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History and Technology: Integrating STEM Content into Elementary Classrooms Through History-Based Themes

Jennifer L. Manwell
Historical Forensics, jlmanwell@hotmail.com

Charles R. Sullivan
Thayer School of Engineering at Dartmouth, charles.r.sullivan@dartmouth.edu

Abstract – Children learn best when they are immersed in and invested in a topic of study. While some skills need to be taught in isolation and in a particular sequence, there is a great value to teaching at the elementary level using integrated thematic units. Themes provide a context for information, helping children see how content is inter-related. Using an inquiry approach engages students even more as they seek answers to their own questions. This is true for the sciences, but it is equally true for social studies. Having students work directly with primary sources supports them to draw their own informed conclusions and be more engaged in the learning process.

Index Terms – Inquiry, integrated thematic units, elementary, 19th Century history, primary sources

THE LATEST TECHNOLOGIES

Kids love technology! They love the latest apps and computer games. They love to surf the web. Imagine their surprise when they discover that the technological advances of the 19th century are also able to pique their curiosity. People learn best when they need to know something, are curious about it, or feel invested in the process and outcome. Inquiry-based, integrated thematic units tend to hook kids in ways that isolated skill building does not.

This paper describes the value of inquiry learning and how the process of providing context for learning can complement this style of exploration. Rather than teaching content in designated academic areas, the approach described here uses a social studies theme in which language arts, math, and science all have a role within an investigation of historical technologies. Much of the discussion revolves around the example of a 19th Century historical theme. In addition to giving students an opportunity to learn history, this theme has many advantages for teaching about engineering and technology while supporting the language arts. The 19th Century is a period in which technology advanced tremendously, with a wide range of important effects on society. The problems being solved and the technologies being developed are relatively easy for elementary students to understand and to work with. This theme is presented as an example of the

approach of combining inquiry learning and thematic units to teach STEM, humanities, and social studies content.

WHY INQUIRY?

“What is that?” they ask when I (first author) appear in the classroom with artifacts from the 19th Century. I could tell these suddenly attentive students the name of the tool I was holding and what it was used for, but that would be the end of the excitement. It is much more valuable to let them discover the tool’s function on their own. Peter Dow supports the need to nurture curiosity in the classroom, “[T]he skills of skeptical questioning and independent thinking may be essential goals of schooling” [1].

I recently spent several months collaborating with a middle school history teacher. I had brought a niddy noddy (Fig. 1) into the classroom to introduce the idea of learning history through an analysis of historical tools and technologies.

FIGURE 1
NIDDY NODDY AS EXAMPLE OF HISTORICAL ARTIFACT
USED AS A “HOOK”



My point was to demonstrate that a lot can be discovered about people by analyzing the tools they created and used. I also wanted the students to get a sense of the simple elegance of older technologies. We were getting ready to use inventories, a 19th century primary source that lists everything a person owned when he died. The students were going to be Historical Forensic Scientists and piece together clues about individuals who lived in their town 150 years earlier. By the end of the class, two boys shared with me their hypothesis that the tool I had brought in had something to do with yarn. They were pleased with themselves for figuring this out and their peers were equally impressed. The next day, one of these boys announced that he and his father had found a pair of ice tongs and could he bring them to school. Yes!!

Process skills such as observing, questioning, hypothesizing, predicting, interpreting, and communicating

are crucial in the sciences and can be embedded into the whole curriculum through inquiry style learning [2]. Inquiry-based learning provides space in the curriculum for students to ask and answer their own questions. Inquisitiveness then leads to experimentation or further research and then to “Aha!” moments. The educators' job is to provide an engaging learning environment, guide the reflective process, and facilitate communication.

WHY THEMATIC UNITS?

In my experience as an elementary teacher in multi-aged classrooms (first author), children like to have context. They want to know why something matters. All too often, we teach algorithms, names and dates, or vocabulary without the accompanying context. For this reason, I prefer – and my students also prefer – using a theme as an umbrella. It provides the scaffolding for the unit as well as the context for the content. I tend to use social studies concepts as themes, pulling in science, math, and language arts to help tell the story.

One year, my theme was “Trade and Transportation.” With a multi-aged group of first through sixth graders, everything has to start out concrete and yet be engaging for everyone. Then we move into more abstract concepts with lots of differentiation. As we studied early American life, each child first created an alter-ego in the form of a miniature “peep” (Fig. 2) using wooden beads, pipe cleaners and felt.



FIGURE 2

LEFT: CREATING PEEP AND FURNITURE RIGHT: PEEP

Later, each student constructed a miniature wooden house and workshop for his or her 19th century peep. I borrowed the idea of creating a miniature village from a curriculum developed at the Greenwood School in Putney, Vermont [3].

LANGUAGE ARTS

In order to give their peep an identity, the students needed to learn about early American life. How did people live? How did people get what they needed? What could they make? How could they acquire what they did not make? To answer these questions, the students needed to formulate research questions, read for information, and synthesize the information. Each child then chose a trade about which he or she was interested.

