Lessons

Bringing STEM to Life: Essentials for Elementary Education
ITEEA Elementary STEM Council’s Innovative Grand Design Challenge!

The winning Challenge earns a one-year I-STEM Education Group Membership as well as one free hotel night in Kansas City, AND a spot in ITEEA’s STEM Showcase!

The NAE Grand Challenges were designed to cause students and educators to think about solutions and challenges affecting all of our lives. It’s now time for elementary-aged students to get in on the action and show the world that they can solve big STEM design problems as well. ITEEA’s Elementary STEM Council is sponsoring the Global Design Challenge for Elementary STEM to provide students with a chance to solve a real problem and show the world that everyone can help find solutions to these global challenges.

Elementary STEM students will work in small design teams to solve the Challenge. Photos and descriptions of proposed solutions will be posted on the ITEEA Elementary STEM Council’s Facebook page and ultimately, the teacher of the team with the most elegant solution to the GDC will be provided an opportunity to present in the STEM Showcase at ITEEA’s Conference in Kansas City, March 27-30, 2019, along with one night’s complimentary lodging. The winning solution will also be featured in the May 2019 issue of the Elementary STEM Council’s journal, and the team will earn an Elementary I-STEM Education Group Membership for their entire school!

The Global Design Challenge: Can you work as a member of a small design team to develop a better product or tool that can be used to give small children doses of liquid medicine?

Participation details are available at www.iteea.org/News/282/134048.aspx. Questions can be directed to Michael Daugherty, mkd03@uark.edu, Virginia Jones, vjones@patrickhenry.edu, or Thomas Roberts, otrober@bgsu.edu.

SUBMISSION DEADLINE: December 31, 2018

ITEEA's 81st Annual Conference
Technology and Engineering Bring STEM to Life!

ITEEA TECHNOLOGY AND ENGINEERING BRING STEM TO LIFE!
KANSAS CITY MARCH 27-30, 2019
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BRINGING STEM TO LIFE: ESSENTIALS FOR ELEMENTARY STEM EDUCATION - LESSONS

Welcome to the newly revised visualized *The Elementary STEM Journal!* In previous years our award-winning journal was *Children's Technology and Engineering*. The Children's Council rebranded as the Elementary STEM Council to emphasize the importance of integrative STEM education at the elementary level. The journal also rebranded to ensure that the publication has an emphasis on a broader, more inclusive definition of integrative STEM.

Our theme for this year, Volume 23, has a focus on Bringing STEM to Life: Essentials for Elementary STEM Education, with a subfocus on four major, broadly defined areas, including:

1. **Lessons** – how we come up with, plan, and implement quality lessons for elementary STEM.

2. **Informal Learning Opportunities** – a broad focus that can cover strategies for teachers to implement good STEM learning opportunities in informal settings (e.g., afterschool clubs, summer camps, etc.).

3. **Finding Balance Between Teaching, Learning, and Application** – a broad focus that balances the demands/requirements associated with teaching and implementing high-quality STEM at the elementary level. An example could include finding the balance between a great project and a limited budget.

4. **Equity in Elementary STEM** – An emphasis on the importance of equitable opportunities in STEM. How do all students gain access to high-quality STEM? How can students achieve at a high level? What should teachers take into consideration when helping students build a positive identity around STEM?

If you are interested in contributing, please visit our link to sign up for a short article, activity, feature article, or literacy strategy at [https://goo.gl/viN5XV](https://goo.gl/viN5XV) or email kdelapaz@iteea.org.

We are very excited about these changes and hope to see many new contributors, articles, and a much deeper knowledge base of what it takes for successful elementary STEM education!

This year we are again offering our Grand Challenge for elementary STEM educators. This unique opportunity has twofold benefits. It provides your students the opportunity for innovation in the classroom by working in small design teams to develop their skills, and the winning team will be featured in the May 2019 issue of *The Elementary STEM Journal*. The teacher(s) of the winning solution will present at the 81st Annual conference in Kansas City, MO, March 27-30, and receive one night’s complimentary lodging at the conference hotel. See page 2 for more details.

Thomas Roberts and I are excited to serve as co-editors of the journal again this year and look forward to many exciting changes as we move our journal into an integrative STEM learning focus. Please feel free to contact either of us if you have suggestions, comments, or questions.

*Virginia R. Jones, Ph.D., is Dean of Student Success and enrollment services at Patrick Henry Community College. She can be reached at vjones@patrickhenry.edu.*
change is good!

by Charlotte P. Holter

Beginning on July 1, 2018 the ITEEA Children’s Council (CC) has a new name. It is now the Elementary STEM Council (ESC). The new name will better encompass the Council’s purpose and what we aim to deliver. Our “look” and “name” have changed, but our purpose and mission are still the same. Our purpose is to promote technology and engineering education for the elementary schools. The mission of the Elementary STEM Council, formerly Children’s Council of ITEEA, is to build a collaborative network of educators dedicated to the advancement of technological literacy at the elementary level.

In order to move forward, let’s take a look at the past. Elementary School Technology Education (ESTE) has deep industrial arts roots in its history, giving credit to the works of Bonser and Mossman during the 1920s. Their philosophy of manual training was a pivotal point in the conception of industrial education. In that day it was common for elementary children to use tools and participate in manipulative activities resembling what we call “hands-on” or STEM education today.

The American Council for Elementary School Industrial Arts (ACESIA) was founded in 1962 as a council of the American Industrial Arts Association. During the 1960s and 1970s a popular general-education program, career education, fostered resurgence in popularity in the industrial arts profession. Mary-Margaret Scobey and Elizabeth Hunt were responsible for the formation and early success of ACESIA. The Elementary STEM Council offers an award opportunity called the Mary-Margaret Scobey award to a person who has demonstrated dedication to elementary school technology education on a sustained basis and has demonstrated a passion philosophically and through activities conducted on behalf of elementary children and teachers. For more information, please visit our webpage: www.iteea.org/About/Leadership/40079/CC.aspx.

Next, in 1987 ASEClA became the Technology Education for Children Council. During this time the focus became an “organized approach to provide children with individualized experiential learning and opportunities to develop interests and self-awareness” (Dreves, 1975). Technology Education for Children (T4C) became nationally recognized, garnering frequent citations of professional publications.

