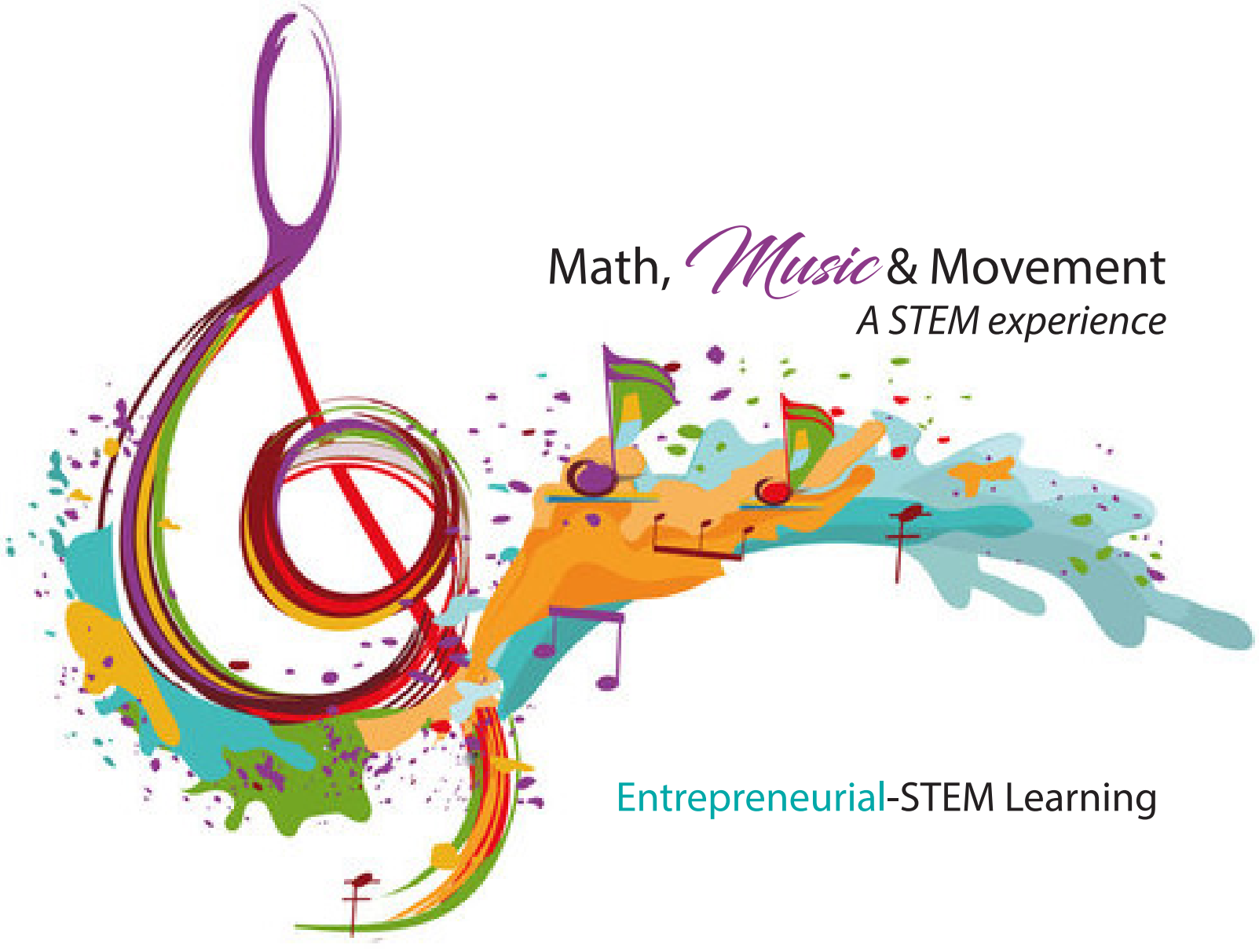
June 2023

# GEORGIA PATHWAYS

MAGAZINE



## Math, *Music* & Movement

*A STEM experience*

## Entrepreneurial-STEM Learning

## Black Women In Tech

ANDREA P. MILLER

## Dreams Take **Flight**

*Your flying car is here*

TAG Technology Association of Georgia

TAG TAG-Ed Education Collaborative

The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEAM learning opportunities and connecting them to Technology Association of Georgia (TAG) resources. Formerly the TAG Foundation, TAG-Ed is a 501(C)(3) non-profit organization formed by TAG in 2000. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEAM education in Georgia.

