Finding Balance Between teaching, learning, and application

Bringing STEM to Life: Essentials for Elementary Education

Finding Balance Between Teaching, Learning, and Application
ITEEA’s Elementary STEM Council Announces Grand Design Challenge Winners

ITEEA’s Elementary STEM Council is proud to announce the winners of the 2018 Grand Design Challenge. The NAE Grand Challenges were designed to cause students and educators to think about solutions and challenges affecting all our lives. In 2018, elementary students from around the world worked in small design teams to design a better product or tool that could be used to give small children doses of liquid medicine. This year’s submissions impressed the judges with the elementary students’ use of the engineering design loop, testing of products, refining of products, and serious consideration of external factors.

The “Bobcat Binkys” team from Benton Hall Academy from Little Falls, NY took first place with their innovative design. Their teacher, Tracy Young, mentored the students as part of an after-school group. The team won a one-year I-STEM Education Group Membership, one free hotel night in Kansas City for this year’s ITEEA conference, and a spot in ITEEA’s STEM Showcase. Tracy Young will be sharing information about her winning design at the STEM Showcase from 4:00-5:30pm on Thursday, March 28 at ITEEA’s Conference in Kansas City, MO.

Earning second place in the Challenge was Plymouth Elementary School in Plymouth, NH. Student Reese Querry and her teacher, Julie Sicks-Panus, submitted an outstanding design.

The 2019 Grand Design Challenge will be announced in late spring. Submissions are due December 31, 2019. Questions can be directed to Michael Daugherty, mkd03@uark.edu, Virginia Jones, vjones@patrickhenry.edu, or Thomas Roberts, otrober@bgsu.edu.
ITEEA's Elementary STEM Council Announces Grand Design Challenge Winners

ITEEA's Elementary STEM Council is proud to announce the winners of the 2018 Grand Design Challenge. The NAE Grand Challenges were designed to cause students and educators to think about solutions and challenges affecting all our lives. In 2018, elementary students from around the world worked in small design teams to design a better product or tool that could be used to give small children doses of liquid medicine. This year's submissions impressed the judges with the elementary students' use of the engineering design loop, testing of products, refining of products, and serious consideration of external factors.

The "Bobcat Binkys" team from Benton Hall Academy from Little Falls, NY took first place with their innovative design. Their teacher, Tracy Young, mentored the students as part of an after-school group. The team won a one-year I-STEM Education Group Membership, one free hotel night in Kansas City for this year's ITEEA conference, and a spot in ITEEA's STEM Showcase. Tracy Young will be sharing information about her winning design at the STEM Showcase from 4:00-5:30pm on Thursday, March 28 at ITEEA's Conference in Kansas City, MO.

Earning second place in the Challenge was Plymouth Elementary School in Plymouth, NH. Student Reese Querry and her teacher, Julie Sicks-Panus, submitted an outstanding design.

The 2019 Grand Design Challenge will be announced in late spring. Submissions are due December 31, 2019. Questions can be directed to Michael Daugherty, mkd03@uark.edu, Virginia Jones, vjones@patrickhenry.edu, or Thomas Roberts, otrobere@bgsu.edu.
BRINGING STEM TO LIFE:
ESSENTIALS FOR ELEMENTARY STEM EDUCATION
FINDING BALANCE BETWEEN TEACHING, LEARNING, AND APPLICATION

KANSAS CITY HERE WE COME!

It is hard to believe we are fast approaching the 81st Annual Conference in Kansas City, Missouri on March 27-30, 2019. It is always a pleasure to meet with like-minded STEM educators and focus on how our passions in Technology and Engineering bring STEM to Life.

As Elementary STEM educators, we appreciate the renewed focus on the importance of engaging students at the PreK level and throughout their educational pathway. Harnessing their creativity, quest for learning and exploring, and innate curiosity is vital for our young learners to engage with the joys and wonders of our natural and manmade world. This year an entire conference strand is focused on sharing our best practices through classroom instruction for students in Grades PreK-12 and beyond. How wonderful to have an opportunity to hear others discuss their practices in their elementary STEM classrooms as well as to listen to secondary educators and borrow or build upon their best practices to engage our elementary STEM learners in new and creative ways.

One of the most important events of the conference is when the ESC (Elementary STEM Council) meets and holds an open session for those who are passionate about promoting elementary STEM education. Be sure to join us for this meeting on Thursday, March 28 at 1:00pm in Pershing West in Kansas City.

This year the ESC is proud to announce a winner in the Grand Design Challenge. The response was overwhelming, and choosing one winner was difficult. The quality, depth, and variety of submissions proves that we are making a difference for our elementary learners. The excitement and engagement displayed in these submissions supports the need for continued high-quality STEM learning. You can see more information about the winners on page 2.

This month’s journal presents many best practice ideas including integrating robotics into the mathematic curriculum, stories of design to assist young learners in unpacking the engineering design process, along with our Books to Briefs article, and featured elementary STEM educator.

I look forward to seeing all of you at the conference and having a chance to meet and collaborate, continuing to bring STEM to life for elementary learners.

Virginia R. Jones, Ph.D., is co-field editor of The Elementary STEM Journal and Dean of Student Success and enrollment services at Patrick Henry Community College. She can be reached at vjones@patrickhenry.edu.
Balance is something that I think each of us strives to achieve on a daily basis, especially as educators. Each educator is focused not only on how to help students learn the content that we are teaching, but also striving to make sure that students can apply these concepts to daily situations. Sometimes we become so focused on the content, differentiating it to maximize learning for all students and ensuring that the students have mastered that content, that we forget to have fun with our students along the way. Finding that balance often requires our willingness to step outside the box and try something new.

As a building administrator, I am able to witness balance in action on a daily basis. Just a few weeks ago, one of our fifth grade teachers planned a lesson with her students in which they solved math problems on a grid in the hallway and directed robots using code to a designated square on that grid. The smiles on the faces of the students and purposeful collaboration was worth all of the time and the risk of trying something new.

This edition of The Elementary STEM Journal is full of articles, lesson plans, and strategies to help you find balance in your classroom and school. We hope that you will find that “spark” to help you find joy in balancing all the facets of your interactions with students.