The introduction of the Technology and Children journal in 1997 was significant in raising awareness, not only as a community dedicated to furthering elementary level design, problem-solving, and STEM, as we know it today, but also to the Council as a whole.

In the last few years, the Council became TECC (Technology Education for Children Council) and then CC (Children’s Council). With the debut of the Elementary STEM Council on July 1, 2018, we continue to endeavor to make an impact on the elementary teaching community. Our journal, Children’s Technology and Engineering, has also undergone a name change to The Elementary STEM Journal. Training and education in improving the pedagogical process of STEM education...
Call for Articles/Activities

ITEEA encourages its readers to submit articles for The Elementary STEM Journal (previously Children's Technology and Engineering). Each issue is themed, and articles should address that theme. In addition to articles and activities, regular features include Books to Briefs, Literacy Strategies, and Career Connections.

The Elementary STEM Journal also offers a peer-review option for publication. At the time of submission, contributing authors will have the option to request that manuscripts undergo peer review prior to publication.

Before submitting, potential authors should consult the themes and subthemes for specific issues and indicate interest in covering a particular topic by emailing kdelapaz@iteea.org.

The theme for Volume 23 (2018-19 school year) is: Bringing STEM to Life: Essentials for Elementary Education with the following subthemes for upcoming individual issues:

- **23-1: Lessons** (September 2018, FULL)
- **23-2: Informal Learning Opportunities** (December 2018)
- **23-3: Finding Balance Between Teaching, Learning, and, Application** (March 2019)
- **23-4: Equity in Elementary STEM** (May 2019)
the technology of paint:

making paint in the elementary school classroom

by Kurt Y. Michael, Amy G. Jones, and Carrie Lawrence
introduction

Have you ever wondered how art class can be a catalyst for STEM? Maybe the acronym you are looking for is STEAM! That’s right: Science, Technology, Engineering, Arts, and Math (STEAM). The art class can be a wonderful playground for exploring technology.

Throughout history, artisans have used a variety of tools and techniques to create art. But, even more important, art allows humans to be creative. As stated by Lewis (1999), “Technology is in essence a manifestation of human creativity” (p. 46). Art class can be the vehicle that brings design, form, materials, and process. One way people communicate their creative ideas is by using paint.

The old idiom is, “A picture paints a thousand words.” Humans have been painting pictures since the dawn of time. Sharing images to communicate ideas has always been at the heart of technology.

Today we use digital cameras, but thousands of years ago ancient people would mix earth pigments, such as charcoal, with animal fat to form images. The animal fat would act as a binder, holding together the pigments to create paint that was then used to decorate the walls of their caves. Many prehistoric cave paintings depicted animals and early human activities (WebExhibits, n.d.) (Image 1).

As a wider variety of natural pigments and binders was discovered, paintings became more complex. During the Renaissance, famous artists like Michelangelo used paint to decorate the walls and ceilings of cathedrals with intricate religious scenes.

Over time humans continued to refine paint technology. In the mid-1800s, as the quality and binding media improved, artists like Vincent van Gogh used oil paints with bright and vivid colors to create masterpieces (WebExhibits, n.d.) (Image 2).

By the 20th century many artists began to use synthetic paints. Scientists developed acrylic paint, consisting of pigments suspended in a polymer emulsion (binder). Acrylic paint was used by pop artist Andy Warhol to create famous images of soup cans (WebExhibits, n.d.) (Image 3).

Today a wide variety of paints is available to artists. They range from natural-based paints to ready-mix oil, acrylics, latex, and enamel. Each type of paint has unique properties such as color, application, drying time, durability, and ease of cleanup (Centre for Industry Education Collaboration, 2013). But regardless of the type used, all paints consist of two main components: pigments and binders. Simply put, pigment + binder = paint!

basic components of paint

Paints are made from pigments and binders. Pigments are granular solids that contribute to the paint’s color, while binders behave like glue holding the pigments together. Examples of natural pigments are clay, rust, and mica.

However, “lake pigments” can also be created by using a liquid dye and mor-
Dant. A “lake pigment” is made by taking a natural dye such as berry juice and adding it to a mordant. A mordant is a substance that attaches with a dye. Some natural mordants are baking soda, flour, or powdered chalk. After mixing the dye and mordant together, the substance is allowed to dry and then crushed into a colorful powder. This powder is called the pigment.

The crushed powder (pigment) is mixed with a binder. The binder is what holds the pigments together, creating paint. Examples of natural binders are linseed oil that can be used in oil paint and egg yoke for temper paints. Even milk can be used as a binder to make milk paint.

Finally, to thin out paint, a solvent may be used. The most common solvent is just plain water. However, for oil paints, turpentine or mineral spirits are used.

Now that you know how paint is made, it is time for you to make your own paint.

**activity**

**Suggested Grade Level: 4th-6th**

In conjunction with an art unit using paint, have your students make their own paint.

**Materials:**
- Sheet of white paper
- Pencil
- Paintbrush
- Small bowl
- Spoon
- Food coloring (dye)
- Baking soda (mordant)
- Elmer’s glue (binder)
- Cup of water (solvent)
- Paper towel

Step 1. Put one teaspoon of baking soda in a bowl.

Step 2. Put three drops of food coloring (dye) into the bowl of baking soda (mordant).

Step 3. Then stir and crush it into a colorful powder. This creates a pigment.

Step 4. Add a teaspoon of Elmer’s glue (binder) to the bowl of powder (pigment), then stir.

Step 5. Add a small amount of water (solvent) in the bowl until you have a desired paint consistency.

Step 6. Now you can begin to paint. Allow your painting to dry.

Step 7. Repeat steps 1 through 5 if you wish to make different colors.
Optional: Have your students experiment with different natural dyes and binders and see if they can create different types of paint. Add glitter or powered cocoa to create new and exciting colors. Adding shaving cream to the binder makes puffy paint. Be creative and make your own paint!

**summary**

Communicating and storing ideas is a vital part of technology. “Symbols are a part of the language of technology” (ITEEA, 2000, p. 167), and one way to create symbols is by creating paint. Paint technology allowed prehistoric people to share their daily life by painting animals on walls.