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Welcome to the June 2023 edition of Georgia Pathways Magazine.

In a world where technology permeates every facet of society, it is essential to provide learning opportunities that cater to all students' interests. That's why, in 2000, TAG created TAG-Ed to provide immersive STEAM experiences that equip the next generation with the skills they need to succeed.

While certain tech courses may not resonate with everyone, there is one universal language that captivates students of all types: music. Georgia's music community stands tall, both within the U.S. and across the world. Within this thriving musical landscape, there is an innovative approach to teaching coding—the fusion of music and technology—that engages students on a personal level.

By teaching coding through music, educators can connect with students on their own terms, demonstrating how technology can be used as a powerful tool for creativity and collaboration across diverse fields of interest.

Last year, Georgia Tech achieved a significant milestone with its educational platform, EarSketch, reaching more than one million users. Since its inception in 2011, EarSketch has transcended boundaries, inspiring students in all 50 states and over 100 countries. The unique program harnesses the power of music and creative exploration to teach students coding in Python and JavaScript.

Atlanta's Rap Plug Academy has emerged as a hub for teaching coding alongside music masterclasses. And, the Atlanta-based company Make Music Count has developed a groundbreaking STEAM curriculum and app for students in grades 2 to 12. By playing the latest popular songs on the piano, students improve their math skills while immersing themselves in the world of music. The influence of Georgia's technology community is clear, with schools across the country incorporating these programs into their own curriculum.

As music and code intertwine, students are empowered to experiment and create, even without prior knowledge of either discipline. Through our educational initiatives, TAG and TAG-Ed hope to inspire a new generation of creators, thinkers and innovators, forging a path forward where the possibilities are endless. Visit https://www.tagedonline.org/ to explore learning opportunities for students of all kinds.

Larry K. Williams
President
TAG / TAG-Ed

Larry K. Williams serves as the President and CEO of the TAG and the TAG Education Collaborative. TAG-Ed's mission is to strengthen Georgia's future workforce by providing students with relevant, hands-on STEM learning opportunities by connecting Technology Association of Georgia (TAG) resources with leading STEM education initiatives.

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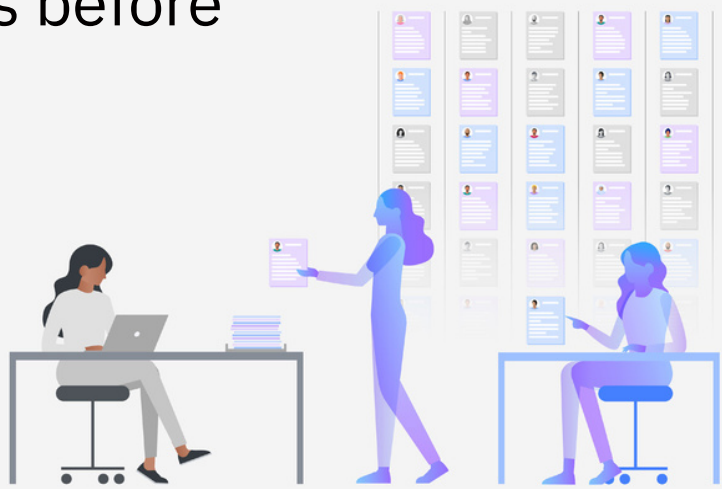

## About IBM® Watson Orchestrate

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**IBM Watson Orchestrate empowers professionals to be in the driver's seat of their work lives with digital employees designed to turn "to-dos" into done.**

With approximately 11 million open job roles in United States, organizations are struggling to find qualified candidates, placing the burden on existing employees to do more than ever. Between tracking down approvals, preparing requisitions, sourcing candidates, reviewing resumes, setting up interviews and the endless number of emails back and forth, recruiters are asking themselves, "How can I ever get ahead?"

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1 Source: US Bureau of Labor Statistics

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Mathematics, Music and Movement:

# Engaging *All* Students Inside the Mathematics Classroom

by Dr. Gina Cherkowski

## Early Music Training and the Brain

There is a prodigious amount of music and learning research looks at how early childhood music training affects music development and other areas of child development such as language, creativity, affective development, motor skills, visual spatial abilities, and social development (Jordan-Decarbo & Nelson, 2002).

It has been noted that music training before the age of seven was found to have a significant impact on brain development (Penhune & Zatorre, 2013). Haley (2001) found that people who had learned to play a musical instrument prior to grade four had higher scores in mathematics than those who did not.

