BOXLIGHT

THE BIG GUIDE TO
STEM

VOLUME № 2

INTRODUCTION

You've probably heard of STEM—you may even teach STEM in your classroom. The key to students' success is not only to learn science, technology, engineering, and math, but also to understand how those disciplines apply to the world around them. Students need to develop the critical skills that will prepare them for beyond the classroom, enabling them to be tomorrow's engineers and innovators.

The focus on STEM is a necessity in order for Americans to be competitive in the future job market. STEM careers will continue to grow, but these courses are scarce in too many schools and communities across the country. A 2017 presidential memodorandum states that "nearly 40 percent of high schools do not offer physics and 60 percent of high schools do not offer computer programming," which will surely hurt those students' chances in the future economy. What's more, "only 34 percent of African American students and 30 percent of rural high school students have access to a Computer Science class."[1]

It's time to make STEM a priority for all students. In this guide, we dive into the many ways to incorporate STEM learning into the classroom, how to engage students in STEM to ensure they're prepared for careers in these fields, and take a look at the STEM products that are changing the way we teach and students learn. You'll also find our collection of top 10 STEM lists to help you do everything from finding the perfect math app or funding opportunity to staying inspired through our favorite STEM blogs and online communities.
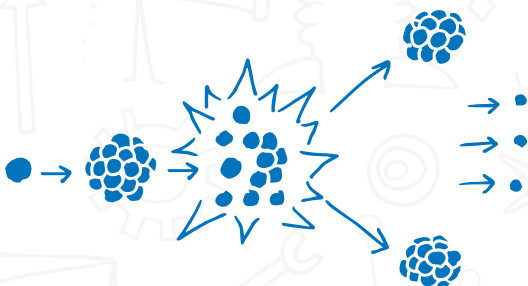
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KRISTY
NERSTHEIMER

WHY STEM IS CRITICAL FOR TODAY'S STUDENTS

At the forefront of education today is STEM (science, technology, engineering, and math), also known as STEAM (adding an A for arts), and even more recently as ST2REAM (adding a second T for thematic teaching and R for reading). The Department of Commerce has indicated that STEM occupations are growing at a rate of 17%, compared to 9.8% in other professions. In short, there will be more STEM positions than any other field. STEM is now the driving force of our future, and we have to prepare our students for a workplace vastly different from today.

To put things in perspective, here is a quick glance at areas in need of STEM knowledge:

- In the science field, there are issues with global warming/climate change, weather, air, space, and medicine, such as cancer or Alzheimer's.

- Technology covers computers, cell phones, tablets, TVs, and the digital age.

- Engineering includes infrastructure, buildings, cities, bridges, and designs.

- Math skills are involved in banking, economy, accounting, investments, and taxes.

STEM occupations are growing at a rate of 17%, compared to 9.8% in other professions.

In order to remain a world leader, we need to send students out into the workforce equipped with these skills. However, our nation's test scores are behind in math and science. The 2015 results of the Programme for International Student Assessment (PISA) indicated that the US ranked 38/71 in math and 24/71 in science. By implementing STEM into the classroom, the hope is to develop more passion and knowledge, which, in turn, will supply our economy with competent employees.

The Many Benefits of STEM Learning

The good news is that STEM covers a multitude of necessary skills: hands-on, critical thinking, problem solving, student-driven, creativity, innovation, collaboration, inquiry, leadership, and teamwork. STEM integrates the curriculum—teachers are no longer just presenting a math lesson, then a science lesson, then a reading lesson, etc. Classrooms are

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implementing units or themes centered around different science subject matter. For example, kindergarteners are learning about structure and design through literature such as *The Three Little Pigs*. The story is read and students ask questions such as how could those little pigs have built a more secure structure so that nasty wolf couldn't have blown down those poorly constructed houses? Then students design and build their own structure and the big bad wolf (accompanied by a leaf blower/hair dryer) tries to blow it down. All content area subjects are needed for this unit: reading and writing are required for the basic premise and design, math is needed to calculate measurements or supplies, soft skills like collaboration and communication are needed to build the structures, technology can be used throughout by videoing before and after attempts so students can go back and redesign—all under the umbrella of a science-driven theme. Students are engaged and problem solving throughout, and they love it.
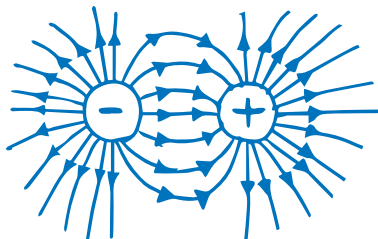
Another benefit of STEM education is brain development. The human brain functions best by making connections. The brain needs both socio-emotion and cognition to function. STEM teaches many soft skills such as teamwork, problem solving, communication, and self-confidence. STEM also allows for hands-on experiences for students. Using more sensory experiences maximizes these connections and takes the learning process to a higher level. This kind of engagement and integration stimulates brain development, allowing for more depth in a shorter amount of time. The earlier that STEM can be brought into the classroom, the better—it can lay the foundation for optimal learning and brain growth.
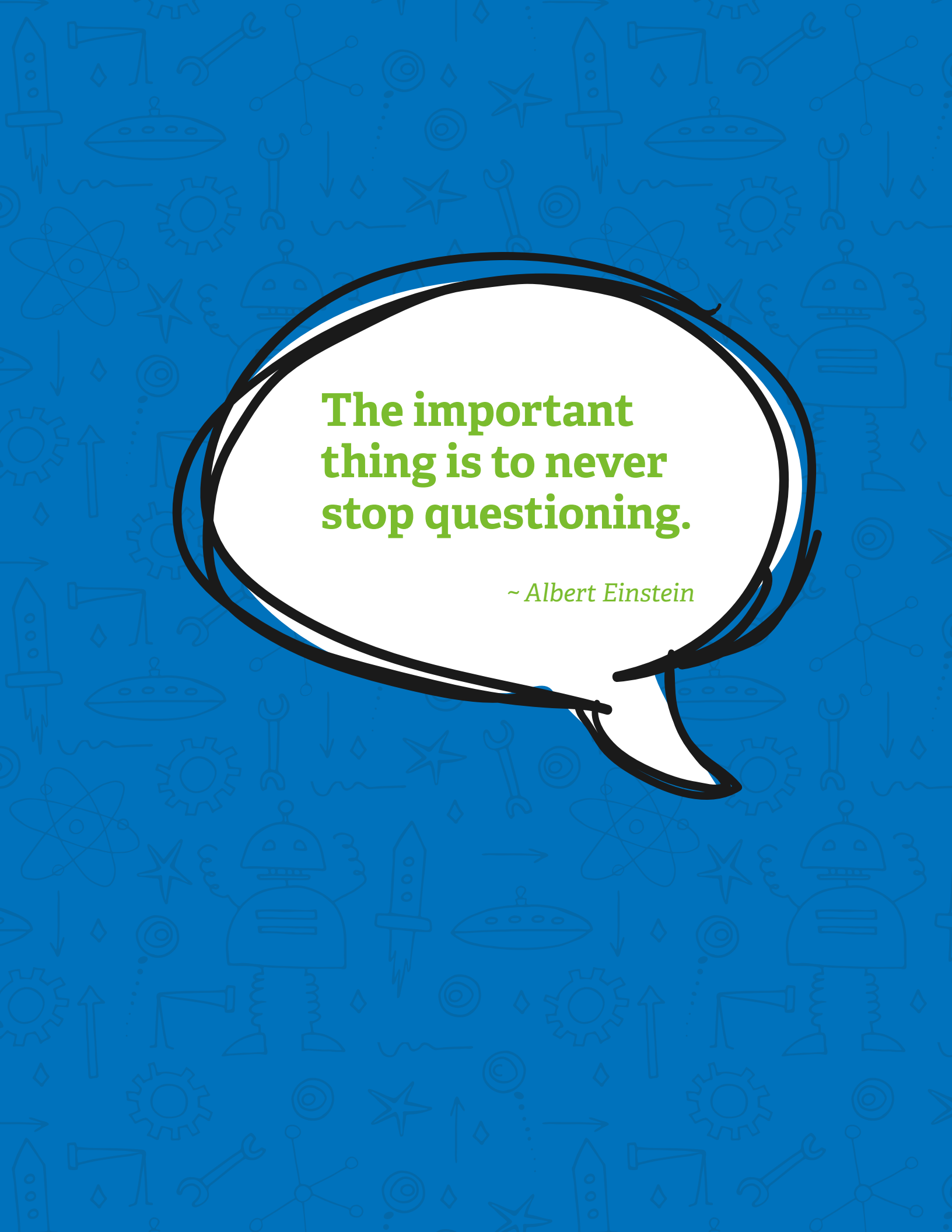
We Need to Engage Girls in STEM

On another note, the need for women in these STEM professions is essential. Stereotypes for girls placing them in a humanities type of profession can start as young as five years old, thanks to all those toys geared toward mothering or nurturing. There are fewer women in STEM professions, which means fewer female role models in those fields, which leads to less interest. STEM professions earn 26% more than non-STEM professions—and currently, a woman makes just 77 cents to every dollar her male counterpart earns. More single parents are mothers, making the wage gap even larger. Adding more women to the math and science industry would offer a better balance of skilled professionals. Presently, women only make

up less than 25% of the workforce in STEM professions.[2] Girls may feel less capable in math and science, so it is critical to encourage our girls with the can-do attitude needed to feel competent in these fields. Offering more science- and math-related activities in a more engaging and fun manner will help pique interest and desire.