Over time, paints allowed artists to capture their surroundings and communicate their creative ideas. Scientists have improved the properties of paint, making them available for a variety of applications. Today paints protect our houses, are used on road signs to help us navigate, and engage artists in the creative process. These are just a few examples of how paints have become a vital part of our society.

**references**


**the elephants’ bridge**

by Brandy Speas

**Book Used:**
URL (Read Aloud): [https://youtu.be/AgWHb5bK80M](https://youtu.be/AgWHb5bK80M)

**Grade Level:** Grade 2

**book synopsis**

*Twenty-One Elephants and Still Standing* is a story about the opening of the Brooklyn Bridge and the concern about its structural integrity by the people of New York. The story begins with the local residents celebrating the bridge’s opening. P. T. Barnum, the founder of the Barnum & Bailey Circus, craved the public spotlight. He saw the concern of the people as his opportunity to align himself with the Brooklyn Bridge. P. T. Barnum offered to march his 21 circus elephants over the bridge to prove its durability and strength.

**lesson synopsis**

After reading the book to the class, the students will build upon this concern of the people to design and construct a sturdy bridge. Working in groups, the students will use the materials provided to design and build a bridge to hold 21 weighted toy elephants while simultaneously meeting other constraints.

**lesson goals**

This lesson is designed to introduce the engineering design process to students and demonstrate how to use it to determine a problem and design solutions. Students will be learning math, science, engineering, technology, and literacy concepts during this lesson.

**student learning objectives**

Students will be able to:
- Apply the engineering design process to design a solution to a problem.
- Use tools to measure and record length when creating a design.
- Identify the who, what, where, when, why, and how of the key details in the text to determine the best solution.
- Identify the main purpose of the text to determine what the author wants to answer, explain, or describe related to a solution.
- Sketch a solution to the problem and describe why specific shapes help the integrity and function of the solution.
- Discuss and analyze how specific structures (technologies) help people meet their needs and wants in the natural world.
The Brooklyn Bridge was an amazing engineering feat in its day.

standards addressed

Common Core Standards (Common Core State Standards Initiative, 2016):

**English Language Arts:**
- CCSS.ELA-LITERACY.RL.2.1
  - Ask and answer questions such as who, what, where, when, why, and how to demonstrate understanding of key details in a text.
- CCSS.ELA-LITERACY.RI.2.6
  - Identify the main purpose of a text, including what the author wants to answer, explain, or describe.

**Mathematics**
- CCSS.MATH.CONTENT.2.MD.A.1
  - Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes.

Next Generation Science Standards (NGSS Lead States, 2013)
  - Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.

Standards for Technological Literacy (ITEEA, 2000):
- Standard 1:
  - Benchmark B: All people use tools and techniques to help them do things. By using technology, people adapt the natural world to meet their needs and wants and to solve problems (p. 24).

**design brief**

**Student Introduction**
P. T. Barnum enjoyed the spotlight. He owned the largest circus in the world and liked to be involved in many things. The Brooklyn Bridge’s opening was a huge spectacle, and he wanted in on the event. He saw people’s fears of the bridge as being unsafe as an opportunity to align his name with the bridge. He marched his 21 circus elephants across the Brooklyn Bridge. Can you build a bridge that can also hold 21 elephants?

**Challenge**
Design and build a bridge to connect two points over a body of water. The bridge should meet the constraints and also be appealing to the eye.

**Criteria and Constraints**
Your bridge must:
- Hold the weight of 21 toy elephants.
- Hold all elephants at once.
- Be two feet in length.
- Be sturdy and strong.
- Use only the materials provided.
- Use no more than 30 LEGO® parts in the design.
- Use no more than 30 K’nex® parts in the design.
- Be documented in the design log.
- Address people’s insecurities.

**Materials**
- Copy of Design Brief for each student
- Copy of Design Log for each student
- Copy of Graphic Organizer for each student
- Pens, pencils, crayons, markers, etc.
- Scissors
- Tape, glue, hot glue (with supervision)
- Craft sticks
- Ruler/yardstick
- String
- Straws
- LEGO® construction kit(s)
- K’nex® construction kit(s)
- 21 weighted toy elephant figures
- Scale
- Computer access

**Procedure**

1. Prior to instruction, have enough copies of the Design Brief and Design Log for the students at each table (pp. 14 and 16-17). (Full-size Design Brief and Design Log are available on the ITEEA website at www.iteea.org/137756.aspx [Brief] and www.iteea.org/137758.aspx [Log].)
2. Have all materials organized in one location so students may select what they need.
3. While reading the book, ask questions such as:
   - Why would it be beneficial to have a bridge connecting Brooklyn and New York City? (Correct answers may be: “So people can access a new area,” “People can get goods from one place to another more quickly.”)
   - What would elephants crossing a bridge prove? (Correct answer may be: “To prove how strong the bridge is.”)
   - Why are the elephants proof of a bridge’s sturdiness? (Correct answer may be: “Because the weight of the elephant is larger than most cars, and if the bridge can hold an elephant, it can hold a car.”)
4. After reading the book, complete the Twenty-One Elephants Graphic Organizer (p. 16). (Full-size Graphic Organizer is available on the ITEEA website at www.iteea.org/137760.aspx.) Then introduce the Design Brief.
5. Introduce the materials to the students. Discuss why certain shapes may be better for certain parts of the bridge. Discuss and explain how those shapes help the bridge function in their solutions before and after they’ve developed them. For example, the cables of a suspension bridge are meant to balance the compression or weight of the bridge. They are in the shape of a parabola, which to the common eye resembles a triangle. See these websites for more information: https://howbridgeswork.weebly.com/suspension-bridge.html or http://mathforum.org/mathimages/index.php/Parabolic_Bridges
6. In groups of 3 or 4, have students complete the Design Log as they do the design challenge.
7. When the students have completed their bridges, they will test them with 21 weighted toy elephants. Elephants can be purchased at www.unitednow.com/product/17146/good-luck-minis.aspx?item=37263. To add weight, attach washers to the bottoms of each elephant using hot glue. Be sure to have each group of students weigh their elephants for accurate analysis of their bridge’s ability.
8. Provide a Bridge Display so students can compare and discuss their designs.

