Bringing STEM to Life: Essentials for Elementary Education

INFORMAL LEARNING OPPORTUNITIES
Elementary STEM Council Preconference Workshop

STEM Strategies for the Elementary Classroom

WEDNESDAY, MARCH 27
4:00pm–7:00pm

Audience: K-5 Educators
Using problem-based learning and problem-solving strategies to address STEM topics with elementary students, this workshop about Elementary STEM will enhance a teacher's ability to ensure that elementary school children in Grades K-5 develop a practical understanding of how to use, create, control, and assess technology through the engineering design process. Ideas, lessons, and quick challenges will be provided for elementary teachers to instantly implement in their classrooms. Participants will investigate why STEM literacy in Grades K-5 is essential to the elementary child's success in an increasingly technologically dependent world. Participants will also engage in standards-based, hands-on, minds-on activities that demonstrate how to integrate children's literature, science curriculum, and mathematics curriculum, and address technological literacy practices to create a well-rounded K-5 STEM classroom.

Presenters: Julie Sicks-Panus and Laura J. Hummell, DTE
$50 – ticket required
Limit: 35 participants

Elementary STEM Council Learning Sessions

THURSDAY, MARCH 28 – SATURDAY, MARCH 30

- Primary STEM is Elementary
- STEM in Urban Schools through Classroom Gardens
- Bringing Engineering to Life in K-2 Classrooms
- Affordance of Virtual Reality in STEM Classrooms
- Raising the Bar for Young Engineers
- It’s Elementary! Engineering for K-5!
- Let’s Go Out on a STEM
- Getting a Head Start on Integrative STEM

ESC Panel Presentation: Coding: It’s Elementary!

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BRINGING STEM TO LIFE: ESSENTIALS FOR ELEMENTARY STEM EDUCATION

INFORMAL LEARNING OPPORTUNITIES

Welcome back to *The Elementary STEM Journal!* This issue focuses on informal learning experiences. We know there is not enough time or resources to teach everything, let alone to teach it how we would like in the traditional school day. Informal learning experiences can help supplement students’ school experiences. Whether visiting a museum, having an after-school robotics club, facilitating a summer camp, or spontaneous learning in authentic situations, informal learning has the ability to provide context to school learning, to extend and deepen engagement with school subjects, and to provide opportunity and access to unique learning settings, materials, and content specialists (Roberts, et al., 2018). Informal learning environments are also a great and proven way to increase students’ interest in STEM (Mohr-Schroeder, et al., 2014) and increase the likelihood that students pursue STEM careers (Kitchen, et al., 2018).

In this issue, with its focus on informal learning, we have a great range of resources that you can implement in a variety of settings. Laura Hummell gives a number of activities students can complete, all while traveling. These activities are great for family vacations, field-trip bus rides, or as part of daily drives to and from work or between after-school activities. Megan Nickels and team give a great introduction to coding with an emphasis on mathematics. The ideas in this article could be incorporated in a number of settings, but also help answer that age-old question students pose in the mathematics classroom: When will we ever use this in real life? Martin Fislake and colleagues give a great overview of technikcamps, a technology- and problem-solving-focused summer camp program in Germany. The article not only provides an international example of exciting STEM happenings but provides great examples of quality technology activities that you could incorporate into summer camp activities. The final article provides a great introduction into using culturally relevant literature to engage students in renewable energy. In addition to these outstanding articles, I also want to highlight a new department you will be seeing in the journal, Elementary Animators. This feature will provide ongoing tips for incorporating animation at the elementary level.

While this journal seeks to provide elementary educators with a range of STEM resources they can use, we also know you do great work every day. To recognize this work, we feature a teacher in each issue. In this issue, Natalie Boe from Valley City, North Dakota shares some of her favorite experiences teaching elementary STEM. Thank you for sharing your experiences with us, Natalie!

With the winter break fast approaching, I also want to remind you of the Grand Design Challenge. Announced earlier this fall, the Grand Design Challenge requires small groups to develop a better product or tool that can be used to give small children doses of liquid medicine. More details, including all of the exciting prizes, can be found on page 38. The deadline is December 31, 2018.

See you at the conference in Kansas City!

**Thomas Roberts** is a teacher educator and researcher at Bowling Green State University in Bowling Green, Ohio. He can be reached at otrober@bgsu.edu.
It has been my pleasure to serve as President of the Elementary STEM Council (formerly the Children’s Council) for the past three years. My term will end at the close of the annual ITEEA Conference in Kansas City, MO. I have watched this organization become stronger and more resolute in promoting its goals, and I’m very proud to be associated with ESC. My deepest appreciation is expressed to our wonderful Council members who sincerely love this profession and are united in making this “STEM” resource for elementary teachers everywhere.

As I reflect on this experience, I am extremely pleased to have led the Council through many positive changes, including embracing a name change that better defines our purpose and mission. Our quarterly journal’s name is reflective of this name change also. As well, the Council has worked to make our website current, with pertinent information and opportunities that benefit those teachers who are trying to improve their teaching. This fall members of our Council offered a webinar specifically geared for Elementary and STEM teachers to learn about best practices that was presented at a convenient time for teachers to participate. Another webinar will be offered in the spring of 2019. Our website has information about conferences and special training held around the country that enhance professional development in STEM teaching. Engineering byDesign™ curriculum is available, with great opportunities for implementing design thinking. This encapsulates what the Elementary STEM Council has to offer. We always welcome your ideas, requests, and suggestions. I am very proud of the accomplishments of the Elementary STEM Council.

As we move forward, I encourage you to plan to attend the 2019 conference in Kansas City. There are great breakout sessions offered by teachers (including elementary) who are excited to share. This is also a great opportunity to network with others with similar interests. A host of vendors showcase the newest and latest things for you to take back to the classroom. The STEM Showcase is another great place to get awesome ideas to take back to the classroom.

Your president-elect, Kim Bradshaw, is the principal at Green Valley Elementary School in Roanoke County, VA. Several years ago teachers in Roanoke County Schools were trained in Children’s Engineering/STEM practices. The county-wide training reinforced the philosophy that student learning is enhanced with hands-on opportunities where students are an integral part of the design process. We are glad to welcome Kim as our leader.

Edward Everett Hale said “Coming together is a beginning; keeping together is progress; working together is success.” Let keep working together for the good of our children.