Everything on this planet is somehow related to science—most decisions and designs involve some type of STEM. STEM education is all about creating innovative, critical thinkers in a global society. It strives to integrate these concepts to make learning more meaningful and engaging. In doing so, students will be able to ask questions, problem solve, obtain, evaluate, and interpret information, as well as have the perseverance needed to get the job done.
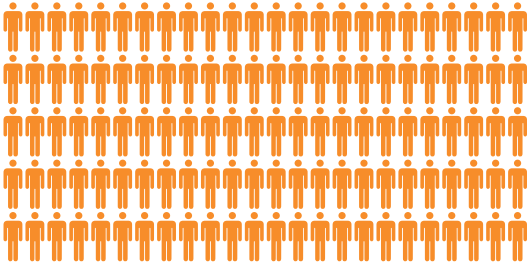
WHY STEM IS CRITICAL FOR TODAY'S STUDENTS | The Big Guide to STEM

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The important thing is to never stop questioning.

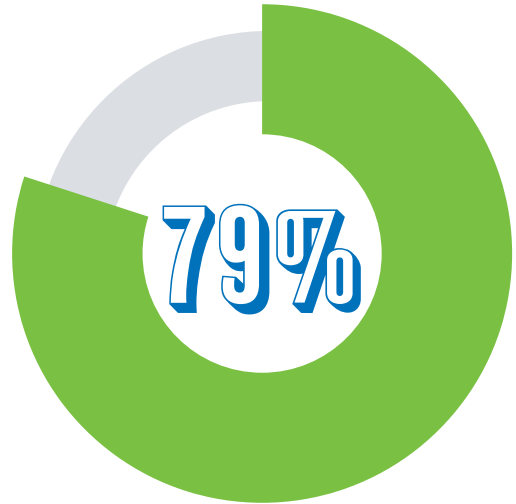~ Albert Einstein

STEM BY THE NUMBERS

THERE ARE 8.6 MILLION STEM JOBS IN THE UNITED STATES [3]

79%

GROWTH IN STEM JOBS SINCE 1990 [4]

45%
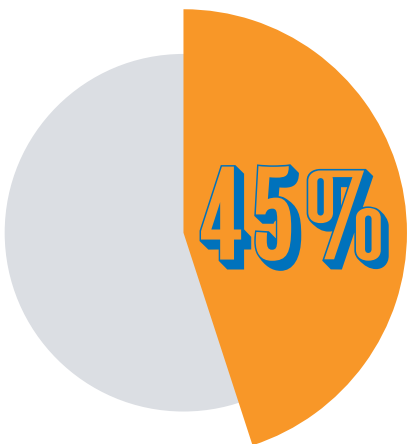
OF STEM JOBS ARE MADE UP OF **COMPUTER OCCUPATIONS** [3]

OUT OF 100 STEM [3] **OCCUPATIONS, 93% OF THEM HAD WAGES ABOVE THE NATIONAL AVERAGE.**

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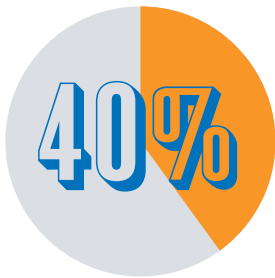
WE NEED STEM IN EDUCATION

THE US PLACED 38TH OF 71 COUNTRIES [5] IN MATH AND 24TH IN SCIENCE.

STUDENTS WHO COMPLETE ALGEBRA II IN HIGH SCHOOL [6]
ARE 2X MORE LIKELY TO COMPLETE A 4-YEAR DEGREE

40% OF CHINESE GRADS FINISHED A STEM DEGREE — TWICE THE NUMBER OF AMERICAN GRADS. [7]

WE NEED WOMEN IN STEM

The number of women who earn STEM degrees each year has increased by over 50,000 in the past decade. Regardless of the positive trend of more women choosing STEM subjects in college, the number of men choosing STEM subjects in college is rapidly increasing as well. As a matter of fact, it's rising much faster than the number of women. Because of that, the gender gap in STEM does not only remain, but is actually growing.

DROPPED TO 24%

THE PERCENTAGE OF WOMEN WITH STEM DEGREES HAS DROPPED FROM 25% TO 24%. IF THE TREND CONTINUES, THIS NUMBER IS GOING TO BE EVEN LOWER IN THE FUTURE. [8]

WOMEN MAKE UP LESS THAN

28%
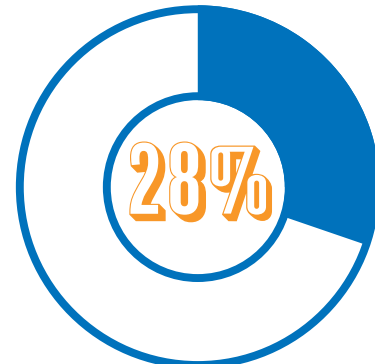
OF THE STEM [9] WORKFORCE

LOOKING TO BRING MORE STEM AWARENESS TO YOUR SCHOOLS, CLASSROOMS, AND STUDENTS? BE SURE TO CHECK OUT OUR TOP 10 LISTS OF STEM RESOURCES!

KELLY BIELEFELD

TOP 10 STEM LISTS FOR TECHNOLOGY, APPS, SOFTWARE, AND RESOURCES

We have created lists of our favorite STEM resources, covering everything from tech to blogs. **Each is marked with an S, T, E, or M to indicate which topic the resource focuses on:**

Top 10 STEM Apps

1		**VIRTUAL FROG DISSECTION:** This realistic frog dissection app is interactive with 3D options for just the right amount of learning—without the smell of formaldehyde.	**S**
2		**THE ELEMENTS:** Visually appealing and interactive, this app is a great way to start middle or high school learners on the periodic table.	**S**
3		**NIGHT SKY:** One of the best apps for watching the night sky, this includes planets and constellations, tracking the difference over time.	**S**
4		**MIMIOMOBILE™ APPLICATION:** This collaboration and assessment app offers a student-centric way to develop formative and summative assessments within the classroom. It's a great technology tool that teachers will want to take advantage of.	**T**
5		**TOUCHCAST:** This video editing app is free and easy for students to use. They can implement green screen technology, captions, and transitions to create professional-looking projects.	**T**
6		**SCRATCH:** This is the free go-to for classrooms looking to learn coding basics and a must-have if you use tablet devices. Students can learn from tutorials and easily become independent with some of the concepts.	**E**
7		**FINGER CAD:** Although there is much more to this app than most students will be able to use, it is a great tool for letting them explore how drafting and design works.	**E**
8		**YUP:** Yup provides students with access to expert math tutoring whenever they need it, right from their smartphone or tablet. Whether students need help with homework, studying, or additional enrichment, Yup tutors are available 24/7.	**M/S**
9		**PHOTOMATH:** This award-winning app scans and solves math problems on a mobile device, with step-by-step explanations to drive learning and understanding.	**M**
10		**FRECKLE:** This is a leveled tool that students can use to help improve math skills at any level from K-8. It is easy to use and differentiate to help all students.	**M**

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Top 10 STEM Tech Products

1		**LABDISC PORTABLE STEM LAB:** This wireless, compact STEM lab allows students to engage and connect with science from anywhere, with inquiry-based learning in a variety of science fields. What's more, it's small enough to fit in the palm of a student's hand.	**S**
2		**MICROSCOPE:** Digital microscopes such as this one are inexpensive and engaging for younger students. There are a range of options (and costs) in this area, so finding the right fit would be important. And if sharing images is all you're looking for—without the need to magnify—then a wireless document camera is probably a better fit.	**S**
3		**DEVICES:** Phones, tablets, laptops, and desktops are critical tools for learning technology. Students should have a varied experience on these devices and need to be more than just users—they must understand the basics of how these tools work. Knowing the advantages and disadvantages of each is crucial, too.	**T**
4		**FLAT PANEL DISPLAYS:** Technology has changed—and greatly improved. The new flat panel displays are easier to mount, easier to use, and easier to integrate in the classroom.	**T**
5		**RASPBERRY PI:** These tiny computers allow students to understand the inner workings of computing. They also have ports that enable users to connect a variety of peripheral devices.	**T**
6		**PROJECT LEAD THE WAY (PLTW):** Project Lead The Way is a comprehensive science curriculum. It introduces the students to different STEM topics, from engineering to computer science, and is available for kindergarten through the 12th grade. It uses a variety of age-appropriate tech products for a hands-on learning experience.	**E**
7		**SNAP CIRCUITS®:** These are great hands-on learning tools for younger students. They are durable enough for classroom use and have variations that include sound, motion, and electricity.	**E**
8		**MIMIO MYBOT EDUCATIONAL ROBOTICS SYSTEM:** The new robotics platform from Boxlight is extremely engaging and user-friendly. This is a great way to introduce coding and basic computer science in any classroom.	**E**
9		**CALCULATOR:** The must-have for any math student in this day and age is a scientific calculator. What isn't true anymore is that is has to be an independent device—it can now be something found on the internet.	**M**
10		**OSMO:** The Osmo suite of activities could fall in the science and engineering section also. They are really cross-curricular and a great fit in any elementary classroom. They continue to add activities and lessons across all areas, which is super-engaging for kids!	**M**