## Music and Math

Historically, there is a strong connection that exists between music and mathematics (Vaughn, 2000).

Recently, there has been a significant and increasing amount of literature bringing awareness to the strong connections between music and math (Hoch & Tillman, 2012), however the vast majority of North American education systems still do not take advantage of this powerful connection.

Much can be learned from this explosion of research as it supports previous assertions that music has a positive effect on one's ability to learn and do math (Gardiner, Fox, Knowles & Jeffery, 1996).

## Math, Music and Spatial Skills

A growing body of research has found that music is connected to mathematical learning as it engages the area of the brain that stimulates the spatial-temporal reasoning system (Rauscher & Shaw, 1994). Spatial skills are critically important as they are considered the foundational building blocks for learning math as well as for performance in

the STEM (science, technology, engineering and math) fields (Uttal, Meadow, Tipton, Hand, Alden, Warren & NewCombe, 2014). Put simple, spatial reasoning is described as a critical higher-brain function that is engaged when students are performing complex tasks like doing mathematics (Rauscher & Shaw, 1994).

Rauscher & Shaw (1997) looked specifically at how musical training impacted spatial-temporal reasoning skills in preschool students. In their study, 78 preschoolers were given pre and post-test to measure their spatial abilities before and after a given treatment.

One-fourth of the preschoolers participated in private piano lesson for ten to fifteen minutes each week for six months in a row. Other students received either computer literacy instruction, singing lessons, or were in the control group. Results of the study showed no statistically significant improvement in the control group, nor in the groups that received computer literacy or singing lessons.

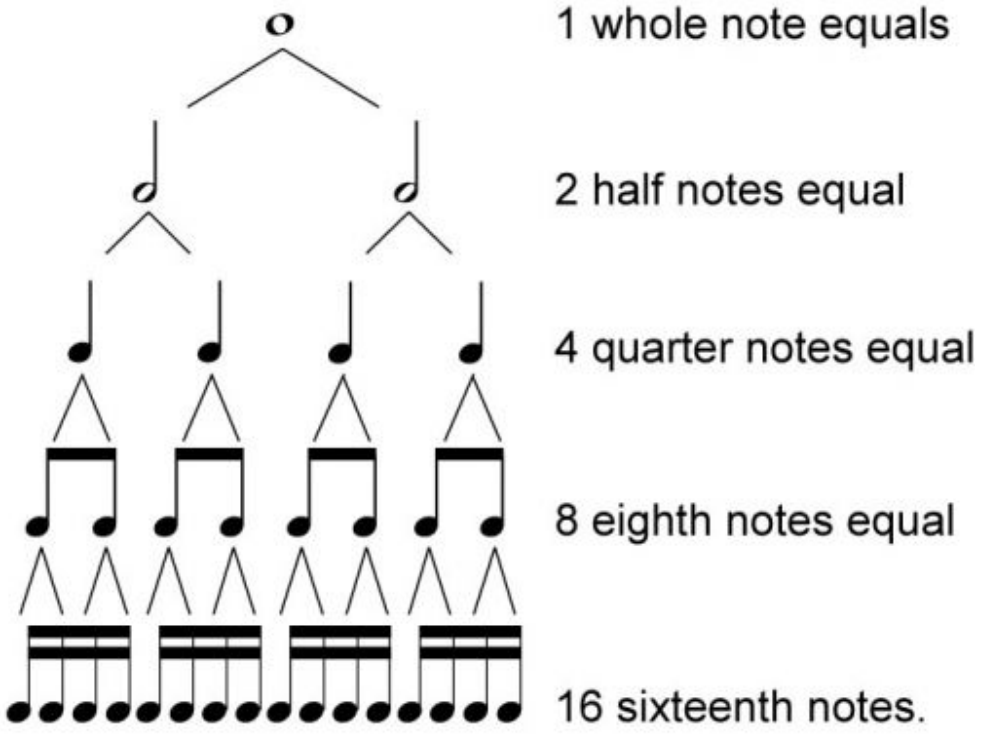
However, the group of preschoolers who participated in piano lessons improved by more than one standard deviation in their spatial temporal reasoning scores which is considered to be statistically significant (Rauscher & Shaw, 1997). Interestingly, these improvements were maintained when students were tested 24 hours later thus linking the improvement of students' spatial skills to long-term memory.

