The Children's Engineering Journal
Convention 2022

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Greetings from the Virginia Children’s Engineering Council. A year ago, as we greeted 2021, we all gladly waved goodbye to 2020 knowing that a better year was just ahead. Instead of returning to “normal,” we discovered that we were more flexible than we ever expected we could be. We learned to navigate safety protocols to ensure that students across the commonwealth continued to receive engaging, hands-on instruction. As a council, we provided a virtual convention that featured outstanding keynote speakers and engaging breakout sessions. The 2022 convention is also scheduled to be an exceptional virtual experience that the council is so excited to present. If you have missed previous conventions, check out the Children’s Engineering Council website for convention resources from 2016-2020.

As scientists and bioengineers worldwide have worked to develop vaccinations to combat COVID for children and adults, 2021 has provided us with the gift of hope. These advances in understanding COVID leave me so excited as I look forward to the year and the Virginia Children’s Engineering Convention of 2023.

I know I speak for the council when I say "we miss you!" We miss being face-to-face and networking over candied bacon and granola bars with educators from across the state. Despite the challenges the past two years have brought, as a council we have not wavered in our commitment to bring educators some of the best STEM professional development available. With this commitment in mind, I have three specific goals as president-elect for the Virginia Children’s Engineering Council:

Goal 1: Hold a convention in 2023 that is either face-to-face or a combination of face-to-face and virtual to the greatest extent safe and possible.

Goal 2: Share the mission of the Children’s Engineering Council with every school division in Virginia.


I look forward to the coming year and working with the council to continue to provide outstanding children’s engineering professional development.

Barbara Westlund
Children are born engineers. They are fascinated with designing their own creations, taking things apart, and figuring out how things work. Engineering activities tap into the natural curiosity and creativity of all children.

I love teaching kids hands-on, life-applicable lessons. It turns out, these types of tasks are how students learn best.

**Why is it essential to teach elementary engineering?**

Engineering is a vehicle for integrating science, technology, engineering, and mathematics (STEM) into all aspects of your lessons and life. It’s an outlet for creativity, design thinking, and creative problem solving. The result is higher student engagement and achievement.

In engineering class and integrating engineering lessons into your course, students learn to work together, stay curious, problem solve and think critically using creativity. Our young engineers benefit through:

1. **Active engagement.** Kids love designing and creating. They stay actively engaged through design-based projects while deepening their understanding of fundamental concepts.

2. **Improved student learning through hands-on, project-based experiences that connect them to everyday STEM applications.**

3. **Technological literacy through practical skills and more profound comprehension of our diverse modern world.**

4. **Knowledge (know about/know that):**
   - what engineering and technology are and what engineers do
   - various fields of engineering
   - nearly everything in the human world has been touched by engineering
   - engineering problems have multiple solutions
   - how society influences engineering and how engineering influences society
   - engineers are from all races, ethnicities, and sexes and have various abilities/disabilities.

5. **Skills/experience (be able to do):**
   - engage in the engineering design process
   - apply science and mathematics to engineering problems
   - use creativity and careful thinking to solve problems
   - envision one’s abilities as an engineer
   - troubleshoot and learn from failure
   - understand the central role of materials and their properties in engineering solutions

6. **STEM is our future.** STEM learning is inclusive and has multiple entry points for all students.

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**“Tell me, and I forget. Teach me, and I remember. Involve me, and I learn.”**

- Benjamin Franklin

The engineering design process emphasizes open-ended problem solving and encourages students to learn from failure. This process nurtures students’ abilities to create innovative solutions to challenges in any subject. In my class, we work to “fail forward fast.” We have a mantra: Mistakes are for learning. The sooner we learn how not to do something, the sooner we learn to engage with many other ways to solve problems. Investigation, curiosity, and teamwork are core to all we do. Undoubtedly, engineering includes all learning standards and all 21st century skills: communication, collaboration, creativity, critical thinking, and citizenship.

How do we do this with so many different demands and time constraints? First, by being intentional. The benefits of elementary engineering are undeniable. Therefore, I purposefully plan engineering integration. (Even if it’s only once a week, your students benefit.) Second, take advantage of my “go to” resources:

1. [Carly and Adam](#)
2. Low prep. [Design Briefs](#) from the Virginia Children’s Engineering Council (VCEC).
3. [Teach Engineering](#)
4. [Better Lesson](#)
5. [Mystery Science](#)
Third, attend the VCEC Convention. This year’s VCEC Convention, held February 8-10, 2022, is going to be amazing! Attend my session: Equity Engineering Through Can Can Robots. Walk away with an implement! Learn how to connect engineering challenges to the real world, creating career and equity connections for all students. It will be fun, fun, fun!

Why teach engineering to elementary students? Bottom line: It matters.

About the Author:
Pamela Hall, a multinational award-winning educator, is a STEM teacher and author dedicated to helping educators consciously connect with and grow all learners. Pamela’s a lifelong learner leading and inspiring thousands of students and educators.