Top 10 STEM Blogs and Online Communities

1		**TEACHING CHANNEL:** This site is great for teachers of all subjects and age ranges. There are videos that model certain procedures and teaching techniques, and the science blog section is definitely worth exploring for those who teach NGSS.	S
2	SkyView	**SKYVIEW:** This NASA blog features up-to-date information and pictures from their latest telescopes and research.	S
3	Mimio Educator Blog	**MIMIO EDUCATOR BLOG:** There is more than just science articles here—these blogs cover engineering and technology areas, too. New articles are updated a few times a week, and it's a great source for ongoing professional learning and keeping up with innovative trends in education.	S
4		**ALICE KEELER:** If you are part of a Google school and use GAFE, stop what you are doing and bookmark Alice Keeler's website/blog. She writes clearly and keeps everything up to date, making it a practical and useful tool for Google educators.	T
5	Free Technology for Teachers written by Richard Byrne	**FREE TECHNOLOGY FOR TEACHERS:** This blog by Richard Byrne is full of resources for all different types of teachers and subject areas. Information and resources for any STEM area could be found here, but technology is the forte.	T
6		**MIMIOCONNECT™ INTERACTIVE TEACHING COMMUNITY:** This online teaching community allows you to connect with fellow educators. Even better, you can access an array of interactive STEM-based lesson plans and activities to engage students of all age ranges across a variety of subjects.	T
7	studio STEM	**STUDIO STEM:** This organization provides project-based learning kits designed around solving a real-world problem. There is a collaborative component to it as well—definitely worth looking into for a PBL teacher.	E
8	NATIONAL GEOGRAPHIC	**ENGINEERS IN THE CLASSROOM:** This site has a great range of STEM projects for classroom use. A joint venture between Lockheed-Martin and National Geographic, these projects are teacher-friendly and easy to implement in the classroom.	E
9	NCTM	**THE MATH FORUM:** This collaborative online group originates from the National Council for Teachers of Mathematics (NCTM). It's a great place for teachers of all levels to collaborate and find resources for their students.	M
10	MCC	**THE MATH COACH:** The Math Coach's blog is a good place for ongoing information about best practices and engagement. Coming directly from a teacher, the information is relevant and practical.	M

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Top 10 STEM Websites

#		Description	
1	ProjectExplorer	**PROJECT EXPLORER:** Geared at students, these videos aim to expand cultural knowledge. Complete with lesson plans and activities, this is an opportunity to learn about science around the globe.	S
2	explore	**EXPLORE.ORG:** This is a great content site for both science and social studies. Vivid videos and pictures bring content to life and make it real for the students.	S
3	Discovery Education	**DISCOVERY EDUCATION:** This is subscription-based and probably needs more teacher direction than other sites, but there are some amazing standards-based videos that make real-world connections—especially in science and social studies.	S
4	Watch Know Learn	**WATCH KNOW LEARN:** This is another go-to and has just about everything. I particularly like the character education videos that range from music to lessons about topics like respect, responsibility, and trust. Most of them have a user review rating, which helps in finding quality.	T
5	ISTE	**ISTE:** All teachers, but especially teachers of technology, should have this website bookmarked. This is the gold standard for how technology can and should be taught and implemented in the classroom.	T
6	NOVA	**NOVA:** You'll find a plethora of STEM ideas, lesson plans, and resources listed here. They are broken down by grade level, and each one includes a short description, which makes searching for something useful a breeze.	E
7	howstuffworks	**HOW STUFF WORKS:** This site is just plain fun—learning doesn't feel like learning because the videos are so appealing. This is a highly engaging site for students.	E
8		**LEARN ZILLION:** This user-friendly site requires a (free!) sign in, but offers access to a ton of PowerPoint-type tutorials on all math and ELA Common Core standards.	M
9		**VIRTUAL MANIPULATIVES:** This site has online graphic manipulatives for all different ranges of math skills. Even though manipulatives are usually used in the elementary setting, this site has good resources for upper-level math as well.	M
10	Greg Tang Math	**GREG TANG MATH:** This is a great site for elementary math—the Kakooma game is excellent for engaging students.	M

Top 10 STEM Events

1		**INTEL ISEF STUDENT SCIENCE AND ENGINEERING FAIR:** This is an international collection of pre-college students who compete with one another in the areas of science and engineering. Even if competing may seem out of reach, the site shares the winners and winning projects, which can get our students' minds thinking about what they could accomplish.	**S**
2	STEM Forum & Expo	**STEM FORUM & EXPO:** This event, hosted by the National Science Teachers Association (NSTA), is a great professional opportunity for all things STEM. For a more specific focus on science-related topics, NSTA also hosts other regional and national workshops throughout the year.	**S**
3	Holiday Card Project	**HOLIDAY CARD PROJECT:** This is a simple holiday project that allows students to use technology to collaborate. This is just one example of many different global learning opportunities available for students.	**T**
4	DROBOTS COMPANY	**DRONE COMPETITIONS:** Because of their low cost and high levels of engagement, drones are in more and more classrooms. Check out this event, which helps to organize and prepare competitions for different grade levels from 4th-12th.	**T**
5	ISTE	**ISTE:** The ISTE conference is the gold standard for professional learning and networking. If it is possible to go, it's a can't-miss opportunity for all STEM teachers.	**T**
6	GLOBAL CARDBOARD CHALLENGE	**CARDBOARD CHALLENGE:** This is a student engineering project that has a really cool backstory. It's a simple concept that can go in many directions for students—all of which require critical thinking and problem-solving skills.	**E**
7		**DISCOVERE:** Working with over 100 organizations, DiscoverE unites and supports engineering and technology volunteer communities in order to bring educational programs—such as Girl Day, Future City, and Global Day—to K–12 students.	**E**
8	national stem VIDEO GAME CHALLENGE	**NATIONAL STEM VIDEO GAME CHALLENGE:** Launched by President Obama in 2010, the Challenge invites middle school students, high school students, and educators to design games that incorporate STEM content or themes in innovative and engaging ways.	**E**
9	Pi Day March 14	**PI DAY:** March 14th, or 3.14, has become known as Pi Day. Celebrating this day in school not only reinforces what pi (π) is, but also makes math fun— often by including pie!	**M**
10	MATHCOUNTS FOUNDATION	**MATHCOUNTS COMPETITION:** This national math competition, sponsored by Raytheon, can be started at the local level without much cost. The national scale of the competition helps middle school students know where they stand nationally when it comes to the area of math.	**M**

Top 10 STEM Software Solutions

1		**MIMIOSTUDIO™ CLASSROOM SOFTWARE:** This powerful collaboration and assessment software allows you to easily create interactive science and math lessons—along with collaborative and team activities—and perform check-ins and assessment to make sure everyone is getting it.	**S**
2		**PEBBLEGO:** To increase students' non-fiction ability and engage their interest in science, this is a great resource. There are activities and writing prompts that help to deepen the students' understanding of the different science concepts.	**S**
3		**WOLFRAMALPHA:** This site could fit in all sorts of places and is hard to define. It is part calculator, part search engine, and part almanac—the pro version is well worth the money. Students of all ages will find useful information, along with the ability to sort and filter amazingly specific data sets.	**S**
4		**NEARPOD:** Nearpod is a classroom presentation software that allows interaction with students through their devices. Teachers can embed pictures and videos, and can also use class-wide questions to check for student understanding of the subject matter.	**T**
5		**PEARDECK:** Peardeck is a classroom presentation software that works as a Google Slides add-on. Teachers can embed formative assessment questions into their presentations to gather quick and accurate feedback from students.	**T**
6		**MICROSOFT OFFICE AND GOOGLE FOR EDUCATION:** Whether it's Office 365 or Google Docs, students need to have word processing skills. Both of these software options can teach students the basics so they can adapt and change to the future world.	**T**
7		**CATIA V5:** This software is used by upper-level high school students. It is one of the industry standards for CAD software and is able to be purchased at a student/school discounted price.	**E**
8		**SKETCHUP:** This software is perfect for middle and high school design classes and allows for all kinds of design specifics and creation of objects and buildings. Plus, upper-level high school engineering students will love SketchUp Pro.	**E**
9		**MAPLE:** Maple Student Edition offers students an interface to work with math and science problems. The math graphics are interactive and colorful, and the software is ideal for upper-level high school math classes.	**M**
10		**DREAMBOX:** This online math software is a great option for elementary students. It's adaptive and aligned to standards, making it a perfect fit for K–8 math classrooms.	**M**

