discussed in Ross Parry's book *Recoding the Museum: Digital Heritage and Technologies of Change,* published in 2007, computers can be used to spread availability of educational programs (1-14). These perhaps could also be more cost effective and also an excellent testing ground for new programming to gauge interest before implementing it on-site, since there is less physical labor involved in computation than there would be in hiring a tour guide, gathering materials for the presentations at the site, et cetera. Since Monticello already implements digitization into their museum practices, this would likely be a straightforward curriculum and program integration if it follows their other digital education practices. (That said, since there is not really any information from an IT perspective, the technical follow through could present itself as more challenging.) From a STEAM perspective, the most beneficial kind of digitization practice would, again, be augmented reality. Monticello currently offers 360-degree views, “Google Street” views, and two dimensional/photographic views of the inside of the home for virtual tours. If this could be adapted to include other smaller landmarks at the site, such as Mulberry Row, the artisan strip on the plantation, explanations of science behind the artisan work could be added in pop-up windows linked on the virtual tours. This will be explored more in the results and conclusions portion of this study.

**Methodology**

If this study could be realized, then its implementation would certainly follow the American Association of Museum’s rule to set measurable goals and objectives in programming (insert source here). Unfortunately, since this is an explorational study versus a performance study, this data can only be extrapolated from outcomes based on similar institutions and their current programming.  Since this is the case, the methodology of this study is as follows (this also reflects the rough outline followed in the early construction stages of this project):

- Research current educational programs available at Monticello, Charlottesville, Virginia and identify their main educational goals.
- Via previous research and understanding of science practices, look for and create connections between current programming and how science could be implemented in these discussions. Use the AAM guidelines to create this program, as well as educational standards from the state of Virginia to align with classroom adaptability.

- Develop a means to employ these connections at Monticello. The intent is to add this kind of learning into preexisting programs with the intent to minimize extra costs and support the idea of side-by-side art and science education.
- Draw ties between programming at Sauder Village, a local historical site that utilizes on-site artisan demonstrations, to new program developed for Monticello.

Since this study is extremely hypothetical, a comparison between a current program similar to the one being proposed for Monticello is vital to ensure that there is proof that this kind of education could work if put forth correctly. Availability of program performance and funding also limits the ability to create quantitative studies comparing numbers and costs of program implementation, so this is the closest means of supporting the proposed program with hard, functional evidence. Additional proof of STEAM program success has already been documented in other institutions, such as the Getty and a collaboration between the Braithwaite Fine Arts Gallery and the Garth and Jerri Frehner Museum of Natural History at Southern Utah University (Grant 144-150), which are even more well known and grant hopeful evidence that STEAM programs could be translated to living history institutions and not just galleries and museums.

One of the most relevant programming initiatives from Grant's study was from year three of her research. During that program, children learned about pollinators and reinforced the science they had learned by selecting a flower and sculpting one of its pollinators with clay. While this is not exactly the same method of learning that would be implemented at Monticello, it still shows the rise in STEAM education trends across the United States. As stated by Grant, "the STEAM trend in education is growing by leaps and bounds because of the perception that engagement in the arts encourages independence, creativity, and critical thinking" (149). Upon the completion of more research regarding the necessity of liberal arts in relation to a well-rounded education and overall wellbeing, STEAM will likely gain more momentum.

**Research Results**

Surface level research of Monticello's educational programs produced the following findings. The focal point of Monticello's educational endeavors is their tour of the main house and the grounds. There are variations of this tour that include "behind the scenes" areas (for example, the upstairs of the main house). The names of their programs are as follows:

- Behind the Scenes House Tour and Day Pass
    - Allows guided tour of upstairs at Monticello
- Monticello Day Pass and House Tour
- Hemings Family Tour
    - Highlights the "best documented enslaved family in the United States."
- Family Friendly Tour and Day Pass
    - Runs specific dates in mid-spring to early fall
    - "Designed for families with children ages 5 to 11."
    - Shorter tour of home that runs approximately 40 minutes
    - Offers hands on activities to appeal to younger children and keep them involved in the tour
- Evening Behind the Scenes Tours
    - Runs specific dates in June through August
    - Allows access to grounds after the site has closed to general admissions
- Hamilton Tour Takeover
    - Run daily through specific dates in April, May, June, July, and August

    - Highlights the differing opinions of Jefferson and Alexander Hamilton while the foundations of the United States were being laid
    - Brought to light after production of Broadway's *Hamilton: An American Musical*
- Slavery at Monticello Tours
    - "Find out how the Monticello plantation operated and about the lives of individual slaves."
- Gardens and Grounds Tours
    - Run daily in April through October
    - Highlights Jefferson's interest in botany, gardening, and agriculture
- Monticello Private Guide