Kimberly Bradshaw is the Principal of Green Valley Elementary in Roanoke County, VA. She has been an elementary educator for 23 years, serving as an elementary principal for the past ten years. Kim is a member of VASCD, ITEEA, ESC, CSL, and serves on the Family Council for Coastal Carolina University. She holds a Masters of Education in Administration and Supervision from the University of Virginia and a Bachelor of Science in Liberal Studies from Longwood College. Kim can be reached at kbradshaw@rcps.us.
ice cream to go!

by Sharon A. Brusic

Book Used:

Grade Level: Grade 2-3

book synopsis
Engaging in fun experiments about heat helps children to better understand this form of energy. This book is full of simple activities that encourage children to explore heat energy using everyday items. Each concept is presented with a probing question and easy-to-follow instructions to promote discovery and critical thinking, with encouragement to record observations in a notebook just like good scientists do.

lesson description
Students work with their teacher to engage in a number of heat-energy experiments. Then children are introduced to a design challenge where they will need to put their understanding of heat energy to work to engineer the best solution to the problem.

lesson goal
The major goal for this lesson is to fully engage students in an integrative science, technology, engineering, and math (STEM) problem that will enable them to apply concepts and skills across all areas in a holistic way.

student learning objectives
Students will be able to:
- Make observations and ask questions about heat energy and how it is transferred.
- Read and follow instructions from an informational text to carry out experiments.
- Use the engineering design process to solve a stated problem within criteria and constraints that requires understanding of heat energy and material properties.
- Create bar graphs that accurately illustrate data collected and analyze the data in order to make judgements about product performance.

standards addressed

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

**English Language Arts > Reading: Literature**
- CCSS.ELA-LITERACY.RL.2.10
  - By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the Grades 2-3 text complexity band proficiently, with scaffolding as needed at the high end of the range.

**Mathematics**
- CCSS.MATH.CONTENT.3.MD.B.3
Draw a scaled picture graph and a scaled bar graph to represent a data set with several categories. Solve one- and two-step “how many more” and “how many less” problems using information presented in scaled bar graphs.

**Next Generation Science Standards** (NGSS Lead States, 2013):
- 4-PS3-2
  - Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 2-PS1-1
  - Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.
- K-2-ETS1-3
  - Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

- Standard 9:
  - Benchmark A: The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others (p. 100).
- Standard 10:
  - Benchmark A: Asking questions and making observations helps a person to figure out how things work (p. 107).
  - Benchmark E: The process of experimentation, which is common in science, can also be used to solve technological problems (p. 108).

---

**design brief**

**Student Introduction**
You and your friends want to enjoy a dish of ice cream at the local park. You are worried that your ice cream will melt by the time you walk there since you don’t have an appropriate cooler to take along. How might you solve this “ice cream to go” problem using simple materials available in your home or school?

**Challenge**
Design and make an appropriate and creative ice cream dish or container that will keep your ice cream solid and cold for as long as possible. Ponder what you learned about heat energy as you solve this engineering problem.

**Criteria and Constraints**
Your solution must:
- Be a unique design that you create, not something that is already available for this purpose.

---

Keeping ice cream cold and solid for a long period of time is difficult. How long does it take an ice cube to melt? Do an experiment to find out, then design something to keep it from melting for a longer time period.

**Materials:**
- Assorted and clean recyclables such as small containers (e.g., yogurt, applesauce), lids (e.g., jars, margarine), foam trays, packaging foam, cardboard tubes, disposable cups, fabric/felt scraps, plastic bags, etc.
Experiments with heat energy require students to use a thermometer to record temperature.

- Roll of aluminum foil, plastic wrap, and wax paper
- Assorted paper scraps for decorating or insulation
- Foam sheets
- Crayons and/or markers
- Yarn
- Cotton balls
- Rubber bands (various sizes)
- Craft sticks
- Tape (masking, clear, and duct)
- Ice cubes (for testing devices)
- Liquid glue
- Scissors
- Notebook paper or spiral notebooks for all students (for design journals)
- Experiment materials as listed in the Lawrence (2016) book

**Procedures:**

1. Provide each child with blank notebook paper or a spiral notebook that can be used as a design journal. If students are not familiar with design journals, spend some time explaining your expectations about what goes in one and how to organize it.
2. Read Lawrence’s (2016) book, *Heat: Fundamental Experiments*, with the class. Invite children to contribute to the reading aloud and answering questions that are posed. Consider having them first write their thoughts in their design journal and then discuss with a small group or the class. Have students try the experiments as a class or in small groups, if enough materials are available. You may want to do a few pages/experiments each day over a week.
3. Present students with the design brief after completing all of the experiments. Explain that you want students to document their design process. Be sure that they know the engineering design process steps and expectations for sketching ideas and documenting their work.
4. When solutions are complete, test each design by placing an ice cube in each one and recording how long it takes for it to melt. Alternatively, pour ½ cup of very cold water into each one and measure the temperature every 5-10 minutes. Record these data, have students create bar graphs of the results, and then have students compare and contrast the solutions. Pose questions such as: (1) How much longer did it take the X solution compared to the Y solution? (2) How much less effective was the X solution than the Y solution?
5. Celebrate students’ solutions by scooping ice cream (or another frozen concoction) into each and walking to the local park or playground. Conduct a debriefing after finishing the treats to further analyze the solutions.
6. As an extension, consider having students make their own ice cream or frozen treat for this activity. Look online to locate instructions to make ice cream in zip-top bags or coffee cans and use this opportunity to further explore heat energy and “ice cream science.”

**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.
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 Thomas Roberts**

$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!**

**ADVANCE ON-SITE REGISTRATION WILL BE AVAILABLE MARCH 1-12 AT**


**ON-SITE REGISTRATION BEGINS MARCH 27TH AT 11:00AM.**
robotics in mathematics:
engaging students in perimeter

by Tabetha Kelley, Megan Nickels, Sarah B. Bush, Matthew S. Taylor, and Craig Cullen
It's 2019, and we now live in a society where technology is used daily by students at all grade levels. New technology, like robotics and computer programming, have the potential to engage students, integrate subject areas, and prepare students for real-world problem solving (Savard & Highfield, 2015). The idea of integrating robotics into mathematics education began with Logo in the early 1980s (Papert, 1980). Papert (1980) believed that robots were a way to make abstract concepts more concrete for students, especially in the area of geometry. In this article, we share two robotics tasks to build students' understanding of perimeter that align to the Common Core State Standards for Mathematics (CCSSM; CCSSI 2010) Measurement and Data Standard 3.MD.D.8, which focuses on solving problems involving perimeter. These tasks were implemented in an author’s third grade classroom.

Two Perimeter Tasks

Students used Wonder Workshop’s Dash robot. It follows commands from the Blockly Software, which students accessed on tablets. The commands used in the Blockly language were “drive forward” and “turn 90°.” Students were placed in groups of three to four.

Task 1: Animal Races

The first task was designed to have students use Dash to “run” a race. Students were to code Dash to move the shortest distance possible around a rectangular figure taped on the classroom floor (Figure 1). Students were given the following prompt:

Dash is interested in running a race. He wants to run the race that is the shortest. Which race should Dash run?

The races were assigned the following animal names: Fox Race (50 cm. by 30 cm.), Elephant Race (80 cm. by 20 cm.), Wolf Race (40 cm. by 40 cm.), Cheetah Race (20 cm. by 40 cm.), Mouse Race (20 cm. by 30 cm.), and Tiger Race (60 cm. by 10 cm.). Following the prompt, students worked to create programming code to help Dash move (or “run”) around the rectangle, which determined the perimeter of the rectangle. Students were allowed to move freely to the different races (e.g., taped rectangles on the floor) as needed and kept a record of the perimeters of each race. Each group completed all races.