LYNN ERICKSON

Top 10 STEM Resources for Robotics and Coding

1	**HOPSCOTCH:** Designed for ages 8–11 and excellent for beginner programmers, Hopscotch is a free iPad app that uses video tutorials to teach students how to code popular games. Kids can then play games created by other users with the app. There are also resources for educators, such as lesson plans and transition guides.	E
2	**KODABLE:** This program provides a tool for coding in the classroom with over 49 free levels of exploring. It is recommended for ages 5+ and is both iPad and web-based. Their comprehensive curriculum focuses on group and independent practice activities that build creativity, collaboration, and communication.	T
3	**CODE.ORG:** If you are looking to integrate coding in the classroom, Code.org provides courses built off curriculum that contain lesson plans, handouts, offline activities, videos, and online tutorials. Using a teacher dashboard, lesson activities can be assigned, activities can be monitored, and sharing permissions can be set. The activities provide a mix of online independent practice, discussions, and unplugged group activities. The Computer Science Fundamentals provides educators with many courses to use with students designed to be flexible. Plus, they provide Hour of Code tutorials for beginner coders.	E
4	**SCRATCH:** This project from MIT's Lifelong Kindergarten Group teaches math, programming, and creative expression through technology. Students can create animations, games, and models that communicate artistry and learning. The application is split into three sections on the screen. In the middle, students can see available drag-and-drop programming blocks. On the right, students can program and edit the appearance of various sprites (characters) that the program provides or use one of their own. On the left, students can see their coding work in action. Scratch meetups are hosted in many different states and provide opportunities for Scratch educators to meet and share ideas and resources. Check out Scratch Day, a yearly gathering of students, parents, and teachers to share Scratch ideas and participate in various activities.	M
5	**GOOGLE CS FIRST:** This site provides students aged 9–14 with activities that introduce computer science and programming through Scratch. Different themes such as animation, sports, game design, storytelling, and art engage students with video tutorials and practice. Each theme includes eight activities and about 10 hours of content that can be spread out over several days or weeks. It is ideal for computer clubs and/or courses. They also offer various Hour of Code activities such as Create Your Own Google Logo, Animate a Name, and High Seas Activity. CS First earned an ISTE Seal of Alignment for addressing the ISTE Standards for Students.	E

6	wonder workshop	**WONDER WORKSHOP DASH/DOT ROBOTS:** Dash and Dot for ages 6–11 are a pair of robots from Wonder Workshop with five accompanying apps that help kids program the robots. Blockly introduces students to coding using visual blocks of code. Though the apps are free, the robots must be purchased either individually or as a package deal, with various accessories for each. In Blockly, students work through a hands-on tutorial and then can complete puzzles where they have to write the prescribed programs. They can also create their own programs, including custom sounds, and save them in the app. The robots will need to be detected via Bluetooth by the app each time they play. Cue robots are designed for students aged 11+.	E
7		**MIMIO MYBOT EDUCATIONAL ROBOTICS SYSTEM:** The robotic opportunities are endless with the Mimio MyBot system. Students can build a variety of robots, connect them to a browser, and code with a simple drag-and-drop interface. Educators have access to on-device materials such as tutorials, videos, user guides, and programming guides.	E
8	ML	**MACHINE LEARNING FOR KIDS:** Find projects to introduce students to the concepts of machine learning and artificial intelligence using the Scratch block-based coding language and MIT App Inventor. Users sign up for a free account from IBM Cloud to get access to Watson, the question-answering computer system. Machine Learning for Kids provides step-by-step instructional guides for creating various data sets to train the AI. Students can then see the machine learning in action as it runs through the Scratch interface.	E
9	Tynker CODING FOR KIDS	**TYNKER GAMES:** Teach your elementary students coding concepts with a focus on activities for grades K-8. Tynker has a comprehensive curriculum, STEM courses, and classroom management tool built right in. They also offer free training for schools.	E
10	CODESPARK ACADEMY / CS UNPLUGGED Computer Science without a computer	**UNPLUGGED CODING ACTIVITIES** do not require the use of a computer and are a great way of introducing coding concepts before students use the computer. Codespark Academy provides various unplugged activities such as Make Your Own Foo and Design a Comic—these activities are provided to educators with a free account. CS Unplugged is a collection of free learning activities that teach computer science through engaging games and puzzles that use cards, string, crayons, and student movement.	E

Need some assistance bringing robotics and coding to your classroom? Consider using DonorsChoose.org or find other creative ways through social media to acquire funds for your program.

TRAVIS RINK

Top 10 STEM Resources for Space

1		**ALDRIN FAMILY FOUNDATION:** AFF strives to cultivate the next generation of space leaders, entrepreneurs, and explorers who will extend human habitation beyond Earth to the Moon and Mars. Their STEAM-based educational tools, curriculum, and programs span from a child's first classroom experience through graduate school and professional programs.	**S**
2		**MIMIO MYBOT AND GIANT MOON AND MARS MAPS BUNDLES:** By integrating ShareSpace's Giant Moon Map™ and Giant Mars Map™ programs with the Mimio MyBot educational robotics system, STEM educational activities have never been more fun and rewarding. Through the use of these highly accurate, large scale floor-sized maps, students can be introduced not only to information about these planets, but also learn about map reading, evaluating and understanding topographic information, geology, how planets form, and the effect of impacts on these celestial bodies.	**T**
3		**THE SPACE FOUNDATION:** The Space Foundation is the world's premier organization to inspire, educate, connect, and advocate on behalf of the global space community. This foundation is a nonprofit leader in space awareness activities, educational programs, and major industry events, including the annual Space Symposium to be held each April.	**S**
4		**STUDENT SPACEFLIGHT EXPERIMENTS PROGRAM (SSEP):** Launched in June 2010 by the National Center for Earth and Space Science Education, this initiative typically gives more than 300 students across a community the ability to design and propose real microgravity experiments to fly in low Earth orbit, first aboard the final flights of the Space Shuttle, and then on the International Space Station (ISS)—America's newest National Laboratory.	**S**
5		**NASA SPACE PLACE:** This site inspires and enriches upper-elementary-aged kids' learning of space and Earth science through fun games, hands-on activities, informative articles, and engaging short videos. With material in both English and Spanish as well as resources for parents and teachers, NASA Space Place has something for everyone.	**S**
6		**AMAZING SPACE:** This space telescope education program promotes the science and beauty of the universe to the education community. Developed for educators and students of all ages, the materials are accurate, instructionally sound, engaging, and carefully crafted to adhere to educational standards. These educational resources are based on the Hubble and James Webb space telescopes.	**S**
7		**NASA APP:** This app does a wonderful job of teaching students about space. It provides you with over 15,000 images and the latest news within astronomy, along with an extensive amount of space resources, images, and information. You can also view over 13,000 NASA videos, check out upcoming sighting opportunities, and watch live NASA TV.	**S**

8		**SOLAR WALK ADS+:** You can use this free interactive space encyclopedia to view a detailed and attractive 3D model of our solar system, allowing you to navigate easily through the universe. You can also explore all the planets in real time, check out their current positions, and learn interesting facts about each of them.	**E**
9		**MCDONALD OBSERVATORY ACTIVITIES:** These engaging, aligned activities create opportunities for K-12 students to explore astronomy, physics, and chemistry in the classroom.	**E**
10		**TEACHING WITH TELESCOPES:** Teaching With Telescopes is designed to help teachers bring small telescopes into the classroom. On this site, you will find an observing guide and classroom activities. Teachers can take an online course on using the Galileoscope (a small telescope ideal for classroom use) and participate in the discussion forum.	**E**

Top 10 Resources for STEM Funding

Money in public education is tight, and a lack of financial resources can mean limited opportunities for STEM learning. Searching for funding can be incredibly time-consuming, so we decided to make it a little bit easier by showing you where to look. Check out these available funding opportunities, which you can take advantage of in order to enhance STEM learning in your classroom:

