STEM FOR ALL!

Learning Opportunities: Inclusive
ITEEA’s Elementary STEM Council is sponsoring the 3rd 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 Process
Elementary STEM students from around the world will work in small design teams to solve the GDC outlined below. As students attempt to solve the GDC, the elementary teacher will document the process with a simple portfolio that describes the problem-solving process, the products developed, results of product testing, as well as the final product presentations. Photos and videos of proposed solutions will be posted on the Elementary STEM Council’s Facebook® site. The design teams will be evaluated and the winning team will be invited to present their solution during the International Technology and Engineering Educators Association Annual Conference in Denver, Colorado on March 24-27, 2021. This team will also be featured in the March 2021 edition of The Elementary STEM Journal.

The Global Design Challenge
One of the original Grand Challenges (NAE, 2008), called for engineers to design systems that helped people live more healthy lives. Search online using the phrase “grand challenges” to find more information. The 2020 GDC calls on you and your team to develop a product that might help solve a worldwide dilemma that we are all facing in 2020.

In 2020, nations around the globe are struggling to prevent the spread of the Coronavirus 2019 (COVID-19). COVID-19 is caused by a new virus and health care officials do not yet have adequate or effective vaccines for the virus. However, the CDC does know that washing hands often with soap and water for at least 20 seconds is a great way to prevent the spread of the virus, especially after going to the bathroom; before eating; and after blowing your nose, coughing, or sneezing (Centers for Disease Control and Prevention (CDC), 2020).

The most common problem is that most people do not wash their hands often enough, nor long enough.

Challenge:
Can you work as a member of a small design team to develop or modify a product or device that will encourage people to properly wash their hands for at least 20 seconds?

LEARN MORE/READ THE FULL CHALLENGE AT iteea.org/ESC-GDC20.aspx

Questions? Email Michael Daugherty at mkd03@uark.edu or Thomas Roberts at otrober@bgsu.edu.
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On the Cover: Brittney (first grade) paints a part of her ocean mural project in her Engineering by Design™ class at Benton Hall Academy (Little Falls, NY). Photo submitted by Tracy Young—BHA STEAM Specialist.
Providing an inclusive learning environment should be every educator’s goal. Inclusion takes on many forms. It requires us to think about providing multiple means of engagement, representation, and expression in the terms of universal design for learning. It requires us to seek out different strategies, to incorporate assistive technology, and to differentiate how we assess students. Being an inclusive educator is not about adding more work or going through a checklist to meet the needs of diverse students. Being an inclusive educator is an opportunity to engage students where they are and provide each and every student with the access to rigorous learning experiences. It gives us the chance to incorporate students’ home languages, cultures, and values into instruction so that the content is more meaningful. This issue is full of proven resources teachers can use in their classrooms to engage each and every learner.

Dan Trent reminds us of the importance of inclusion, but also the unique position that STEM and career and technical education have in promoting inclusion. As he notes, the real-world, hands-on, cooperative learning that are hallmarks of our profession can position us to be more inclusive than a traditional lecture format. In our Books to Briefs department, Jana Bonds provides a wonderful introduction to the engineering design process that is grounded in the context provided by the children’s book, *Ara the Star Engineer*. Worch and colleagues offer a hands-on exploration of the structure and function of living animals. In the Kids Code department, Kelley Buchheister offers strategies to make mathematical connections through the use of Cubetto, a hands-on coding robot. Chelongs and colleagues offer an integrated activity where students take on the role of a honeybee to better understand the importance of cooperation, to understand why hexagons are important to beehives, and the importance of pollination. Tracy Young provides a great activity that encourages children to explore natural and renewable resources through making wind turbines. Finally, Virginia Jones reminds us of the importance of including culture in STEM, especially as we work to make sure STEM is a community where each and every student belongs. I hope you find these resources as helpful as I have and think about how they can help you create inclusive learning environments.

As this unprecedented school year comes to a close, we are already looking toward next year’s journal, which marks its 25th year! We also eagerly anticipate the arrival of ITEEA’s new *Standards for Technological and Engineering Literacy* as they pertain to elementary educators. We will be working to bring in more voices and new sections in the journal. If you are interested in sharing strategies, tools, and resources you have found or used, we hope you consider writing for the journal. I also encourage you to submit a proposal for ITEEA’s 83rd Annual Conference to be held March 24-27, 2021 in Denver, Colorado. Proposals for session presentations and the popular STEM Showcase are available at [www.iteea.org/Application_To_Present_2021.aspx](http://www.iteea.org/Application_To_Present_2021.aspx). I hope you all have a safe summer, and we hope you join us for our next issue in September.

**Thomas Roberts** is co-field editor of *The Elementary STEM Journal* and a teacher educator and researcher at Bowling Green State University in Bowling Green, Ohio. He can be reached at otrober@bgsu.edu.
This issue's theme is **STEM is for ALL: Inclusive.** While I like to think that we all strive to create inclusive learning environments, the current challenges of remote teaching and learning make this task even more difficult. The “digital divide” is more apparent than ever, as many schools and universities are delivering instruction online even as some students do not have the technology tools needed to access the materials. As we all figure out how to manage teaching and learning online, think about the following questions: How can I reach students who do not have reliable technology access? How can I incorporate assistive technology to reach students with a range of learning abilities? How can I engage different modalities to make instruction more meaningful to diverse students? Given that most students are at home with parents or guardians now, how can I incorporate students’ home cultures in lessons? I certainly do not have all of the answers; however, I have been incredibly moved by all of the people sharing resources, strategies, and tools to help make this transition work the best it can.

ITEEA’s Elementary STEM Council has shared resources through social media. Julie Sicks-Panus created “how-to” videos about creating pop-up books for her elementary STEM students. Tracy Young created a range of videos for at-home activities to support students. Tracy also shared some of her invaluable expertise in an article in this issue. Our members also showed the importance of making during the pandemic. Virginia Jones put her making skills to use to sew face masks (see photo above). Other STEM teachers have transformed their 3D printers from classroom tools to manufacturing personal protective equipment. This giving spirit and wealth of knowledge is what I like most about the Elementary STEM Council members. They’re not just great educators; they’re great people who put their skills to use to help others.

As I recently transitioned into the role of President of the Elementary STEM Council, I’m fortunate to work alongside board members like Virginia, Julie, and Tracy. I’m also incredibly lucky to have worked with and learned from previous presidents, like Laura Hummel, Charlotte Holter, and, most recently, Kim Bradshaw. A professional community like the Elementary STEM Council is invaluable. We plan to provide more opportunities to share resources and engage with elementary STEM educators in the future. The 3rd annual Grand Design Challenge has been announced (details are available on page 2 of this issue). I hope you will consider engaging your students in this timely challenge and submit their work to this competition. We also are looking for energetic members to share their expertise with a larger audience. If you’re a member of the Elementary STEM Council, you’ll be receiving information on opportunities to join committees and on elections for a few positions on the board. I hope you will consider getting more involved with this talented group of elementary STEM professionals.