This study confirmed that the music instruction has significant impacts on students' spatial-reasoning skills as the students who received piano instruction show significantly more improvement than the other children did on the a puzzle based assessment.

## Music and Sequential Reasoning

Music is said to have a positive impact on sequential reasoning, another important math skill (Gardiner, 1996). Sequential tasks involve logic, order, realism, practicality, time-lines, organization and being able to pay attention to details. In a study specifically designed to compare different types on music training on math skills, one group of first graders were given music instruction that emphasized sequential skill development and musical games involving rhythm and pitch while another group was given more traditional music lessons for six months.

At the end of the study, the students who were given the music instruction that emphasized sequential skill development along with musical games scored significantly better in math than




the students who received more traditional style music instruction (Gardiner, 1996).

## Music and Fractions

Fractions are difficult to learn for many children (Hecht, Vagi, & Torgesen, 2007; Mazzocco & Devlin, 2008) and adults (Stafylidou & Vosniadou, 2004). This is highly disconcerting as fractions students' knowledge of fractions is a strong predictor of their overall later high school mathematics achievement (Siegler, Duncan, Davis-Kean, Duckworth, Claessens, Engel, Susperreguy, & Chen, 2012). Furthermore, students that do not understand fractions often struggle with algebra and mathematical reasoning (Courey, 2006).

According to Susan Courey, assistant professor of special education at San Francisco State University, music can impact learning fraction in positive ways. At Hoover Elementary School in the San Francisco Bay Area, some students participated in a musically enhanced math curriculum while others students received traditional math instruction. After six weeks, the students in the musically enhanced group scored fifty percent higher on a fraction test compared to students in the traditional math class (Courey, 2006).

What was even more interesting was that significant gains were made by lower-performing students.

Lower-performing students from the musically enhanced curriculum scored forty percent higher on their final test on fractions compared to their lower performing peers in the traditional math class. According to Courey this is because lower-performing students often found it difficult to understand fractions when they were presented in textbook or in a diagram.

She goes on to say that adding music gives students additional ways to learn and understanding fractions, removes barriers for many students and provides them with multiple ways to learn and understanding math equations.

Finally, music has also been linked to problem solving as according to Gardiner, musical training conditions the brain to do tasks similar to those it has to do when working on math problems (2003).

## Music, Movement and Other Important Math Skills

In addition to facilitating spatial skill development, increasing sequential skills, and enhancing fractional reasoning, learning math through music combined with movement (dance) has been found to be particularly beneficial for students as they learn math (Schaffer, Stern & Kim, 2001). For example, according to McCutchen (2006), when students participated in a dance based math class, students' attitude towards math students improved and they scored much higher than the students who were in the more traditional, non-dance based math class.

"Lower-performing students from the ***musically enhanced*** curriculum scored forty percent higher on their final test on fractions compared to their lower performing peers in the traditional math class."

In addition to improving attitudes towards math, dance has been found to be an innovative way to teach students the fundamentals of mathematics in a ways that helps students see and understand these ideas. Dance provides students with basic intuition about the abstract and sometimes hard to grasp concepts found in math. For many students, dancing enables them to apply an abstract mathematical idea to a more familiar real-world context which they can see, feel, and experience.

When students experience math through dance, this makes math more accessible and engaging for many students (Wasilewska, 2012). According to Kokona, (2009), "Culture and Arts can help practitioners train and develop a further understanding of Dance Mathematics principals,".

Many people find it strange to combine dance with mathematics as they see math as a realm of rationality that limits expression and creativity while dance is seen as a form of free expression that is highly creative. However, upon closer inspection we can see a lot of connections and commonalities between math and dance. For example, there are a lot of mathematical ideas that can be found in dance such as time and space, rotation, number, geometry, patterns, sequence, number, and even graphing (McCutchen, 2006). Research suggests that dance has been found to be highly beneficial for understanding mathematical concepts like combinatorics, symmetry, geometry, and patterning (Schaffer, Stern & Kim, 2001).

Additionally, abstract mathematics and various methods of analysis can be applied to help dancers of all skill levels understand dance at a much deeper level. Many choreographers often create their dance pieces based on intuition and feeling however, it has been suggested that being explicitly aware of the mathematical principles they are applying might help them with the creative process (Wasilewska, 2012).