Pamela has appeared on PBS and local news and written for many magazines, such as Educator Insights. She’s a passionate educator who specializes in student relationships, class culture, engaging challenging students, and hands-on, life applicable learning. She encourages educators to be strong and embrace self-care. She’s an ordinary cappuccino-drinking, chocolate-eating mom and wife from Virginia with an extraordinary passion to make a positive difference.

Click here to see her book: Be Their Warrior- Helping ALL Students Succeed Through Culture, Community, & Being STRONG.

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VDOT launched a new STEM kit loan program in September 2021. Educators in Virginia can borrow two different STEM transportation-themed kits complete with lessons and supplies needed to do hands-on activities with students in grades three to ten.

Virginia educators are welcome to sign up to borrow a kit for a one-month time period. Kits are mailed to educators at the beginning of the requested month. Contact VDOT STEM coordinator Syndra Yancy at syndra.yancy@vdot.virginia.gov or call (804)-904-2207 for more information.

STEM lessons, PowerPoints, and additional outreach resources are located on our VDOT STEM website: https://www.virginiadot.org/info/stem.asp.

Technical Drawing Kit w/ Keva Planks    Sensor Kit w/ MakeyMakeys
Education is Sharing

By Jean Weller

#GoOpenVA Administrator, Virginia Department of Education

Sharing is what education is about. We share with our students, with our parents, and with one another. It’s also how we grow, professionally. Learning how others approach teaching strategies that we might find challenging, or that we just have never thought of, keeps educators in the growth mindset that all great teachers cultivate.

Generally, we share close to home—colleagues in the same school or even division. Sometimes, we get to share at conferences, like VCEC. These are good, but now you have the chance to share beyond your own professional learning community.

The Virginia Department of Education has developed a place for educators to share teaching ideas, lesson plans, and even professional development sessions. Called #GoOpenVA, it is located at https://goopenva.org and is open to everyone (though only Virginia educators who are registered users can actually post things—registration is free, of course, and is most often handled by your division’s single-sign-on portal so you don’t even have to remember a password).

#GoOpenVA was launched just before the pandemic, so you may not have heard about it yet—we have all been a little busy with other things! But as we slowly emerge from emergency mode, it is a great little service that you can take advantage of. Search for lesson plans, created by teachers who have been there, done that. Add your own lessons to the database—and share your creativity with teachers who are hungry for new ideas.

Everything on #GoOpenVA is copyrighted with an “open license,” and is called OER (openly licensed educational resource). This means that educators who use the materials posted are given permission to edit, or adapt, the ideas and lessons and then to re-share their edits with others (called “remixing” in the OER world). If you find a cool lesson plan but you need to tweak it because your students use a particular tool, or need to have directions in a language other than English, or need to have more visuals—you can do that without worrying about asking the copyright owner for permission ahead of time. (Yes, I know. Teachers already do this, even with copyrighted materials. But that is usually just for their own students and limited in reach. All the work you put into adapting someone else’s lesson gets lost to other teachers facing the same needs—so everyone ends up reinventing the wheel, again and again.) Of course, you might decide you like the lesson as is, because we do have some great teachers in Virginia!

In order to get the ball rolling, #GoOpenVA started our existence with some lessons that were created by national and international education entities, like TeachEngineering and the Massachusetts Institute of Technology. These, of course, were never aligned to the Virginia Standards of Learning, but they are part of our system and can be searched by keyword using our search engine. After launching #GoOpenVA, we began gathering lessons from Virginia educators and education entities. Most of these are aligned with the Virginia standards and you can search by particular SOL indicator.

To learn more about Creating and Remixing on #GoOpenVA, visit the #GoOpenVA Help Hub. You can find all kinds of helpful things there, from recorded screencasts to illustrated step-by-step printable instructions. One of my favorites is the ever-updated Copy-and-Paste Resources for Use by Creators (OER images, audio, video, etc.) which links to sites that provide free and openly licensed materials you can use in presentations, student materials, and for any other purpose. A lot of people think that anything you find free on the Internet is copyright-free—that is not true, and it’s important to be aware that the image you downloaded of tractors moving hay from Google may be a copyright violation, especially if used in online resources. Or it might not be. Why take a chance? Start with those openly licensed resources and you will be much less likely to be breaking any laws!

Remember that you can view/download all of the resources on #GoOpenVA anytime, but if you want to become part of a community of mutual mentors, you
need to become a registered user (see [Getting Access to #GoOpenVA](#) for instructions on how to easily join this free VDOE-supported resource).

**What you can find on #GoOpenVA:**

### Getting Started with Osmo Learning Tool

**Overview**
In this resource, teachers will learn how to set up their Osmo learning tools and begin having students engage in learning using it.

This lesson is part of the Virginia K-12 Computer Science Pipeline which is partly funded through a GO Virginia grant in partnership with Chesapeake Public Schools, Leoudon County Public Schools, and the Loudoun Education Foundation.