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book synopsis

Ara and her best friend robot, DeeDee, love wondering and discussing numbers. One day Ara wants to know how many stars are in the sky. DeeDee has an error in trying to answer her question, so Ara wonders how to fix her robot. She realizes she needs help. Ara goes on an adventure with DeeDee and visits Innovation Plex. Here she learns key strategies for problem solving from trailblazers and real-life engineers. They teach her the importance of planning, brainstorming, creativity, communication, collaboration, and tenacity. Ara and DeeDee put what they learn into action and Aha! Success! Ara discovers that collaboration and teamwork solve problems, and she can be an engineer just like the friends she made on her adventure. This inspiring story will help all children, especially young girls, see themselves in the diverse backgrounds and exciting careers presented in this book.

lesson description

The book is a simple way to introduce the power of problem solving using the engineering design process and serves as the starting point for inspiring children to recognize and see themselves in possible engineering careers. After discussing the story, children are challenged to work in small groups using the design process to create a recycling sorting station for their new family robot.

lesson goal

The primary goal of this lesson is to engage students in thinking like an engineer and collaborating with others while designing a solution to a problem.

student learning objectives

Students will be able to:
- Recognize that anyone can problem solve and think like an engineer.
- Identify and use measuring and building tools and materials appropriately in solving the given challenge.
- Use the engineering design process to design and construct a solution to a problem following given criteria and constraints.
- Use planning and drawing strategies to communicate solutions in the design process.
- Explore characteristics of problem-solving, including collaboration and creativity.
- Ask questions, make observations, and gather information to understand a story and brainstorm solutions through written plans and verbal discussions.
standards addressed

Common Core Standards (Common Core State Standards Initiative, 2019):

English Language Arts > Reading: Literature
- CCSS.ELA-LITERACY.RL.1.1
  - Ask and answer questions about key details in a text.

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

Next Generation Science Standards (NGSS Lead States, 2013):
- K-2-ETS1-1
  - 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 1:
  - Benchmark B: All people use tools and techniques to help them do things (p. 24).
- Standard 9:
  - Benchmark D: When designing an object, it is important to be creative and consider all ideas (p. 102).
  - Benchmark E: Models are used to communicate and test design ideas and processes (p. 102).

design brief

Background
Ara’s best friend is a robot named DeeDee. Robots are machines that gather information about their environment and use that information to follow instructions to do work. Just like DeeDee had errors in the story, robots in real-life run into problems and need humans to help troubleshoot solutions. Imagine that your family recently won a robot from the local robotics club. It is designed to help sort recycling. Unfortunately, the club forgot one important part—a place that the robot can put all the sorted recycled goods. Thankfully, you know how to think like an engineer! Don’t forget the power of having a plan, brainstorming, communication, and collaboration, just like the engineers in Ara’s story.

Challenge
Work with your partner(s) to design and build a sorting station for your new robot to sort recycling in your home. Customize the station based on what you know are the main goods your local recycling facility collects AND what your family typically uses. Your robot sorts based on size and material, so be sure to consider this in your design.

Criteria and Constraints
1. Your design process must be well documented in the engineers’ notebook.
2. Your station must:
   - Have at least 3 sorted areas.
   - Be stable enough to hold 4 recycled pieces at a time.
   - Keep recycling contained from weather and animals.
   - Have an easy way to remove the recycled pieces.
   - Use only the materials and tools provided.
3. Use creativity when designing your station. Make it look appealing and reflect you!

Materials
- Various recyclables for student testing and building (plastic containers, cans, bottles, newspaper, etc.)
As covered in the story, teamwork and collaboration are keys to successful problem solving. Be sure to give students the opportunity to work together. Photo credit: Pixabay.

- Cardboard boxes and scraps of various sizes
- Simple tools (e.g., scissors, rulers)
- Coloring utensils (e.g., markers, crayons, colored pencils)
- Paper scraps or construction paper
- Craft sticks
- Pipe cleaners
- Tape (masking, duct, clear)
- School glue and/or hot glue (with supervision)

Procedure

1. After reading *Ara the Star Engineer* aloud, engage children in a discussion. Prompt with questions that give children the opportunity to analyze the message of the story—the fact that everyone can think like engineers as long as they remember the importance of planning, brainstorming, communication, and collaboration.

2. Define engineering. Possibly discuss types of engineers and ask students to share what they know about what engineers do or if they know anyone in the field.

3. Introduce the role of robotics in the world today and consider showing a brief video of some everyday robots. Ask children if they have ideas for robots they wish were invented.


5. Present and explain the design brief. Consider showing examples of common recycling bins they may have seen in different places (e.g., chain restaurants, school cafeteria, parks).

6. If developmentally appropriate, have children follow along and plan out simple ideas in the prepared engineers’ notebook, on a design log, or even on plain paper.

7. Explain that you want students to plan, plan, and plan some more and that their documentation is a critical key to success.

8. Give children time to share their solutions and talk about their thought process. They can use their engineers’ notebook to guide their discussion. Where appropriate, point out where students have shown they are thinking like engineers or used great planning, brainstorming, communication, or collaboration.

Support Materials

- Read Aloud Video: [www.youtube.com/watch?v=fukBFLCqip4](http://www.youtube.com/watch?v=fukBFLCqip4)
- Author’s Website: [www.arastarengineer.com/en/](http://www.arastarengineer.com/en/)
- Design Brief: [www.iteea.org/173947.aspx](http://www.iteea.org/173947.aspx)
- Engineers Notebook: [www.iteea.org/173951.aspx](http://www.iteea.org/173951.aspx)

references


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using living organisms to investigate fossils:
a 6E lesson plan

by Eric Worch, Emilio Duran, and Lena Duran
Using Living Organisms to Investigate Fossils: A 6E Lesson Plan is an engaging and dynamic lesson where third grade students learn how scientists study structure and function of living animals to describe how similar-looking extinct animals may have behaved based on fossil evidence, as well as to speculate on the existence of unpreserved soft body parts. Students use their observation skills and existing knowledge about animal structure and function to address the challenge of identifying similarities and differences between pill bugs and trilobites. This lesson exemplifies how formative assessment probes can be used seamlessly within existing instructional models to assess and ensure that all students progress adequately during the learning cycle. Ultimately, this strategy provides differentiated opportunities that help all learners master disciplinary core ideas.

introduction and background

This third-grade lesson uses the 6E instructional model (Duran, et al., 2011) to help students understand that scientists make inferences about structure and function of extinct species by examining extant species (NGSS, 2013: K-LS1, 3-LS4-1, 3-LS4-2, 3-LS4-4). The 6E model is a modification of the 5E model developed by the Biological Sciences Curriculum Study (BSCS & IBM, 1989)—Engage, Explore, Explain, Elaborate, and Evaluate. Although there are other 6E models (e.g., Burke, 2014; Kähkönen, 2016), some of which include an engineering component, this 6E model inserts the Express phase after the Explain phase to formatively assess how students are progressing toward mastering the learning objectives. With this knowledge, the teacher places students into appropriately differentiated activities in the Elaborate phase to support their specific learning needs. Unlike Universal Design for Learning (UDL), which helps students overcome their individual academic and social-emotional hurdles (Zalaznick, 2019), the 6E Learning Cycle differentiates support based on each student’s current understanding of the concepts being taught while still being able to include UDL strategies.

engage

(5-10 minutes)
1. Show HD images of trilobite fossils that include the back and underside of the animal, as well as it rolled into a ball like a pill bug (see Materials). Provide interesting facts about trilobites, including when and where they lived (see Background).
2. Ask students about structures (parts) they may see and to complete Handout 1.
3. Scientists have discovered that trilobites have additional structures that are not visible on most fossils. Show an artistic rendering of a trilobite showing antennae, jointed legs, and tail structures.
4. Ask, I wonder how scientists determined trilobites should have these parts when we haven’t seen them in the fossils? Discovering how this is done is the objective of this lesson.

explore

(20-25 minutes)
1. Introduce the pill bugs, aka roly-poly bugs. Discuss the need to treat the pill bugs with care and respect. The Petri dish should not be shaken and it should be lifted to observe the underside of the pill bugs.
2. Ask if students have seen pill bugs before, where they saw them (dark, moist areas), and whether they tried to pick one up. Connect the name roly-poly to how pill bugs roll into a ball to protect themselves when they sense danger.
3. Allow 3-5 minutes for students to observe the pill bugs freely. Ask students what they noticed about their pill bugs and if they recognize any body parts? Introduce “structure” as another name for “part.”
4. Allow 10-15 minutes for students to use Handout 2 to find the structures on their pill bug. Key questions: 1) What other animals have you seen that have a shell-like covering? 2) Can you point out the head, thorax, and abdomen? and 3) How are the pill bug’s jointed legs similar to and different from your own legs? After the allotted time, have students push their Petri dish to center of the table.

explain

(15-20 minutes)
1. Begin this phase by debriefing what students learned in the Explore phase. Reinforce the names of the main structures and introduce the term “function.” Use HD images
and/or video to view pill bugs up close (see materials). Point out main structures, including the gills on the underside.