On the journey,
Charlotte P. Holter

Charlotte P. Holter, Ed.D., an elementary teacher for 30+ years, is currently a Gifted Education Specialist for Rockingham County, VA. She is an adjunct professor for James Madison University, Harrisonburg, VA and has been extensively involved with elementary STEM/Children’s Engineering professional development for both preservice and inservice teachers. She has published elementary STEM Education materials for use in the classroom. Dr. Holter can be reached at charlo56@vt.edu.
The elementary STEM journal  December 2018

my magnificent thing

by Sharon A. Brusic

Book Used:

Grade Level: Grade K-2

book synopsis

A creative young girl has a great idea and decides to make the “most magnificent thing.” Despite the fact that she makes things all the time, she struggles to get this one just right. Her frustration builds until she finally wants to quit. However, her assistant (her dog) suggests a walk instead. To her surprise, the break does her good, and she returns with a new perspective and the motivation to finish the job she set out to do. This is an inspiring story to help young engineers recognize the reward of perseverance when designing and engineering solutions to problems.

lesson description

The book serves as a launching point for helping children to recognize some of the habits of mind that are important during engineering activities. After reading the story, children are challenged to create their own magnificent object or tool while exploring the feelings they may have when going through this design process.

lesson goal

The major goal for this lesson is to engage students in identifying a problem and designing a solution to that problem using simple tools and materials in order to create an object or tool.

student learning objectives

Students will be able to:
• Identify and use tools that help people to accomplish tasks.
• Identify a problem that can be solved by engineering a solution using simple tools and recycled or reusable materials.
• Engage in the engineering design process to solve a stated problem within criteria and constraints.
• Use planning and drawing strategies to help communicate about a design idea.
• Explore engineering habits of mind, including perseverance.
• Compare and describe objects with measurable attributes.

standards addressed

Common Core Standards (Common Core State Standards Initiative, 2018):

English Language Arts > Reading: Literature
• CCSS.ELA-LITERACY.RL.K.1
  o With prompting and support, ask and answer questions about key details in a text.

Mathematics
• CCSS.MATH.CONTENT.K_MD.A.1
  o Directly compare two objects with a measurable attribute in common, to see which object has “more of”/”less of” the attribute, and describe the difference.
**Next Generation Science Standards** (NGSS Lead States, 2013):

- **K-2-ETS-1**
  - Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.

- **K-2-ETS1-2**
  - 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.


- **Standard 2**
  - Benchmark C: Tools are simple objects that help humans complete tasks (p. 34).
  - Benchmark E: People plan in order to get things done (p. 34).

- **Standard 5**
  - Benchmark A: Some materials can be reused and/or recycled (p. 66).

**design brief**

**Student Introduction**

The girl in our story used her creativity and design skills to solve a problem. She also learned to keep trying even when it seemed difficult. It's your turn to work hard and make your own magnificent thing.

**Challenge**

Use tools and materials to plan and create your own magnificent object or tool that solves one of the agreed-upon problems.

**Criteria and Constraints**

- Choose a problem from the class list.
- Document your problem-solving process by making drawings.
- Your object or tool must use at least three recyclable or reusable materials.

**Materials**

- Lots of assorted recyclables and reusable items such as small containers (e.g., yogurt, applesauce), lids (e.g., laundry soap, bottles), foam trays, cardboard tubes, broken toys or random parts (e.g., bolts, nuts, springs), cereal or shoe boxes, disposable cups, straws, fabric scraps, etc.
- A few simple tools (e.g., hole punch, scissors, hammer, screwdriver, pencil sharpener, handsaw)
- Various paper scraps
- Crayons, markers, and/or colored pencils
- Paper clips (all sizes)
- Brass paper fasteners
- String or yarn

**Procedure**

1. During and after reading the book, *The Most Magnificent Thing*, engage children in a discussion. Pose questions that engage children in analyzing the message of the story—the importance of perseverance when solving problems.

2. Discuss the idea of recyclable and reusable materials. Have lots of these items on display; talk about the difference between recyclable and reusable. Ask students if they have other suggestions for items that could be added to this collection.

3. Introduce the idea of tools that help people do tasks. Show several examples of tools and discuss how and why they are used. Explain which tools are safe for children to use and which are only appropriate for adults’ use.
4. Conduct a brainstorming session with the children about some simple problems they might have that can be solved by designing a new object or tool using mostly recyclable or reusable materials. Write all of the ideas on the board or flip chart. Pose questions to get the children to consider many different options. Once the list is finished, narrow down the list to 1-3 problems that you want the children to focus on for this design problem. Choose problems that suit the grade level and the materials and tools available. If needed, use some of these as starting points for ideas:
   - A device to keep pencils from falling off a desk.
   - A special container to hold small treasures (e.g., coins, shells, stones).
   - Something for the teacher’s desk to store supplies like paper clips and rubber bands.
   - A new type of game to play during recess.
5. Explain that you want students to document their design process using lots of sketches. Either provide plain white paper to do this or have them document the process using a simple design log. (See Design Log on page 9 and at www.iteea.org/143551.aspx).
6. When all children have finished designing and making their products, hold a “Magnificent Thing Expo.” Have children share their solutions and talk about how their objects’ shapes and designs help them to function and solve the problem. Where appropriate, emphasize how tools help people get things done by focusing on what tools children used to produce their objects.
7. Reinforce the math standard by having children compare objects that were designed to solve the same problem. Pose questions such as: (1) Which solution is the heaviest? Lightest? (2) Which product uses the most recyclable materials? The least?, and (3) Which object is the shortest? Tallest?
8. After the activity, engage children in discussing the feelings they experienced while designing and making; compare their feelings to the girl in the story.

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.

Sharon A. Brusic is a professor in the Department of Applied Engineering, Safety and Technology at Millersville University of Pennsylvania. She is also the coordinator for early childhood education students’ minor in integrative STEM education methods. She can be contacted at Sharon.Brusic@millersville.edu.
**Design Log**

Sharon A. Brusic (2018)

- Use tools and materials to plan and create your own magnificent object or tool that solves one of the agreed-upon problems.
- Draw two different ideas for your design in the thought bubbles.
- Choose the design you think is best. Build it!
- Test your design. Answer questions on back.
- Draw a picture in the box. Show what your final design looks like.
- Evaluate your design. Make it better if there is time.
- Share your design with others at the Magnificent Thing Expo!

**Color the face that best answers each question.**

- How well does your design solve the problem?
- Did you use at least three (3) recyclable or reusable materials?
- Did you work hard even when it was difficult?

**From ITEEA's Children's Technology and Engineering**

**The Best of Books to Briefs**

Books to Briefs has long been a popular feature in ITEEA's Children's Technology and Engineering journal. Educator authors begin with children's books and make clear connections to technology and engineering elementary curriculum through ready-to-use lesson plans, goals, worksheets, and more. *The Best of Books to Briefs* is organized into three relevant content areas:

- The Engineering Design Process
  - The Environment
  - Making Connections

Members $19/Nonmembers $22
Product number: P267E

Purchase and download *The Best of Books to Briefs* in the ITEEA eStore at www.iteea.org/STEMProducts.aspx
travel time and informal teachable moments

Laura J. Hummell, DTE
introduction

According to Rogoff, et al (2014), an informal learning opportunity can be characterized as the following:

- Not following a specified curriculum and often not professionally organized but rather originating accidentally, sporadically, in association with certain occasions, from changing practical requirements.
- Not being systematic necessarily, but related to real-world authentic situations.
- Experienced directly as a part of everyday life.
- Often spontaneous and creative.

Informal learning environments can often be impactful because they give children (and adults) the chance for learning to occur wherever and whenever they want it to happen. One of these informal learning environments may arise from the time spent traveling to and from school and home.