Most students chose the “try and retry” method at the beginning of this task to determine the total length of the sides of the rectangle. They would “try” a length of one side and program Dash to move that length. Students noticed Dash only moved in increments of 10 cm. Although students were shown the length of a centimeter in previous mathematics lessons, it became evident that they still did not have a concrete understanding of the length of the unit because all groups started with a length such as 100 cm. Students noticed that their length estimate was either greater or less than the length the particular side of the rectangle in their race because Dash would either go past the end of the tape or would not reach the end. Students would revise their thinking, edit their program, and “retry” (Figure 2). As they moved throughout the different races, they would ask each other questions such as, How far do you think this line is? and would make comparisons with other races by saying, In the other race the side length was 20 centimeters. This one looks like 20 centimeters. Let’s try that.

We found that students would also compare the length of the line segments to the length of their feet. Several students realized their foot was approximately 20 cm. long. Using this knowledge, they would walk along the longer line segments to come up with an estimate for a line segment that was 80 cm. or 100 cm. long. They would then program Dash to move that distance. One participant used this strategy numerous times in order to estimate the length of the sides. When the line segment was shorter than his foot, he would program Dash to travel less than 20 cm. We found it incredibly interesting that students used the length of their own feet as estimation tools and thought maybe this was because they used their
own feet as nonstandard units of measure when first learning about measuring in the primary grades.

At the end of each race, students had to determine the entire length of the race (the sum of the side lengths of the rectangle). Interestingly, some groups began debating whether the turn of 90° should be included in the length of the race and thought it should be calculated because it was a number in the Blockly coding and it was a movement Dash made. Other groups disagreed because, although Dash was moving, this movement was not determining a side length. This sparked a lively whole-group discussion. Students who felt strongly it should not be calculated explained that if he is just turning a corner then he is actually not running the race on the tapeline. Those in opposition proclaimed that the "forward" blocks in Blockly were measured in centimeters and centimeters were a length measurement unit. Students said that they needed to add up the numbers associated with the "forward" blocks to find the total length of the race. Eventually, after a heated debate, we geared the discussion to focus on the attributes of a rectangle, and the class came to consensus that the "turn" was not part of the total length of the rectangle.

Task 2: Lake Boardwalks
In the second task, students were told Dash's neighborhood wanted to create different boardwalks around six different lakes with the prompt: Dash's neighborhood wants to build some boardwalks around the lakes. They can only build in rectangular shapes around the lakes. A model of each lake is shown on the floor. How long is each of the boardwalks around the lakes? The lakes were named Echo Lake (160 cm), Bay Lake (200 cm), Trout Lake (320 cm), Lake Helen (280 cm), Lake Branch (240 cm), and Friendly Lake (260 cm). Students were tasked with finding the perimeter of the boardwalks around the lakes. The shape of the boardwalks were all composite rectangular shapes. After programming Dash to move along the painter’s tape, the students drew pictures and labeled the boardwalks on their paper and calculated the perimeter (Figure 3).

A challenging aspect in Task 2 was whether to turn Dash left or right at a corner. In previous tasks, Dash always turned in one direction. This task required turns both left and right to move around the composite rectangular shape. One group continually programmed Dash incorrectly, causing the robot to turn away from the tapeline. Frustration was evident in their voices when they realized Dash should have turned left instead of right or vice versa. To figure this out, students would line themselves up with the way Dash was facing using their hands to determine if Dash should turn left or right. Then they would fix their code and start Dash from the beginning.

When programming the length of the sides for Lake Branch (Figure 4), students quickly noted that all sides were the same length. When asked, How do you know that all sides are 20 cm? the students responded that all the edges looked like squares. They also said that squares have sides that are the same length. This led some groups to expand upon the previous statement of adding all sides to using multiplication to find perimeter. They saw that there were 12 sides, and all sides were 20 cm, so they skip counted by 20 and used 12 x 20 to find the perimeter (Figure 5). Using multiplication as a tool to more efficiently find the perimeter was a key takeaway for students.
concluding remarks

Students were excited and engaged in learning mathematics using the Dash robot as a tool. During and since these perimeter tasks concluded, students have asked if and when they would be learning mathematics again with the robots. Importantly, using robotics as a tool to learn about the important concept of perimeter made it concrete for students. Students had to use estimation, problem solving, and reasoning as they programmed the robot, which is much more powerful than a worksheet of perimeter problems. As consistent with Papert (1980), the use of robotics did indeed provide a vehicle for students to create their own learning!

references


Tabetha Kelley is a graduate student at the University of Central Florida and a third grade teacher. She can be reached at Kelley.t@Knights.ucf.edu.

Megan Nickels is Assistant Professor of K-12 STEM Education at the University of Central Florida. She can be reached at Megan.Nickels@ucf.edu.

Sarah B. Bush is Associate Professor of K-12 STEM Education at the University of Central Florida. She can be reached at Sarah.Bush@ucf.edu.

Matthew S. Taylor is a post-doctoral scholar at the University of Central Florida. He can be reached at Matthew.Taylor@knights.ucf.edu.

Craig Cullen is Associate Professor of Mathematics Education at Illinois State University. He can be reached at cjculle@ilstu.edu.

This is a refereed article.

ESCape the ordinary and join ITEEA’s Elementary STEM Council! The Elementary STEM Council (formerly ITEEA’s Children’s Council) offers resources, lessons, news, and more about programs in elementary science, technology, engineering, and mathematics around the world.

Membership includes a subscription to The Elementary STEM Journal, a dynamic, practical journal for anyone interested in STEM literacy in Grades K-6.

Learn more and join today at www.iteea.org/ESC.aspx
ACTIVITY

streaming differentiation and integration

exploring a new educator resource

Chris San Antonio-Tunis, Owen Berliner, and Christine M. Cunningham


introduction

Teachers face myriad challenges in today’s classrooms, including subject matter integration and differentiating instruction for diverse learners. As classrooms become more diverse, and as testing and other requirements continue to take time away from instruction, teachers must carefully balance the needs of their students with other mandates and requirements. Fortunately, recent innovations in classroom technologies, while not a silver bullet, show potential to mitigate these and other challenges. Services like Google Classroom and Moodle are making it easier for educators to create, distribute, and grade assignments. Tablets are becoming cheaper and thus more ubiquitous, and mobile phones, once regarded as solely a distraction, have become powerful learning tools.

However, not all new classroom technologies are created equal. With U.S. investments in learning technology surging toward 20 billion in 2018, products abound. While some of these innovations are imagined and developed by educators, others are crafted by Silicon Valley entrepreneurs. The EiE project at the Museum of Science, Boston, has grounded its work in a belief that tools for educators should be developed in close collaboration with educators. In this article, we describe a new digital component to our flagship engineering curriculum, Engineering is Elementary. Developed alongside educators and designed to streamline differentiation and integration, this new resource will help educators balance the complex demands of the teaching profession.