2. In small groups, students use the word banks in Handouts 3a and 3b to label the structures on both diagrams and discuss the possible function(s) of each structure. The purpose of this activity is to get students thinking about the relationship between structural features and what they do to help the animal survive.

3. As a class, display each diagram one at a time. With the class’ help, the teacher fills in each blank. To save time, use labeled diagrams.

4. After the structures are properly labeled, ask students to describe the function or functions they think each structure has. Shape students’ ideas into scientifically accurate ones. The correct functions are recorded by the students.

express

(5-10 minutes)

1. Display side one of the formative probe for the whole class (Handouts 4a and 4b), pass out a copy to each student, and read the prompt and choices. Students should circle the name of the “friend” they agree with and provide an explanation. Next, display side two of the probe and follow the same procedure. Collect the probes without discussion.

2. Use results to assign students to one of three Elaboration tiers to provide the appropriate level of challenge and scaffolding (Keeley, 2014). Although the teacher plans for three tiers of instruction, there may be a tier to which no students are assigned based on the answers to the probe.

elaborate

(35-40 minutes)

All Tiers

1. Divide students into tiered groups. Project the image of the trilobite with only the lobes labeled (Handout 5) and pass out the trilobite fossil or HD image to each group. Draw attention to the three longitudinal lobes of the body.

2. Students in all tiers will apply what they learned about the functions of pill bug structures to infer the functions of trilobite structures.

Novice

1. Students in the novice tier use labeled diagrams of a trilobite to locate the structures on their fossil/image (Handouts 6a and 6b). Ask for ideas as to why they are missing.

2. Using their knowledge of pill bugs, students discuss the functions of the following trilobite structures: head, thorax, abdomen, legs, antennae, exoskeleton, eyes, mouth, and nose.

3. Students record the function(s) of three trilobite structures and explain their reasoning in the Trilobite Structures and Functions Table (Handout 7).

4. Students complete a Venn diagram (Handout 8) to compare and contrast structures of the pill bug to those of the trilobite.

Target

1. Students in the target tier receive two unlabeled diagrams of a trilobite with the soft and hard structures present (Handouts 9a & 9b). Students identify and label structures using the provided word bank.

2. Groups discuss which structures are visible in the trilobite fossil/image and which are not. Using their knowledge of pill bugs, they discuss the functions of the structures of trilobites.

3. Students record the function(s) of three trilobite structures and explain their reasoning in the Trilobite Structures and Functions Table (Handout 7).

4. Students complete a Venn diagram (Handout 8) to compare and contrast structures of the pill bug to those of the trilobite.

Advanced

1. Students in the advanced tier receive diagrams that are missing all of the soft structures (Handouts 10a and 10b). Knowing that a trilobite is an arthropod like a pill bug, groups draw the missing soft parts of the trilobite.
and label as many structures as they can using the provided word bank.

2. Students discuss and record the function(s) of three trilobite structures and explain their reasoning on the Trilobite Structures and Functions Table (Handout 7).

3. Students complete a Venn diagram (Handout 8) to compare and contrast structures of the pill bug to those of the trilobite.

**Closure All Tiers**

1. Students summarize the differences and similarities between pill bugs and trilobites in relation to structures and their functions (Handout 8).

**evaluate**

1. Formative assessment occurs in all phases of the learning cycle using students’ oral comments and written responses on the handouts. This information is used to direct contemporaneous instruction and identify areas needing whole-group clarification in subsequent instruction.

2. The results of the Express probe receive a more systematic and thorough analysis to identify each student’s current strengths and weaknesses in relation to the concepts of structure and function.

3. Students are placed into one of three tiers of instruction designed to provide an appropriate level of challenge and scaffolding to help each student meet the teacher's learning objective(s).

This engaging third-grade lesson is unique, as it follows the 6E instructional model (Duran, et al., 2011) and is an effective and novel way to help meet the learning needs of all students as they explore and express their understanding...
Write the name of each structure in the blanks.

- abdomen
- antenna
- gills
- head
- leg
- mouth parts
- thorax
- uropod

Write what you think is the function of each structure:

1. 
2. 
3. 
4. 
5. 
6. 
7. 
8. 
9. 
10.

**Handout 4a. Formative assessment probe – part 1 – for the express phase**

**Why Do Sloths Have Claws?**

Kayla considers the ideas her three friends have talked about. “Well, how can we figure out which idea is right?”

Marley:

Let’s find the teacher—she’ll know the answer!

Ethan:

I know I’m right—my dog digs stuff up all the time.

Julio:

Why don’t we watch the sloth for a while and see what it does?

If you were Kayla, which friend would you agree with? Explain why you think so.

**References**

Biological Sciences Curriculum Study (BSCS) and International Business Machines (IBM). (1989). *New designs for elementary science and health: A cooperative project between Bio-

Logical Sciences Curriculum Study (BSCS) and International Business Machines (IBM). Dubuque, IA: Kendall/Hunt.


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NOTE: Handouts for this article are located online at: www.iteea.org/173809.aspx
kids code

Figure 2. Color-coded arrows to represent left and right turns and connected tiles.

mathematical precision through meaningful connections by Kelley Buchheister

tools to support mathematical precision through meaningful connections

ACTIVITY

Figure 2. Color-coded arrows to represent left and right turns and connected tiles.
As they move about their environments, young children have opportunities to reinforce their relational understanding and build mathematical vocabulary.

Coding activities can provide opportunities to extend content explorations and provide meaningful connections among mathematical ideas, early literacy skills, and geography.

Cubetto, the hands-on coding robot, was integral in Ms. Megan’s preschool classroom. Recognizing her children’s excitement, she used the robot to create collaborative, problem-solving experiences where the children explored spatial relations and used mathematical vocabulary to describe positions in space, “Cubetto is far away from the mountain” or “We need to make Cubetto go around the river—he can’t go through it!” As they navigated the obstacles, Megan fostered her preschoolers’ rational counting and number sense. She encouraged children to evaluate proposed ideas and justify their thinking as they debated how many tiles to use in order to move Cubetto from Point A to Point B: “No. We need to have four green tiles. He has to go forward four spaces, see? One, Two, Three, Four. Not five. You don’t need a green for the turn. You need a different color to turn.”

Each experience followed the direction of Megan’s preschoolers, and she built support systems to scaffold their representational understanding, directional sense, and visualization skills. For instance, as she observed her children struggling to remember left and right directions, Megan added color-coded arrows to Cubetto's top face (Figure 2, page 15) to address the developmental difficulties and maintain her focus on counting, spatial sense, and building precise mathematical language.