- Osmo Teacher intro video
- Support Resources from Osmo Website
- Osmo Teachers Guide PDF
- Osmo Words Teachers Guide PDF

The Virginia K-12 Computer Science Pipeline provides lessons and professional learning for K-12 teachers.

### TeachEngineering

**Hands-on Activity**
Invent a Backscratcher from Everyday Materials

Click here to rate!

**Summary**
Being able to recognize a problem and design a potential solution is the first step in the development of new and useful products. In this activity, students create devices to get “that pesky itch in the center of your back.” Once

One of our national providers is TeachEngineering.

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**Virtual Field Trip in Scratch Remix (Regions of Virginia)**

Overview
During this unit, students will take you on a virtual field trip through one of the regions of Virginia. In this way, they will use CS concepts like events to switch scenes and sprites and sensing (conditions) to interactivity.

A remix by one teacher of another teacher’s creative idea—merge the lesson in Scratch with learning Virginia geography!

**Electronic Scrum Board: Collaborative Work Model**

This scrum board can be used in any subject. It is a project management tool. It can also be a process learners use. Sometimes in expecting learners to participate in a group project, some or all of the learners may not have a process to help adult learners facilitate group project work with a business perspective.

The original author originally used this technique using post-it notes (EXPERIMENTAL), so he/she created a google doc Scrum Board Template.

Information about Scrumming in the classroom

Tools that teachers can use with their students.
Quick lesson plans for teachers who need SOMETHING right now!

Nationally created tools teachers and students can use for exploration.

Teaching Computer Science Through the Lens of Children’s Books

By Thea Clark and Dana Dembeck
Elementary Instructional Technology Coaches
Frederick County Public Schools

Teaching the computer science standards can be daunting for classroom teachers. They get overwhelmed and do not feel they have adequate knowledge of the standards on their own. Through a simple but powerful exercise, we can help teachers see how much of the computer science standards they are already teaching. By giving them time to highlight the words in the computer science standards that they recognize that they already teach in other subjects, the weight begins to lift. Once they begin to see that many of the concepts are already being covered in other areas, we can then move on to integration. Language arts instruction is the bulk of an elementary teacher’s day. No one can deny that anytime we give a child a chance to interact with a book it’s going to produce a learning experience for the child.

As elementary instructional technology coaches, we have found that a book is our foot in the door of the classroom. Several years ago, prior to computer science implementation, we started digital citizenship book lists.
to use with students. Our love for literature carried over into computer science when those standards were implemented. Our books are divided into two parts. One set of books that we use are about core computer science content. These books are what we use to introduce computer science. We then also use the books to practice various comprehension strategies while we are learning computer science. Some of our favorites include the Hello Ruby series by Linda Liukas. These books teach about coding, computational thinking, how computers work, and how the internet works. Through these engaging stories, we tie whatever strategy the students are currently working on during their language arts block.

As students begin to have an understanding of basic computer science terminology, we begin to help them make the connections. For example, when students are looking for the main idea, we can use the computational thinking skill of abstraction and only focusing on the key information while ignoring the small details in the story. Also, when stories have repeating parts, we can point out that these are similar to loops when we are creating algorithms and programs. When students are breaking apart words or sentences, they are using the computational thinking skill of decomposition. There are so many connections and ways to incorporate computer science into other subject areas.

The second set of our book collection involves the books they are using with their adopted reading program. Once students are able to articulate computer science basics such as creating algorithms, they can apply those to what they are learning. We teach students how to do unplugged coding. The students can create algorithms to sequence events in the story or capture the main idea. We take words and or pictures from the story and have them create algorithms to code a “robot” to various spots on the coding mat. Teachers love using this as a center while they are meeting with small groups, and their students are engaged!

To learn more about our journey with CS and children’s literature join us Thursday, February 10, at 5:30 p.m.!
Innovative Designer

By Elizabeth Kirk

Standards, standards, standards. Yep, every content area has them, even computer science. We know standards are important and help bring equity to the students of Virginia. We always connect our STEM and children’s engineering challenges to standards because of natural connections and integrations. But what about standards for STEM? Well, we now have standards, or at least a content strand, in the new Digital Learning Integration Standards (DLIS).

The Digital Learning Integration Standards (DLIS) are worth delving into and integrating throughout your curriculum. These standards replaced the computer technology standards and are truly an improved version that look beyond just computers. They use the term “technologies” as digital and nondigital, including “...different facets, tools, apps, and applications that support and enable students” and include “...unplugged activities.”

The content strands are Empowered Leader, Digital Citizen, Knowledge Constructor, Innovative Designer, Computational Thinker, Creative Communicator, and Global Collaborator. They have specific correlations to the Profile of a Virginia Graduate and provide a learning progression of skills divided into grade bands (K-2, 3-5, 6-8, 9-12), allowing for a more manageable approach for integration. Connections to design thinking can be found throughout the strands but specifically in the Innovative Designer strand (my favorite). Let’s take a closer look.