1		**STEMFINITY:** A one-stop resource for all things STEM, STEMfinity has taken the time to find over 1,000 grant opportunities throughout the United States, which can easily be searched by state.
2		**GRANTWATCH:** On GrantWatch, educators can find federal, state, city, local, and foundation grants all in one place. The grants are categorized by type (i.e. teacher grants, science, technology, etc.) and frequently updated.
3		**DONORSCHOOSE:** On this site, teachers post what they need for particular classroom projects. A donor can choose to help fund the project—when the project reaches its goal, the website sends the materials directly to the school. The program supports K-12 classrooms, as well as public charter schools, in all 50 states across America.
4	Afterschool Alliance	**AFTERSCHOOL ALLIANCE:** Afterschool Alliance has gathered an array of funding opportunities specifically for STEM education—from federal agencies, corporations, foundations, and more—along with resources to help you better understand the various types of funding available.
5	DIGITAL wish	**DIGITAL WISH:** Looking for new classroom technology to help further your STEM curriculum? Digital Wish works like a gift registry—simply build a wish list of tech products, let prospective donors know how it will help your students, and start fundraising. They also have a separate area for grants with a calendar of deadlines so you won't miss out on funding opportunities.
6	GRANTS.GOV	**GRANTS.GOV:** This site allows educators to search and apply for federal grants. Teachers can easily search for STEM grants by plugging in a keyword or clicking on the category that best matches their needs.
7		**STEMGRANTS.COM:** This site offers a free guide to over 100 grants for STEM learning, listed by deadline for easy reference. They also have resources to help you write proposals, funding news, and a variety of STEM resources and tools.
8	BOXLIGHT	**BOXLIGHT FUNDING GUIDES:** Boxlight has created five downloadable guides to help you get the funding you need for the tech you want. Each guide focuses on a single fund and explains specifically how Boxlight technology or software qualifies for that fund.
9	Ed	**U.S. DEPARTMENT OF EDUCATION:** Our government recognizes the need for today's students to learn vital STEM skills so that they can be prepared for tomorrow's jobs. Here, you'll find out more about the DOE's focus on STEM along with funding opportunities to help you bring STEM into your classroom.
10	THE JOURNAL	**THE JOURNAL:** This is a great magazine that looks at the different technologies used in K-12 schools. They publish several eNewsletters that include a grants section, and post regularly updated listings of funding opportunities for STEM education right on their site.

Top 10 STEM Resources for Girls

This list is a little different from the others as it focuses on STEM resources aimed at girls—many of which cover all four topics within the world of STEM. Women are underrepresented in these fields, so it's critical that we show girls they are just as capable as their male counterparts when it comes to STEM professions.

1		**NATIONAL GIRLS COLLABORATIVE PROJECT:** This organization works to inform and encourage girls to pursue careers in STEM fields by expanding and strengthening STEM-related opportunities for girls. The organization has a ton of valuable resources including events, girl-focused STEM programs, local groups, and ways to connect with other partners.
2		**CARNEGIE STEM GIRLS:** This comprehensive site offers activities and resources for students, parents, and teachers that are designed to get teens excited about STEM. There are also after-school programs and opportunities available to help girls envision the possibilities for careers in STEM fields.
3		**FABFEMS:** This website hosts a directory of women in STEM professions, known as FabFems. The directory aims to connect these inspiring females to young women, girl-serving STEM programs, and other organizations that are working to increase career awareness and interest in these fields, giving girls the opportunity to have STEM role models they can truly relate to.
4		**GIRLS INC.:** This organization delivers life-changing programs that inspire girls to be strong, smart, and bold. Serving girls aged 6–18 in 400 cities across the United States and Canada, Girls Inc. helps girls to value their whole selves and develop the strength to achieve academically, lead healthy lives, navigate barriers, and discover an interest in STEM fields.
5		**GIRLS WHO CODE SUMMER IMMERSION PROGRAM:** This free summer program gives girls the opportunity to learn computer science through real-world projects, participate in workshops, and connect with females in the field. Even better, Girls Who Code partners with some of the hottest tech companies in the world, giving 10th and 11th grade girls the chance to learn coding while gaining exposure to tech jobs.
6		**GIRLSTART'S GIRLS IN STEM CONFERENCE:** In order to boost interest and engagement in STEM for girls, Girlstart offers comprehensive year-round programming to foster STEM skill development—helping to spark future interest in STEM careers. This unique annual conference features hands-on workshops for girls in the fourth through eighth grade led by women in STEM professions.
7		**GIRLS THINK OF EVERYTHING:** This book, written by Catherine Thimmesh, details the incredible inventions by women and girls that have made our lives simpler and better. It provides a great insight into what inspired these women, how they turned their ideas into reality, and how readers with great ideas can start inventing themselves—including a list of organizations to help them get started.

8		**MARBLE RUN CHALLENGE:** This activity is a great way to get girls inspired about engineering, and can be as simple as giving them the tools and a fun hands-on challenge to solve. This success story provides ideas on how to organize one of these activities in your school.
9		**SMART ADVENTURES MISSION MATH 1: SABOTAGE AT THE SPACE STATION:** This space-themed app is aimed at boosting confidence in math for girls aged nine and up. Featuring integrated STEM content, users explore a space station as they solve puzzles by putting their math skills—from fractions to volume and mass—to use.
10		**DAISY THE DINOSAUR:** If you want to introduce basic computer programming to your kids, this iOS app is amazing. The object of the game is to do drag and drop coding to make Daisy the Dino jump, turn, shrink, and spin. It's also a great conversation starter about how apps are made possible through programming!

Basically, I have been compelled by curiosity.

~ Mary Leakey

DENISE SCRIBNER

HOW TO CREATE STEM-FOCUSED LESSONS

First, let's do a quick rundown of the STEM acronym:

- **SCIENCE:** The study of the natural world.

- **TECHNOLOGY:** One surprise: The STEM definition for technology includes any product made by humans to meet a want or need. Under the STEM definition, a chair is technology—and so is a pencil.

- **ENGINEERING:** The design process students use to solve problems.

- **MATH:** The language of numbers, shapes, and quantities that seems so irrelevant to many students.

New to this mix is the addition of A for art or agriculture in the classroom to create STEAM, by which the power of learning is enhanced (much like water is changed to steam, creating energy). After all, art makes you think, look, and feel—all of which are needed for innovation. Why agriculture? Because we need it to survive, of course! If you eat, you need agriculture. If you wear clothes, you need agriculture. If you take medicine, live in a house, or write with a pencil, you need agriculture.

> **The concepts of innovation can apply to any subject!**

So, I put it to you to convert your thinking to STEAM rather than STEM when tweaking your already great lesson plans in order to create STEAM-focused lessons. Here are six ideas on ways this can happen:

1. STEAM LESSONS INVOLVE TEAMWORK

Teamwork is a 21st century skill that corporations are looking for when hiring new employees. Create grading rubrics that enhance the use of each student's skill set during a group assignment, rather than just checking off a task as completed. For example, have a worksheet where each member of the team must explain their role and check off the key elements they personally contributed as part of the assignment. This will not only reduce the number of papers you need to grade (with a group rather than an individual's work), but will also help to enforce the idea that when a team works together, great things
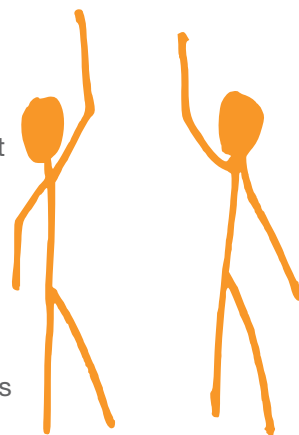
can be accomplished—including a good grade.

2. INCORPORATE HANDS-ON LEARNING
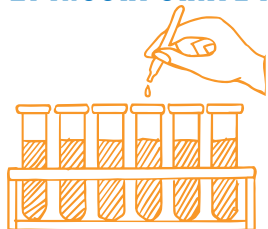
STEAM lessons must include hands-on inquiry and open-ended exploration. Like a guide through the wilderness, a teacher's lesson content should first guide their students through the maze of the unknown and then allow their students to control their own ideas and design their own investigations to apply the newfound knowledge. In that way, critical thinking skills are developed.

3. MAKE IT RELEVANT

It is important to remember that when planning STEAM lessons, you also need to focus on real-world issues and problems. Students must understand the issue first to learn basic concepts, and then apply the concepts learned in order to innovate. Innovation is another 21st century skill that makes an individual highly valued in today's workplace. Visit MiddleWeb for some suggestions of real-world projects students might focus on.

4. TURNING FAILURE INTO A POSITIVE

Teachers should retool their lesson planning to include failure as a necessary part of the learning process. Parents, teachers, and even your students often see failure as a negative act. But truth be told, the act of failing creates an opportunity to develop tenacity, grit, and perseverance. Not every student is the golden athlete or wonder mathlete, yet their unique skill sets are equally as important when problem solving. I like to use the word FAIL as a positive thought acronym. FAIL is the **F**irst **A**ttempt **I**n **L**earning. Don't ignore the F grade, embrace it to create and develop a solution so that students accept and learn from them and try again. The lesson focus is on developing solutions to persevere, not just content knowledge.