Other supports Megan incorporated into her lessons helped develop her children’s representational understanding and visual-spatial thinking. While not initially the goal, in her reflections Megan noticed how the rotating small-group roles she cre-

![Figure 1. Ms. Megan (far left) and her team consider different routes for Cubetto as they analyze how to use Cubetto to explore key mathematical ideas for the 4- and 5-year-olds in their classes.](image1)

![Figure 3. “Path tester.”](image2)

![Figure 4. “Cubetto card.”](image3)
ated offered children experiences with various representations and encouraged mathematical communication. For instance, the “button pusher” responded to the group’s cues to determine when to try the path. The “tile placer” listened to the group’s counting to connect the final number to a quantity of tiles. The “path tester” (Figure 3) followed the proposed routes with the “easy mover Cubetto.” Each of these roles offered opportunities to move from more concrete programming with the tangible coding tiles to using pictorial representations or numerals to represent the movements as they recorded the possible routes, drawing shapes and arrows on the “Cubetto Cards” (Figure 5) Megan created.

After navigating Cubetto through the countryside, the city, and even outer space on the provided maps, the children in Megan’s class wanted to design their own maps. One of Megan’s culminating activities in the unit included creating a map of their community (Figure 6).

In designing maps, children applied directional language as they represented community locations. They used ordinal language when discussing what areas of the map to develop first, and considered measurement as they reflected on the size of roads, buildings, and playgrounds. Megan fostered her children’s thinking and made connections to their experiences with GPS devices, treasure maps, and activities with Cubetto. Megan extended the children’s work with maps through “read aloud” that emphasized characters’ movements through space such as “Bears in the Night,” “Rooster’s Off to See the World,” “Rosie’s Walk,” and “The Last Stop on Market Street.” She prompted children to think about what tiles they could use to represent characters’ movements and what the map would look like to represent settings throughout the story.

Megan’s responsive teaching provided valuable opportunities to encourage 21st century skills in an integrated context. From her children’s interests, Megan generated thoughtful explorations that developed precise mathematical language and meaningful connections. Using coding as a foundation for mathematical explorations can offer an opportunity to see how mathematics is represented through a different lens. As in Megan’s case, mathematics can become a tool even preschoolers use to communicate mathematically as they explore environments and use precise language to propose and evaluate possible routes on each journey.

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information security analysts

by Virginia R. Jones, DTE
The emerging STEM career of Ethical Hacker is also known as an Information Security Analyst. Their primary job is to plan and carry out security measures to ensure their company or organization is protected from outside threats to their networks and computer systems.

Ethical hacking became a career from companies’ desire to understand the threats and security issues that hackers could introduce into their computer systems to cause a shutdown or compromise the company’s data, whether about the company itself or its customers. Hacking became prevalent as a “hidden danger” when computer systems automated many of the services companies offer. There are three generally recognized categories of hackers—white hat, gray hat, and black hat.

According to Tech Target (2020), the definition includes: “An ethical hacker, also referred to as a white hat hacker, is an information security expert who systematically attempts to penetrate a computer system, network, application, or other computing resource on behalf of its owners—and with their permission—to find security vulnerabilities that a malicious hacker could potentially exploit” (para 1). A white hat hacker is a “good” guy. This person has good intentions and follows all rules and regulations when checking out computer networks. This white hat person makes sure all regulations, rules, and laws are followed. An ethical hacker keeps a company ahead of threats and unwanted intrusions into their systems. This analyst uses a method called “pen tests” or penetration tests to break through the company’s firewalls and other methods of protection. These tests are routinely run to discover vulnerabilities or possible targets so that companies can develop protective measures—firewalls—to protect their sensitive data from outside threats. Ethical hackers often run “attacks” to understand where the possible weaknesses are and develop computer programs or countermeasures to protect against them. They are the first line of defense for most companies in protecting their systems.

Information Security Analysts usually have at least an associates degree or a bachelor’s degree in computer science, information technology, or a related field. Hackers also need to have a strong background in computer programming, especially multiple computer languages. There are also industry-recognized credentials such as Certified Ethical Hacker. This credential was developed in 2003 and has become one of the leading credentials recognized by the U.S. Department of Defense (EC-council, 2020).

Ethical hacking careers will continue to grow and expand in their scope and operations. According to Standards for Technological and Engineering Literacy Core Disciplinary Standards (ITEEA, 2020), the impacts, influences, and application and maintenance of technological products and systems are core criteria for defining technology and engineering STEM education.

**resources**


**Quick Facts: Security Analysts**

<table>
<thead>
<tr>
<th>2018 Median Pay</th>
<th>$98,350 per year $47.28 per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical Entry-Level Education</td>
<td>Bachelor’s degree</td>
</tr>
<tr>
<td>Work Experience in a Related Occupation</td>
<td>Less than 5 years</td>
</tr>
<tr>
<td>On-the-Job Training</td>
<td>None</td>
</tr>
<tr>
<td>Number of Jobs, 2018</td>
<td>112,300</td>
</tr>
<tr>
<td>Job Outlook, 2018-28</td>
<td>32% (much faster than average)</td>
</tr>
<tr>
<td>Employment Change, 2018-28</td>
<td>35,500</td>
</tr>
</tbody>
</table>

Virginia R. Jones, Ph.D., DTE, Dean of Student Success and Enrollment Services at Patrick Henry Community College, is co-field editor of The Elementary STEM Journal and ITEEA President-Elect. She can be reached at vjones@patrickhenry.edu.
honeybees and humans – an interconnected experience

by Isma-ae Chelong, Johnny J Moye, DTE, and Cory M. Madison

Photo Credit: Brittany Madison.
Most people love honeybees. These cute little creatures are one of the most recognized insects in the world.

Teachers, students, and parents will enjoy learning how we humans and honeybees depend on each other and share many similarities. One example is that we work together to help each other. Using a honeybee theme, an elementary teacher can easily present students with lessons and activities using an integrative science, technology, engineering, and mathematics approach.

Providing an activity and supporting information, this is the final of a series of articles focusing on a honeybee-themed elementary classroom. Moye and Madison (2019) provided 3rd to 5th grade teachers with the background information needed to formulate a theme that could be used for a single lesson or for an entire school year. The second article (Moye, Chelong, and Madison, 2020) presented examples of specific science, mathematics, social studies, and English language arts standards that could be integrated into honeybee-themed lessons. Teachers can use one or more of the three articles to formulate lessons and activities. These articles contain but a small portion of possible integrative STEM opportunities teachers could explore and use. The more familiar teachers are with the world of honeybees, the more apparent it is how we can use that information to compare them to the world of human beings. Our existence with this insect is very interconnected.

**lesson overview**

All creatures on earth have their role to support their life and the lives of others. We humans must work with each other and with nature in order for our world to sustain life. It is easy to compare the lives of humans and honeybees. Living in colonies, honeybees work extremely well together. Every bee has a mission in life—to support their colony. When they are very young they help feed the babies and keep the beehive clean. When they are old enough to go out on their own, they become foraging bees and leave the colony to collect food to support their family.

A human colony is our home, where our family lives. We have the same responsibilities as honeybees. When we are young, we learn that we must clean our rooms and help around the house. Helping sometimes means taking care of the babies (like younger bees). Once we get older, we learn how to survive on our own. Survival depends on food, so as adults we must learn how to work to support our family in our own home. It is wonderful how well we work together. Like honeybees, we learn what is expected of us and do it without having to be told. Of course, no human or honeybee is perfect. We make mistakes but try hard to do the best we can to help the others in our family. And we depend on our family to help us, too.