Engineering is Elementary

Since its founding in 2003, EiE has been guided by the philosophy that all students can engineer, and that the process of engineering provides unique opportunities for multidisciplinary instruction in the elementary classroom. Developed collaboratively with educators, the curriculum uses engineering design challenges to integrate science, math, and technological literacy. Additionally, each unit begins with a storybook that sets the context for the activities and integrates English language arts and social studies into the lesson. The storybooks and the integrative nature of the curriculum resulted directly from the insights of educators who strongly suggested the resource allow for cross-disciplinary instruction.

To date, the curriculum has reached over 200,000 educators and 19.6 million students nationwide. When we began, digital assets in elementary classrooms were limited, and digital infrastructure in schools was often nonexistent or unreliable. Classroom technology has changed dramatically in the last 15 years, prompting us to explore how we, as curriculum developers, might leverage the digital medium to transform our paperback storybooks into a more interactive, multifunctional tool.

collaborative development of a new digital resource

Development of this new resource began by learning from and with classroom teachers. In a series of surveys, interviews, and focus groups, we asked educators to tell us about the digital infrastructure at their schools and the availability of various technologies such as laptops and tablets. We asked how well supported they felt by their schools to learn and utilize new technologies and what functionalities and capabilities they would want from a digital version of an EiE storybook. Over 700 educators from all 50 states and six countries participated in this initial outreach. From these early data we gained three important insights:

- Classrooms are more diverse than ever, and educators desperately need resources that can be easily differentiated.
- With limited time in the school day and an ever-changing landscape of standards, curricula that integrate multiple subject areas help educators streamline their instruction while also prompting students to view their work as interconnected and relevant.
- Educators do not always receive the technical support they need to implement new technologies and rarely have time to learn new and complicated systems. Therefore, any new resources must be straightforward and intuitive.

differentiation

To differentiate their instruction and meet the needs of their diverse learners, educators must provide multiple avenues for children to understand content. Acknowledging this, we built several functionalities into the digital storybooks to facilitate differentiation. Educators can toggle between abridged and unabridged versions depending on the reading level of their students and the time they have available. They can also choose between Spanish and English versions, accommodating the needs of Spanish-speaking students. We also included an integrated text-to-speech reader capable of reading the storybook aloud. This can be used by the educator as a whole-class read-
aloud, or by individual students who may benefit from listening and following along. Finally, we included an OpenDyslexic typeface, a font designed to mitigate some of the common reading errors associated with dyslexia.

**cross-content integration**

Educator feedback highlighted their desire for a resource that could integrate content across a range of disciplines. To address this, we developed a set of features that connect the story’s content to science, social studies, and engineering. These include:

- Integrated vocabulary definitions with text-to-speech that allow students to receive vocabulary support.
- Interactive engineering design process call-outs that help students better understand the steps that engineers take to design a technology.
- Interactive maps with key points of interest that provide opportunities for geographic and cultural connections.
- Interactive animations that help students explore and understand complex science concepts.
- Discussion questions that encourage students to reflect on what they have read.

Whether the storybook is used in a whole class setting, by students in small groups, or by students on individual devices, these features bring multiple subject areas together under one platform. This allows users to dig deeper into the multiple disciplines highlighted in the narrative. It also emphasizes the interconnectedness between content areas, which helps students find relevance and meaning in their work.

**straightforward and intuitive**

As we added features, we kept a close watch on how these capabilities might create complexity. To ensure ease of use, we created an intuitive dashboard (Figure 1.1) where all of the aforementioned features can be toggled on or off by the educator or student. This also allows an educator to customize the platform to accommodate learning goals and students.

We also designed with technological accessibility in mind. Because of variances in technological infrastructure across schools and districts, we made the digital storybook available through a device-agnostic, web-based platform. This circumvents compatibility issues and affords teachers the flexibility of using the books on most modern devices, regardless of which technological ecosystem the school has invested in.

**educators report digital version is a valuable resource**

As our development neared completion, we wanted to, once again, gather feedback from educators about the resource. We granted access to over 400 educators from around the country and asked them to use the platform with their students and provide evaluative input. Roughly 70 educators provided survey feedback, and a dozen agreed to more in-depth follow-up telephone interviews. Survey data suggest the digital storybooks are an improvement over the original print version, with 71% of respondents reporting they would prefer to use the digital version (Figure 1.2). Data also suggest that the digital version is straightforward and intuitive, with 79% of respondents reporting that they found it to be so (Figure 1.3).

We conducted interviews with a select group of educators who were willing to provide additional feedback. Takeaways from these conversations suggest the digital version effectively engages students in authentic learning experiences, while making interdisciplinary integration easier for the educator:

“I teach in a low income district with 75% free lunch. We are 1:1 with iPads. My kids really liked the maps feature because geography is not something we spend a lot of time with. They really liked seeing the country where the character was located, and how far from where they live. We also did the discussion questions with a partner. I think it held their attention better than the paper version.”

– Ginger, Slocomb, Alabama
“Showing them a Google Map of where the character was from, showing them the region, etc. got [the students] more excited.”

– Antonio, Buffalo, Minnesota

By creating a resource that is easily differentiated, educators are better able to provide learning opportunities for all of their students:

“We had students of all reading levels and several EL students. Everything from the vocabulary to the way it was structured enabled better differentiation opportunities.”

– David, Lake Wales, Florida

**looking ahead**

Regardless of our continued advancements in technology, teaching will always be a challenging profession. It will always require dedication, content and pedagogical expertise, and an ability to balance the demands that compete for an educator’s time and attention. However, just like the chalkboard, the textbook, overhead projector, or document reader, technologies can support teachers as they create learning experiences for their students. After gathering advice and feedback from over 700 teachers, we are excited to officially release our new digital storybooks. With particular attention paid to differentiation and integration, we hope they streamline these common challenges and support teachers in balancing the demands of their profession. Lastly, we hope this resource fulfills the mission of Engineering is Elementary to support educators in reaching all of their students.

**Figure 1.2.** Preference of Digital Version Over Paper.

**Figure 1.3.** Ease of Use.

Chris San Antonio-Tunis is a project manager on the Engineering is Elementary Research and Evaluation team at the Museum of Science in Boston. In this role, Chris works collaboratively with EiE project leaders to align their project goals with effective evaluation strategies. He designs data collection instruments, supports data collection processes, and manages the analysis of evaluation data so that EiE can make evidence-based improvements to its offerings. He holds an M.Ed in Education Research from the Harvard Graduate School of Education.

Owen Berliner is a project manager on the Engineering is Elementary Curriculum team at the Museum of Science in Boston. In this role, Owen led the design and creation of the EiE digital storybook platform. Additionally, he contributes to the project by developing new curriculum units and associated educational resources. He holds an M.A. in Social Sciences from the University of Chicago.