5. WEAVING MATH AND SCIENCE INTO YOUR LESSONS

Don't forget that STEAM lessons should also apply rigorous math and science content. Plan time to collaborate with other math and/or science teachers to gain insight into how course objectives can be woven into one of your lessons. Students can then begin to see that science and math are not isolated subjects, but work together to solve problems—adding relevance to math and science learning.
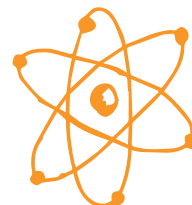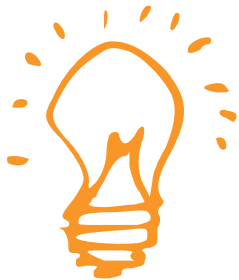
6. GET CREATIVE

Use art or agriculture to engage your students in math, history, science, or even music concepts. For my high school students, I like to use art by having my students create emoji-style picture icons to remember a concept, followed by a correctly structured complete sentence definition. Another example is when I ask my ecology students to explain the processing of a particular recycled product using a storyboard or graphic novel depicting a superhero or villain rather than a research paper. Music can involve agriculture when students learn songs (and the history behind those songs) that field workers sang to help with their task, or a ballad that describes a historic event. Mathematics can interweave agriculture with students calculating the square footage of a field, the percentages of nutrients that need to be placed into the soil, or how much profit is gained from the sale of harvested wheat vs. the expense of planting the wheat. It's all in the approach and not just the content.
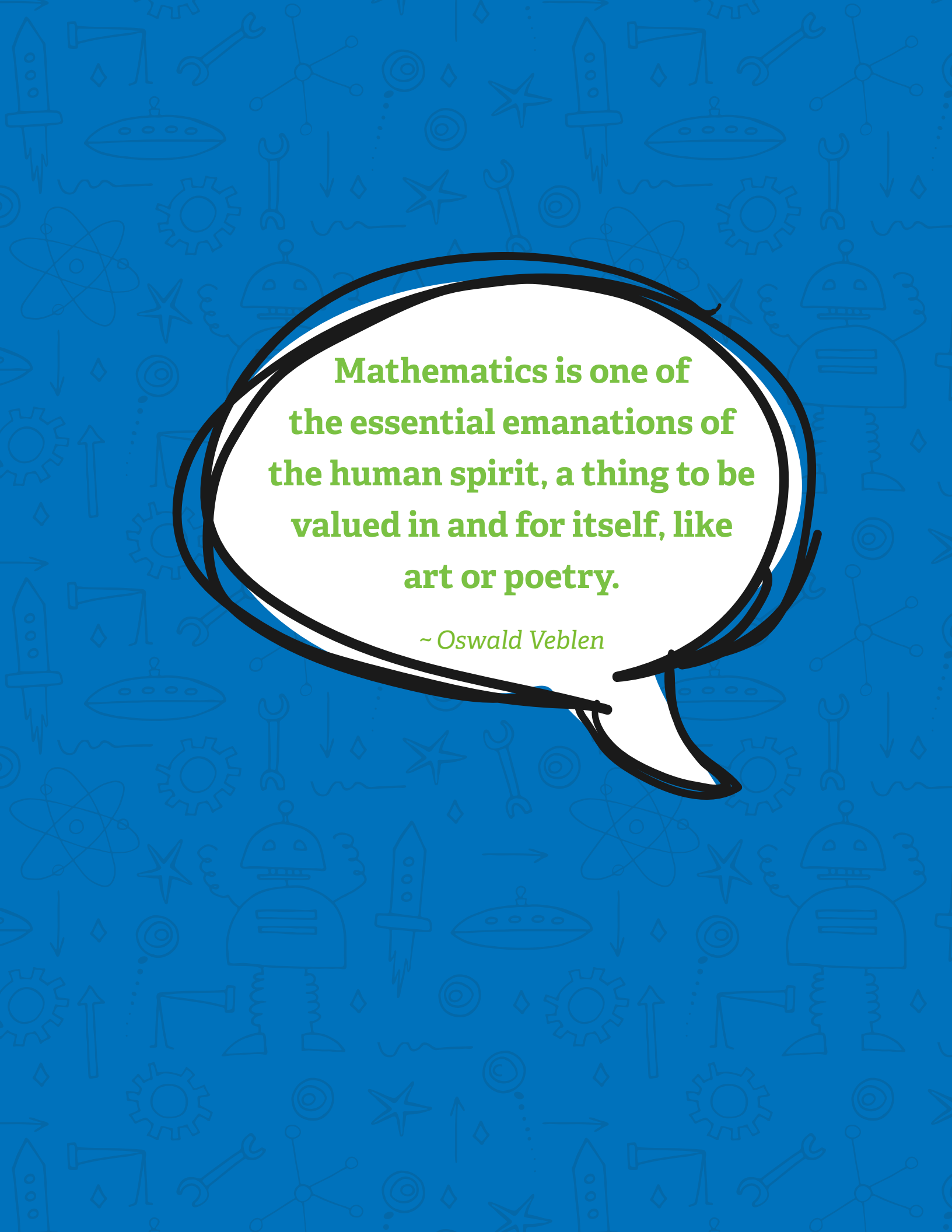
PUT IT ALL TOGETHER

To start down that path of innovation, I assemble my students into cooperative groups of no more than four. Their task is to define innovation in one of the following ways: a sentence, a list of ten words, a pictorial representation, or another way of their choosing. This way, they work as a team (tip #1), control their way to solve the assignment (tips #2 and #3), and include creativity (tip #6) immediately. Each group then displays their work in a gallery for the entire class to view during a gallery walk to see what the other groups developed.

Next, the students view a video about innovation. During the video, I have the students write down each innovator's name, what they do, and something they said that engaged them. Did any of what the innovators said match your students' gallery walk of ideas? Probably. I then ask students to share what innovations in biology, ecology, or any topic they can name. You are now on your way to engaging STEAM into the classroom.

Becoming STEAM-focused is a simple concept of innovation. Become an innovator and take the challenge!

Mathematics is one of the essential emanations of the human spirit, a thing to be valued in and for itself, like art or poetry.

~ Oswald Veblen

STEPHEN
BARKER

TOP THREE CONSIDERATIONS WHEN SELECTING ROBOTICS FOR YOUR STEM ACTIVITIES

Robotics has become a popular activity for incorporating STEM in the classroom. Among other things, robots are engaging, eye-catching, dynamic, and more interesting than a book for capturing and holding a student's attention. Unfortunately, the vast majority of classroom robots end up being little more than toys made to drive to and fro or side to side without really providing an opportunity for any scientific exploration and learning. When selecting robotic products to introduce in the classroom, it is important to look at the overall educational value of the system—particularly with regard to how it can be used to promote scientific exploration and learning together with the application of mathematic principles.
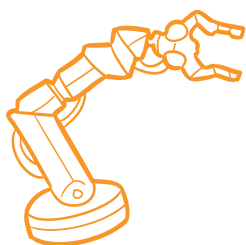
1. NOT ALL ROBOTS HAVE WHEELS

The vast majority of robots at work in our world today are not vehicles, but automated manufacturing machines—conveyor belt systems that perform things like quality inspections and order fulfillment. Robots—or mechatronic systems, to be more accurate—include any system which integrates sensing devices with a computing platform and the ability to affect changes on the environment it is monitoring.
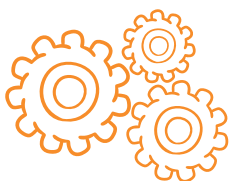
2. DOES THE SYSTEM PROVIDE AN OPPORTUNITY TO MASTER STEM PRINCIPLES?

Another caution when selecting equipment and curricula to promote STEM education is to make sure that it provides an opportunity to actually use, master, and apply scientific and/or mathematic principles into the problem solving nature of the activities. Too often, a device that uses a processor and sensors will be offered for STEM education, but the students are limited to simply using the device without the opportunity to apply their knowledge to problem resolution. These limited systems may be inviting, but their educational value ends up being limited to observation and not engagement.

" If the robots are going to take over your job, you ought to be learning to control and program the robots.

A good example of a robotics system that promotes STEM education is the Mimio MyBot, especially when coupled with the Mars Exploration Bundle developed in conjunction with ShareSpace Education, a key program of the Aldrin Family Foundation. This bundle combines a powerful robotics control system with a rugged aluminum build system, a variety of different sensors and measurement devices, and a highly detailed floor-sized map of the planet Mars. Measuring over 600 square feet, the map is colorful, highly unique, and captures students' attention. Using the map, lessons involving physics, geology, and geography become more engaging—even more so as the students start using the robots to explore and analyze the Martian surface.