**activity**

Honeybees live in colonies. A colony could be located in a tree or in a hive used by beekeepers to raise bees. No matter where honeybees live, they create hexagonally shaped cells to raise their brood (baby bees) and to store their food. Bees eat honey and pollen for energy and protein. They collect their food from trees and flowering plants. Bees provide a very important function as they fly from plant to plant. They pollinate plants as they gather nectar and pollen. Plants must be pollinated in order to survive. Pollination is a critical function in our ecosystem. It would be detrimental if bees did not pollinate the plants that we humans and other life need to survive.

Today you will act as one of the thousands of honeybees in a colony. Your first job will be to create hexagonally shaped honeycomb. Once you complete the three hexagonal shapes in your worksheet, you are to take your pollen and nectar (colored pencils) and go to other parts in the colony (other students’ worksheets) and place your nectar and pollen in those cells. Remember, honeybees work quickly and efficiently to fill all the hexagonal cells with pollen and nectar. You must work fast so you will have enough food to eat.
during the cold winter months when no (or very few) flowering plants are available.

**lesson goal**

The goal for this lesson and activity is to support the idea that each of us has responsibilities. Like honeybees, we are expected to do our part. In society, parents, siblings, teachers, and our community depend on each person to know what is expected of them and for them to do their best in meeting those expectations.

Using honeybees as an example, this lesson will introduce students to the pollination process and why pollination is necessary to sustain life on earth. It will also address collaboration between students to ensure that their colony (the classroom) is being taken care of and will provide the food necessary for the upcoming winter months. Teachers will reinforce acceptable cultural norms and explain that each of us are individuals but depend on each other.

**student learning objectives**

Students will learn:

- The necessity of cooperation and teamwork with others. The speed of working in teams is similar to bees.
- What a hexagonal shape is and why it is the strongest and most practical shape bees use in the hive.
- What pollen is, why pollination is important, why pollen from different plants is different colors.

**challenge**

The colony must be built and filled with food. There is so much work to do. To survive, everyone needs to help. Students are to act as bees. They must first build their honeycomb so they have a place to store food in the hive. Once the comb is available, foraging honeybees must fly from plant to plant, collecting nectar and pollen, and take it back to the colony to store for future food.

**Standards Addressed**

**Science**

*NGSS 3-LS2-1: Ecosystems: Interactions, Energy, and Dynamics.* Construct an argument that some animals form groups that help members survive.

**Technology and Engineering**

*STEL-1A: Compare the natural world and human-made world.*

**Mathematics**

*CCSS.Math.Content.3.MD.D.8:* Solve real-world and mathematical problems involving perimeters of polygons, including finding the perimeter given the side lengths, finding an unknown side length, and exhibiting rectangles with the same perimeter and different areas or with the same area and different perimeters.

**Social Studies**

*NCSS-Early Grades-Culture-1:* Culture refers to the behaviors, beliefs, values, traditions, institutions, and ways of living together as a group of people.

**English Language Arts**

*CCSS.ELA.Literacy.W.3.3:* Write narratives to develop real or imagined experiences or events using effective technique, descriptive details, and clear event sequence.

**Materials**

Worksheet, metric ruler, and colored pencils.

**Procedure**

Following the examples provided in the worksheet, students will draw at least three hexagon shapes on the worksheet. Using colored pencils, students will go to different classmates’ honeycomb and fill one of their cells with a color representing pollen. Students may use any color they prefer.

**resources**


Linear Measurement Information: [www.youtube.com/watch?v=w3UxxhRhgAo](https://www.youtube.com/watch?v=w3UxxhRhgAo)

**extension**

Ask students to critically analyze the questions on page 2 of the worksheet. If time permits at the end of the class session, the teacher could encourage discussion about what students learned...
about honeybees, pollination, benefits and disadvantages, teamwork, etc.

This activity will help students learn about life and how we humans are so connected, and dependent upon, plant and animal interaction.

references


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Producing innovative technology, he currently conducts research on the stingless bee project. Isma-ae can be reached at isma-ae.c@yru.ac.th.

Johnny J Moye, Ph.D., DTE, serves as ITEEA Senior Fellow. He is a retired U.S. Navy Master Chief Petty Officer, a former high school technology teacher, and a retired school division CTE Supervisor. Johnny can be reached at johnnyjmoye@gmail.com.

Cory M. Madison is an Operations Crew Supervisor at Louisville Gas and Electric Company. He’s a parent of two boys, ages five and eight, who love the outdoors. Cory can be reached at tecmad7@gmail.com.

NOTE: The worksheet for this article is online at: www.iteea.org/173807.aspx.

Create Honeycomb and Provide Food
Your Family is Counting on You!

Name: ___________________

You are a honeybee, and winter is quickly approaching. As a honeybee you and your colony must quickly build a lot of honeycomb and fill it with pollen and nectar. This is necessary so you, your queen, and your family will have food to eat over the winter months. The pollen will provide protein, and the nectar will become honey. Your challenge is to create hexagonal honeycomb cells and put pollen and nectar into them.

Following the example provided in the box, you are to create at least three additional hexagonal shapes. You will need to use a ruler because each hexagon must be the same size as the existing cells and fit directly next to other cells. Your measurements must be accurate to correctly make the comb. Once you complete your cells, you will use a colored pencil to fill in one of your cells with pollen. You will then fly to other parts of the hive (the classroom) and fill in one cell in each of your classmates’ cells. Different colors represent pollen from the different trees and flowers. Use the pollen that you will like your honey to taste like.

Remember: honeybees work very well with each other. If you are finished, and someone in your family is having problems making their cells, you can be a helper bee and explain to them how you completed your hexagonal cells.

NOTE: Colors represent trees and flowers identified in the cells. Answer questions on the next page.

Create Honeycomb and Provide Food
Your Family is Counting on You!

Were you able to complete the three hexagonal shapes? Yes or No

What was the length of each side of the hexagon shape? _______________________________

What problems did you experience creating your shapes?
_____________________________________________________________________________________________
_____________________________________________________________________________________________

What did you do to overcome those problems?
_____________________________________________________________________________________________
_____________________________________________________________________________________________

What would you do differently if you were assigned this challenge again?
_____________________________________________________________________________________________
_____________________________________________________________________________________________
making wind turbines
by Tracy Young
During these trying times of the COVID-19 pandemic, you might be wondering what STEM activities you can have your students do at home or activities to do with your own children. There are numerous “real world” activities that can be explored. Let’s begin by thinking about some of our natural resources as well as nonrenewable and renewable resources.

You can start a conversation with your students by asking the question: What are natural resources, renewable, and nonrenewable resources?

Natural resources can be either renewable or nonrenewable. They serve as the sources of energy for electricity generation. Coal, oil, and natural gas are fossil fuels; they are nonrenewable resources because it takes millions of years for them to form. Solar, moving wind, moving water, and biomass resources are examples of renewable resources. All sources of energy used to produce electricity require energy conversion to change their original form of energy to electrical energy.

After conversations have been had about natural resources, renewable resources, and nonrenewable resources, pose the question: What do you know about wind energy?

Wind energy (or wind power) refers to the process of creating electricity using the wind, or air flows that occur naturally in the earth’s atmosphere. Modern wind turbines are used to capture kinetic energy from the wind and generate electricity (American Wind Energy Association). A wind farm or wind park, also called a wind power station or wind power plant, is a group of wind turbines in the same location used to produce electricity. Wind farms vary in size from a small number of turbines to several hundred wind turbines covering an extensive area. Wind farms can be either onshore or offshore.