At first, any time spent traveling may seem fun and exciting. That is, however, until your students or children get tired, boredom sets in, and devices power down and can't be easily charged. With groups of children, boredom can increase fidgeting and eventually fighting, and that frustrates everyone. Informal learning opportunities abound during travel times. Whether you are traveling to or from school, a meeting or practice, a relative's house, or wherever, coming up with travel-related activity ideas that support informal learning can prevent boredom and conflict among your young passengers. Games, observations, and other informal learning opportunities and activities can help keep everybody entertained, engaged, and content.

Travel time is an excellent opportunity to get creative young minds focused on positive, self-directed learning that makes the travel time and distance go that much faster than if they weren't engaged. Individualized learning is a key component of informal learning, initially because there is flexibility in who is engaging in the learning and when the learning occurs. Everyone must travel somewhere eventually, and these travel times offer a multitude of chances for informal learning.

There are a multitude of resources available that are adaptable for where you and your students live and learn. Whether it is on the coast, inland, in a desert, in the mountains, near a body of water, in a city, in the country, or wherever you live, there are opportunities for the children you teach (or live with) to explore their environments, understand the unique and amazing characteristics of where they live, and appreciate their worlds.

One set of vetted, informal, educational resources is available through the educational materials website called SMILE. SMILE was launched in 2010 by a group of science museums dedicated to bringing science, technology, engineering, and math (STEM) out of the academic cloister and into the wider world. Our organizations are resource hubs for educational programs that involve people of all ages and backgrounds. The founding partners of howtosmile are the Lawrence Hall of Science, the Exploratorium, the Science Museum of Minnesota, the Children's Museum of Houston, and the New York Hall of Science. The howtosmile collection focuses on the best educational materials on the web, in addition to learning tools and services—all designed especially for those who teach school-aged kids in nonclassroom settings. (Reference: About howtosmile page www.howtosmile.org/about.) Using SMILE resources is as easy as registering, logging in, and searching its numerous informal learning resources.

activity #1: travel time in my world

Grade Levels: Kindergarten, 1st and 2nd grades
Age Levels: Ages 5-7

STL Standard Used:
Standard 1. Students will develop an understanding of the characteristics and scope of technology.

Benchmarks: In order to comprehend the scope of technology, students should learn that:
A. The natural world and human-made world are different.
B. All people use tools and techniques to help them do things.
C. Things that are found in nature differ from things that are human-made in how they are produced and used.

As people travel from place to place, either on a bus, in a car, on foot, on a bicycle, etc., it is important for everyone to be aware of the environment, weather, and surroundings. Always encourage your students to actively observe the world around them.

- During their travel time to/from school and home or to/from home and other activities for 3-5 days, have students do regular eye-spy observations and describe what they see daily.
- Discuss the similarities and differences of what they saw.
- Have them create a collage/chart with drawings, photographs, magazine/computer-printed pictures, words, sentences, or other items related to their daily observations.
activity #2: travel safety

Grade Levels: 3rd-5th grades
Age Levels: Ages 8-10

STL Standard Used:
Standard 12. Students will develop the abilities to use and maintain technological products and systems.

Benchmarks:
D. Follow step-by-step directions to assemble a product.
E. Select and safely use tools, products, and systems for specific tasks.
F. Use computers to access and organize information.
G. Use common symbols, such as numbers and words, to communicate key ideas.

- Have the students sort the items into the categories “Nature-Made” vs. “Human-Made.”
- Explain and discuss how we know what the characteristics are for each type and how they are similar and how they differ.

- Have them discuss and then write or draw the safety concepts, equipment, and items they encounter and use when traveling.
Suggested topics may include, but are not limited to:
- Safety practices, rules, or regulations for walking, driving, biking, etc.
- Safety equipment and other items:
  - Helmets
  - Car seats
  - Seat belts
  - Air bags
  - Signs and lights (e.g., stop signs, school zone signs, etc.)
  - Speed limits
  - Road markings (crosswalks)
- Bring in examples of travel directions or products they use.
- Explain they how to get to/from school using certain transportation systems, such as buses.
- Have students record the most frequent or prevalent signs and symbols they see when traveling daily or weekly.
- Have students brainstorm and design better safety equipment or improve existing signs or road markings.
- For enrichment, have the students teach others about safe practices while traveling.

activity #3: travel games

Grade Levels: 3rd-5th grades
Age Levels: Ages 8-10

STL Standard Used:
The Designed World: Standard 17. Students will develop an understanding of and be able to select and use information and communication technologies.

Benchmarks:
D. The processing of information through the use of technology can be used to help humans make decisions and solve problems.
E. Information can be acquired and sent through a variety of technological sources, including print and electronic media.
F. Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.
G. Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.

- Have the students brainstorm or research travel games and travel safety on their own time based on their interests.
- Then have them create their own version of travel games using basic, intermediate, or advanced uses of technology to entertain and educate while traveling.
- Have them teach their games to younger students or their peers while traveling to/from school.
- For enrichment, have the students create an app using an app creator software package and appropriate/available equipment (Krol, 2018). The goal of the app should be to keep younger students safe and engaged while on the school bus, riding home in a personal vehicle, or walking home from school.

activity #4: my dream trip

Grade Levels: Kindergarten, 1st and 2nd grades
Age Levels: Ages 5-7

STL Standard Used:
Standard 1. Students will develop an understanding of the characteristics and scope of technology.
Benchmarks:
In order to comprehend the scope of technology, students should learn that:
A. The natural world and human-made world are different.
B. All people use tools and techniques to help them do things.
C. Things that are found in nature differ from things that are human-made in how they are produced and used.

- Have the students describe or draw their dream trip.
- Have them explain where they would go and how they would reach their destination.
- Have them brainstorm and list what transportation technologies they would use and what they might see along the way.
- Have them distinguish between what they encounter being either natural or human-made.
- Have them create something three-dimensional to represent their trip, such as a sculpture, model, device, etc.
- For enrichment, have them teach/present to others about their dream trip and what it would take to achieve it.

conclusion
Informal learning can often be as impactful, if not more so, than formal learning because of the very nature of finding educable moments in everyday life and the interactions children have with one another and their worlds. Daily, while commuting to/from school or traveling somewhere new, people have hundreds of opportunities to engage informally with the environment and other people. Allow your students and your own children to find ways to be active observers and participants in these encounters with the natural and human-made elements in their worlds.

references

Laura J. Hummell, Ed.D, DTE, is a technology and engineering educator. Her main interest is the promotion of elementary technology and engineering education throughout the world. She can be reached at laurahummell@gmail.com.

additional web-based resources
Elementary Project-Based Learning Resources
www.bie.org/blog/pbl_and_literacy_a_perfect_match_for_elementary_schools
www.bie.org/blog/3rd_grade_project_real_life_lessons_in_fables_fairy_tales
www.bie.org/blog/lowering_the_driving_question_age

Informal Learning Resources
https://trainingmag.com/trgmag-article/7-informal-learning-lessons/
www.climedia.com/2011/03/16/the-five-myths-of-informal-learning/
www.teachthought.com/learning/what-classrooms-can-learn-from-informal-learning/

Travel Game Ideas
www.minitime.com/trip-tips/10-Best-Car-Games-for-Kids-article
computer programming:
algorithm for mathematics exploration!

by Megan Nickels, Sarah B. Bush, Bethany Fralish, Karen Karp, Matthew S. Taylor, Samuel R. Bush, and Jeff Karp
Did you know that...