Christine M. Cunningham is a vice president at the Museum of Science in Boston and the Founding Director of Engineering is Elementary. Her work has focused on making engineering and science more relevant and accessible, especially for populations that are underserved and underrepresented in STEM. She holds joint B.A. and M.A. degrees in biology from Yale University and a Ph.D. in Science Education from Cornell University.
stories of design:
using books to unpack the engineering design process

by Michelle Forsythe, Judy Jackson, and Danielle Medeiros
Take a glance around any place there are young children—a home, a schoolroom, or even an informal learning center—and you’ll most likely find a stack of books.

The right book provokes curiosity, challenges misconceptions, raises intriguing problems, and inspires children to experience the world through someone else’s eyes. Both the National Academy of Engineering (NAE) and the International Technology and Engineering Educators Association (ITEEA) recommend that teachers and parents use books to introduce children to the diverse ways in which engineers have impacted our world. “Stories that dramatize the rich legacy of engineering achievements” can “bring the experience of engineering to life” (NAE, 2008, p.44). Problems presented in children’s stories can also be used to launch engineering design challenges. For example, Standards for Technological Literacy: Content for the Study of Technology details how a teacher can use the story Mike Mulligan and His Steam Shovel to initiate an investigation of how to get a miniature steam shovel out of a hole dug in a tub of wet sand (ITEA, 2007).

In our work with elementary students, we take these recommendations one step further by also using books to reverse-engineer the processes by which engineers solve problems. Like Hill-Cunningham, Mott, and Hunt (2008), we view children’s literature as providing a “real life” application for the engineering design process (EDP). Most often, we use trade books and picture book biographies of engineers and inventors with younger students and chapter book biographies with older students. Biographies are particularly effective for exploring the EDP because they present a “chronological sequence of events with a framework that assists readers in developing their understanding about the person-of-study and that individual’s achievements” (Werderich, Farris, & McGinty, 2014, p.66).

![Figure 1. EDP stages in Whoosh! Lonnie Johnson’s Super-Soaking Stream of Inventions](image)

<table>
<thead>
<tr>
<th>EDP Stage</th>
<th>Summary of excerpt from Whoosh!</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Robot</strong></td>
<td></td>
</tr>
<tr>
<td>Imagine</td>
<td>Lonnie is inspired by a TV show to build a robot.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>He gets his robot to turn and move.</td>
</tr>
<tr>
<td>Improve</td>
<td>But he struggles to get the transmitter to work.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>He uses his sister’s walkie-talkie to fix the robot’s transmission issue.</td>
</tr>
<tr>
<td><strong>Galileo probe</strong></td>
<td></td>
</tr>
<tr>
<td>Ask</td>
<td>NASA needs a back-up power system for Galileo probe.</td>
</tr>
<tr>
<td>Imagine</td>
<td>Lonnie comes up with a solution.</td>
</tr>
<tr>
<td>Communicate</td>
<td>He shares his ideas, but some at NASA doubt him.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>Lonnie builds his power system, and it works.</td>
</tr>
<tr>
<td><strong>Super Soaker</strong></td>
<td></td>
</tr>
<tr>
<td>Ask</td>
<td>Refrigerators and air conditioners need a new cooling system.</td>
</tr>
<tr>
<td>Imagine</td>
<td>Lonnie thinks water and air pressure might solve the cooling problem.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>He makes a pump and nozzle and tests them with a faucet.</td>
</tr>
<tr>
<td>Imagine</td>
<td>The stream blast gives Lonnie the new idea to make a water gun.</td>
</tr>
<tr>
<td>Ask</td>
<td>Lonnie needs to make parts that kids can handle.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>He builds a prototype and tests it out at a picnic.</td>
</tr>
<tr>
<td>Communicate</td>
<td>He fails to convince toy companies to make his water gun.</td>
</tr>
<tr>
<td>Create &amp; Test</td>
<td>Lonnie keeps working on other projects.</td>
</tr>
<tr>
<td>Improve</td>
<td>He makes a revised prototype with a new tank.</td>
</tr>
<tr>
<td>Communicate</td>
<td>A toy maker is impressed by his invention. The Super Soaker is born!</td>
</tr>
<tr>
<td>Ask</td>
<td>Lonnie is still in his workshop solving problems!</td>
</tr>
</tbody>
</table>

The EDP details a series of iterative actions that guide engineers as they investigate problems and construct, refine, and communicate solutions. Although there are several accepted versions of the EDP, most versions feature a cycle by which engineers “continually enhance and improve their design through repeated testing, analysis, and redesign” (Parker, Smith, McKinney, & Laurier, 2016, p. 400). When working with young children, we typically use the version of the EDP developed by The Museum of Science, Boston as part of its Engineering is Elementary project (Cunningham, 2009). This easy-to-understand EDP model...
features five stages: Ask, Imagine, Plan, Create & Test, and Improve. Although we use this specific EDP model throughout this article, we have found that most models of engineering design can be reverse-engineered using well-chosen biographies and trade books.

To initially unpack the EDP, we read aloud to the class a biography about an engineer or a trade book that contains an obvious problem. As we read, we pause to connect key story elements and actions to the EDP. The complexity of how students perceive these EDP stages builds as they re-encounter these stages at different moments throughout the book. For example, Figure 1 outlines the progression of EDP stages in the book *Whoosh! Lonnie Johnson’s Super-Soaking Stream of Inventions* (Barton, 2016). This book explores Lonnie Johnson’s journey as an inventor, including his creation of the hit Super Soaker toy. Later, students formalize their understanding of the EDP by creating a presentation, a project, or an artifact that summarizes the problem (or problems) that the characters faced and how they used each component of the EDP to solve that problem. These integrated literacy and STEM activities support students’ holistic understanding of design and align with Standards 8, 9, and 10 of *Standards for Technological Literacy* (ITEA/ITEEA, 2007).

Because the EDP is a cycle, it may be entered at any point. However, it is not a linear process. Consequently, “it is important that [students] realize that these steps do not have to be completed in a set sequence. Rather, they should be completed in any sequence that will produce the best results” (ITEA, 2007, p. 102). One of the strengths of using biographies and trade books to explore the EDP is that the “messiness” of this sequence is often evident in the storyline. For example, as was seen in Figure 1, when Lonnie Johnson tested his design for a new refrigerator system, the test inspired him to think of a way to create a new toy.

After the first collective unpacking of the EDP, we have students track and report the unique stages of the EDP that occur during new stories. Students can create response sticks labeled with each EDP stage (Figure 2). Then, during class read-alouds, the students can raise the corresponding response stick whenever they notice a particular EDP stage in action. The first few times that we use this reading-comprehension strategy, we typically focus students’ attention by having each student be responsible for only one or two EDP stages. However, as students’ literacy skills and their knowledge of the EDP grow, each will eventually work with the entire set of EDP stages. A similar literacy strategy using sticky notes instead of response sticks can be used during individual silent...
reading (Figure 3). Students can place a sticky note labeled with an EDP stage on the page where they notice that stage in action. Once students are familiar with the EDP, we often give them a blank EDP template (Figure 4) to fill in during a class read-aloud or individual reading. Sometimes we add a sixth EDP stage—communicate—to the blank space in the bottom left corner. With all of these strategies, it is important that students not only identify the EDP stage, but that they also justify their selection. We use probing questions and facilitated student-to-student talk to elicit and discuss the ways that students are interpreting the engineer’s actions in the book.