3. WHAT SENSORS ARE PROVIDED SO YOU CAN EXPAND THE AREAS OF STUDY?

Below are some examples of sensors included with the Mimio MyBot system and how they can be used in STEM activities:

- **HIGH-RESOLUTION COLOR SENSORS** that can be used to explore the optical spectrum and experiment with the reflective, transmissive, and absorptive qualities of different materials.

- **THREE AXIS GYROSCOPES,** which measure angular movement in each of the three axes and can be used to move along a fixed heading while monitoring side-to-side tilt and front-to-back pitch, enabling course correction should the robot begin to tip or approach a steep incline.

- **MAGNETIC COMPASS AND THREE-AXIS ACCELEROMETER,** which enables the robotic system to find magnetic north and can report changes in velocity in the different axes. In addition to motion exploration, this allows a demonstration of vectors and vector arithmetic.

- **OPTICAL AND ULTRASONIC DISTANCE MEASUREMENT** for exploration of the speed of light and sound, as well as the ability to sense objects in the robot's path for automatic collision avoidance.

- **INFRARED LIGHT DETECTION AND LOCATION,** which expands on light and color experimentation by moving into the non-visible part of the spectrum.
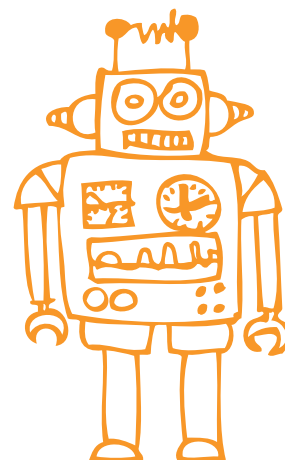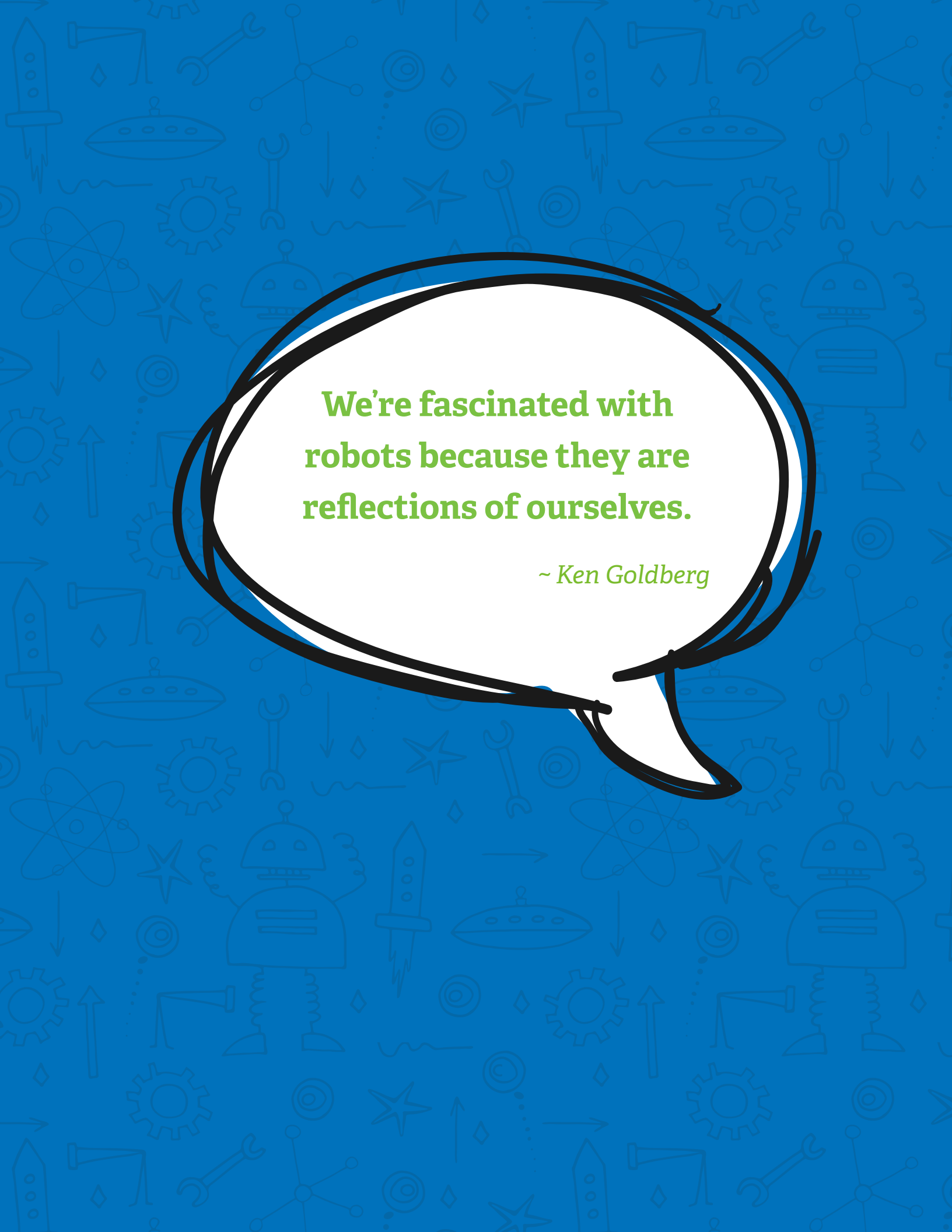
- **AMBIENT LIGHT SENSORS** to explore physical phenomena regarding light, including coherency and loss over distance due to areal diffusion. They can also be used to record light levels over time using the MyBot's built-in data-logging capabilities. Data from any of the sensors can be recorded periodically over the course of days and made available to spreadsheet programs for analysis and graphing.

- **MAGNETIC FIELD SENSORS** to locate and measure magnetic fields, providing a hidden target for an autonomous robot hide-and-seek game.

These small, ruggedly packaged and pre-wired sensor modules allow students to observe real-world physical phenomena in a cost-effective and fun way, enabling educators to base lessons on more than just whiteboard drawings. With Mimio MyBot, you can bring science to life.

Our world today is increasingly dependent on technology, and the future workforce will embrace candidates who have the ability to not just use STEM products, but who have developed true STEM skills: the ability to apply their knowledge of science, mathematics, and technology to solve new problems. This new generation of skilled workers will have the ability to develop new and better technology solutions to solve tomorrow's problems.

As the saying goes, "If the robots are going to take over your job, maybe you ought to be learning to control and program the robots."
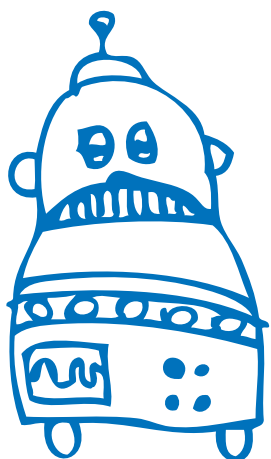
We're fascinated with robots because they are reflections of ourselves.

~ Ken Goldberg

KELLY BIELEFELD

BRANCHING OFF FROM THE STEM

When we discuss STEM classes and content, by their very nature, we are talking about multiple cross-curricular concepts. Engineering is math and math leads to technology, which requires science, which is what engineers study, and so on and so forth. So why should we consider how STEM concepts can branch out even further into our classrooms?

The answer to this question flows in two directions. First, students learning math and science must know that they are not learning in a vacuum. There are implications to how products are designed and marketed—not just how they are engineered. As students learn and understand this, they broaden their understanding of what the ultimate goals of learning about math and science are in the first place: to improve the lives of others.

As I said, the answer flows in both directions. The students with a strong proclivity to learn in STEM fields need their view broadened, but those who are on the outside looking in can see STEM content in a different light through cross-curricular learning. Who knows, these students might even find their niche in the STEM world and can pursue a career in that area.

THE RELEVANCE OF STEM

As a teacher, this might seem like a challenging and daunting thing to undertake. You may think you don't have enough time to teach math as it is, so how are you going to teach it in a cross-curricular model? I would contend that teachers actually have more instructional time when using this model than less, although it usually requires more prep and planning at the start.

Here are some unique ideas for how teachers can branch off the STEM and help students to consider how relevant these topics are:

DESIGN: More and more, this is becoming a critical area of production. Through 3D printing and advanced tooling, companies can make almost any kind of contraption in any color and any style. The students in the art classroom really should work with students in the engineering classroom to discuss and plan designs. Both disciplines have a lot to learn from one another, and collaboration will produce better products in the end.

TECHNICAL READING AND WRITING: Students who love writing will love the challenge of technical writing. Descriptions must be clear, concise, and full of technical language and jargon—this can make some technical reading exceptionally hard for students. Again,

this can be a perfect opportunity for a science student to provide a description of a lab process to another student, who is tasked with creating a description of it.

CAREER AND TECHNICAL EDUCATION: Many CTE classes are STEM classes, but not all. Other areas, such as family and consumer sciences as well as health and medical fields, overlap with STEM content, but also stand on their own. The math required in these classes is at a higher level and a perfect place for teachers to show relevance to students. It also shows students in CTE classes how important math and science skills are—especially if they don't already realize it.