- Many students decide the STEM subjects are too challenging, boring, and/or uninteresting before they enter eighth grade (PCAST, 2010)?
- Women, minorities, and other groups remain vastly underrepresented as STEM majors and in STEM careers (Hill, Corbett, & Rose, 2010; PCAST, 2010).
- Students who show interest in STEM disciplines by the eighth grade are up to three times more likely to become STEM majors in college (PCAST, 2010).

We must respond to these STEM statistics! As stated in NCTM's Principles to Actions: Ensuring Mathematical Success for All (2014), we must “increase the number of high school graduates, especially those from traditionally underrepresented groups, who are interested in, and prepared for, STEM careers” (p. 3).

In this article, the authors share how students from a Southeastern urban city were transported from their current life as fifth graders to a STEM career as a computer programmer. We describe two different programming stations, engaging students in the same four programming challenges presented in Blockly programming language. You do not need to implement both stations in your classroom to meaningfully employ the computer programming challenges we share—you can use whichever one best aligns to your available resources. The programming challenges align primarily to fourth and fifth grade content standards within the Common Core State Standards (CCSSI, 2010) such as the algebraic ideas behind patterns (4.OA.5), the relative size of measurement units (4.MD.1), angle measurement (4.MD.5.b), lines of symmetry (4.G.3), and multiplication fluency (5.NBT.5).

Introducing the stations

To start, we gathered all students on the rug in the center of the classroom. We then explained that they were going to complete four exciting Frozen®-themed programming challenges (Figure 1) at two different stations and have the opportunity to talk with real computer programmers at the end of class! We used a whole-group discussion, asking questions such as How does a robot know how and where to move? Do robots speak our language? and How can robots interpret our language? in order to help students begin to think like programmers and understand more precisely what is meant by the word coding. At the first station, students partnered on a laptop to engage in Frozen®-themed coding challenge puzzles found on a free website, code.org (2017). At the second station, students completed the programming challenges with a real robot named Dash (Wonder Workshop, 2017; www.makewonder.com/Dash/; Figure 2).

Programming challenges: a closer look at the mathematics

Programming Challenge 1 required students to use their knowledge of geometry content by focusing on the properties of squares—including the number of sides and interior angle measures. In order to precisely write code to successfully complete this challenge and represent the idea that squares have four equal sides, students had to program their robot to go the same distance when making each of the four sides of the square. The robot also must turn exactly 90° each time when forming the square (representing...
Using the repeat block to repeat multiple lines of code was a new, real-life, and interesting way to engage students in thinking about multistep patterns, something more typically explored in traditional mathematics lessons through noncontextual numerical or geometric patterns. The student work sample in Figure 4 highlights how students created algorithms, developing a reflective use as opposed to rote use. Along these same lines, Programming Challenges 3 and 4 introduced the idea of combining familiar simple shapes into complex designs with nested loops, eventually creating a beautiful snowflake as a culmination of their programming efforts. Of course, this was perfect within the Frozen® theme. These programming challenges further engaged students in the mathematical application of sequential patterns, repeats, and recursion through the context of computer programming.

While many mathematical concepts are central to each of the four programming challenges, there was explicit attention to students’ mathematical thinking by having them complete questions in a math log (Figure 5).

**career connection: virtual meeting with computer programmers**

To link to real-world endeavors, our class videoconferenced with three computer programmers to engage in a meaningful conversation about mathematics in the workplace. Students were organized around three smartboards so they could see the programmers. We were also intentional in recruiting a female programmer, as we wanted students to recognize that all people have options to work within the computer programming business.

The computer programmers asked students: *What mathematics did you need to use today to be able to complete the coding challenges?* Students enthusiastically responded that they used patterns to repeat their code and they used multiplication to figure out how many times to repeat a code. Two mathematical ideas that emerged during the coding challenges were the use of both the properties of a square and angle measurement. Students explained that in order to code the creation of a square, they had to use their knowledge of geometric properties.

Next, we gave students the opportunity to

![Figure 3. Sample repeat block of code used at all stations (for programming challenge 2).](image3)

![Figure 4. Sample student response for Programming Challenge 2.](image4)

![Figure 5. Student math log.](image5)

---

**Code.org Math Log**

1. What is the purpose of the “repeat block” when coding? When you use the “repeat block,” what mathematical operation is involved?
2. In Puzzle 6, suppose you want to repeat the square five times instead of ten times. How many degrees would you need to set the turn block between each square? Describe your thinking using both words and drawings.
3. When a block says “move forward by 100 pixels,” how would you describe a pixel in words? Are there any units of measure that are similar in size to a pixel? What other units of measure could be used to measure the lengths by which Elsa and Anna move?
4. How did your knowledge of angle measurement help you understand what code to write?
5. When you created different snowflakes, how did the degree of the turn relate to the number of times the code was repeated? Describe any patterns or relationships you noticed between the degrees and the number of code repetitions using both words and drawings.
6. How do you know if your snowflake has line symmetry? Describe your thinking using both words and a drawing.
ask questions about computer programming careers. They were eager to ask questions, both predictable and unpredictable, including: Are you able to program video game systems? How many people does it take to program a computer? What types of things do you program? What made you become a computer programmer? And How long have you been doing this career? Through the computer programmers’ thoughtful responses, students were able to take away key ideas including: computer programmers love their careers because of the problem solving and mathematical thinking involved; some computer programmers create video games, but many programmers do other exciting work; and that, surprisingly for the students, it takes hundreds of people to put together all of the parts it takes to program (create) an entire computer! We have included two sets of questions (Figure 6): (1) Culminating Questions that can be used in part or whole, for students to answer individually or in a small- or whole-class groupings, after the programming challenges and prior to the virtual meeting and (2) Reflections Questions that were used at the end of our exploration.

conclusion

These computer programming challenges and accompanying career connections provided a relevant STEM context for working with important mathematics concepts related to measurement, geometry, multiplicative thinking, and algebraic thinking. We hope that by sharing this work we inspire other teachers to explore the integration of mathematics and technology via computer programming as a meaningful way to explore mathematics ideas conceptually and engage students in thinking about STEM careers!

References


Culminating Questions

1. Overall, what mathematical ideas did you use the most when coding today?
2. What essential mathematics must computer programmers know to do their jobs?
3. If you were having a computer programmer create a video game for you, what mathematics questions would you ask them to determine if she or he were qualified for the job?
4. What is one question you would like to ask a computer programmer about their job?

Reflections From Conversation With Programmers

1. What surprised you the most from talking with the computer programmers?
2. What are you left wondering about after the virtual meeting?
3. Is computer programming a career that you might consider? Why or why not?

Figure 6. Culminating questions and reflection questions from conversation with programmers.