Although at first it might seem daunting to find an appropriate book to reverse-engineer the EDP, this journal as well as other publications have compiled lists of books that have been vetted by experienced STEM educators. These resources offer reliable starting points to look for trade books that promote students’ STEM learning (Authors, in press). For example, this journal has long formatted a column called “Books to Briefs” that models how to use books to launch an engineering design challenge. Many of these book selections can also be used to explicitly trace the EDP in action. Likewise, each year the National Science Teachers Association (NSTA) reviews recently published trade books and issues a list of the Best STEM Books K–12, which can be found at www.nsta.org/publications/stembooks/. In addition, the NSTA journal Science and Children includes a “Teaching Through Trade Books” column that recommends two STEM books per issue. Finally, the

Engineering is Elementary project of The Museum of Science, Boston includes children’s literature suggestions within the content area connections section of its curriculum, which can be found at www.eie.org/eie-curriculum/eie-content-area-connections#alarms.

Examples of picture book biographies, chapter biographies, and other trade books that we have used to unpack the EDP can be found in Table 1. Picture book biographies include simplified text and informative illustrations that present a snapshot of the problem-solving process of an engineer or inventor. The picture book biography Balloons Over Broadway: The True Story of the Puppeteer of Macy’s Parade reveals the many roadblocks and redesigns involved in making the famous Macy’s parade balloons. Chapter book biographies typically dig more deeply into the life of an engineer or inventor, as each chapter often details a different key moment, place, or problem in their lives. The chapter book Who Were the Wright Brothers? explores how Orville and Wilbur Wright applied their observations of birds and their understanding of bicycles to design the first successful flying machine (Buckley, 2014). Other fiction and nonfiction trade books that include a problem, a review of a plan of action, the creation and testing of a prototype, or a reasonable, workable solution can also be used to unpack the EDP. The trade book The Most Magnificent Thing weaves a story of the frustration and eventual success that often accompanies the "create & test" and "improve" phases of the EDP.

In this article we have focused on using books to unpack the EDP. However, similar literacy strategies can also be used to explore engineering habits of mind, such as systems thinking, creativity, optimism, collaboration, communication, and ethical considerations (Katehi, Pearson, & Feder, 2009). Teachers can pass out response sticks labeled with these habits of mind. Then, as the teacher reads the biography or trade book aloud, students can raise the corresponding response stick whenever they notice a character in the story using a specific engineering habit of mind. When this happens, the teacher can

Table 1. Picture book biographies, chapter biographies, and other trade books for unpacking the EDP.

<table>
<thead>
<tr>
<th>Picture Book Biographies</th>
<th>Chapter Book Biographies</th>
<th>Other Trade Books</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manfish: A Story of Jacques Cousteau</td>
<td>The Inventions of Alexander Graham Bell</td>
<td>The Most Magnificent Thing</td>
</tr>
<tr>
<td>The Marvelous Thing That Came From a Spring: The Accidental Invention of the Toy That Swept the Nation</td>
<td>Shoes for Everyone: A Story of Jan Matzeliger</td>
<td>Rosie Revere, Engineer</td>
</tr>
<tr>
<td>Mr. Ferris and His Wheel</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
pause the reading and ask the students to explain how the character applied that particular habit of mind to solve a problem or address a challenge.

Engineers use the habits of mind and the EDP to systematically and efficiently solve problems and design new innovations. Parents and teachers can use biographies about engineers and trade books with identifiable problems to reveal the nature of what engineers do and enable students to connect to the actions of engineering design. Although STEM educators have often used books to create briefs for launching engineering challenges, Foster (2009) has recommended that educators also “increase the degree to which the activities bolster reading comprehension.”

Our approach to using biographies and trade books to unpack the EDP presents one way to integrate more sophisticated literacy strategies within engineering lessons.

references


Michelle Forsythe is Assistant Professor of STEM Education at Texas State University. She can be reached at mforsythe@txstate.edu.

Julie Jackson is Associate Professor of Science Education at Texas State University. She can be reached at julie_jackson@txstate.edu.

Danielle Medeiros is a graduate student in the Department of Curriculum & Instruction at Texas State University. She can be reached at dm1100@txstate.edu.
STEM Children’s Rhymes

STEM London Bridge

by Emily Yoshikawa Ruesch and Scott R. Bartholomew

Rhyme

London Bridge is falling down,
Falling down, falling down,
London Bridge is falling down,
My fair lady.

Build it up with bricks and mortar,
Bricks and mortar, bricks and mortar,
Build it up with bricks and mortar,
My fair lady.

Bricks and mortar will not stay,
Will not stay, will not stay,
Bricks and mortar will not stay,
My fair lady.

London Bridge is falling down,
Falling down, falling down,
London Bridge is falling down,
My fair lady.

The meaning of the song is what it says. It addresses the stability (or lack of stability) of the bridge. There are varying verses following the first verse that many know by heart. The intermediate verses all address suggestions (both realistic and fanciful) of how to fix the problem, along with reasons why those suggestions may fail.

When the rhyme’s lyrics were first written, its popularity grew immensely, especially in the UK and USA.

Source: www.historicmysteries.com/london-bridge-is-falling-down/

London Bridge 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 together and go over “London Bridge is Falling Down” 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.

overview

This activity allows students to use a familiar children’s rhyme to learn and incorporate principles of integrated STEM. Students practice recognizing words and identifying a problem (we want the students to build a bridge that meets certain constraints).

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 a span and a car in the classroom to test and improve their designs.

materials

• Span for bridge to go over (could be tables or blocks, one foot apart)
• Hotwheels car
• 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

• Require bridges to meet more constraints or carry higher weights.
• Require annotated drawing indicating where compression or tension may be put onto a bridge.

history

“London Bridge is Falling Down” is said to date back to the middle ages, or perhaps beyond.
identify the problem

We want to be able to build a bridge that won’t fall down. The bridge needs to span one foot and needs to be able to support a hotwheels car.

activity

The students will participate in a design challenge where they have to design a bridge that meets specific criteria. There will be teacher sign offs so that students work through the design process.

On the worksheet, have the students list three different ideas that they could do to make a bridge. This could include rails, pillars, a strong road, etc. 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 go look at materials. Once they know what materials are on the table, have the students list three things that they could use to build the bridge that meets those constraints.

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 description of their bridge.

build, improve, and share

Have the students build from their drawn designs. Allow the students to test the design using the span created and the hotwheels car. As they see what works and what needs improvement, encourage them to go back and improve and make further iterations on their design.