The next step was to create a backstory for these crafters. Who was in his or her family? How old were they? What were their names? What brought them to Peep Village (our representational early 19th Century New England village)? Although we did not use census information, I could have offered students a choice of families who had actually lived in their hometown. The 1860 and 1870 federal census records are especially rich with information: names and ages of all occupants in the household, occupations, attendance at school, what state or country they moved from, and the total worth of their assets. It is especially fun for students to invent the historical fiction explanation for why people with different names might have lived in the same house.

The children presented their research and historical fiction backstories to their parents during an Open House. The students were invested in their characters and had an authentic audience with whom to share their information.

Later, after Peep Village had been established, the children wrote articles for their (invented) local newspaper: *The Peep Village Gazette*. They shared news with each other, advertised their peep's wares, and wrote obituaries when tragedy struck. This entry in *The Peep Village Gazette* was the inspiration for a class play that the children later created:

Last winter there was a hay fire in Peter's horse barn. Fortunately Peter awoke to the smell of smoke. He ran to the door, opened it, and let the horses out. They ran to a nearby field. They grazed waiting for the barn fire to go out. The faster horses were in one barn and the slower horses were in another barn. It was the slower horse barn that caught on fire. While the horses were out in the pasture, wolves broke through the fence. Luckily Peter went out to fight the wolves instead of the fire. He yelled at the top of his lungs, "Help me put out the fire!" He has a very loud voice and alerted nearby neighbors, who alerted others in far off towns. 402 people joined a bucket brigade to help put out the fire. They succeeded! One person died in the fire. "At least not all of them died," says Peter sadly, because one person died.

Peter the Peep
(Written by a first grader)

MATH

We had made our peeps as 1:24 scale models of people. Therefore the peeps' houses and workshops needed to be 1:24 scale as well. After the original design had been created, the children made careful measurements before cutting the wood for their own buildings. Once the students had finished building their peeps' homes, Peep Village went from an idea to a physical reality. The students worked together to draw a map of their newly established town (Fig. 3).



FIGURE 3
CREATING A MAP OF PEEP VILLAGE

More recently, with the middle school group, I (first author) also focused on early American New England village life. In that situation, we did not have the time or resources to build model houses. The students, working in small groups, represented actual local families from mid-19th century census records. Their simulated families traveled through a representational village illustrated on a game board (Fig. 4). The students, in their family groups, chose different buildings to visit in the town, experienced life changing events as they picked “Chance Cards,” sorted “Tool Cards”, and maintained account books. At the general store, they traded for store-bought goods using a “General Store Catalog” created from multiple primary source documents such as inventories and account books [4].

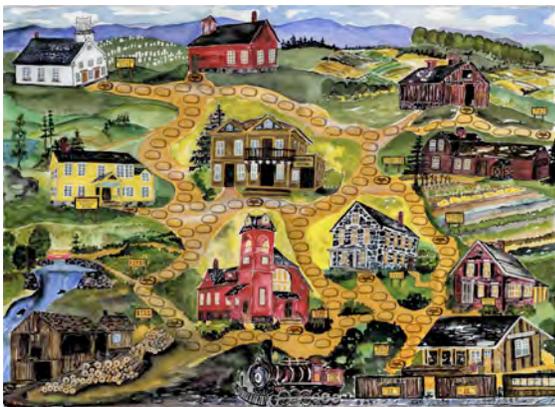


FIGURE 4
GAME BOARD ILLUSTRATION OF
REPRESENTATIONAL NEW ENGLAND VILLAGE [4]

Other ways to embed math into an American History unit are to graph data such as changes in the population of towns through the decades, create payday story problems in which day laborers get reimbursed for their help, use primary source account books to calculate household expenses, and cook historical recipes.

SCIENCE

The students explored the woods behind the school to find a suitable outdoor location for Peep Village. They decided on

an area that had a small flow of water that they used to simulate the Connecticut River (Fig. 5).

The students had learned that having water to power the mills would be an important aspect of their town’s livelihood. This led to a more in depth investigation of how mills work and of simple machines. The floor loom in our classroom offered a more concrete look at simple machines for the younger children.



FIGURE 5
OUTDOOR LOCATION OF PEEP VILLAGE

As the children learned more about 19th century village life, they learned about some of the clever technological advances that resulted from seeking solutions to problems. For example, one way of mechanizing the rotation involved in roasting a chicken was to use the inner workings of a clock. The introduction of the cast iron cook stove made a huge impact on daily life as did mechanized farming equipment and indoor running water. Each tool the students encountered had a story to tell about how 19th century New Englanders lived and how their lives changed with each innovation.