## Conclusion: STEM + Arts = Opportunities for all

Math is a critical and necessary skill for all students in today's technologically-advanced, data-rich world. Students who are not mathematically literate will be greatly disadvantaged in this future world. Consequently, it is unjust not to give every student the opportunity to be mathematically literate so they can be optimally positioned to be a full and active participant in their future.

Since neuroscience tells us all students can do math at high levels, (Boaler, 2012), we know this goal is not only a nice dream, it is in fact attainable. Therefore, society must ensure all students can access the mathematics easily, effectively and in ways that allow them to understand it in their own way.

Share this issue with your students, peers, parents and industry professionals you know. Make this a new monthly connection for curiosity, interaction, college prep and career development.

Many parents really enjoy this content as they too pursue their personal life-long learning goals.

***Local industry and government leaders need to know about this resource as their future employees decide and prepare how to spend their careers.***

# When Dreams Take Flight

By **Mark Jennings-Bates**
Keynote Speaker, Adventurer and Author


Having grown up in the UK, it was natural for me to read books which more often than not portrayed a classic "colonial pioneering spirit". Historically, what the British lacked in terms of empathy and understanding, they made up for with adventurous DNA.

I grew up in an era that allowed me to witness mammoth tasks being accomplished, such as climbing the highest peaks in the world and crossing the biggest oceans or putting man on the moon. I remember one day as a young school child the whole school stopping and moving to the assembly hall to watch a small black and white TV portraying the image of one small man, very far away, stepping on to a very large moon. Disbelief was only one of many emotions at the time.

Fast forward to today and we are now living in an era where we invent more things in a month than we used to invent in decades.

Disruptive innovation is the buzzword of the day and anyone with an idea and a group of people behind them saying "It can't be done" is turning in to an overnight hero. In reality however, there is no such thing as an overnight hero. My journey as an adventurer has taken many years, decades. Yet as soon as a Guinness World Record is attained, the press quickly acclaims "He or she achieved the world record on their first attempt".

But you and I know it is never the first attempt. Whether it is Thomas Edison finding a few thousand ways to not make a lightbulb or Louis Pasteur working tirelessly for decades to invent cures for common ailments that were reducing the mortality rates for people in that day, success is never overnight! Our journey of discovery as a human race is far from over. Every day multiple column inches are dedicated to young entrepreneurs, scientists, technologists and inventors who in one form or another have created success in the field of science and discovery.

***So where is my Flying Car?***

We have put man on the moon, broken the sound barrier and created aviation vehicles that can take of and land vertically. Why has the flying car been so elusive? The dream to fly a car was around long before the Jetsons.

Since the Wright Brothers first defied gravity in 1903, inventors have been clamoring to further the pursuit of aviation and break new records, reach new heights and improve on a less than perfect technology. Even after the success of their invention, Orville Wright was still prone to a dose of pessimism as he looked through his crystal ball:

***"No flying machine will ever fly from New York to Paris …[because] no known motor can run at the requisite speed for four days without stopping."***

- Orville Wright

Even in those days at the dawn of invention, people's crystal balls were still foggy and yet history continues to repeat itself. Anytime you step in front of the crowd and lead with a new technology or invention, it gets pretty lonely by definition. You had better have a good constitution and know what you are getting in to and how to get out. As management guru Steven Covey would say - **"begin with the end in mind."**

That is exactly the approach the team at PAL-V in Holland took when they stepped in to the arena of Flying Cars. They believed that the concept of developing a flying car was feasible and history would prove that too often the focus had been on designing a vehicle which could not fit in to any regulations.

Today, Drones are providing heartburn for regulators wondering how they can fold these tiny unmanned vehicles in to existing regulations. The same has been true for flying cars. How do we handle development of new technology in a regulatory framework. While many focus on developing technologies that truly push innovation, PAL-V's team recognized that the commercial reward was in developing the first feasible flying car. A vehicle that could be regulated within todays stringent set of criteria for aviation and yet was still practical as a road driven vehicle.

Many awkward looking vehicles have been invented and even worked to some extent but nothing has gained traction in a commercial sense. That is exactly what PAL-V is hoping to change. With a car that looks "James Bond cool" and an aircraft that is equally as cool to look at as well as fly, what is notable is that a lot of the design features are simply borrowed and reworked from existing proven technologies. Juan de la Cierva invented the first rotary wing aircraft in 1920 with the development of what we know today as the Gyroplane.

What is interesting about his technology, even to this day, is that it is an inherently safe aviation platform. A wing design in autorotation means it cannot stall!