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

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.
London Bridge

London is falling down
Falling down, falling down
London Bridge is falling down

My fair

Build it up with bricks and mortar,
Bricks and mortar, bricks and mortar,
Build it up with bricks and mortar,
My fair lady.

and mortar will not stay,

Will not stay, will not stay,
Bricks and mortar will not stay,
My fair lady.

London Bridge is falling down
Falling down, falling down
London Bridge is falling down
My fair lady

aerospace engineering

technicians

by Teena Coats and Bryanne Peterson

Photo credit: Wikimedia Commons.
Aerospace engineering is dedicated to advancements in aviation and space travel.

For many years, humans have dreamed of getting off the ground to explore the sky and amongst the stars. Throughout history, there are reports of individuals making crafts that allow them to float and glide through the air, such as makeshift wings and balloons filled with hot air. It wasn't until the 19th century that the designing of these flying machines really “took off.” The turn of the 20th century saw some of the biggest advances in the study and development of getting humans off the ground and into the air (Rae, 1961). The sky is not the limit for aerospace engineering technicians today though; these individuals design, test, and build the aircraft and spaceships that allow humans to leave the ground and explore new heights (BLS, 2018).

Aerospace engineering technicians work to bring the engineer’s vision to life by building, modeling, testing, calibrating, and recording data on aircraft systems. Technicians are also responsible for designing and building the testing facilities to test the products on the ground or in a computer simulation before they ever see airtime. To test the aircraft products, technicians may use a wind tunnel or other special equipment to understand how the crafts will operate once they are no longer on the ground (Reese, 2016). Technicians may also work in laboratories that assemble missiles and other projects for the military. For some, like those working on military projects, special security clearances may be a part of the job (BLS, 2018).

To pursue a career as an aerospace engineering technician, students are encouraged to take science courses as well as practical skill courses such as those in career and technical education. A technician may specialize in one specific area, or they may be a generalist, working across fields related to aerospace engineering. People in these jobs can expect to make a difference in the future of the world, especially as we work to turn science fiction into reality with cars that fly and space travel to other planets. Aerospace technicians will serve a vital role in developing the technology of tomorrow.

**Quick Facts: Aerospace Engineering and Operations Technicians**

<table>
<thead>
<tr>
<th>2017 Median Pay</th>
<th>$67,240 per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$32.33 per hour</td>
</tr>
<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>12,100</td>
</tr>
<tr>
<td>Job Outlook, 2016-26</td>
<td>7% (As fast as average)</td>
</tr>
<tr>
<td>Employment Change, 2016-26</td>
<td>800</td>
</tr>
</tbody>
</table>

**references**


**Teena Coats** is currently pursuing her doctoral degree in STEM education at NC State and is a graduate of the Integrative STEM Education MA program at Virginia Tech. She can be reached at tlcoats@ncsu.edu.

**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.
ELEMENTARY ANIMATORS

Animation Aventureland

by Douglas Lecorchick, Victoria Anne Hoeveler, and Gianna Mastrandrea
overview

Disney animators, F. Thomas and O. Johnston, circa 1980 developed twelve 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 as the pedagogical approach.

teacher script

Class, today we continue 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 to bring those drawings to life, this allows us to become the “Animator.” We will read Chapters 2 and 3 today and complete the activity at the end of each chapter.

Animation Adventureland

Chapter 2 - Animation Principle of Squash and Stretch

Miss Petunia smiled, leading Matias, Millie, and Pocket to a little cabin just past the lake. The cabin was filled with balloons and bouncing balls colored all the shades of the rainbow.

“Now children, time for your second trial of Squash and Stretch,” Miss Petunia said. She began to bounce a ball. “See how the ball moves? It quite literally squashes and stretches as it bounces!” She handed Matias and Millie some chalk. “Now for your trial, I would like to see you draw the same movement.”

Matias and Millie thought long and hard on how to draw the movement of the ball.

“It’s like gravity is pulling the ball down when it hits the ground!” Matias exclaimed.

“We have to show that the rubber is flexible, I suppose,” Millie remarked. “Maybe give me a try?” Millie asked and Matias handed her some chalk.

Millie drew a series of four spheres. The first stood normally, the second stretched upwards into an oval shape, the third went back to its normal standing position, and the fourth squashed into the ground. Millie threw her arms up in excitement and ran to Miss Petunia to check her work.

Miss Petunia assessed Millie’s drawings.

“Very close, but you’re missing just one part!” Miss Petunia said. “Why don’t you have Matias bounce the ball while you’re trying to draw and then just sketch what you see?”

Millie and Matias nodded, ready to take on the challenge!

Matias began to bounce another ball and Millie drew four spheres again. She drew one in a normal position, then one flattened to the ground, the third stretching upwards as it bounced back to the sky, and lastly a sphere back to normal!

“Miss Petunia did we pass the second trial?” Millie and Matias asked in unison.

“You absolutely did! Congratulations, you can move on to the third trial now.” Miss Petunia beamed, proud of them.
Student Activity

Now you try! Can you draw what this piece of jello would look like if it was dropped from a fridge?

Chapter 3 - Animation Principle of Arc

Miss Petunia kept Matias and Millie in the same room for the third trial. Although this time, she took out a box containing blocks.

"Arrows will be your third trial! Just as fun as the others," Miss Petunia promised. She tossed the block back and forth. "See how the block follows an arc like a rainbow?" Matias and Millie nodded in agreement. "Now for this trial, I would like see how you draw the arc of a moving object! Remember it has to follow a certain path," Miss Petunia winked.

"We can draw a series of blocks like we did with the ball in Squash and Stretch, don’t you think?" Millie said.

"I don’t see why we couldn’t," Matias answered.

"Then why don’t you give it a try this time?" Millie encouraged Matias and passed him the chalk.

Matias drew three square blocks. The first stood normally, the second was stationed up and to the right of the first block, and the third moved even farther up! Millie looked over his work, and together they decided it was time to show Miss Petunia.
With a brow raised, Miss Petunia looked over the drawings. “Hmm I think you’re missing some steps,” Miss Petunia corrected. Why don’t you try again? If I were you, I would have Millie help draw more blocks than just three.”

“Okay!” Matias gave her a thumbs up.

Matias began to add more blocks to the drawing as did Millie. Together, they drew them in a pattern, going up and then down. The drawings created the shape of a semicircle when completed. At last they felt ready to tell Miss Petunia!

“Did we pass the third trial? We really feel like we did it right this time!” Matias said.

“Perfect! The blocks move in a near perfect arc. Can’t wait to see you both complete the fourth trial!” Miss Petunia laughed.

**Student Activity**

Now it’s time for you to try! Let’s see you draw the arc of a frisbee being tossed to a puppy!

---

**Douglas Lecor-chick, Ed.D.,** is STEM education enthusiast with a calling to facilitate collaboration among professional educators. He can be reached at dlecorc@ncsu.edu.