For Innovative Designer, the standard reads, “Students use a variety of technologies, including assistive technologies, within a design process to identify and solve problems by creating new, useful, or imaginative solutions or iterations.” Isn’t that the heart of STEM and children’s engineering? VCEC’s mission is to promote design, engineering, and technology in our elementary schools, and now we have the standard (content strand) to back up what we know is best for students!

There are four learning priorities for Innovative Designer. Let’s take a closer look at the elementary performance indicators for these.

1. The first priority specifically focuses on “...a purposeful design process for generating ideas, testing theories, creating innovative (digital) works, or solving authentic problems.” Our K-2 students are to ask questions, suggest solutions, test ideas, and share with teacher guidance. Our Grade 3-5 students continue these skills with specific mentions of practicing a design process and making a plan again with educator guidance.

2. The second priority focuses on planning and managing a design process that considers constraints and risks. Our K-2 students use technologies (digital and non-digital) in a design process and are aware of the systemic process of design with guidance from an educator. Our Grade 3-5 students continue with this guidance to plan and manage a design process.

3. The third priority dives into redesign as students develop, test, and refine prototypes as part of a cyclical design process. Teacher guidance continues to be important, as well as reflecting on the role of trial and error.

4. The fourth priority calls out specific skills that all students (and adults) need, including perseverance and being able to work with open-ended problems. These skills continue with educator guidance at the elementary level.

Innovative Designer supports the design process approach of STEM and children’s engineering. It promotes problem solving, critical and creative thinking, collaboration, communication, and the skills all students need to be life ready. So, integrate the STEM/children’s engineering challenges and activities that you love! Fiddle with new non-digital technologies to provide hands-on experiences. Model how to problem solve, redesign, and persevere (even fail!) with your students. Design and create new activities knowing that you are meeting our Virginia Standards of Learning while promoting what’s best for students.

Thank you, Virginia, for developing standards that align to the skills that students need to make learning deeper and more meaningful while providing them with problem solving strategies that will last a lifetime. Let’s all be Innovative Designers!
STEAM Girls Club

By Amy Holt, Shelley Pohzehl and Courtney Strauss

Have you noticed a need in your school for creative ways to get girls excited about STEAM and STEAM-related careers? We did, and we did something about it!

In our school, our robotics team was heavily dominated by male students. We also held a Math and Chess club that was better represented by male and female students. However, what our school did not provide was an opportunity for female students to learn about STEM careers. Statistics show that in 2019 only 27% of STEM careers were held by women, even though women make up 48% of the workforce. Why?

We know that STEAM in schools is an educational experience that aligns with having a growth mindset, and it acts as an access point for guiding student inquiry and creativity. With this in mind, our team was tasked with creating a plan for the development of STEAM as a school focus. We began our journey by attending the VCEC Convention in 2019, and we left feeling so inspired that, on the drive home, we recognized the need for STEAM for our female students and created a plan for implementing a STEAM Girls Club at our elementary school. Our goal was simple: to expose girls to STEAM-related careers and get girls excited about STEAM. Our program design was straightforward and consisted of monthly meetings, with each meeting devoted to one STEAM-related career. During that meeting, the girls would meet with a female guest speaker from a STEM career and participate in a hands-on related activity.

With the support of our principal, we were able to pool our resources to get our club started. When we proposed this club to the school, the responses were overwhelmingly positive. We had so much interest in joining that we had a waiting list right from the start. We opened the club to girls in grades one through five. We surveyed the girls to see which topics/careers they wanted to know more about, and we went from there. Once we had this list of interesting topics, we brainstormed who our speakers might be and what activities we might do. Teachers volunteered to help with the club, and we borrowed resources from our colleagues. We initially asked for volunteer speakers from friends, family, and parents within our school community.

STEAM Girls has been well received by our principal, staff, and community. Our principal has been extremely supportive of our club from the start. The STEAM momentum started by our little club resulted in a new STEAM teacher position that was added to our Encore class rotation this school year. Parents have been equally supportive by signing up their girls for our programs, volunteering to be guest speakers, and donating supplies.

When schools went remote due to the pandemic, we were having so much fun that we didn’t want to stop our club, so we didn’t! We committed to meeting virtually twice a month on Zoom and adapted the format to make it work for us. Our first meeting would be with our speaker, and instead of the hands-on activity that our girls were accustomed to, we ended the meeting by giving the girls a task, or design challenge, that was related to our speaker/topic. Our second meeting was a design challenge showcase, which was a culminating activity where the girls could present what they worked on the previous week. We used Canvas to post information and announcements and See-saw for the girls to post their design.
challenges. We made the most of an unfortunate situation, and this format allowed us to reach speakers that wouldn’t have been able to come to school to talk to us. We were able to talk to an aerospace engineering and physics double major, an infectious disease specialist with the Centers for Disease Control and Prevention, a veterinarian, a museum curator, an environmental scientist, an engineer, and a geologist. One thing that surprised us doing this virtually was the level of engagement from the girls. They were just as focused and asked even more questions on Zoom than when we were in person.