Wind turbines work on a simple principle: instead of using electricity to make wind—like a fan—wind turbines use wind to make electricity. Wind turns the propeller-like blades of a turbine around a rotor, which spins a generator, which creates electricity. Making wind turbines is a great activity for students of all ages to participate in, and materials can be easily found around their homes. There are also many variations of wind turbines that can keep students building and comparing designs and collecting data.

**making a wind turbine**

**Standards**
The standards and benchmarks for this lesson are outlined in the chart below.

<table>
<thead>
<tr>
<th>Standards for Technological Literacy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STL 5</strong> The effects of technology on the environment.</td>
</tr>
<tr>
<td><strong>STL 6</strong> The role of society in the development and use of technology.</td>
</tr>
<tr>
<td><strong>STL 8</strong> The attributes of design.</td>
</tr>
<tr>
<td><strong>STL 9</strong> Engineering design.</td>
</tr>
<tr>
<td><strong>STL 10</strong> The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.</td>
</tr>
<tr>
<td><strong>STL 11</strong> To apply the design process.</td>
</tr>
<tr>
<td><strong>STL 12</strong> To use and maintain technological products and systems.</td>
</tr>
</tbody>
</table>

Little Falls, NY
### Common Core State Standards for English Language Arts

**SL4** Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and organization, development, and style appropriate to task, purpose, and audience.

### Next Generation Science Standards

**4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

**4-ESS3-1** Obtain and combine information to describe that energy and fuels are derived from natural resources, and their uses affect the environment.

### Common Core State Standards for Mathematics

**4.NF.6** Use decimal notation for fractions with denominators 10 or 100. For example, rewrite 0.62 as 62/100, describe length as 0.62 meters, locate 0.62 on a number line.

**4.MD.3** Apply the area and perimeter formulas for rectangles in real-world and mathematical problems.

**4.G.1** Draw points, lines, line segments, rays, angles (right, acute, obtuse), and perpendicular and parallel lines. Identify these in two-dimensional figures.

### Materials

Pencil, compass, ruler, protractor or cup (to trace), string, straw, washers (or coins), tape, cardstock, scissors, and a fan.

### Procedure

1. Using a compass, ruler, and protractor, measure and draw a 10-cm-diameter circle with a pencil on your card stock. If compass, ruler, and protractor are not available, trace a cup. Cut out the circle.
2. Fold the circle in half, then fourths, then eighths. Open the circle back up. Each angle should measure 45°.
3. Place a quarter-sized object in the center of the circle and trace it. This will be the guideline for where to cut the blades. Cut 8 blades by cutting along the 8 fold lines, to within 2 cm of the center. Make sure not to cut all the way to the center. When finished cutting, use the point of a sharp pencil to poke a small hole in the center.
4. Bend each blade gently up on one side so that all blades are curved up in the same direction. Don’t over-bend the blades. Just bend them to give them a curve or twist. You may need to make adjustments to the blades when you use your turbine.
5. Set up the turbine system by sliding the blade on the wooden skewer about 4–5 centimeters from the blunt end.
and taping it in place. Tape may be needed on both sides of the blade to securely attach it to the wooden skewer.

6. Slide a straw over the wooden skewer.

7. Attach a string to the end of the skewer and tie a small washer (or tape a coin) at the other end of the string.

8. Use tape or other materials to create a system that allows the string to roll up on the end of the skewer causing the washer (or coin) to wind up.

9. Hold the wind turbine in front of a fan so that the turbine will spin and roll up the string, lifting the washer.

- Ask students: What is the input of the energy system, what is the process, and what is the output? (The input is the wind, the process is the wind turning the turbine, the output is the energy being transferred to the string to wind up the washer or coin).
- Students can discuss and record the terms turbine, system, source, fossil fuels, kinetic energy, and potential energy.

**Extension**

- Once the 1 washer (or coin) is lifted, add more coins to see how many can be lifted.
- Create a new version (or versions) of a wind turbine to compare.
- Explore wind turbines in your area for further discussion (practicing safe social distancing).

This is a fun and informative activity that keeps students engaged. This activity could lead to conversations about how other turbines work. Students can research other ideas on how “simple” wind turbines could be made with materials found around their home. If materials are available, students could possibly look further into small motorized turbines and how they work.

If you have any questions, comments or have additional ideas, please contact the author at the email address below.

**resources**

Office of Energy Efficiency & Renewable Energy
Forrestal Building
1000 Independence Avenue, SW
Washington, DC 20585

American Wind Energy Association
1501 M St. NW, Suite 900
Washington, DC 20005
[www.awea.org/about-awea](http://www.awea.org/about-awea)

Engineering byDesign™
International Technology and Engineering Educators Association
1914 Association Drive, Suite 201
Reston, VA 20191
[www.iteea.org/STEMCenter/EbD.aspx](http://www.iteea.org/STEMCenter/EbD.aspx)

Tracy Young is the STEAM Specialist at Benton Hall Academy in Little Falls, NY. She is the Engineering byDesign™ instructor for students in kindergarten through grade five. Tracy is also the secretary of ITEEA’s Elementary STEM Council. She can be reached at tyoung@lfcsd.org.
inclusion in the classroom:
definitions, populations, and best practices
by Dan Trent, DTE
Inclusion and diversity have become "hot topics" in almost all areas of our society in recent years.

Large and successful companies embrace inclusion and diversity as key components of their company culture and use this information to promote their "brand." Many schools and universities, both public and private, strive to be inclusive. In fact, organizations that lack diversity or fail to embrace inclusion may be publicly ridiculed for being insensitive.

As teachers and mentors, we have an important role to play in creating a supportive and inclusive learning climate for all students. Research shows that many common educational and social practices reinforce inequities and work against the success of students from underrepresented groups. Thus, promoting success for all learners requires us to reflect on our own practices and engage in deliberate, intentional efforts to model and promote an equitable teaching and learning environment (University of Kansas, n.d.).

Research confirms that businesses that utilize diversity and inclusion initiatives and employ more diverse teams outperform those with a more homogeneous workforce. Similarly, inclusion and diversity practice in educational settings lead to improved student performance among all students. Most agree that inclusion is a "best practice" for almost all organizations.

Casale-Giannola (2014) found that Career and Technical Education, which is foundational for integrative STEM education, is uniquely positioned to provide inclusion opportunities for "at risk" student populations. The study found students in CTE classes benefit via differentiated instruction, real-life connections, opportunities for active learning, repetition, cooperative learning, and meaningful teacher-student relationships.

The words inclusion and diversity are often used interchangeably. In order to create clear diversity and inclusion strategies, it is important to understand the difference between the two. Diversity includes any dimension used to differentiate groups and people from one another. When talking about diversity in a school or workplace setting, we focus on respecting and appreciating what makes people different in terms of age, gender, ethnicity, religion, disability, sexual orientation, education, and national origin (SMARP, 2019).

Inclusion, on the other hand, includes organizational efforts to make individuals of all backgrounds feel welcomed and equally treated. An inclusive organizational culture makes people feel respected and valued for who they are as individuals or groups. People who feel welcomed are often much more committed to their work, are more motivated, and have higher levels of engagement. The process of inclusion focuses on making people feel valued and important for the organization's success. When people feel valued and appreciated, they function at full capacity and feel part of the organization's mission and values (SMARP, 2019).