In conjunction with these standard tours, Monticello offers home educator days; an archaeology program through University of Virginia (in which the participant gains 6 credits); an opening film (approximately 15 minutes) that introduces visitors to Monticello and Jefferson's life; the Griffin Discovery Room in which visitors from ages 6 to 12 can learn about childhood during the 1800s; field trips that have different programs based on students' grade levels; adult group tours and programming; Monticello Digital Classroom and virtual tours; "Age of Jefferson" free online course through Coursera; and online galleries of the grounds and interiors of the home. For academics, Monticello hosts conferences and symposiums. In the gift shop, Monticello has educational books regarding specific topics of the house (i.e. *The Fruit and Fruit Trees of Monticello*).

Clearly, Monticello already has a well-rounded and established educational program that appeals to a variety of individuals and beginning to expert historians. The museum, as Parry suggests, is implementing digital aids to create greater accessibility of their programs. While this is a tie between technology and history, it is not the one that this proposed STEAM program will pursue. Rather, it is the tie between the site itself and science, not the delivery of the information through science. The area of Monticello that would be best suited for an art and science combination programming would be Mulberry Row, situated on the top of the hill near the house museum. As of 2011, Monticello was working to restore the four workshops of this street, now destroyed over the span of time (Stein). It is unclear how far along Monticello staff has come in this restoration and education planning process.

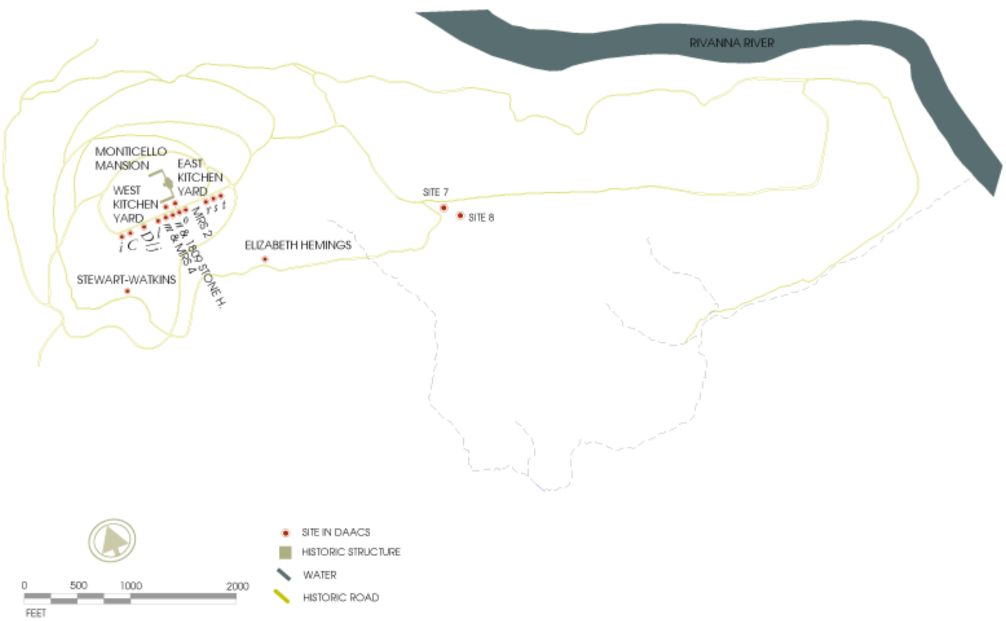


*Figure 1. Archaeological map provided by Digital Archaeological Archive of Comparative Slavery. Mulberry Rowe is situated by the East Kitchen Yard and the Monticello Mansion.*

This area was considered the "principal plantation street" as well as the artisan workshop area. This street was home to a variety of workers, ranging from hired help to enslaved persons. Based on the census of workers, one can assume that the following were the types of artisan workshops open while the plantation was functional:

- Woodworking and/or carpentry: sawyers, joiners, plasterers)

- Metalwork: nailers, charcoal burners, blacksmiths, tinsmithers
- Tanneries: lime burners
- Cobblery: shoemakers
- Masonry: bricklayers, stonecutters
- And textiles: quillers, weavers, spinners, carders (individuals who would brush the wool for it to be spun.

These workers were in addition to basic positions necessary for an agriculturally centric plantation to thrive. It is in areas like these that historical sites branch out to incorporate demonstrations to help show visitors what life was like during that time period.