Due to the popularity of the club, we were asked to run a weeklong STEAM Girls summer camp. We had so many girls sign up that we offered two different time slots each day to accommodate the number of girls. We didn’t have speakers for this summer camp, so the format was a little different. We were able to focus on STEAM skills and the design process and had the girls engage in critical thinking and deep discussion about their learning. We delved into coding using Ozobots, Spheros, BeeBots, and Scratch. This seemed to be a highlight of the camp for the girls.

Initially, we started this club during the 2019-2020 school year with a small budget. Our funding primarily came from club dues that provided a club shirt for each girl and paid for our consumable supplies. We received a $2,000 grant in the spring of our club’s first year that we used to purchase Spheros. Our club was virtual for the next school year (2020-2021), so we did not collect dues. We were able to provide a free, one-week, in-person STEAM girls’ camp during the summer that was funded by a different grant. Our club for the 2021-2022 school year will start in January, and we plan on collecting dues to purchase shirts and basic supplies.

If you are interested in starting a STEAM Club at your school, we recommend just jumping right in and using the resources available to you. Don’t be afraid to check with the staff in your building. You can ask for help, supplies, or speaker recommendations. Do the same and reach out to your school community; you’ll be surprised what resources are available to you. Worry about grants and funding later. It doesn’t need to be perfect or pretty, just make it hands-on and exciting. Reflect on what went well, focus on what is interesting to your club, make any adjustments, and have fun!

We are excited to meet in person again this January and use the title of STEAM Girls. Now that there is a STEAM teacher in the building and they are doing lots of hands-on activities each month in the classroom, we will focus on coding and related jobs in the tech industry. We plan to partner with the STEAM teacher on a STEAM night at our school and promote an interest in coding and a love of technology.

VCEC is where it all started.
Idea to Object: Driving Ingenuity, Creativity and Design with 3D Printing
By J.R. Bontrager
3D Specialist at 3D Herndon

3D printing has gone from a niche tool making tchotchkes and toys to revolutionizing the manufacturing pipeline. With this technology growing in daily use, the need to educate early in a child’s academic career is imperative. The advantage of 3D printing in the classroom is that students can see their work transformed from the screen to a physical object. Now students can design parts, 3D print prototypes and make iterations to have fully working components. These models can visually aide in showing simple or complex ideas and concepts in all the STEAM curriculums.

3D printing can create shapes, mechanisms, and geometry that cannot be manufactured normally. All of this lends to near-limitless possibilities of integration into the classroom. With programs like TinkerCAD, educators and students can learn cooperatively in the 3D space. Making simple objects like keychains, name plates, and cookie cutters, any student can learn the three fundamentals of 3D: placing shapes, grouping shapes to create components, and using shapes to cut more complex geometry. With these basics as building blocks, anything can be created in such a simple program.

For educators that are as new to the technology as the students there are several free, online 3D model repositories that offer pre-made, educator-created lesson plans. One such site, Thingiverse, offers these lesson plans complete with all the relative 3D models, 3D printing instructions, handouts, and additional resource checklists. Additionally, organizations like NASA and the Smithsonian have catalogs of 3D printable engineering parts, aerospace models, and historical artifacts. With such a broadening range of accessible models, lesson ideas, and creative uses of 3D printing, this technology can help stimulate learning, critical thinking, and problem solving in STEAM classes and beyond.

Das Fernweh
By Katherine Mangum

It’s my favorite word and it means a longing for distant places or to be homesick for a place you’ve never been (thelocal.de 30 January 2019).

Fernweh...I was introduced to this entrancing word and its magical meaning in June 2019. I was at the Goethe-Institut in Washington, D.C., preparing to lead a two-week Transatlantic Outreach Program (TOP) STEM Study Tour to Germany. Full of nervous energy while waiting to welcome my traveling companions, I reached into a bowl of colorful button pins each customized with a German word. I pulled fernweh, and I’ve been its word fan ever since.

Almost two years into the COVID-19 pandemic I find myself whispering fernweh as I remind my fifth-graders to pull up those masks and maintain safe distances during our science and engineering classes. Like every teacher across the globe, I am yearning for a break from the rigidity of our all-too-familiar COVID classroom routines. As international travel restrictions ebb and flow, I long to confidently exchange my 2020 summer travel vouchers and set off on a new learning adventure. Every time I whisper fernweh, my mind immediately wanders back to TOP and the deeply enriching experiences I shared with 14 STEM teacher leaders from across North America as we traveled throughout the state of Baden-Württemberg in southwest Germany almost three years ago.