When discussing inclusion, we need to identify groups that we perceive to be "left out" or isolated. The list includes, but is not limited to: individuals with disabilities, women/girls, "other race" populations, immigrants, rural and inner-city populations, as well as gifted and talented students. Each of these groups presents its own unique challenges to inclusion. They also offer powerful insights and perspectives that can enrich everyone from all backgrounds.

The population most often mentioned in the research includes people with disabilities (both physical and mental). The Alliance for Inclusive Education (2020) defines inclusive education as education that includes everyone, with nondisabled and disabled people (including those with "special educational needs") learning together. They assert that the education system often creates barriers for disabled learners. Some of these barriers are
Gender equity is an ongoing issue across many aspects of society, not just education. Maryville University (2020) has published a "Definitive Guide to All Gender Inclusion" that states that gender inclusion is a concept that transcends mere equality. It is the notion that all services, opportunities, and establishments are open to all people and that male and female stereotypes do not define societal roles and expectations. They claim that discrepancy in workplace wages is one of the biggest indicators that a lack of gender inclusion still exists. We might go a step further and purport that the wage gap exists because we do not encourage girls to explore high-paying STEM careers. It further states one must include females to achieve gender equity.

Racial inequity continues to be a social issue decades after the Civil Rights movement began. Sanchez (2019) claims that race perceptions are engrained early. She says that preschool-aged children begin to observe in the world around them the things that make individuals different. Teachers have the opportunity to teach children the importance of recognizing the differences and being accepting towards others who are racially different. Lessons tailored around racial diversity help children extend their knowledge about others and help develop positive attitudes towards racial diversity. Not acknowledging a difference or not engaging in talk about racial diversity with students can actually increase racial inequality. Sanchez emphasizes one must include all races to achieve racial equity.

Including immigrant populations used to be seen as an issue only for states near international borders. There are large immigrant populations all across the country, not just in so-called "border states." We must be inclusive for all immigrants regardless of the size of the group. It may be even more important for a single student to feel welcome and included than if there is a larger group.

Students in rural environments and kids in inner cities often face similar inclusion issues (or lack of inclusion issues). They may face both physical and emotional harassment at home or in the neighborhood where they live. Rural students often feel isolated and alone. Inner city youth may seek solace in gangs to find a sense of belonging. School can be one of the few "safe" places for these individuals. Having a connection to an organization or group of people that makes one feel able to "be yourself" not only results in greater engagement and creativity, it is a psychological need (Florentine, 2019).

In Career and Technical Education, gifted and talented students are often overlooked as a group with inclusion issues. These students are sometimes excluded from participation in CTE courses due to scheduling conflicts. These so-called "band kids" or other high achieving students may be forced to choose between participating in band or advanced placement courses and CTE classes. Yes, well-organized students with good time-management skills should be a part of the Career and Technical Education landscape.
Inclusion in the classroom is vitally important in the creation of successful schools just as inclusion in the workplace improves productivity there. Best practices for inclusion utilized in business are well suited and easily adaptable for classroom situations. Some of these include: establishing a sense of belonging for everyone, empathetic leadership, and understanding that inclusion is an ongoing process (Florentine, 2019). For individuals to bring their best self forward, a sense of belonging must first be established. For real change to occur, each individual leader (teacher, staff member, principal) must buy into the value of belonging—both intellectually and emotionally. Everyone in the building needs to feel included.

The Center for Teaching Excellence at the University of Kansas (n.d.) has an extensive library of resources for classroom teachers including these best practices: make your classroom inspiring for underrepresented students (e.g., discuss the contributions of diverse scholars); include diversity and disabilities statements on your syllabus; establish guidelines and goals for classroom interactions (e.g., highlight the importance of respecting others’ perspectives, avoiding generalizations, and being careful not to ask others to “represent” a group you perceive them to belong to); build rapport and community in your class (e.g., incorporate peer learning; create diverse teams to avoid isolating underrepresented students or creating homogenous groups); reflect on your own background and experiences and ask students to do the same; create a positive climate for difficult discussions, and scaffold the discussions (e.g., be an active facilitator by rewording questions, correcting misinformation, and referencing relevant material) and choosing content and examples that address and correct misinformation, and referring to “represent” a group you perceive them to belong to); build rapport and community in your class (e.g., incorporate peer learning; create diverse teams to avoid isolating underrepresented students or creating homogenous groups); reflect on your own background and experiences and ask students to do the same; create a positive climate for difficult discussions, and scaffold the discussions (e.g., be an active facilitator by rewording questions, correcting misinformation, and referencing relevant material) and choosing content and examples that address and model diversity, regardless of the subject (University of Kansas, n.d.).

At this point, it is important to mention a common practice that is mistakenly thought to be a best practice. “Colorblindness” is often cited as evidence that a group is inclusive. Simply having individuals from different backgrounds included within a population does not qualify as inclusion. In fact, this practice can lead to completely avoiding the topic of racial identity, thus impairing inclusion rather than encouraging it (Sanchez, 2019).

Teachers must look for ways to increase student exposure to the diversity of human experience. Successful teachers promote a sense of belonging, validation, and mutual respect in their classrooms. An inclusive classroom climate is one that embraces diversity and creates an atmosphere of respect for all members. We should capitalize on the rich array of experiences, backgrounds, and skills that diverse faculty and students bring to the classroom to the benefit of all (Center for the Integration of Research, Teaching and Learning, 2020).

references


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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.

ITEEA Elementary STEM Council

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

Linda Harpine

Gifted Resource Teacher
Rockingham County Public Schools
Harrisonburg, Virginia

2020 Winner of the Elementary STEM Council's Mary Margaret Scobey Award
Virginia Children's Engineering Council Member

by Linda Harpine

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 introduces 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.

Linda and two of her students pictured on the very first Technology and Children (now The Elementary STEM Journal) cover, September 1996.
What has been your favorite moment in your STEM class?
The best moments of engineering projects are when students have that “Ah ha” look on their faces. It happens when some part of their plan doesn’t work quite the way they expected and they have to persevere to overcome the failure. It is exciting to see the pride in their eyes when they are able to rethink, redesign, and reconstruct a successful product!

What is your favorite activity to introduce students to STEM?
One of my favorite challenges is for fifth grade students to design and build their own motorized vehicle. The vehicle must have its own unique design, move forward under its own power, and include a 3D-printed component created by the student using the software, Tinkercad. Students first research the invention of the automobile, look at prototypes of cars of the future and as a group read the book, *If I Built a Car* by Chris Van Dusen. They keep an engineering portfolio where they document their ideas and designs for constructing their own unique vehicle. In the portfolio they make drawings

In Linda's own words:

What do you like about teaching STEM?
I have incorporated STEM activities in my classroom since the early 1990s. At that time these activities were referred to as Design, Technology, and Engineering, and later, Children's Engineering. As the facilitator of elementary STEM projects for many years, I find it most rewarding to observe children actively engaged in the Engineering Design Process. As they work to solve a variety of "hands-on/minds-on" challenges, students have the opportunity to brainstorm, research, plan, collaborate, design, create or build, evaluate, redesign, and communicate their processes and products. The best part is that they are able to apply what they know and have fun! These are memories they will have for a lifetime.

Students learned about children who have traveled to their school in Columbia via a zip line. Their challenge was to design and build a zip line that would safely transport a toy passenger from a height of 7 feet to the floor below. Vocabulary included mass, speed, slope, friction, gravity, and acceleration.

Completed motorized vehicle with 3D-printed bull horns that were student designed on Tinkercad.