This is a refereed article.
technik camps:
a technology education program in Germany

by Nils Bergs, Martin Fislake, Jana Siegel, and Jens Zimmermann
The technikcamps project was implemented by the department of technology at the University of Koblenz, and today they see themselves as complementary to the educational school curriculum, especially in the federal state Rhineland-Palatinate. In the concept of the technikcamps, a learning environment is created by teacher students from the technology education or the computer sciences department or former technicians to guarantee an expert guidance.

The initiator of the project is the head of the department of technology teaching at the University of Koblenz, Dr. Martin Fislake. Since the initial four courses in 2003, the technikcamps have been an ongoing success story. Today the project has expanded to about 100 week-long courses per year with different technology-driven subject areas and has been developed to a teacher training center, where future teachers may gain their first teaching experiences.

The areas offered in the technikcamps include: wood, mechanics, energy, electronics, film, image and video technology/digital-image processing, robotics, computer science, CAD, and much more. In this area it is possible to implement engineering, technical facts, and technical ways of thinking and acting together with like-minded people. The participants are instructed to examine their talents, to deepen their interests, and to be sensitized for technical professions. Especially for young and interested children, the camp offers the opportunity to live out their natural urge for technical issues.

For the people included in the technikcamps, it is so important to ensure the continuity of the offer and to further develop the courses in terms of quality, continuity, and internationality.

In summary, the technikcamps represent a worthwhile project of the department of technology teaching at the University of Koblenz that is intended to support teacher education and to help young people gain access to technology and engineering.

In addition to a general presentation of the technikcamps, two courses will be described by way of example in order to give an insight into the recent work.

scaffolding framework of the concept

The camps program takes place during the Easter, summer, and autumn holidays and distinguishes itself from everyday school life. The individual courses usually last five days, with a daily attendance time of 9:00am-3:00pm.

The first necessary step of the camp concept is getting to know the other participants. To consolidate group cohesion, there are some icebreaker games, encouraging the children to talk together. When the children get to know each other, they are more open. It is really important to ensure good group work, which the children need for the course. The second step to guarantee a respectful social interaction is to implement rules together. For example, no smartphones while working or listening to others. After getting to know each other and manifesting some rules, the work can start.

At the end of each day, there will be feedback about what the kids reached that day, what problems appeared, and the goals for the next day. The following day starts with a discussion about the problems of the day before. The camp participants think about the problems and discuss different solutions together. If all problems are solved, the work process starts again. When a group finishes its work, the group members can start with

Figure 1. Participants programming their robot (Fislake & Bogdol, 2004).
a bonus project, such as building a poster or banner for the presentation day.

On the last day of the course there is a presentation by the children for their parents to show their solutions, buildings, and achievements. They also get a certificate and a stamp in their collection book.

The students’ age starts with six years, and they are divided into age cohorts (6-8, 8-12, 10-14, 14+). The group size is limited to be at least six and at most sixteen kids and two instructors who are specially trained in methods and didactics in order to ensure optimal care.

As a didactic concept, the technikcamps use action-oriented approaches and playful access forms to support inventing and problem-solving work. The instructors are more like learning guides: they may help the kids to find a path to solutions when a problem occurs but will never give them precast solutions. Because of that, the independence and the technical thinking and acting of the children will be strengthened.

Besides the main task to build and program, the children also get time for sports and a tour of the campus where they visit the subject areas of computer science and physics and get to see alternative robotic systems in the research laboratories.

**examples**

Good examples of the varied topics young people can learn about during the technikcamps are the robonauten-camp and the industry-camp that follow up with the subjects of robotics and coding.

Following is a short overview of what happens during the camps and what young participants can learn from them.

**the robonauten-camp**

At the beginning of the course the mentors introduce the topic and the material to the children. The main task for the children is to build an autonomous mobile robot that can complete an obstacle course in the final Robonauten-Cup.

In the first step they build their own robot with the help of LEGO MINDSTORMS® construction sets. The use of construction sets and not prefabricated robots will give the children a stronger reference to their object and an emotional commitment.

After they have finished this first step they get an easy programming task, where the robot should drive a square for example. For the programming part, they also get a short introduction by the instructors of the software that is included in the LEGO MINDSTORMS® construction sets.

The software uses a graphic programming language, which is especially suitable for people at the beginning of learning programming. After they have passed this task, they get to work with different sensors on the robot, which they also have to build in the construction of the robot. The first sensors they get to work with are touch-sensors and, depending on the individual learning speed, also light-sensors.

With the help of an exemplary obstacle course and an information and idea exchange with the other participants, the kids will learn over the week how to build and program an autonomous mobile robot. With these experiences they will have to pass the Robonauten-Cup, which will be on the last camp day.

The Robonauten-Cup takes place in a public location like a museum and with the attendance of the parents and the public to get an official frame. During the competition the participants compete in teams and must build a new robot that has to pass an all-new obstacle course. The robot is judged on the time it takes to complete the course as well as how well it
passes the obstacles. The cup closes with an awards ceremony where the children get prizes and certificates for their performance (Fislake & Bogdol, 2004).

the industry-camp

The main task in the industry-camp is to build a conveyor to simulate an industry, like a production line with different manufacturing cells. The kids work in groups of up to four attendees and have to build at least one part of the conveyor. At the end of the camp all cells will be combined and put together into one large conveyor.

To design and operate the cells in the production line, they have to use fischertechnik© construction kits, including a TX/TXT-controller and program it with the software RoboPro©. The participants get a short introduction into the handling of the construction kit, the software, and the composition of the controllers, motors, and sensors.

Once the participants learn how to design with the construction kit as well as how to code using the software, they have to combine both. For that, they design a little pinwheel and program it as a training task.

But first, there has to be an introduction to the topic. Some questions like “What is a production line or a conveyor?” “Where do we have conveyers?” or “Which manufacturing cells are in a production line?” must be resolved. To clarify these questions, the mentors can use short film clips or name some local companies.

After this, they are all familiar with the kit, the controllers, the sensors, and the software. So they all together think about which stations the conveyer should include and create a weekly time sheet. Then the children are split into small groups where they decide which group builds which part of the conveyor, and the work process can start.

In every group, everyone is an engineer now, and they can utilize their creativity and reinforce their capacity for teamwork and their independence.

After all groups finish their part of the production line, they start putting the pieces together to create one big production line and bring it to function. On the last day of the camp, the presentation for the parents takes place.

references


STEM Children’s Rhymes

by Emily Yoshikawa Ruesch
and Scott R. Bartholomew

STEM

Little Boy Blue
overview

This activity allows students to use a familiar children's rhyme to learn and incorporate principles of integrative STEM. Students practice recognizing words and identifying a problem (we want the students to design something to help wake up Little Boy Blue).

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 should be given a space in the classroom to test and improve their designs.

materials

- 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

- Specifically requiring instruments to be made that reach three different decibels.
- Have students design a process to help keep Little Boy Blue awake.

history

The origin of “Little Boy Blue” is said to go back to Cardinal Thomas Wolsey (1475-1530). Wolsey was an unpopular, self-made man who was rich and arrogant. Additionally, he had made many enemies at court.

As a child prodigy, he received the nickname “Boy Bachelor” for receiving his diploma from Oxford at the age of fifteen. He was known for “blowing his own horn” in pride of his accomplishments.