**support materials**

Please see the Twenty-One Elephants Graphic Organizer, Design Log, and Design Brief on the following pages.

**references**


NGSS Lead States. (2013). Next generation science standards: For states, by states. Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS.


Brandy Speas is a senior at Millersville University. Upon graduation she will be certified in Pennsylvania PK-4 general education and K-8 special education with an endorsement in Integrative STEM Education. She also has an Associate’s degree in Graphic Design, Digital Media, and Digital Photography. She can be contacted at brspeas@millersville.edu or at brandyspeas@yahoo.com.
The Elephants’ Bridge

Design Brief

Student Introduction
P.T. Barnum enjoyed the spotlight. He owned the largest circus in the world and liked to be involved in everything. The Brooklyn Bridge’s opening was a huge spectacle, and he wanted in on the event. He saw the people’s fears of the bridge as being unsafe as an opportunity to align his name with the bridge. He marched his 21 circus elephants across the Brooklyn Bridge. Can you build a bridge that can also hold 21 elephants?

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- Use no more than 30 K’nex® parts in the design.
- Be documented in the design log.
- Address the people’s insecurities.

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TWENTY-ONE ELEPHANTS and Still Standing

Author:

Characters:

Setting:

Problems:

Solution:

Main Idea:

I know this because...

Detail 1:

Detail 2:

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TWENTY-ONE ELEPHANTS
and Still Standing

DESIGN LOG

My name:

My Group Members:

What is a design process?

1. Discover the problem?
   State the problem in your own words.

2. Explore the problem.
   Think about what you learned. Look for answers.
   What is a bridge’s purpose?

   What makes a bridge sturdy and strong?

   What loads must a bridge hold?

   What materials are used to make the Brooklyn Bridge?

What could people from both cities easily do now that the Brooklyn Bridge was open?

What clues does the author give you that this bridge was unlike anything the people had ever seen?

What made the bridge different than other bridges?

What was the purpose of having the elephants cross the bridge?
3 Decide solutions!
Sketch at least two possible bridge designs. Use color if necessary to show how your bridge will look. Identify the materials being used for the solutions and how much of the material you will need. Include specific lengths and measurements.

Sketch 1

Sketch 2

When you are done, circle the sketch you plan to build!

4 Create a solution!
Use the materials and tools supplied to build your best solution. Draw a picture of your solution or take a photo and glue it here when it is completed. Include final measurements (length and width) of each material used.

Give your bridge solution a name:

5 Test the solution!
Place the 21 elephants on your bridge! Answer the questions below. Circle the correct response

Is your bridge 2 feet?
YES    NO

Does your bridge connect 2 points over water?
YES    NO

Does your bridge wobble?
YES    NO

Does your bridge have a name?
YES    NO

Does your bridge hold 21 elephants?
YES    NO

If no, how many elephants did your bridge hold?

6 Evaluate the solution!
Answer the questions below.

What worked best for your solution?

What shapes did you use?

Why did you use these shapes?

What could you have changed in your solution to make it better?

7 Show Everyone!
Think about how you will share your design with classmates. Answer these question to prepare.

Will you have a photo of your design or your actual design for presentation? If you don’t have your actual design, why?

What information will you present with your design? List all information and why you feel it is important to let others know.

After the presentation, what feedback did your peers give you about your design?

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school-based mentoring

by Douglas Lecorchick, III, Julie Maynard, Megan Morin, Scott Nichols, Bryanne Peterson, and Emily Yoshikawa Ruesch
Researchers have confirmed that approximately 40% of students in the United States are not ready for kindergarten upon entry and continue to lack requisite mathematics and science skills when they reach fourth grade. Only 34% of fourth grade students attained “At or Above Proficient” scores on the science section of the National Assessment of Educational Progress (NAEP), while a mere 40% scored in the same range on the mathematics portion (STEM Smart, 2013). These sub-par indicators are most certainly due to lack of exposure to engaging STEM activities and lessons. Current school readiness data, including achievement indicators in mathematics and science, suggest that young students are not being provided with the support they need to be successful STEM students; what has yet to be presented is a successful intervention to rectify the problem. As elementary school provides the foundation for future educational success, it makes sense to explore potential pitfalls and interventions here first.

Through a grant from the National Science Foundation (NSF), The Joan Ganz Cooney Center at Sesame Workshop reported that a lack of effective exposure to the STEM disciplines in the K-5 space may be attributed to uncertainty from teachers and parents. While “[m]any parents and teachers experience anxiety, low self-confidence, and gendered assumptions about STEM topics, which can transfer to their children and students,” they “appear to be enthusiastic and capable of supporting early STEM learning; however, they require additional knowledge and support to do so effectively” (McClure, Guernsey, Clements, Bales, Nichols, Kendall-Taylor, & Levine, 2017).

To improve students’ STEM readiness, we as a field need to find a way to neutralize the transference of adults’ anxiety and negative perceptions of STEM fields.

mentoring as a solution

The concept of having mentors for elementary students has been used in education for decades, especially for at-risk students. School-based mentoring programs often recruit community members as volunteer mentors and tutors for students. Becoming increasingly popular are peer mentoring programs in which high school students mentor elementary or middle school students, which has been an untapped resource for most schools. Peer-mentoring provides an opportunity for educators to leverage the expertise of high school students participating in STEM programs of study to provide mentorship and guidance to elementary students without enhancing any “STEM-anxiety” they may already be experiencing. This symbiotic relationship can benefit both the high schoolers and elementary schoolers alike.

Mentoring provides benefits to mentors and mentees, as both develop emotional support and friendships, improved self-esteem and confidence, an increase in their set of knowledge and skills, and an enhanced social network (Barton-Arwood, Jolivette, & Massey, 2000; Fishman, Stelk, & Clark, 1997; Utley, Mortweet, & Greenwood, 1997). Additionally, with established roles in student-led mentorship, students have heightened comprehension in their content area (Goodrich, 2017; Shields, 2001).