Here, one can incorporate the example of Sauder Village to prove the efficacy of this style of programming. Sauder Village is "living history museum and farm" in which volunteers and staff use demonstrations as a means of interactive learning. The buildings on site include a variety of activities focused around the principal artisan practices of Sauder Village. The craftsmen at Sauder Village consist of basket weavers, tinsmiths, blacksmiths, glass blowers, coopers (barrel makers), broom makers, potters, quilters, spinners, weavers, and woodworkers. It is clear that many of these occupations coincide with positions held at Monticello, thus making it easy to see how demonstrations could be incorporated at the presidential home. In regard to integration of science, the following chart is a means by which different scientific disciplines are already connected to the artistic practices and only require the addition of scientific information to create a more well-rounded STEAM program.

Unlike Sauder Village, Monticello does not have any functioning artisan buildings to house. As mentioned before, there is an attempt to restore Mulberry Row, but as of now, it would be difficult to hold artisan demonstrations on site without the necessary materials and space in which to do so. This all said, it is practices such as glass blowing and blacksmithing that are the best means to create a STEAM program. One of the few, if only, possibilities of STEAM programming that requires minimal space is incorporating botany and scientific sketches (and thus drawing classes) on top of the hill near the gardens and fields.

However, before even proposing possible connections, one must understand the Virginia curriculum and learning that will be used in conjunction with building this STEAM program for interactive learning and programming at Monticello. Since STEAM requires the integration of both art and science, I will be looking through both of these standards set forth by the Virginia Department of Education in order to better understand how this program could be successful in relation to checking off learning targets in the classroom. I will also integrate historical and social science standards, since Monticello is a historical site. However, these will not be the main focus of the study and are likely already met by Monticello's academic programming staff.

Since elementary to middle school standards are scattered between disciplines, it is easier to focus on subject standards versus grade standards. Science standards for physical science, are the most easily implemented, as they most closely relate to the artisan practices and are a combination of physics and chemistry, which could be more easily taught in tandem in non-science situations such as Monticello. There will also be the inclusion of earth science standards in relation to agriculture and environmental science. Visual arts standards listed below and are general goals from the learning standards that are not connected to grade levels. History and social sciences are taken from American history from the 1700s to 1865. The most relevant learning objectives to this study are presented below. These goals below are sourced from the Commonwealth of Virginia's Board of Education's publications from 2013, 2015, and 2018. These are the most up-to-date standards as per the Board of Education's website.

- Physical science
    - PS.3 “The student will investigate and understand that matter has properties and is conserved in chemical and physical processes. Key ideas include
        a) Pure substances can be identified based on their chemical and physical properties;
        b) Pure substances can undergo physical and chemical changes that may result in a change of properties;
        c) Compounds form through ionic and covalent bonding; and
        d) Balanced chemical equations model the conservation of matter.”
    - PS.4 “The student will investigate and understand that the periodic table is a model used to organize elements based on their atomic structure. Key ideas include
        a) symbols, atomic numbers, atomic mass, chemical groups (families), and periods are identified on the periodic table; and
        b) elements are classified as metals, metalloids, and nonmetals.”
    - PS.5 “The student will investigate and understand that energy is conserved. Key ideas include
        a) energy can be stored in different ways;
        b) energy is transferred and transformed; and
        c) energy can be transformed to meet societal needs.”
    - PS.6 “The student will investigate and understand that waves are important in the movement of energy. Key ideas include

a) Energy may be transferred in the form of longitudinal and transverse waves;

b) Mechanical waves need a medium to transfer energy;

c) Wave can interact; and

d) Energy associated with waves has many applications."

- PS.8 "The student will investigate and understand that work, force, and motion are related. Key ideas include

  a) Motion can be described using position and time; and

  b) Motion is described by Newton's laws" (Science Standards of Learning 32-34).

- Earth science
  - ES.4 "The student will investigate and understand that there are major rock-forming and ore minerals. Key ideas include

    a) Analysis of physical and chemical properties supports mineral identification;

    b) Characteristics of minerals determine the uses of minerals; and

    c) Minerals originate and are formed in specific ways."

  - ES.5 The student will investigate and understand that igneous, metamorphic, and sedimentary rocks can transform. Key ideas include

    a) Earth materials are finite and are transformed over time;

    b) the rock cycle models the transformation of rocks;

    c) layers of Earth have rocks with specific chemical and physical properties; and

d) plate tectonic and surface processes transform Earth materials.