If the notion of fernweh has you a little bit curious or like me, you are looking for a fantastic STEM professional development experience, I highly recommend TOP! It is a unique public/private partnership between the Federal Foreign Office of Germany and industry leaders. Founded in 2002, TOP provides social studies and STEM educators complimentary standards-aligned lesson plans and resources to use in their classrooms. The TOP team, with their beautifully curated materials and social media accounts, helps North American teachers keep current with up-to-date information on contemporary Germany and offers a balanced view of Germany as an important international partner. Eager to enhance the global competencies of teachers and students alike, TOP promotes education, dialogue, and experiences on topics including culture, the
German school system, apprenticeship programs, history, politics, and sustainability projects.

Prior to the spring of 2020, TOP took approximately 100 educators to Germany on six different, two-week study tours during the months of June and July. For the past two summers, TOP has been hosting virtual study tours to Germany. I’ve had the opportunity to make hummus with a Berlin-based intercultural cooking project, take a hike in the Black Forest, share ideas with German educators from Bavaria, learn about bionics with the Esslingen-based robotics manufacturer Festo, and so much more all from the comfort of my home.

Fortunate to participate in a TOP STEM Study Tour in 2015 and again as a group leader in 2019, I cannot stress how much I have grown personally and professionally through my connections with TOP. My adventures exploring modern Germany with like-minded educators have truly been the highlight of my teaching career!

Since my TOP STEM Study Tours, I have maintained wonderful friendships, shared professional resources, and co-presented at national conferences with my cohorts. My experiences in Germany have inspired more than science lessons and engineering challenges in my classroom. My students have enjoyed comparing and contrasting their lives with the lives of German children as they research daily life and schooling in contemporary Germany. They have been eager to try a few German words and basic phrases using https://kinderuni.goethe.de/?lang=en. Retooling old plans to add a German twist has brought new life to a few classic lessons and activities. The standards-aligned TOP resources are engaging and fun! I have even used them with my FIRST LEGO League robotics teams!

When the time is right, the TOP team will share information on how to apply for their next in-depth STEM study Tour opportunity. Until then, please visit https://www.goethe.de/ins/us/en/spr/unt/efd/top.html to learn more about the TOP program, access curriculum resources and materials to use with your students, or sign up for one of their bespoke virtual study tour experiences. If you do, you just might find yourself whispering fernweh in class, too!!

https://www.thelocal.de/20190130/fernweh/

https://issuu.com/topteachgermany/docs/top_mgu_fall__hires_2015

Photo credit - Wood Powell, Managing Director, Transatlantic Outreach Program

Have you joined VCEC?
Visit https://childrensengineering.org
Navigate to the Organization tab and select Become a Member.
VCEC only $10 / year
VCEC, VTEEA, ITEEA combined membership $55 / year
TOP Solar Boat Challenge Plans  
kmangum@st.catherines.org

**Background:** Students have a basic understanding of energy and energy transfer from prior science experiences. They can build simple electric circuits using provided components. Students know energy from the sun can be converted into electricity using a solar cell and can describe this process in age-appropriate terms. Students understand solar energy is renewable. Students have researched Freiburg, Germany. They have compared Freiburg’s reputation as a leader in sustainability to their own community and they know the history of the Bächle.

**Engineering Design Challenge:** Harness the power of the sun to transform its radiant energy to work for you. Using any of the materials provided, work with a partner to design, build, and race a solar-powered boat.

**Criteria:**
- The boat must not exceed 15.5 cm in width or 23 cm in length.
- The boat must use a solar cell to power the electric motor.

**Suggested Materials:**
- 16- to 18-ounce recycled plastic bottles
- balsa wood blocks
- Styrofoam blocks
- flat pieces of cork/corks
- sandpaper
- empty pint cartons
- chenille stems
- cardstock
- glue/glue dots
- foam tape/duct tape
- paper clips and fasteners (brads)
- solar cells with alligator clips/leads
- hobby motors with alligator clips/leads
- plastic coffee straws/regular drinking straws
- assorted LEGO pieces
- cardstock/thin cardboard
- access to water
- Race Record Sheets

**Tools:**
- scissors
- centimeter rulers
- push pin paper drills
- hot glue guns with glue
- permanent markers
- X-Acto knives
- wire strippers
- tubs for testing boats
- stopwatches/timers
- iPads/devices for recording
- light for testing boats

**Racetrack Ideas:** 20’ x 6” guttering; Cub Scout Raingutter Regatta Inflatable Raceway; 2x6s, 2x8s, plywood, tarp to build your own; PVC pipes to build a track.

**Targeted Virginia Standard of Learning:** Science 5.6d
Supporting SOLs: Science 5.2, 5.4, 5.9

**Targeted Standard for Technological and Engineering Literacy:** 7
Supporting STLs: 8

**Next Generation Science Standards:** 4-PS3-2, 4-PS3-4, 3-5-ETS1-1, 3-5-ETS1-2
Design, Construct, Test, and Refine Solar Boats
Working with a partner, students sketch and label a design for their solar boat. The labeled sketch must include the circuit containing the motor and solar cell. It should also include the propeller. Once the teacher approves the sketch, the students may begin the construction process. Students may test their boats using the provided tub of water. A light should be provided if the students must be indoors for testing. Students adjust and refine their designs before race day.