MUSIC: There is a lot of great research on how learning music helps students with reading and math. The patterns and thinking required easily transfers to math. But for kids who love music and aren't as into STEM classes, music can be the link to learning more about these fields. For example, one of my teachers used a Makey Makey with potatoes to create a mini piano. Not necessarily something to do for the sake of creating great music, but by marrying the two together, it is possible for students to learn a little bit from both areas and discover how each can work together.

DATA: Data can be part of a math class or part of a technology class, but it can also be part of many other classes. Data itself isn't really an area of standalone content, but it is something that all students need exposure to. Whether it's data in a weightlifting classroom, data from a science lab, or even data from practice after school, both math and technology can help students to understand and make sense of it.

There are many ways to make STEM relevant and meaningful for students—this list is not exhaustive by any means. The idea of STEM concepts branching out into other content areas around the school is one worth exploring for all teachers, both STEM and otherwise. The reality is that the careers of the future will require skills that overlap in all of these areas.

STEM already crosses curricular areas if done correctly. Instead of adding a bunch of letters to the acronym, teachers can just know that STEM touches almost everything that students do. Through proper planning and creative thinking, students from all different interest areas can learn more deeply about how the content areas intersect. STEM classes that we already have can sprout and grow "branches" throughout the entire school.

CONTRIBUTORS

Kristy Nerstheimer, Elementary Teacher

Kristy is an elementary teacher in Overland Park, Kansas. She has been a classroom teacher for over 20 years and has a Master's Degree in Curriculum and Instruction. Kristy lives in Overland Park with her husband, two kids, a dog, a cat, and two rabbits.

Email: kristynerstheimer@gmail.com

Kelly Bielefeld, Principal

Kelly has 13 years of experience as an elementary school principal. He holds a Bachelor of Science in Secondary Education from Kansas State University, along with a Master's Degree in Educational Leadership and Administration from Wichita State University. As a principal, he has worked in rural, urban, and suburban schools, and has experience in both parochial and public school settings.

Twitter: @KellyBielefeld | Email: kbielefeld@usd264.org

Denise Scribner, Science Teacher
Presidential Awards for Excellence in Mathematics and Science Teaching
Denise has been teaching since 1976. She has spent the past nine years at Eisenhower High School in Goddard, Kansas teaching ecology, biology, and forensic science to grades 9–12.
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She holds a B.S. in secondary education from Emporia State University and is licensed and certified in Kansas for biology, zoology, and physical education. Denise has been nationally published, presented at numerous professional development workshops, and been recognized with copious awards and honors. She is the 2016 winner of the Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST), the highest recognition that a K–12 mathematics or science teacher may receive for outstanding teaching in the United States.

Email: dscribner@goddardusd.com

Lynn Erickson, Educational Technology Specialist for Stafford Public Schools

Lynn has over 22 years of experience in education. She began her educational career as a language arts and math teacher. During the past 15 years, she has been working as an educational technology specialist assisting various schools in both Connecticut and Mississippi with technology integration in all subject areas. In 2006, Lynn was awarded Mississippi Technology Educator of the Year from the Mississippi Technology Educators Association. She is a national conference speaker, a course instructor for several professional development courses, and a Google Certified Educator. Lynn was also awarded 2019–20 Stafford Teacher of the Year.

Email: lynreedy@gmail.com

Stephen Barker, VP of STEM Education at Boxlight

Stephen Barker is the VP of STEM Education at Boxlight, which provides the Mimio MyBot educational robotics solution. Stephen has more than 30 years of experience in robotics and technology innovation.

Email: stephen.barker@boxlight.com

Travis Rink, High School Assistant Principal

Travis has 17 years of experience teaching science and two years in administration. He holds a Bachelor of Science in Secondary Education from Kansas State University, along with Master's Degrees in Curriculum and Instruction and Educational Leadership and Administration from Wichita State University. As a teacher, he took on various Boxlight-related roles, including the Mimio Masters program, MimioConnect moderator, Teacher Team presenter, and Quick Learn moderator. As the Boxlight Educator Advocacy Leader, Travis now manages the Boxlight training programs available globally, as well as the Teacher Teams and MimioConnect lesson development.

Recently, he returned to his first love—being in school every day—and has assumed the position of high school assistant principal.

Twitter: @trink72 | Email: trink@goddardusd.com.

CONCLUSION

There are many ways to incorporate STEM into the classroom, so it's important to find the one that works best for both you and your students. After all, the goal is to spark interest and engagement in order to show as many students as possible how rewarding and exciting careers in these fields can be. Career growth in STEM isn't slowing down, so it's imperative that we prepare our students today for the jobs of the future.

Equipped with five senses, man explores the universe around him and calls the adventure Science.

~ Edwin Powell Hubble

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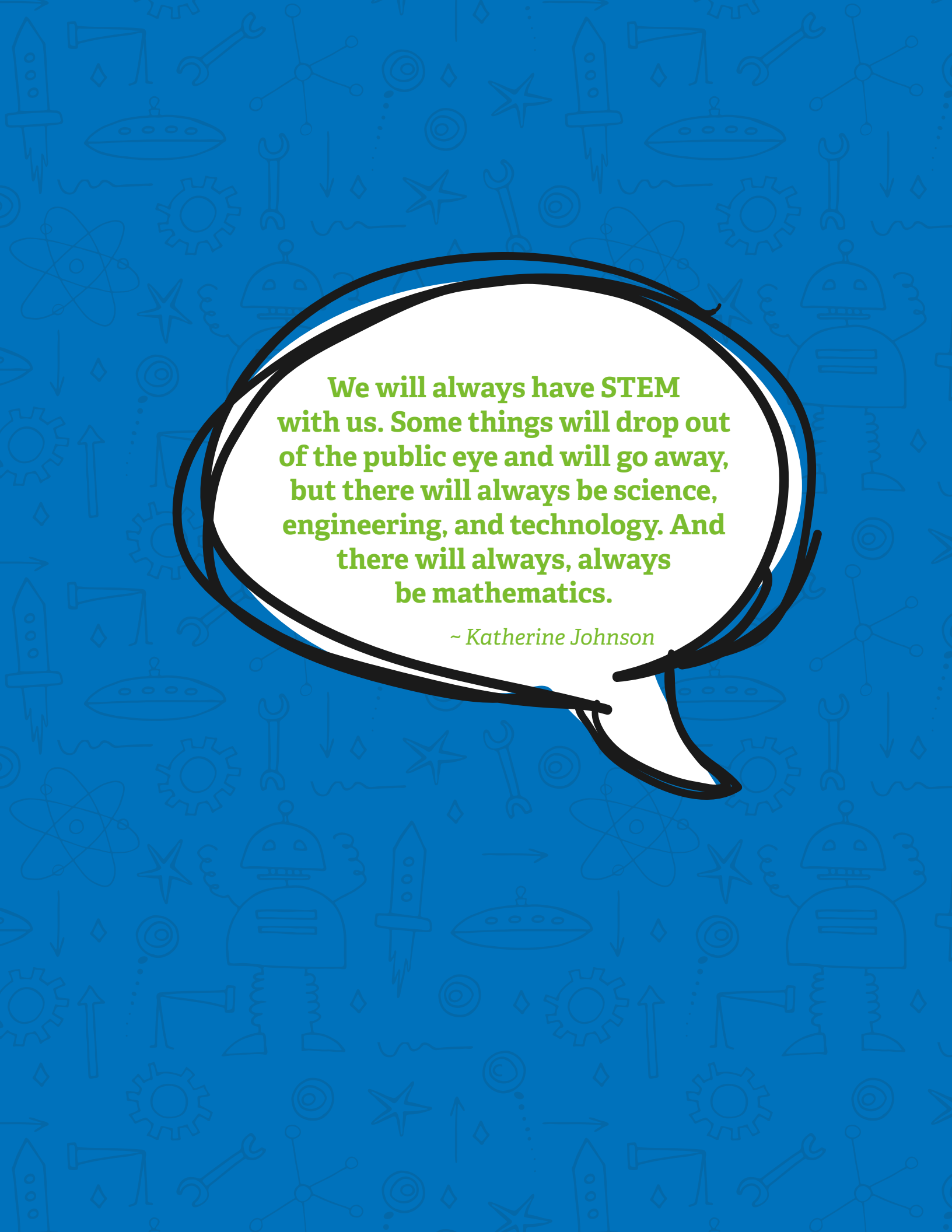[4] https://www.pewsocialtrends.org/2018/01/09/diversity-in-the-stem-workforce-varies-widely-across-jobs/

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We will always have STEM with us. Some things will drop out of the public eye and will go away, but there will always be science, engineering, and technology. And there will always, always be mathematics.

~ Katherine Johnson

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