As mentees, students are growing by learning and practicing new skills with a trusted friend. They can also see mentors as role models through modeled appropriate behavior and experiencing multiple interactions with individuals of different backgrounds, learning and practicing the expected norms of the environments (Barton-Arwood, et al., 2000). Those benefits to the mentee are important, but mentors can also benefit from the process. Mentors have improved self-esteem by modeling appropriate skills and knowledge to another peer, increased opportunities to interact with peers with different backgrounds, and gain experience in public service (Barton-Arwood, et al., 2000).

There is a third population that can be affected through having a peer-mentoring program in place—the teachers. Having students from high school STEM programs of study work with elementary students on engaging STEM-based activities would potentially help ease any angst teachers are experiencing by
introducing these content areas as a type of playful learning (McClure, et al., 2017). It may also alleviate some of the pressures associated with teaching in the K-5 arena, including planning, preparation, and other school- and district-wide initiatives, which, in turn, could give perspective on how STEM content can easily be integrated into the general classroom. Alison Gopnik from the University of California posits that “Everyday playing is a kind of experimentation—it’s a way of experimenting with the world, getting data the way scientists do, and then using that data to draw new conclusions” (NSF, 2012). Based on this premise, high school mentorship, as a form of integrating STEM content into elementary classrooms, presents itself as a feasible solution, or at least a reasonable place to begin addressing some of the barriers at the elementary level.

examples of successful mentoring in elementary school

The Iowa High School Athletic Association (1996), under the direction of the Board of Control and Representative Council, requested information on the involvement of high school student leaders in mentoring programs from member schools. After receiving close to one hundred responses, elementary principals and teachers in the school districts were surveyed to compile a list of characteristics for high school mentors: (a) caring students who are responsible and have the desire to make a commitment; (b) good communication skills, including listening skills; (c) patience to work with students who may not grasp ideas quickly; (d) positive attitude, enthusiasm, and a willingness to share part of themselves with younger students; and (e) students who exhibit good citizenship and moral character, in and out of school.

Some high school student leaders had release time during the school day to visit elementary schools on a weekly or monthly basis, while others used their study hall to mentor students at elementary schools. High school student leaders also mentored elementary students during after-school programs. The association emphasized, “Students who are willing to make the commitments to be positive role models are truly student-leaders, regardless of their background, socioeconomic status, academic abilities, etc.” (Iowa High School Athletic Association, 1996).

Another successful mentoring example is that of Brentwood High School in Brentwood, New York. Brentwood uses a Science Buddy program that pairs upperclassmen interested in science with younger students, including elementary students. During the mentorship program, elementary and middle school teachers have Science Buddy mentors to facilitate student research project design (Grella, 2013). During the first year of the Science Buddy Program, over 940 middle school students participated in their science fair.

A third and final example is from ITEEA 21st Century Leadership Academy Fellow Douglas Lecorchick. Lecorchick has implemented a successful mentoring program in which 70 academic and intellectually gifted fifth grade students from Lee County School District participate monthly in a two-hour enrichment-focused, afterschool STEM club. Ten high school students meet weekly to discuss, plan, and organize the monthly meeting. All activities are facilitated by the high school students while being guided by Lecorchick, a STEM specialist for the district.

what does implementation look like?

There is no one right answer for what a peer-mentoring program looks like. That being said, there are a few recommended do’s and don’ts that can be offered as a starting point for educators to consider when building a program.

<table>
<thead>
<tr>
<th>Do’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provide structure and support for the mentors.</td>
</tr>
<tr>
<td>• Encourage mentors to remain engaged throughout each activity.</td>
</tr>
<tr>
<td>• Look for teachable moments to coach each mentor through unexpected obstacles.</td>
</tr>
<tr>
<td>• Elicit feedback from the mentor to use in future planning sessions.</td>
</tr>
<tr>
<td>• Select mentors who will be positive role models for elementary students.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Don’ts</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Micromanage or relegate mentors to assistants.</td>
</tr>
<tr>
<td>• Expect mentors to handle disciplinary incidents.</td>
</tr>
<tr>
<td>• Be quick to correct or interrupt the mentor while they are giving instructions. Instead allow them to find their “voice.”</td>
</tr>
<tr>
<td>• Select mentors based on their background, socioeconomic status, or academic abilities.</td>
</tr>
</tbody>
</table>
Additionally, sample lesson plans from Lecorchick’s after-school STEM club are provided on pages 22-23 and on the ITEEA website at www.iteea.org/137766.aspx and www.iteea.org/137768.aspx. While this club happens to be for gifted students, it’s important to note that peer-mentoring programs have a history of success with students from a wide range of scholastic aptitude. In fact, mentoring is a successful scaffolding option for differentiation in the classroom. Students come in with varying skills and experience, which causes difficulty, as teachers are often faced with questions from differentiated students that they have limited time and resources to address (Hébert & Speirs Neumeister, 2000). The addition of mentors in the classroom can help to implement an individualized educational experience for students while bringing a higher level of thinking to younger ages (Stanulis, Little, & Wibbens, 2012) without overloading the teacher.

references


Douglas Lecorchick, III is a STEM Education enthusiast with a calling to facilitate collaboration among professional educators. He can be reached at dlecorc@ncsu.edu.

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Megan Morin is a Graduate Assistant for the Education and Workforce Programs at the FREEDM Systems Center and a PowerAmerica Institute and Technology, Engineering and Design Education Ph.D. student at North Carolina State University. She can be reached at mcpatber@ncsu.edu.

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Bryanne Peterson, Ph.D., has a decade of classroom experience and now works with educators to improve STEM education and career development in their classrooms. She can be reached at bryanne@vt.edu.

Emily Yoshikawa Ruesch is a Project Lead the Way teacher at the Weber Innovation Center. She currently teaches digital electronics, engineering design, and physics with technology. She can be reached at emruesch@wsd.net.
Sample Lesson Plan 1

Marshmallow Catapults

The Catapult helps students understand the main idea of how manipulating elasticity and targets work. The idea was to allow them to figure out a way in which popsicle sticks could be set together to form a catapult. Later they were given an idea of how the catapult would have been constructed to form a perfect shoot of the marshmallow.