Develop a Plan to Race Solar Boats and Collect Data
The students will work with the teacher to establish and document guidelines for racing the boats. The class will determine how to collect and record race data. This plan must include opportunities for each student to participate in data collection. Working together, students will create and share a record table/sheet. The students will develop a plan for documenting and sharing the outcomes of the races.

Analyze Data
Students will compare different solar boat models as they analyze data. They will work to draw conclusions about the effectiveness of the various designs. The teacher will guide and document student thinking as the students discuss.

Draw Conclusions
After class discussions, students will show their understanding through journal writing. They will be expected to incorporate related vocabulary and support their claims with evidence from their shared experience. A labeled solar boat diagram should be included in the journal. The diagram should integrate effective design elements related to the class data and discussions.

Modifications
Students could follow provided step-by-step instructions for building a solar boat, rather than designing and building their own.

Extensions
- Students can design and print their own boat(s) and/or propeller(s) using TinkerCad and a 3D printer.
- Students can learn to waterproof their motors by watching SeaPerch training videos (https://www.youtube.com/watch?v=ngdXihaZgAY).
- Students could determine the optimal angle for their solar cell and build adjustable solar cell stands to add onto their boats.

**See next page for research resources**
Richmond, VA Resources for Teachers & Students

City of Richmond Resources
https://www.rva.gov/sustainability/news
https://www.viridiant.org/homeowners-2/solar/

St. Catherine’s Resources
https://www.st.catherines.org/school-life/environmental-stewardship

VCU Resources
https://sustainability.vcu.edu/about/
https://fmd.vcu.edu/sustainability/
https://sustainability.vcu.edu/campus/resource-use/solar/

University of Richmond Resources
https://sustainability.richmond.edu/

Germany Resources for Teachers & Students

Articles on Solar Power in Germany
https://en.wikipedia.org/wiki/Solar_power_in_Germany

Freiburg
Freiburg was named Germany’s most sustainable city in 2012.
Freiburg is known as Europe’s “solar city”.
Freiburg ~ City of Vision
Freiburg ~ New City Hall

Freiburg’s Vauban (TOP Fall 2020)
https://www.youtube.com/watch?v=YBFCXsR2zVU
http://www.passivhaus-vauban.de/idee_en.html
https://www.youtube.com/watch?v=6XeMHuO_6-0
http://www.stevemelia.co.uk/vauban.htm
https://www.freiburg.de/pb/site/Freiburg/get/params_E-1604864046/647919/Infotafeln_Vauban_en.pdf
Hillsboro Charter Academy (HCA), a small public charter school and part of Loudoun County Public Schools (LCPS), opened in 2016. It was started by passionate parents and teachers who wrote a charter proposal to the district with the idea of a school that had a mission and vision focused on STEAM education and keeping the small community environment. All of the scholars enrolled at HCA are LCPS students that were offered a spot at our school through an open lottery system, which occurs in March each year. HCA is free; the only requirement is to live in Loudoun County. We have amazing retention, and most students come in kindergarten and stay through grade five. We currently have 144 students (the maximum capacity with 24 in a class) and there are over 300 more students on our waiting list. Our school is small, with one class of 24 scholars per grade level. We have six classroom teachers, one each for K-5, and six specialists (STEAM, Art, Music, Physical Education, Library, and Guidance) that teach STEAM on a daily basis. While we have 24 in each class, we also have a kindergarten teacher’s aide all day, a grade one/grade two floating teacher’s aide, and a grade three/four/five floating teacher aide in the academic-focused mornings, and then we co-teach with pairing specialists with classroom teachers in the afternoon during our E3 (Explore! Engage! Engineer!) time.

We give priority to quality professional development by purposefully planning our yearly calendar around PD opportunities, including conferences and workshops, so that there is no school for our scholars during the PD. This makes it possible for HCA to send our entire teaching faculty to conferences/workshops to learn as well as promote our innovative STEAM/E3 Program and collaborate outside the school building. We have done this for opportunities like the Virginia Children’s Engineering Conference (VCEC), the Space Exploration Educators Conference (SEECC) and coming up this year, the International Technology and Engineering Educators Association Conference (ITEEA). This not only promotes bonding as a team but also gives us a common training and theme to take back to the school and implement in a timelier fashion than if we all went to separate training sessions.