In anti-Wolsey propaganda in 1529, King Henry VIII forced Wolsey to forfeit his land and property to the crown. The lyrics to the rhyme are said to be taunting him over losing his property and no longer being able to blow his own horn.

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

Rhyme

Little boy blue, come blow your horn,
The sheep's in the meadow, the cow's in the corn.
But where's the boy who looks after the sheep?
He's under a haystack, fast asleep.
Will you wake him?
No, not I - for if I do, he's sure to cry.

Little Boy Blue lesson plan

Level: Kindergarten
Duration: 1.5 hours

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.
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 Boy Blue” together.
Use the cut-out sheets to allow the students to fill in the blanks. Once you have repeated the rhyme together, hand out the planning sheets and go over the key details of the rhyme.

Where are the animals?
What is Little Boy Blue supposed to do to stop this from happening?
What happened to Little Boy Blue?

identify the problem

We want to stop the animals from wandering. In order to do this, we need to wake up Little Boy Blue. The students need to design something that can help to wake up Little Boy Blue.

activity

The students will participate in a design challenge where they have to design a way to help wake up Little Boy Blue. 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 make to wake up Little Boy Blue. When they are finished with this, have them get a teacher sign-off.

Once the teacher has reviewed the three ideas, have the students go look at materials. Once they know what materials are on the table, have the students list three things that they could build to wake up Little Boy Blue.

Have the students pick their favorite idea and do a more detailed drawing of it. Once the drawing is complete, have the students find the teacher to explain their product. The teacher can then write down the product description.

**build, improve, and share**

From their drawn designs, have the students build. Allow them to come up and test the design in class. In testing, you could have something that measures decibels (or how loud the invention is), or a homemade seismometer to check for movement. As they see what works or what needs improvement, encourage the students to go back and improve and make further iterations of their design.

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

Little Boy Blue,

Come blow your [______],

The sheep's in the meadow,  
The cow's in the corn;

But where is the [______],

Who looks after the [______]?

He's under a [______],

He's fast asleep.

Will you wake him?

No, not I,

For if I do,

He's sure to cry.

Note: The Little Boy Blue Portfolio can be accessed at www.iteea.org/143546.aspx, and the Little Boy Blue Fill-In can be accessed at www.iteea.org/143548.aspx.
incorporating engineering and renewable technologies into the K-5 classroom through culturally relevant literature and design challenges

by Lisa B. Bosman, Kelli L. Chelberg, and Greg J. Strimel
1. Introduction

Understanding the need to increase STEM interest and participation across all populations from primary school through higher education, an Engineering professor collaborated with faculty from Teacher Education and Humanities to submit a grant proposal to do just that. The college was awarded funding to (1) develop culturally relevant engineering and renewable energy-based curriculum for primary school teachers, (2) pilot the curriculum through YMCA after-school programs, and (3) offer K-5 educators and YMCA instructors professional development workshops to allow for individual exploration and engagement on how one might implement engineering curriculum into their classrooms. The purpose of this article is to provide an overview of the project and provide experiences for teachers to further implement engineering within their classrooms.

2. Curriculum Development

The curriculum and instructional materials for this project were developed by undergraduate engineering students as part of their first-year engineering experience. The goal of this development process was twofold: first, introduce undergraduate students to the various engineering disciplines and renewable energy technologies through the curriculum development process, and second, leverage the college students’ own experiences to produce engaging instructional resources for children in Grades K-5. The aim of the resulting curriculum was to provide children the opportunities to engage in and explore the activities related to the various engineering disciplines/renewable energy technologies while allowing them to explain to others the disciplines/technologies in terms of future career opportunities.

2.1 Engineering Curriculum Development (K-2nd Grades)

First, culturally relevant engineering-focused children’s books were developed by the undergraduate engineering students to engage elementary students in discussions about the different engineering disciplines. An example of one of these books, within the aptly named Future Engineer in Training Series, can be seen in Figure 1. This example focuses on engaging students in biomedical engineering within a relevant context related to the culture of the Menominee Indian Tribe of Wisconsin. Next, LEGO-based design challenges were created to offer students hands-on experiences to explore the actions of those working in each discipline (see Step 1 of Figure 2). Lastly, worksheets, such as the one provided in Figure 2 were used to encourage students to explain the activities of the engineering discipline.

2.2 Renewable Energy Curriculum Development (3rd-5th Grades)

The curriculum for Grades 3-5 focused on renewable energy. Similar to the engineering curriculum for Grades K-2, culturally relevant children’s books were created and used to engage students in conversations about renewable technologies (Figure 3). K’Nex-based design challenges offered students the ability to explore a renewable energy curriculum within the context provided in the children’s book (Figure 4), and worksheets were used to encourage students to explain the opportunities related to and functions of the highlighted technologies.

2.3 Lessons Learned / Teacher Tips for Curriculum Development

How can others adapt this work? Engage: Engineering-focused children’s books are developed to engage young pupils through culturally relevant design scenarios.

Figure 1. Engage – Children’s book created by undergraduate engineering students to engage young pupils in engineering through culturally relevant design scenarios.

Figure 2. Explore (Step 1) – Biomedical engineering design challenge related to the culturally relevant children’s book provided in Figure 1. Explain – Biomedical engineering worksheet to guide elementary students in explaining the activities of a specific engineering discipline.
books were used to engage the K-2 students, and renewable energy children's books were used to engage the Grade 3-5 students. To achieve the objective of incorporating humanities into higher education STEM courses, the books were developed by first-year college engineering students. Details of the book-writing process can be found here: www.wiete.com.au/journals/GJEE/Publish/vol19no3/10-Bosman-L.pdf. The books were formatted and published using freely available online tools, CreateSpace.com and Amazon.com. Through these resources, teachers can either create their own books or find a relevant, "engaging" design for students to replicate can aid in the development of visual-spatial skills. Design challenges allow students the flexibility to think outside the box and can aid in the development of creative-thinking skills. Teachers can leverage older students to play a role in creating design challenges. In addition, K'Nex provides extensive opportunities to extend the lesson in their 69-page teacher guides, and there are many free resources available online (see below for a list of resources).

What are potential pitfalls?
The children's books required about 20 minutes to read. Since the attention span for this age group is limited, the project leaders decided to read half the book during each session. For the LEGO curriculum, initial LEGO designs were printed in black and white, which provided difficulty in recreating. Thus, the project leaders recommend printing in color to improve the visual-spatial skills. In addition, individual work appeared optimal for the design challenges. For the K'Nex group, working in groups of 2-3 students is ideal. Furthermore, hydroelectric lessons should be done outside during warmer weather, as there is a high potential for making a mess. If there is poor weather, a lamp can be used for solar lessons to simulate the sun; for wind lessons, a fan can be used to simulate the wind.