Each student had a different take on how to construct the catapult. Most followed the idea of rubber-banding popsicle sticks together at one end to serve as the base of the catapult. They would then slide the stack of sticks in between two other sticks that they had already banded together. Next they used a fourth rubber band to secure all of the craft sticks together. After the catapult is finished, set the marshmallow in place and add force to the catapult to shoot the marshmallow. Each catapult was made in approximately 10 minutes.

<table>
<thead>
<tr>
<th>Photo</th>
<th>Material Used</th>
</tr>
</thead>
</table>
| ![Photo](image.jpg) | • Popsicle sticks  
• Rubber band  
• Masking tape  
• Plastic spoon  
• Marshmallows |
Cardboard Furniture

To develop an idea of how designing works, students were directed to create and draft a chair in groups. Students became familiar with the engineering design process behind prototypes. The chairs had to be sturdy and be able to support at least 70 pounds. Most of the students tested different prototypes to assess the strength needed to achieve their design.

Most of the students used more than 55 minutes to build their cardboard chair. Most were in groups of four, and all helped to put together the furniture. Each student derived their ideas from previous knowledge and the overall idea of what a chair looks like. At the end, all of the students understood the basics of the engineering design process.

<table>
<thead>
<tr>
<th>Photo</th>
<th>Material Used</th>
</tr>
</thead>
</table>
| ![Photo](image) | • At least 5 pieces of cardboard  
• Masking tape  
• Duct tape  
• Scissors  
• Paper/pencil |
STEM Children’s Rhymes

by Emily Yoshikawa Ruesch and Scott R. Bartholomew

STEM Little Bo Peep
overview

This activity allows students to use a familiar children’s rhyme to learn and incorporate principles of integrated STEM. Students practice recognizing words, identifying a problem (we want to be able to help Little Bo Peep organize a system to give the sheep the correct tail), and developing solutions and prototypes.

This activity is designed to take approximately 90 minutes. The progression includes: reviewing the rhyme, completing a cut-out and fill-in activity, and producing a STEM portfolio. Once the students have worked through the portfolio, they will work to build a prototype of their solution. While prototyping, the students will use “tails” in the classroom to test and improve their designs.

materials

• Tails and sheep (could be cutouts, pictures, cotton-ball tails, etc.)
• Handouts (Cut-out/Fill-in activity, STEM design portfolio packet)
• Building materials (e.g., construction/tissue/printer paper, cardboard, pipe cleaners, straws, toothpicks, Styrofoam, tinfoil, etc.)

suggestions for adapting to older grades

• Have students design a system or process instead of just assigning tails to sheep.
• Require an automation process for sorting tails by size or color.

history

“Little Bo Peep” is not related to any historic event. However, it is a rhyme unique for the English language used. The name “Little Bo Peep” is actually derived from the words “bleat” and “sheep.” This rhyme also brings up literary terms that are often forgotten, such as “espied” and “hillocks.”

Source: www.rhymes.org.uk/little_bo_peep.htm

Little Bo Peep lesson plan

Level: Kindergarten
Duration: 1.5 hr

lesson objectives

K.CCSSI_ELA.RR.1. With prompting and support, ask and answer questions about key details in a text.
K.CCSSI_ELA.RR.2. With prompting and support, identify the main topic and retell key details of a text.

Rhyme

Little Bo-Peep has lost her sheep,  
And can’t tell where to find them;  
Leave them alone, and they’ll come home,  
Bringing their tails behind them.

Little Bo-Peep fell fast asleep,  
And dreamt she heard them bleating;  
But when she awoke, she found it a joke,  
For they were still all fleeting.

Then up she took her little crook,  
Determined for to find them;  
She found them indeed, but it made her heart bleed,  
For they’d left their tails behind them.

It happened one day, as Bo-Peep did stray  
Into a meadow hard by,  
There she espied their tails, side by side,  
All hung on a tree to dry.

She heaved a sigh and wiped her eye,  
And over the hillocks she raced;  
And tried what she could, as a shepherdess should,  
That each tail be properly placed.

K.CCSSI_ELA.RR.3. With prompting and support, describe the connection between two individuals, events, ideas, or pieces of information in a text.
K.CCSSI_ELA.CC.2. Confirm understanding of a text read aloud or information presented orally or through other media by asking and answering questions about key details and requesting clarification if something is not understood.

phase one

Gather the class and go over “Little Bo Peep” together. Use the cutout sheets to allow the students to fill in the blanks. Once you have said the children’s rhyme together, hand out the planning sheets and go over the key details of the rhyme.

What are different problems that Little Bo Peep faced in this children’s rhyme?
• Little Bo Peep lost her sheep.
• Little Bo Peep needed to find a way to put the tails back on the right sheep.

identify the problem

With the students, explain that in order to help Little Bo Peep, they should design a way for her to organize which tails go with which sheep.
**Activity**

The students will participate in a design challenge where they have to design a system to assign the correct tail to each sheep. There will be teacher sign-offs so that students work through the design process.

On the worksheet, have the students list three things that they could do in order to find the sheep and identify which tail belongs to each sheep. When they are done with this, have them get a teacher sign-off.

Once the teacher has looked at the three ideas, have the students look at materials. Show the students a set of sheep and tails (have the sheep and accompanying tails be different colors and sizes). After the students have received the sign-offs, show the students the set of sheep and tails, and have the students draw a more thorough design.

Once the drawing is complete, have the students find the teacher to explain their product. The teacher can then write down the description of their system.

Once the design that they draw, have the students build. Allow them to come up and test the design on sheep with accompanying tails brought into class. As they see what works and what needs improvement, encourage the students to go back and improve and make further iterations on their design. Students can also compete and see which system is the fastest. Criteria can be added, such as a system that can be done within three minutes with one person.

The students can then come together and as a class they can explain their systems and share what they chose and discuss improvements or questions peers may have.

**Little Bo Peep STEM Worksheet**

List three ideas to help Little Bo Peep figure out which tails go with the correct sheep.

1. ___________________________________
2. ___________________________________
3. ___________________________________

Teacher Initials______

Go look at the materials and then list three ideas that you can make using the materials we have.