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

**Gianna Mastran-drea** is a freshman in computer science at NC State University with a minor in graphic communications. She can be reached at gmmastra@ncsu.edu.
meet Brenda Julissa Diaz
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.

by Brendajulissa Diaz

Brendajulissa Diaz was born in Aibonito, Puerto Rico, in 1972. She received a B.E. degree in Agricultural Science and Civil Engineering from the University of Puerto Rico, in 1996 and 2002, respectively.

In her own words:
In May 2014, I moved to Grants, New Mexico. Beginning in August 2014, I was with the Grants Cibola School District as a substitute teacher before becoming a 6th grade educator with Provisional License–Level I in 2015 to 2018. My current research interests include Science, Technology, Engineering, and Math (STEM). I’m a member of the International Technology and Engineering Educators Association (ITEEA), New Mexico Council of Teachers of Mathematics (NMCTM), American Association of Chemistry Teachers (AACT), National Science Teachers Association (NSTA), and New Mexico Science Teachers Association (NMSTA).

On May 1, 2017, I was nominated for the 2018 Golden Apple Excellence in Teaching Award in New Mexico. In April 2018 I received the ITEEA Teacher Excellence Award in Atlanta, Georgia. On May 15, 2018 I received a recognition from Grants Cibola County School Board of Education for the 2018 Teacher Excellent Award.
In February 2017, there was a “Cardboard Hand Competition” for 4th-6th grades. Almost 300 students participated in the competition; the experience was amazing.

In June 2017, a student from our school participated for the first time in the “You Be The Chemist” National Competition in Washington, DC. My first student in the competition was Kylette Garcia. In June 2018, my student was Saira Sierra. It’s was an excellent experience for them.

ask the teacher:

1. What do you like about teaching STEM?
   I believe that STEM education is most effective at motivating students to learn and explore. This tends to enhance the students' self-confidence and engagement.

2. What has been your favorite moment in your STEM class?
   I have a few favorite moments: Cardboard Hand Competition, Robotics Competition, and Chemistry National Competition in Washington, DC.

3. What is your favorite activity to introduce students to STEM?
   My favorite activity to introduce students to STEM was “Chemistry National Week.” We celebrate it every October by making an experiment for 4th-6th graders. This year, we'll conduct a kinetic sand experiment.

4. What are your future goals?
   My future goals are to finish my teaching license requirements, get a masters degree in education, submit a proposal for an engineering school in New Mexico State University-Grants, and develop a STEM program for 3rd-6th graders.

Brendajulissa Diaz can be reached at Brenda.diaz@gccs.k12.mn.us.
IN MEMORIAM
DR. LAURA JOHNSON HUMMELL, DTE
1968-2018

More than just an outstanding educator and colleague, Laura was a shining star, full of enthusiasm, who believed deeply in the possibility of success for every student and worked tirelessly to make it happen.

ITEEA and Laura’s many colleagues would like to recognize her countless contributions to the technology and engineering education profession and the association as well as to the Council on Technology and Engineering Teacher Education, Technology and Engineering Education Collegiate Association, Council for Supervision and Leadership, and the Elementary STEM Council, including many years of helping to lovingly grow The Elementary STEM Journal.

Laura was renowned for inspiring others. As part of a recent Elementary STEM Council webinar, she shared a quote often attributed to W.B. Yeats and typical of her mindset: “Education is not the filling of a pail, but the lighting of a fire.”

We will miss your extraordinary contributions, but even more, your generosity of spirit and your wonderful heart.
KELVIN® No CO2 Dragster Launchers are used by many schools in the U.S.A. for “Project Lead the Way”

KELVIN® Kel-Air™ ORIGINAL Air-Powered Dragster Launcher
Economical & easy to use 1 or 2 lane system; use for multiple launches. Features updated look, enhanced pneumatic valve and controls, new finish gate bumpers and a launch switch that sends vehicles speeding down the track under the power of compressed air (never CO2). Req. air compressor with pressure gauge. Gr. 6-12.

840814 .......................................................... $245

KELVIN® Kel-Air™ ELECTRONIC Air-Powered Dragster Launcher with Track & ClassView™ Timer
For 1 or 2 lanes. Compressed air launchers vehicles safely and economically when the hand-held controllers are pressed. Includes electric air launcher (#851367), ClassView™ Timer with Power Supply, 24 ft. L Track, Pre-Wired Start/Finish Sensors Gates. [2] Portable Air Compressors and [50] Dragster Kits. Allow $150 for U.S. shipping

841564  Kel-Air™ Electronic Launcher w/ Track & ClassView™ Timer .............................................. $2,295
851956  Add. Hand Controllers - Blue/Red/Yellow .......................................................... $30

No CO2 Dragster Kit PRE-DRILLED
Blanks w/ Axle AND Power Input Holes
Includes 10 in. long blanks pre-drilled with axle holes and air input holes as well as wheels, axles, straw, screweyes and washers.

842380  Bulk Pack of 50 Kits ............... $3.20 Per Kit $160

KELVIN® Experimental Wind Turbine with Toy Motor Generator
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
842268  Assembled w/Stand .............. $199

Toy Motor Generator Kit Only
Build your own! Comes with motor/generator, gearbox parts and hub. **NOTE: Does not come with blades, PVC stand or wind turbine class parts.**

851924  ............ $85 or $75 ea./5+

KELVIN® WinData® Data Collection Interface
Displays a graph of voltage on your computer. For best results, use with KELVIN® motor #851363.

842354  Monitors up to 3 Motors.. $145
842363  Monitors up to 6 Motors.. $225

As Low As 99¢ Per Student

Basic Car Platform Parts
Add your own body design from foam, cardboard, etc. Includes wood bases, 400 wheels, 200 axles and straws.

841417, [100] Kits, $99
841415, [20] Kits, w/ Wood Base, $129
842096, [20] Kits, w/ Plastic Base, $129

KELVIN® Kre8® DC Motor Parts
Electromagnetic motor with magnets, a reed switch and a battery.

283736, [20] Kits, $195

As Low As $6.45 Per Kit

KELVIN® Solar Racers™

As Low As $9.95 Per Student

Blinking LEDs Parts

842162, [30] Kits, $58.50

As Low As $1.95 Per Student


851956  [A] PowerPole™ (Req. Power Supply).. $150
851051  [B] Variable Speed Power Supply – Required .......................................................... $125

NEW! PowerPole™ Balsa Planes
842445  Pre-Cut Balsa Kit w/ Motor, Props, Wire ........ $14.95 or $12.95 ea./10+
842446  Balsa Blank Kit (Not Pre-Cut, U-Design™) .......... $12.95 or $9.95 ea./10+

KELVIN® BULK PACKS SAVINGS!

Over 45 in. TOTAL HEIGHT!
LARGEST Selection and BEST Prices
www.kelvin.com

As Low As $3.25 Per 10+

SOLE MULTIMETER, 990177
KELVIN® has the BEST Prices on Multimeters! As Low As $3.25

NY State Contract #PC67818

KELVIN®’s Latest Catalog is Online with a full line of projects, parts, and more for STEM- Science, Technology, Engineering & Math. Visit www.kelvin.com