What costs are involved?
The largest cost is associated with the K'Nex; each K'Nex renewable energy kit costs about $200. All the books developed through this project are available on Amazon.com for less than $10 per book; links to the books can be found here: www.cmnstemhero.com/childrens-book-development.

free engineering resources
- Engineering is Elementary (www.eie.org/)
- Teach Engineering (www.teachengineering.org)
- www.educatingyoungengineers.com/lego-club-activity-ideas/
- https://thestemlaboratory.com/lego-stem-activities/
- https://kidssteamlab.com/lego-boat-engineering-project-for-kids/

free renewable energy resources
- www.eia.gov/kids/
- https://climatekids.nasa.gov/menu/renewable-energy/

3. curriculum pilot – YMCA after-school program
The curriculum was piloted at five different at-risk metropolitan-based after-school programs impacting over 120 elementary school participants. The
Engineering curriculum was delivered to Grades K-2 students, and the Renewable Energy curriculum was delivered to Grades 3-5 students. Upon completion of the program, students received a certificate (Figure 5).

## 4. teacher professional development workshops

Two different workshops were offered to local K-5 teachers, one in December 2016 and the other in January 2017. The workshop was about three hours long, and teachers received hands-on guidance towards using the curriculum. Six different schools were represented, with a total of 42 teacher participants with grade distribution as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>K</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>Coordinator</th>
<th>Preservice</th>
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<tbody>
<tr>
<td></td>
<td>2</td>
<td>0</td>
<td>3</td>
<td>11</td>
<td>10</td>
<td>13</td>
<td>2</td>
<td>1</td>
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</tbody>
</table>

### 4.1 Standards Alignment to Next Generation Science Standards

The teachers were shown how potential demonstration of student outcomes could occur through the implementation of the curriculum in the classroom.

<table>
<thead>
<tr>
<th>K-2: Engineering and LEGO Standards</th>
<th>Standards</th>
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</thead>
<tbody>
<tr>
<td>(1) Engage (Book Reading)</td>
<td>K-ESS3 Earth and Human Activity</td>
</tr>
<tr>
<td>(2) Explore (Design Challenge)</td>
<td>K-PS2 Motion and Stability: Forces and Interactions</td>
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<tr>
<td>(3) Explain (Worksheet)</td>
<td>2-LS2 Ecosystems: Interactions, Energy, and Dynamics</td>
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<tr>
<td></td>
<td>2-ESS2 Earth's Systems</td>
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<td></td>
<td>K-2-ETS1 Engineering Design</td>
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<tr>
<th>3-5: Renewable Energy and K’Nex Standards</th>
<th>Standards</th>
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</thead>
<tbody>
<tr>
<td>(1) Engage (Book Reading)</td>
<td>4-ESS3 Earth and Human Activity</td>
</tr>
<tr>
<td>(2) Explore (Design Challenge)</td>
<td>4-PS3 Energy</td>
</tr>
<tr>
<td>(3) Explain (Worksheet)</td>
<td>5-PS3 Energy</td>
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<tr>
<td></td>
<td>5-LS2 Ecosystems: Interactions, Energy, and Dynamics</td>
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<tr>
<td></td>
<td>3-5-ETS1 Engineering Design</td>
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As an alternative to deploying the curriculum to the entire class, based on teacher feedback, some educators recommend using the curriculum (books, design challenges, and worksheets) as a means of differentiated instruction. A second grade teacher noted, “I have four students that are particularly creative and high achieving academically that could benefit from working with this kit to challenge them in engineering and problem solving.” A 5th grade teacher stated, “I plan to use this as a tool for my students who excel and need differentiated instruction. They will first read the book, talk about it, make the model, report about it, and show the class.” Lastly, another 5th grade teacher mentioned, “I plan to use this resource for students who may not otherwise be engaged normally to spark their interest in math and science concepts.”

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physical therapists, PT assistants, and aides

by Bryanne Peterson
The human body is an amazing thing. With 206 bones and over 650 muscles, expertise in how these parts connect is a sought-after skill.

Physical therapists, called PTs, are experts in the human body's function and movement and use these skills to help people. Their job revolves around promoting their patients' ability to "move, reduce pain, restore function, and prevent disability" (APTA). With such an important job, they can't do it alone; PTs frequently have both assistants and aides to help them ensure patients of all ages and backgrounds remain mobile and healthy.

Due to the nature of their work, people who work in physical therapy are frequently moving as they help care for patients. However, the work physical therapy teams do varies by the type of patient. Some PTs specialize in certain types of physical therapy—orthopedics or sports medicine, for example—while others help all sorts of patients with a variety of issues such as pain management or decreased mobility. This type of work requires a strong knowledge of human anatomy and problem-solving skills—that's a physical therapists' specialty. While all bodies are basically structured the same, what works for one patient will not necessarily be the right way for a second patient. Without being able to see inside the body, PT teams rely on observation and patient input to figure out the best way to treat pain and mobility issues. They also receive data and input from other members of a patient's health-care team, consulting with physicians and surgeons as well as their own assistants and aides to ensure the best outcome for their patients. Once they have a plan for a patient, therapy begins. The PT or assistant would help patients do specific exercises or use special equipment, and the aide may clean the equipment after helping book the next appointment.

With people living longer than ever before, this job market is expanding rapidly. Physical therapists, physical therapy assistants, and physical therapy aides are each listed as one of the top 20 fastest growing occupations (BLS). Physical therapists are required to have a professional degree and earn over $85,000 a year (BLS); 21 percent of PTs own their own practice, making them entrepreneurs, as well (APTA). To be a physical therapy assistant, a two-year degree is required, and these individuals make over $55,000 a year, while an aide position typically requires a high school diploma and on-the-job training making around $26,000 annually (BLS). People in this field typically have a strong desire to help others and feel good about their work; physical therapists have even been ranked in Forbes’ “The Ten Happiest Jobs” (APTA).

<table>
<thead>
<tr>
<th>Quick Facts: Physical Therapists</th>
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<tbody>
<tr>
<td>2017 Median Pay</td>
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<tr>
<td>$86,850 per year</td>
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<td>$41.76 per hour</td>
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<td>Typical Entry-Level Education</td>
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<td>Work Experience in a Related Occupation</td>
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<tr>
<td>On-the-Job Training</td>
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<tr>
<td>Number of Jobs, 2016</td>
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<tr>
<td>Job Outlook, 2016-26</td>
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<td>Employment Change, 2016-26</td>
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<table>
<thead>
<tr>
<th>Quick Facts: Physical Therapist Assistants and Aides</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 Median Pay</td>
</tr>
<tr>
<td>$57,430 per year (Assistants)</td>
</tr>
<tr>
<td>$25,730 per year (Aides)</td>
</tr>
<tr>
<td>Typical Entry-Level Education</td>
</tr>
<tr>
<td>Associate's degree (Assistants)</td>
</tr>
<tr>
<td>HS Diploma + on-the-job training (Aides)</td>
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<tr>
<td>Work Experience in a Related Occupation</td>
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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.
AnimationLand

by Douglas Lecorchick, Victoria Anne Hoeveler, and Joyce Liang
overview

Disney animators, F. Thomas and O. Johnston, circa 1980, developed 12 principles of animation that are still the foundation of animation programs today. These principles can be taught to elementary students, provided the correct platform and pedagogy. This feature provides the platform, and the storybook format is the pedagogical approach.

teacher script

Class, today we will begin learning about animation. Animation is “bringing to life.” When we draw, either with a pencil and paper or we begin to model using software on a computer, we want to bring those drawings to life; this allows us to become the “Animator.” We are going to read a story, and at the end of each chapter there is a challenge activity.