TRANSPORTATION

Time passed in Peep Village, and when the students returned from their school vacation, they were presented with the problem that their village was overcrowded. Some of the peeps decided to move west and take advantage of the new land deals. Using a transportation map from 1835 [5] and diary entries written by Stillman Churchill during his 1849 journey across the country [6], the students worked in teams to plan routes from Vermont to Ohio.

[April 2, 1849]

*Weather fine left Penn, to day at 11 A.M.
arrived in Columbia at 8 P.M.
left immediately in the Canal Boat
ascended one inclined plane perpendicular
height 170 feet*

Each team had to take into consideration tolls on turnpikes and fares for canal and train travel as they planned their route.

The topic of transportation offers many opportunities to incorporate science and technology concepts and approaches with humanities and social studies content. We

chose to do an in-depth investigation of canal transportation. The picture book *Tobey Boland and the Blackstone Canal* [7] initiated social justice discussions about why the Irish laborers working on the canal were not welcome in Worcester, Massachusetts, and therefore had to live in “Shanty Town.” The book also provided fodder for story problems such as “The laborers worked 11 hours a day, 6 days a week and earned \$9 every month. If they were paid by the hour, how much would they have earned?” We discussed the impact of these new canals on farmers. We investigated initial methods of construction as well as what happened when canal walls collapsed. Students experimented with concepts of floating and sinking, water displacement, and load line. They constructed their own simple clay canal boats (Fig. 6).



FIGURE 6
CLAY CANAL BOAT

To help the students better understand canal locks, we created a working model (Fig. 7A & 7B), constructed with a wooden frame and clear acrylic sides. Upper and lower canal sections, 12 cm deep and 15 cm wide, are vertically separated by 30 cm. Natural water flow is simulated by a small pump (designed for a small fountain) that carries water from a catch basin below the lock to the top canal section.

The students had the opportunity to use the lock with their own boats that they had previously designed and built. By using the lock, the students better understood how a canal boat could navigate both up and downstream. The model illustrated the problem and the engineering solution, while also demonstrating gravity and fluid flow concepts. Additionally, it helped them understand transportation issues in the 19th Century.

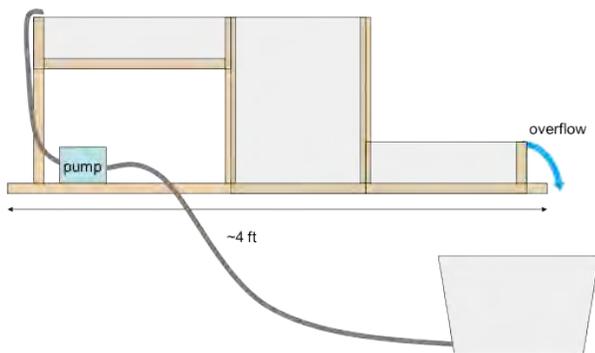


FIGURE 7A
DIAGRAM OF CANAL LOCK



FIGURE 7B
MODEL OF CANAL LOCK

The scale of the lock is small enough to allow students to work with it directly, hands-on, but it is large enough that the consequences of opening a gate at the wrong time is an exciting and dramatic surge, adding a visceral element to the understanding of the energy of water behind a gate or dam, and to the understanding of the challenges that had to be overcome to use canal transportation.

INTEGRATING STEM, HUMANITIES, AND SOCIAL SCIENCES

Inquiry based learning has been used for a long time within the sciences. It is still an emerging methodology of teaching social studies content. However, regardless of the topic, students are more invested in their own learning when they are engaged in hands-on projects. Combining STEM, humanities, and social studies elements into interdisciplinary units of study offers students both meaningful context as well as rich content. These projects are even more meaningful when they incorporate authentic opportunities for students to share their learning such as presentations to families and community members, letters, newspaper articles, and theater performances.

REFERENCES

- [1] Dow, Peter. (1999) “Why Inquiry? A Historical and Philosophical Commentary.” *Foundations*, Vol 2, National Science Foundation.
- [2] Ash, Doris. (1999). “The Process Skills of Inquiry.” *Foundations*, Vol. 2, National Science Foundation.
- [3] Connect Staff. 2004. “Village.” *Connect* (18)1.
- [4] Manwell, J.L. and B. White, *In Their Shoes Game*, Historical Forensics, 2013, URL: <http://HistoricalForensics.com>
- [5] The Newberry Library, *Historical Maps in K-12 Classrooms*, URL: http://publications.newberry.org/k12maps/module_10/index.html
- [6] Churchill, Stillman. *Diary, 1849* (vol 1), Library of Congress American Memory Collection, URL: http://memory.loc.gov/cgi-bin/query/D?upboverbib:1:/temp/~ammem_Zaua::: p. 1
- [7] Rooney, Thomas L. (2005) *Tobey Boland and the Blackstone Canal*. Ambassador Books, Inc: Worcester, MA.

AUTHOR INFORMATION

Jennifer L. Manwell, Elementary Educator, Historical Forensics
Charles R. Sullivan, Associate Professor, Thayer School of Engineering at Dartmouth