- ES.6 "The student will investigate and understand that resource use is complex. Key ideas include

  a) Global resource use has environmental liabilities and benefits;

  b) Availability, renewal rates, and economic effects are considerations when using resources;

  c) Use of Virginia resources has an effect on the environment and the economy; and

  d) All energy sources have environmental and economic effects" (Science Standards of Learning

- ES.8 "The student will investigate and understand that freshwater resources influence and are influenced by geologic processes and human activity. Key ideas include

  a) Water influences geologic processes including soil development and karst topography;

  b) The nature of materials in the subsurface affect the water table and future availability of fresh water;

  c) Weather and human usage affect freshwater resources, including water locations, quality, and supply; and

  d) Stream processes and dynamic affect the major watershed systems in Virginia, including the Chesapeake Bay and its tributaries."

- ES.9 “The student will investigate and understand that many aspects of the history and evolution of Earth and life can be inferred by studying rocks and fossils. Key ideas include
  a) Traces and remains of ancient, often extinct, life are preserved by various means in sedimentary rocks;
  b) Superposition, cross-cutting relationships; index fossils, and radioactive decay are methods of dating rocks and Earth events and processes;
  c) Absolute (radiometric) and relative dating have different applications but can be used to together to determine the age of rocks and structures; and
  d) Rocks and fossils from many different geologic periods and epochs are found in Virginia.

- Visual Arts
  - “Develop understanding of the relationship of the visual arts to history, culture, and other fields of knowledge.”
  - “Develop understanding and appreciation of the roles, opportunities, and careers in the visual arts and related areas” (Visual Arts Standards *v*).
- History and social sciences
  - USI.1 The student will demonstrate skills for historical thinking, geographical analysis, economic decision making, and responsible citizenship by
    a) “analyzing and interpreting artifacts and primary and secondary sources to understand events in United States history;”
    e) “comparing and contrasting historical, cultural, and political perspectives in United States history;

f) “determining relationships with multiple causes or effects in United States history;”

g) “explaining connections across time and place” (History and Social Science Standards *i*).

**Proposed Program**

From reviewing these standards, once can now link different artisan practices to different academic standards set forth by the Board of Education of Virginia. The graphic below will show the link between artisan practice, science, and the academic standards previously listed.

| *Artisan Practice* | *Connection to Science* | *Related Science Standards* |
|---|---|---|
| Blacksmithing | Metallurgy practices, physics of heat, principles of matter, chemistry (reaction of different metals to one another, such as copper and zinc to make brass) | PS.3<br>PS.4<br>PS.5<br>PS.6<br>PS.8<br>ES.4 |
| Glass blowing | Physics of heat, principles of matter, chemistry (reaction of different elements to create different colors) | PS.3<br>PS.4<br>PS.5<br>PS.6<br>PS.8 |
| Agriculture | Environmental science, biology, botany | ES.5<br>ES.6<br>ES.8 |

| | | |
|---|---|---|
| | | ES.9 |
| Masonry | Environmental science, geology | ES.4<br><br>ES.5<br><br>ES.9 |

*Figure 2. Comparative chart of artisan practices, their respective scientific connections, and what standards can be used in conjunction with these ties.*

From this chart, museum educators can then draw on textbook material of surrounding K-12 high schools (depending on the program's intended audience) then sprinkle the scientific basis throughout the preexisting information listed and/or presented around the site. The goal is that this integration should be relatively easy and only require the addition of more information, not the revamping or creation of an academic program. Although one could simply create STEM courses offered at Monticello that focus only on the science of practices without demonstrations, it would be more time consuming than necessary in comparison to using preexisting frameworks. The most difficult aspect of this kind of programming would be, as mentioned before, where demonstrations could be held to encompass a more interactive sphere of learning in which many enjoy watching and participating.

Mimicking Grant's study that selects one standard and one activity, this proposal will focus on standard ES.5 in relation to blacksmithing then propose an artistic activity. Standard ES.5 focuses on the different kinds of rocks (igneous, metamorphic, and sedimentary) and how the rock cycle functions. Blacksmithing directly links to mineral deposits, requiring sedimentary and/or igneous rock deposits from which to smelt iron (Extraction). Since Charlottesville, Virginia, and ultimately Monticello, resides near the Appalachians, there is plenty of sedimentary rock from which to smelt iron. Students can discuss with their tour guide the various kinds of sedimentary rock surrounding the plantation, then explain themselves how sedimentary rock is formed (erosion processes).