1. ___________________________________
2. ___________________________________
3. ___________________________________

Teacher Initials______

Choose one idea that you had and draw it with as much detail as you can!

Find the teacher and explain the drawing to them so they can take notes below.

**Emily Yoshikawa Ruesch** is a Project Lead the Way teacher at the Weber Innovation Center. She currently teaches digital electronics, engineering design, and physics with technology. She can be reached at emruesch@wsd.net.

**Scott R. Bartholomew** is an assistant professor of Engineering/Technology Teacher Education at Purdue University; West Lafayette, IN.

Correspondence concerning this manuscript should be addressed to Emily Yoshikawa Ruesch at emruesch@wsd.net.
Little Bo Peep

Little Bo-Peep has lost her [ ]
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That each tail be properly placed.
environmental engineering

by Bryanne Peterson

CAREER CONNECTIONS

technicians
With new job creation on the horizon and a chance to make a difference, students should consider looking into a career as an environmental engineering technician.

Environmental engineering technicians work in laboratories and out in the field recording observations (both written and via photograph) and test results (BLS, 2018). These skilled workers conduct pollution surveys, testing the water, soil, and even air to help monitor and find ways to combat the negative effects of pollution (BLS, 2018; Science Buddies, 2018). Their job includes testing, operating, and sometimes even customizing different technologies (BLS, 2018; Science Buddies, 2018).

Due to the nature of their work, EETs must have strong observational, critical-thinking, and problem-solving skills; they are the “eyes and ears of environmental engineers,” and the engineers rely on them to help identify both problems (for example unexpected findings or a mechanical breakdown) and solutions in the work they do (BLS, 2018). Because they work on a team, environmental engineering technicians must have good communication skills, too. It’s also important that environmental engineering technicians have an eye for detail—for both data collection and the legal and technical documents that define regulatory requirements. All these skills are built during an environmental engineering technician’s education. Environmental engineering technicians usually have at least an associate’s degree in environmental engineering technology or a related field (BLS, 2018; Science Buddies, 2018).

By working toward a career in environmental engineering, students can feel good knowing their future work will make a difference for the community and potentially society at large. Pairing that with a 13-percent increase expected in job growth by 2026 that’s faster than average, and median pay of over $50,000 a year, this may be a strong job prospect to explore for those interested in science and nature.

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**Quick Facts: Environmental Engineering Technicians**

<table>
<thead>
<tr>
<th>2017 Median Pay</th>
<th>$50,230 per year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Entry-Level Education</td>
<td>Associate's degree</td>
</tr>
<tr>
<td>Work Experience in a Related Occupation</td>
<td>None</td>
</tr>
<tr>
<td>On-the-Job Training</td>
<td>None</td>
</tr>
<tr>
<td>Number of Jobs, 2016</td>
<td>17,000</td>
</tr>
<tr>
<td>Job Outlook, 2016-26</td>
<td>13% (Faster than average)</td>
</tr>
<tr>
<td>Employment Change, 2016-26</td>
<td>2,200</td>
</tr>
</tbody>
</table>

**references**


Bryanne Peterson, Ph.D., has a decade of classroom experience and now works with educators to improve STEM education and career development in their classrooms. She can be reached at bryanne@vt.edu.

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so, you want to make a print shop!

by Brian Stanley
Developing new lessons is always exciting, challenging, and rewarding. However, it becomes even more exciting when you find a new product that you know your students will enjoy. I stumbled upon the Inkodye display while browsing my local arts and crafts store. While the name itself is fun to say, my brain began to ramble with ideas and projects that could be created using this fun kit. I bought all three products and the accessories because I needed (wanted) to try this project at home before creating and sharing with my students.

Upon reading the directions on the back of the packages, a lesson emerged naturally and, as always, focused on STEAM. The project would include not only the STEM principles, but also the integration of art, place-based education, and entrepreneurship. Using these subjects, the lesson title became: So You Want to Make a Print Shop. For the students this would be a natural expansion of a previous lesson in which they learned how to make silk screens using wooden picture frames, a staple gun, cheesecloth, and ink. As a graphic designer, I always look for ways to incorporate my passion for design with a twist of science. My afterschool students are always eager to see what crazy combination of subjects I will throw at them. We do have to prepare for these hands-on projects, because they take a couple days to complete.

To begin the lesson, students researched local history to learn about the textile industry that once flourished in our community. As the students explored the Fieldcrest business, we began to create 3D models of their stores and their locations. Progressing, we used our tablets to start designs for logos and other artwork they wanted to create on shirts that would eventually be produced using the Inkodye kits. Before dying, the students had to recall the elements and principles of design. I ask them to create random doodles and observe the natural lines, shapes, and forms that they create. As they respond, I write their answers on the board. After everyone has a chance to share their observation, we look for similarities between the results and find that Line, Shape, Color, and Form become apparent. We discuss what these terms mean in the art realm and then connect them with the vocabulary that engineers use. It is always great to see the expression on their faces when they realize that artists and engineers often think and talk the same way. It helps demonstrate that careers requiring extensive training are in fact obtainable if they use the skills that they have known for years. Showing them how artists and engineers focus on problems/ideas, creating a plan/sketching, and experimenting with mediums/building materials helps them see that they, too, can become engineers.

After these buildup activities come the Inkodye kits, and the students are ready. After selecting their materials, we follow the directions on the kit. I allow the students to bring in their own objects or find materials in our supply closet. Next, we make sure that the blinds are closed tightly and we have our fabric or paper ready to go. I recommend having the students sketch or draw their layout beforehand with helpful reminders of what makes an interesting design. After they have their layout drawn, we briefly discuss why we had to close the blinds: the ink reacts to ultraviolet rays from the sun. Use the example that this type of light will give you a tan and is what makes Inkodye develop its color. We also make sure that that we have our gloves on...
because the dye is permanent and can stain clothes. One packet of dye is handed out to each student and is typically enough to cover a small pouch. Next, we make sure that we have cardboard under the material we are using and that everything is laying flat. You can buy a roller, but a foam brush will also work to spread out the dye. If there is an excess, you can use a paper towel to wipe it off. Then we lay our chosen object onto the damp material. Then comes the magic. Take the projects outside and let the sun do its thing. In full sun, your project should be ready in about 15 minutes. If it is cloudy or windy, make sure that you give it some extra time, and that the wind will not blow away your work. Once back inside, we have our prints! The final step (and I’ve done this two ways), is to collect all projects for a quick wash using the HOT/COLD setting; or you could let the students take them home with instructions.