Completed motorized vehicle with 3D-printed palm tree that was student designed on Tinkercad.
that include measurements and labels as well as descriptions of problems they encounter and how they are solved. Students use simple hand tools such as a junior hacksaw, table vise, sawing jig, hand drill, hot glue gun, and, of course, safety glasses to construct the vehicle framework. Bass wood sticks, wood dowels, wood wheels, and craft sticks are among the materials provided for this part of the project. Once the chassis is complete, students add the electrical components that power the vehicle. They use a wire cutter/stripper to make a complete circuit that includes a 3.5-volt motor with motor pulley and 2 AA batteries to power a pulley attached to one axle. Students then make a homemade switch to operate their rubber-band-powered vehicle. Recycled materials are used to finish the body of the vehicle. To complete the project, students use Tinkercad to design a hood ornament or other car accessory that is attached to the vehicle body. This has been a favorite project of many students over the years.

What tips do you have for people who are just starting to teach elementary STEM?
Beginning elementary STEM teachers need to realize the importance of the “T” and “E” in STEM, and that these projects can be integrated into the regular classroom curriculum. They should know that the definition of Technology is anything in our environment that is human made or human altered. A chair, a wheelbarrow, and a pencil are all examples of technology. They must understand that technology does not have to involve electronics. The “E” in STEM represents the Engineering Design Process where students apply Math and Science to solve real-world problems or challenges. At the elementary level these challenges can be taken from children's literature. As students move through the engineering process, they should have the opportunity to explore different types of materials and tools as they design solutions to simple challenges. For young students, the engineering process should be more important than the final product. Students should be allowed to experience failure along with the opportunity to create a successful solution to a problem. It is also important for teachers to present challenges to students where there are multiple ways to solve the problem, and not all of the solutions should look the same.

What are your future goals?
After forty-nine years of teaching at the elementary, middle school, and university levels, I will retire at the end of the 2019-20 school year. I plan to mentor local teachers with their classroom engineering activities. I may also continue as an adjunct instructor at James Madison University, teaching future teachers in a Children's Engineering class. I will continue to support the Virginia Children's Council and its annual convention. The best part of retirement will be "engineering" with my five grandchildren!
STEM + C:

Integrative STEM learning embedded with cultural/heritage algorithms

by Virginia R. Jones, DTE
introduction

Underrepresented populations, or underrepresented minorities (URMs) are important participants in developing the STEM pipeline. Using the cultural heritage of our melting pot of learners highlights how STEM components are embedded in many of the indigenous traditions. These “heritage algorithms” (Culturally Situated Design Tools, n.d.) help overcome inherent misconceptions about race and gender in teaching integrative STEM by engaging students by exploring heritage artifacts through nontraditional activities. This approach makes the STEM learning tangible, relatable, and arouses the curiosity in these learners to explore and become more invested in integrative STEM activities and careers.

research and need

How does culture affect integrative STEM learning as well as learning in general? A critique often voiced regarding our approach to engineering ethics or practices evolves around a “black-box” approach, which doesn’t thoroughly provide insight to the intricate nature of technological practice (Nia, et al, 2019). Practices we employ in integrative STEM learning do not exist in a vacuum but are interwoven in the daily lives of all in our society. It is understood that our society is a melting pot of cultures—a tradition valued by most Americans—and understanding that leads us to appreciate that our methods of developing technological practices, specifically teaching practices, must be cognizant of all cultures, traditions, and heritage artifacts of our learners. “In order to be able to address this concern, this study suggests that most technology development practices be understood first of all as multi-aspect systems—involving different peoples, institutions, companies, and infrastructural entities” (Nia, et al, 2019, p. 59).

STEM + C (culture) is a construct that must be explored to ensure our underrepresented populations engage, participate, and aspire to STEM learning and careers. One group, The Culturally Situated Design Tools (CSDT) team, had a mission to promote justice and equality by exploring cultural or heritage algorithms in Science (CSDT, n.d.). Originally funded through a National Science Foundation grant awarded to University of Michigan, Principal Investigator Dr. Eglash, its genesis was based on the concept of Ethnomathematics in 2000 (CSDT, n.d.). Originally focused on engaging learners with mathematical concepts, it morphed into using technology tools coupled with cultural artifacts to engage learners in many different areas.

For Latina students, especially females, limited participation is prevalent due to tensions between groups of participants versus cultural community values. Utilizing the “making and doing” process “touted for its potential to democratize STEM” (Nation & Durán, 2019, p. 1) showed that this process is problematic for young women of color, often limiting their aspirations for continuing in a STEM career (Nation & Durán, 2019, p. 1). Similarly, Native American students are more likely to drop out of high school (McFarland, et al., 2018). The inequities in STEM education are addressed partially by enforcing state standards such as Minnesota benchmarks (Minnesota Department of Education, 2009) shown below:

Standard 3.1.3.2.1 specifically states: “Understand that everybody can use evidence to learn about the natural world, identify patterns in nature, and develop tools. For example: Ojibwe and Dakota knowledge and use of patterns in the stars to predict and plan” (Deustua et al., 2019, p. 2).

Recognizing cultural heritage by using a teaching methodology that embraces it is key to ensuring student success and engagement. Kana’iaupuni et al. (2010) stated: “education is both an individual and a collective experience, where engagement and success can be enhanced and enriched via strength-based approaches, which integrate the culture and community of learners” (p. 2). The study concluded:

First, culture-based education (CBE) positively impacts student social emotional well-being (e.g., identity, self-efficacy, social relationships). Second, enhanced socio-emotional well-being, in turn, positively affects math and reading test scores. Third, CBE is positively related to math and reading test scores for all students, and particularly for those with low socio-emotional development, most notably when supported by overall CBE use within the school (Kana’iaupuni et al., 2010, p. 1).

heritage algorithms

What is a heritage algorithm, and how can one use it to make learning more tangible and relatable to all learners, especially underrepresented learners?
One defines an algorithm broadly as a set of steps or procedures to accomplish an end, or a problem-solving method (Merriam-Webster, n.d.). These problem-solving methods using heritage as a context can engage learners to explore their heritage along with working on current real-world problems. Brain-based research proves that using tools, such as these heritage algorithms, to guide the “doing and making” of STEM activities equips learners to be STEM problem finders (Bevins & Jones, 2020). Using cultural heritage tools assists in developing the emotional, psychological connection needed to embrace STEM learning. Emotional intelligence or quotient (EQ) is an important construct to develop a lifelong learning path inclusive of integrative STEM learning.

Exploring the work done by CSDT and the Native Sky Watchers (NSW), one can draw upon multiple ways of using mathematics, science, and technological skills in conjunction with historical readings in teaching and applying integrative STEM learning, or STEM + C. Using artifacts such as weaving, bead looms, manbetu, corn rows, or graffiti (CSDT, n.d.) in integrative STEM lessons can engage learners on a deeper level as they learn the history, the cultural significance and value to the culture, and practical applications to our current society.

Educators can use heritage algorithms to expand their STEM teaching. As stated in Bell (2018), educators are “are increasingly comfortable with the notion of developing their practice informally and independently,” and developing their STEM practice can be “used as a mechanism to share and subsequently shape new STEM teaching and learning pedagogical principles and to engage in interdisciplinary pedagogical discourse with the aim of enhancing professional practice” (p. 734).

summary

Integrative STEM educators provide connections to real-world learning and careers of the future through their classroom approaches to STEM learning. Adding in cultural components engages underrepresented populations in ways that traditional making and doing activities in our current STEM toolbox cannot do. Exciting these underrepresented learners by embracing their heritage builds a level of confidence, a desire to learn, and an emotional connection to the value of STEM careers and STEM learning.

references


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