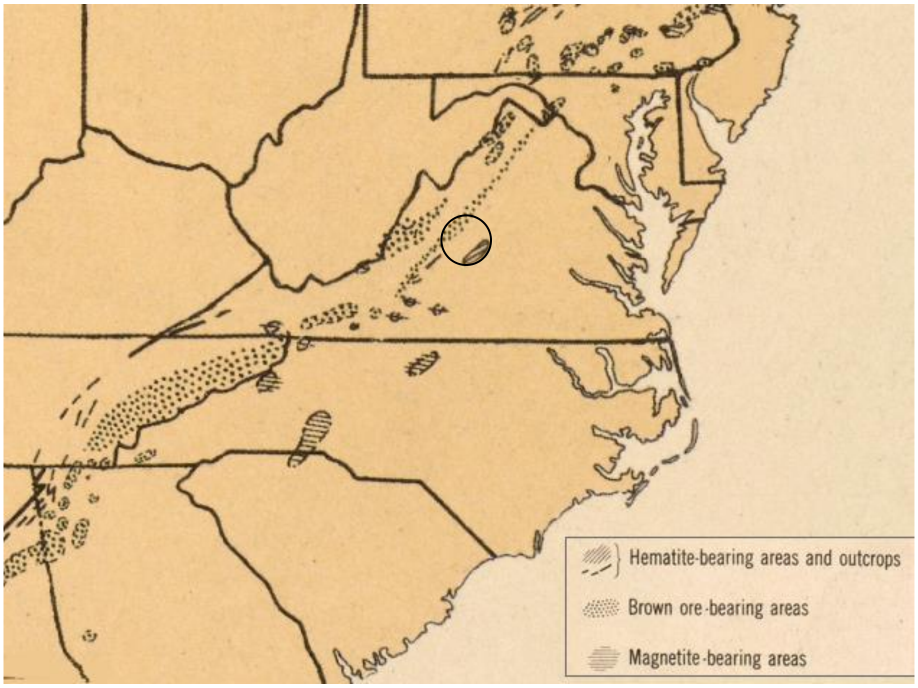


*Figure 3. Map of iron ore regions of Virginia provided by Appalachian Ironworks. Circle demarcates approximate region of Monticello.*

After touring the grounds, students could then watch a blacksmithing demonstration to fulfill the artistic side of this STEAM activity. Although blacksmithing was more focused on creating tools during the colonial era, there was still intricate work completed by these smiths to fulfill architectural needs and wants of their commissioners. Since the 1700s, blacksmithing has forged ahead into even more artistic practices, such as sculpture work, shown short biographies of blacksmiths in an article written by Jacqueline Weaver. One artist in particular, Mark Kindschi, uses repoussé, a technique by which the artist creates low relief from hammering the back of the metal. This was the same technique implemented in the creation of the Statue of Liberty, showing how artistic blacksmithing can be in different contexts (Weaver).

Since blacksmithing is not a safe activity for children to directly participate in, from there, students could practice blacksmithing techniques using flat tin sheets that they are able to hammer, similar to the tinsmith shop referenced during the overview of Sauder Village. This would have to be for older children or younger children with adult supervision, as nails and hammering is involved in this activity, but would ultimately be a way for students to have a more hands-on opportunity than what they would have otherwise at Monticello in regards to Mulberry Row artisans' work.

**Conclusion**

This program/activity proposal is only one of the ways in which science standards can be used in conjunction with preexisting liberal arts programs at historical sites. Of course, this study is not a be all end all, nor should it be perceived as a declaration of a successful program. Since this project is extremely hypothetical in nature, one cannot say for certain if it would succeed or fail if implemented at Monticello. Introducing Sauder Village as a successful example of crafting demonstrations is only a way of proving that the demonstrations are something visitors enjoy, and Jacqualine Grant's study further shows successful integration of STEAM in "informal learning environments" such as museums, zoos, history centers, etc (150). Even with this written evidence of STEAM success, there are other variables such as funding, accessibility, public interest, and public cost of attendance for extra programming that may affect how well the program would perform.

This all being said, exploratory studies such as this is just one of the baby steps into fully integrating STEAM learning into informal education environments. As mentioned before, STEAM is gradually gaining footing in educational practices, but may be more apt to do so in informal educational settings. Since these informal settings can work outside of state standards and include what they would like, when they would like, they can more freely play with programming techniques than classroom teachers who are required to cover a list of topics. The hope is that this study will inspire other similar institutions, historical sites, museums, etc., to continue researching the process of STEAM integration in their curriculum and ultimately create a more enriching educational environment for their visitors, child and adult alike.

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