To conclude, the students create their own business plans for their print shops. We talk about the basics of running a business, the pros and cons of offering certain services, and how much they should charge. Then for a parent night, we show off our own business models and hold a competition for which student has the best business model.

This lesson is truly an interdisciplinary project for my students, who were able to take advantage of our county’s rich history in the textile industry, make connections of art and STEM, and learn about what it takes to be an entrepreneur. They were able to think critically and learn about a fun process using a natural resource. I hope this fun lesson will inspire you to think in an interdisciplinary way and create a project using the Inkodye kits. The possibilities are endless, and this kit can help you easily make the transition from STEM to STEAM.

Brian Stanley currently serves as Assistant Coordinator of MHC After 3 at Patrick Henry Community College, in Martinsville, VA, leading an afterschool enrichment program for local middle and high school students. Brian has been working in afterschool programs since 2009 and holds Bachelor’s degrees in Studio Art, Psychology, and Public Policy and Community Service from Emory & Henry College.
meet Natasha Craft

This article features Natasha Craft, recipient of ITEEA’S Teacher Excellence Award in 2018.
Natasha Craft is a K-5 STEM lab teacher at Pulaski Elementary in Somerset, KY. She has taught elementary school for 21 years. For the past four years she has been a PLTW Launch lead teacher in her building, as well as a Launch Master Teacher, where she gets to share her passion for the program with teachers all over the country. Recently, Natasha was awarded both the Teacher Excellence Award by the International Technology and Engineering Educators Association and the Presidential Award for Excellence in Science and Mathematics Teaching. Natasha lives in Somerset, Kentucky with her husband and four children. Natasha can be reached at natasha.craft@pulaski.kyschools.us.

**What do you like about teaching STEM?**

Teaching STEM is fun, challenging, and engaging! I love the excitement and determination I see in the eyes of my students. In traditional classrooms, all the different subject areas are taught in isolation, and the students struggle to make meaning out of their learning. I feel that the STEM lab provides authentic learning. Students see firsthand how science, technology, engineering, and math are used together to solve real-world problems. They develop a persistence for working with difficult problems; they learn how to communicate and collaborate with others; and they learn how to fail and how to recover from failure. The level of learning taking place in my classroom is astounding, yet I feel like I go to work and play! It’s the best job in the world!

**What has been your favorite moment in your STEM class?**

What I have found is that many students who have struggled in the traditional classroom find success for the first time in the STEM lab. My favorite moment occurred when a particular student constructed an amazing tower as his solution to our design problem. My first response to him was, “Wow! You’re going to be a great engineer one day!” I will never forget the look on his face as he turned to me and said, “You really think I can be an engineer?” That moment was a game changer for him and a powerful reminder for me that words matter. As Angela Maiers said in her article for the Huffington Post, “Young leaders and learners are waiting for the invitation to be part of something big; something that matters.” Let our words invite them.

**What is your favorite activity to introduce students to STEM?**

I introduce all my students, K-5th grade, to STEM using the Project Lead the Way (PLTW) Launch program. There are four modules available to each grade level: two engineering, one biomedical, and one computer science. I usually begin with one of the engineering modules because the children immediately fall in love with STEM due to the engaging nature of the activities. Launch is an amazing program that empowers the students to take the lead and become independent learners while I step back and become the facilitator of learning. The Activities-
ect-, Problem- (APB) based approach that is used in all the PLTW modules provides the students with scaffolded activities and projects that are hands-on and real-world. Not only do they learn STEM concepts, they learn many soft skills such as teamwork, tenacity, problem solving, and communication.

What are your future goals?
My goal for the immediate future is to continue to share my passion about STEM with every student I have the pleasure of teaching. I want each and every one of them to know that I believe in them. The future is theirs, and I want to make sure they acquire the skills and confidence they need to be successful.

Currently, I serve as a Launch Master Teacher for PLTW, so during the summer I get to work with teachers and schools across the country to help bring STEM teaching and learning to children. As for the more distant future, I would enjoy working for Project Lead the Way full time. I can also see myself working with state and national education departments on policy and workforce development. In the end, I’ll see what opportunities God places before me.

Donna, Ethan, and Zoey testing out their tower design and building skills.

The 2019 ITEEA STEM Showcase is Looking for Elementary Applicants!

ITEEA is already building on the tremendous success of the Atlanta Showcase with well over 100 presenters as we continue the planning for Kansas City in earnest! Consider being a part of ITEEA’s STEM Showcase next March—capitalizing on the opportunity to share your knowledge with your colleagues and creating some great PR for your program!

The 2019 ITEEA STEM Showcase provides a forum to feature your best exemplar of elementary technology and engineering instruction! Apply today to share your STEM idea, technique, or best practice related to learning activities, marketing materials, career guidance, facility design, program design, assessment methods, equity, or classroom and laboratory management techniques. Showcase applicants are asked to illustrate a single element of technology or engineering teaching and learning that exemplifies good STEM instruction to share with conference participants. ITEEA will be compiling these exemplars to share online as well with our members.

The online application deadline is October 15, 2018.

Apply now at www.iteea.org/ITEEA_Conference_2019.aspx
Questions? Email kdelapaz@iteea.org.
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851956 Add. Hand Controllers - Blue/Red/Yellow ......................................................$30

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Includes: motor/generator, gearbox parts, hub, corrugated plastic for blades, PVC stand with sturdy base, multimeter, LEDs, breadboard, printed house layout, wire, terminals, and instructions.
842267 Kit w/Stand ........................................$125
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Build your own! Comes with motor/ generator, gearbox parts and hub. NOTE: Does not come with blades, PVC stand or wind turbine class parts.
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844246 Balsa Blank Kit (Not Pre-Cut, U-Design™ ) ..............$12.95 or $9.95 ea./10+

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