HCA cultivates an inclusive and respectful environment that celebrates differences and fosters ethical behavior and global citizenship. One of the unique aspects of HCA’s small-school culture is the distinct opportunity for students of all ages to interact with one another, regardless of grade level. Scholars know each other well and frequently collaborate in cross-grade-level activities. Students participate in lessons and activities that teach friendship, tolerance, diversity, hard work, teamwork, responsibility, respect and conflict resolution. To build on such lessons, HCA provides a weekly opportunity for one scholar in each grade level to tell the class about themselves personally. HCA participates in National Unity Day in order to bring our students together and commit to treating each other with kindness and respect. Students also participate in the Great Kindness Challenge, in which each student does at least one random act of kindness at school—which contributed to HCA’s recognition as a Kindness-Certified School.
HCA aims to foster a safe learning environment in which children can fully develop their abilities, balancing academic achievement with social and emotional needs. Through our emphasis on a growth mindset, we create a culture in which mistakes are encouraged and failing is celebrated with the intent of being able to try again. This empowers our students to be risk-takers who put forth extensive effort in all academic endeavors. We also teach students about social and emotional resilience, helping them identify their individual strengths and how to use those strengths to “bounce back up” when feeling down. We add coping and calming strategies in combination with other lessons on connections and relationship-building. These efforts allow diverse individuals to collaborate successfully, which is critical to HCA’s overall instructional approach.

Because we are a STEAM-based elementary school, we do not have a siloed engineering curriculum; rather, it is integrated into our instructional design. The courses are designed by grade level and are scaffolded as our scholars progress through our school STEAM curriculum. The STEAM/E3 curriculum starts with the science and mathematics Standards of Learning for Virginia (SOLs), and then the implementation of the curriculum is driven by the ITEEA Standards for Technological and Engineering Literacy (STEL). This program at HCA is designed to create a strong foundation of the engineering design process integrated across the school and surrounded by a growth mindset. The STEAM/E3 program focuses on the 21st century skills that scholars need to succeed in the real world. It provides opportunities for discoveries, inventions, innovations, iterations, and success through a collaborative lens. Scholars begin the program in kindergarten with an engineering notebook and are taught the importance of intellectual property from the start. Our STEAM/E3 program empowers our scholars to explore, engage, and engineer in a safe and fun environment.

The engineering design process is a common language throughout our school. We have designed an engineering vocabulary progression that helps to keep a common language across the campus when related to engineering. The teachers all have posters of the engineering design process in their classrooms and infuse the process into their everyday teaching.

E3 is a specific block of time every day in our schedule where the entire school is doing real-world, relevant learning. E3 shows our scholars the application, or the “why,” of what is being taught in our core subjects. During E3 time, we co-teach with specialists (modeling collaboration) to incorporate STEAM, inquiry-based lessons, passion projects, and guest speakers (like NASA engineers, the Space Force, authors and even Miss America 2020), which all facilitate project-/problem-based learning.

Our faculty has regular meetings to talk about integration of the STEAM program into E3 time as well as how to plan for a STEAM lesson versus a regular lesson. We do a “speed meeting” planning session where our specialists rotate from teacher to teacher to help plan how to most effectively implement our E3 time. During E3, students are often given (or come up with) real-world problems to solve. Our scholars learn the engineering design process beginning in kindergarten in their STEAM class. It is reinforced in other classes, and scholars often apply it during E3. They also learn how to work productively in a group beginning in kindergarten, with specific training on giving constructive feedback, and lots of practice with combining ideas from different group members. Scholars, K-5, self-evaluate their group work in STEAM, which means they need less support in this area from teachers when they are working in groups during E3.

E3 is a culmination of each of the courses offered in our program and the synthesis of our core instruction and STEAM. Most E3 projects begin with a driving question about a real-life problem students are tasked with solving. Students are given explicit instruction
in skills they may need to adequately solve the problem, often hearing from expert speakers to provide them with the background knowledge they may need through our established Technical Advisory Group (TAG) Team, which is composed of parents and community members whose purpose is to provide technical knowledge to scholars and help make the learning experience rigorous and relevant for the scholars. Though instruction for background knowledge and skills is instructor-driven, the solutions themselves are left to the students to design. Usually, students are given time to brainstorm on their own. They then share their ideas with partners or small groups and re-engineer solutions based on their collaboration. Building the design comes next, with presentations and reflection following. Though well-developed, the process is fluid, and adaptations are made based on the students' passions, the curriculum being taught, and the real-life problems being faced in the school or community. We also have a school-wide Exhibition of Learning (EOL) twice a year for the scholars to showcase their learning to their parents and the community.

At HCA, we believe that creating STEAM design challenges that are real/relevant to elementary scholars in an environment where it is safe to fail, through the lens of a growth mindset, is vital to the success of a quality STEAM program. Sprinkle in 21st century skills, and there is no limit to STEAM success!

Spring Run Elementary School is located in Chesterfield County and is in its fifth year of having a STEAM resource program. Each year, the program grows creatively and technically. The students collaboratively work on the engineering design process while incorporating robotics at an early age. The class is offered once a week to kindergarten through grade five, but also has a Robotics Club and a STEAM Team to ensure the passion for STEAM goes beyond the classroom. The in-depth look at STEAM careers and future paths leads the students into secondary choices and builds upon the programs offered to them later.
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