Animation Adventureland

Introduction

At the very last house on Anyhow Lane where an oak grew tall and the mailbox was painted by handprints, lived Mr. and Mrs. Bennett with their daughter, Millie. For Millie’s whole life, ten years and three quarters to be exact, their family never changed much, unlike the Johnsons down the road with their four sons and another on the way. The Bennets enjoyed a perfectly content life, but nevertheless Millie felt something missing and spent her every birthday wish on a little brother or sister. She almost gave up hope, until last Thursday when they headed to the airport to meet a most special someone.

Millie waited at the baggage claim and searched through the crowds of people. The day had finally come to meet her new little brother, Matias. He flew all the way from the Dominican Republic to be with them, and Millie could hardly contain her excitement. Soon, a boy with shaggy hair and rosy cheeks rushed out the gate.

"Hola!" Matias smiled, running full force to greet her.

Millie met him halfway and gave him the greatest of bear hugs. The two jumped with glee and talked nonstop the whole way home. Matias even brought his pet gecko named Pocket! At last, her family felt whole.

First thing, Millie gave him a tour of their home. They started from the basement and worked their way up, only stopping for a quick snack in the kitchen, though Matias spent a particularly long time in his new room, rummaging through every nook and cranny.

“This is all mine?” he asked, to which Millie nodded a yes.

Millie couldn’t imagine what his life was like before becoming her brother, but what she did know was that she would try her very hardest to be the best big sister she could be.

“Why don’t we open that toy chest and play with your new toys?” Millie suggested. She had picked the toy chest from an antique store only days before his arrival.

Matias didn’t have to be told twice and flung the lid open. He dug through the toys, sinking further and further and further…until falling in completely!

"Matias!” Millie jumped in head first after him. She fell down a long hole and landed in a soft bed of grass. Butterflies fluttered around her head, and clouds puffier than cotton candy floated across the sky. Matias shook dirt from his hair. Even Pocket let out a squeak from the impact. “Are you okay?” Millie asked.

“Sí,” he said.

“Hello there! We don’t get many guests around here.” A woman with a dazzling smile greeted them. “My name is Miss Petunia. So nice to meet you."
Millie knew better then to talk to strangers, but Matias had yet to learn such a lesson. “Do you think you could help us find our way home?” Matias asked.

Miss Petunia dangled a key in front of them. “If you complete my twelve trials, then you most certainly can go home. Until then follow me.”

And so it began...

Chapter 1 - Animation Principle of Staging

Millie and Matias followed Miss Petunia until they reached a crystal clear lake, though the beach was completely empty! No towels or umbrellas, not even some toys!

“For your first trial, you must complete what I like to call Staging,” Miss Petunia said.

“What's Staging?” Matias asked.

“Wonderful question! Staging is when you place certain objects to fit a particular setting or idea. Now why don’t you two try Staging the beach of this lake?”

Millie and Matias ran over to the far end of the sand where bins of decorations lined the water’s edge. Inside were props and toys of all kinds! The possibilities of what they could use were endless.

“I'm going to use these towels. Why don’t you find an umbrella or some sand toys?”

“Sounds good!” Matias said.

Millie grabbed the first towels she found and ran back to Miss Petunia without checking on Matias.

Millie laid the towels down perfectly next to each other. Though when she turned around she found that Matias grabbed the wrong toys! He found toy trains and bears, though nothing to dig through the sand or build castles.

“I'm afraid that isn't quite right. Why don't you try one more time?” Miss Petunia pointed back to the decorations and props.

Again, Millie and Matias ran over to the bins.

“I'm sorry I didn’t get it right,” Matias frowned.

“That's okay! We all make mistakes sometimes,” Millie gave him a smile of reassurance. “Look for plastic toys you find on the beach this time.”

They dug through the bins until eventually finding the correct toys. Millie even found a sun umbrella! Together, they rushed back to where Miss Petunia waited for them.

They placed the new toys by the water. Then Millie set up the umbrella over the towels for shade. Matias and Millie waited for Miss Petunia as she looked over their creation.

“Looks like a perfect day for a beach outing to me! I deem your first trial to be successful!” Miss Petunia declared. “Now it’s time for your second trial!”

Millie and Matias jumped with excitement. They completed Staging and had fun while doing it!
**Student Activity**

See this desert? Why don't you try Staging by drawing in features of what you think makes a believable desert scene? Hope to see you for Matias and Millie's second trial!

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

*Victoria Anne Hoeveler* is a junior at North Carolina State University where she studies English with a concentration in Creative Writing and a minor in Art Entrepreneurship.

*Joyce Liang* is an artist studying in the Maryland Institute College of Art and Schuler School of Fine Art in Baltimore, Maryland.
meet Natalie Boe
The Elementary STEM Journal strives to not only share great ideas, but to also highlight the great work happening in elementary STEM classrooms across the country and around the world. Teacher Highlight will introduce readers to one extraordinary elementary STEM teacher in each issue. Each featured teacher is either an ITEEA Teacher Excellence Award winner or is part of an ITEEA Program Excellence Award-winning program at an elementary school. We congratulate them for the great work they do for their students and thank them for being willing to share their experiences in The Elementary STEM Journal.

Natalie Boe is a fourth grade teacher at Washington Elementary School in Valley City, North Dakota. She has been in education for close to 30 years and earned her master’s degree in Technology Education in 2007 from Valley City State University.

by Natalie Boe

In Natalie's own words:

While attending my first ITEEA Conference about 20 years ago, I saw a demonstration using film canisters and Alka-Seltzer tablets to make mini rockets. That’s when I became hooked on the idea of incorporating hands-on activities in my classroom to reinforce concepts I am teaching, and I haven’t stopped since. I truly have a passion to make learning fun and relevant for my students. STEM activities have enabled me to give children the opportunities to become inventors and innovators in the classroom.

Designing and constructing Magnetic Levitation Vehicles is by far my favorite STEM activity to teach. The kids get so excited to see their creation magically floating down the track using the forces of magnetism. My favorite moment is when a student presents their completed project and shares their enthusiasm with the class. STEM activities provide students with an opportunity to pursue their passion and inspires them to love learning.

This year, I will be involved with workshops at Valley City State University that will allow me to share my excitement for Technology and Engineering and inspire high school girls to explore future STEM careers. I will also continue to promote STEM at the elementary level by helping teachers prepare and implement engineering challenges in their classrooms. I look forward to attending next year’s conference in Kansas City and reconnecting with the many friends I’ve made as a member of ITEEA.
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.

The Global Design Challenge: elementary STEM students will work in small design teams to develop a better product or tool that can be used to give small children doses of liquid medicine. Learn full details about the Challenge at [www.iteea.org/News/282/134048.aspx](http://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

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The Elementary STEM Journal

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:

- **23-3:** Finding Balance Between Teaching, Learning, and, Application (March 2019)
- **23-4:** Equity in Elementary STEM (May 2019)
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