From a practical point of view it might be a great starting point for a flying car project. The famous autogyro Little Nellie was actually featured in the Bond Movie, You Only Live Twice.

The ability to have a car that can drive quickly and handle well was solved using the IP from the Dutch Company Carver who invented a tilting cab technology for three wheeled motorbikes. To put the various aspects of this hybrid vehicle together and make a legitimate flying car is the challenge. The challenge as it turns out was worthy of global business leader Robert Dingemanse's attention. Dingemanse heads up the team at PAL-V who have created a vehicle that fits in to todays regulations and is practical in both the worlds of ground transportation and aviation.

Finally a flying car that will be accessible to the general pubic and capable of driving down the highway to the closest airport before taking off in to the wide blue yonder. An old saying that I heard as a young boy is entirely appropriate for the development of the PAL-V even though it was written as advice for a young bride.

**Something old** - The Gyroplane technology of Juan de la Cierva

**Something new** - The technology that combines the power of flight with the ability to drive.

**Something borrowed**, - The Carver Tilting cab design

**Something blue,** - The skies that many people have yet to explore with their flying car and a silver sixpence in her shoe. Perhaps a prophecy of the commercial value of PAL-V's technology.

Now PAL-V is about to embark on a new journey - commercialization of it's invention. It is the path to commercialization that my business partner Andre Voskuil specializes in and following is a short article from Andre on how you can plan to create new Intellectual Property in such a way as to make it practical to market.

***Who is Andre Voskuil?***

Born in the Netherlands, mentored by one of the world's best commodity traders, Andre Voskuil made a name for himself in Europe's financial industry. He managed a portfolio of over half a billion dollars for celebrities and high profile clients before reaching the age of 30. His professional career has spanned from institutional investments to senior executive positions in both public and private companies.

Andre is known as the "Dutch Oracle" for making accurate predictions in the

Photo- left to right;
Mark Jennings-Bates & Andre Voskuil

markets and his uncanny ability to analyze companies and businesses. Among some of his foresights are publicly calling the 2008 debt crisis and the unprecedented rise of gold and oil. Business leaders and investors around the world consult with Andre to receive his independent expert analysis and practical advice.

Andre is passionate about helping investors and entrepreneurs to preserve and grow their wealth. He works with a select group of quality clients to help them manage their investments and businesses and acts as their trusted advisor and personal confidante. His style is professional, unique and brutally honest, yet, compassionate. "I have worked with thousands of professional investors from all over the world.

***"It is my goal to assist both professional and individual investors master the markets and make more money. I actively analyze and investing for our closed private company Dutch Oracle Capital. Nobody has a crystal ball, but with smart work and a good network of people around you can make excellent returns. That's my passion and I love to share that!"***

If you have a great concept or technology that will surely bring value to the market place, it is not necessarily a guaranteed commercial success.

***How do you successfully take your technology to market? How do you attract the required capital to grow from concept to an actual business?***

Many entrepreneurs that start a new venture are exceptionally bright in their field of expertise related to the technology or product they wish to market. However, having a concept or some kind of Intellectual Property (IP) is only half of the equation. The other half is execution on the commercialization. If you have a technology that has great value and must be brought to market, you better have a strategic path worked out to secure future milestones towards shareholder success.

***What are the 5 critical steps to take your IP to market?***

1. Secure your IP to the point where you can claim it as an intangible asset on your balance sheet. Patents and commercial agreements such as licenses are key.

2. Get to revenue as quickly as possible. Build a "pipeline" of commercial leads, preferably through LOI's and MOU's.


3. When your IP venture is pre-revenue or requires additional capital to grow, make your corporate structure and valuation conducive to attracting those investors. Raising capital is a full-time effort, prepare the documents professionally and allocate a concerted effort into securing the round as opposed to one meeting here and there.

4. There are countless smart people in many centers in the world trying to figure out new advanced concepts and technologies. If you have something good, bring it to market asap. Technology is perishable and you can actually put a mathematical value on that window of time. You will lose a certain amount of opportunity value for every month that you will not advance towards commercialization.

5. The monetary rewards are ALL in the share value and structure, NOT in the actual sales or revenues. It's easy to make irreversible mistakes in your share cap table that could cost dearly when it's time to expand or exit. Misdirecting control or the company/technology can be a big reason for technologies to fail to succeed to commercialize. Spend time crafting your share structure and everything that comes with it.

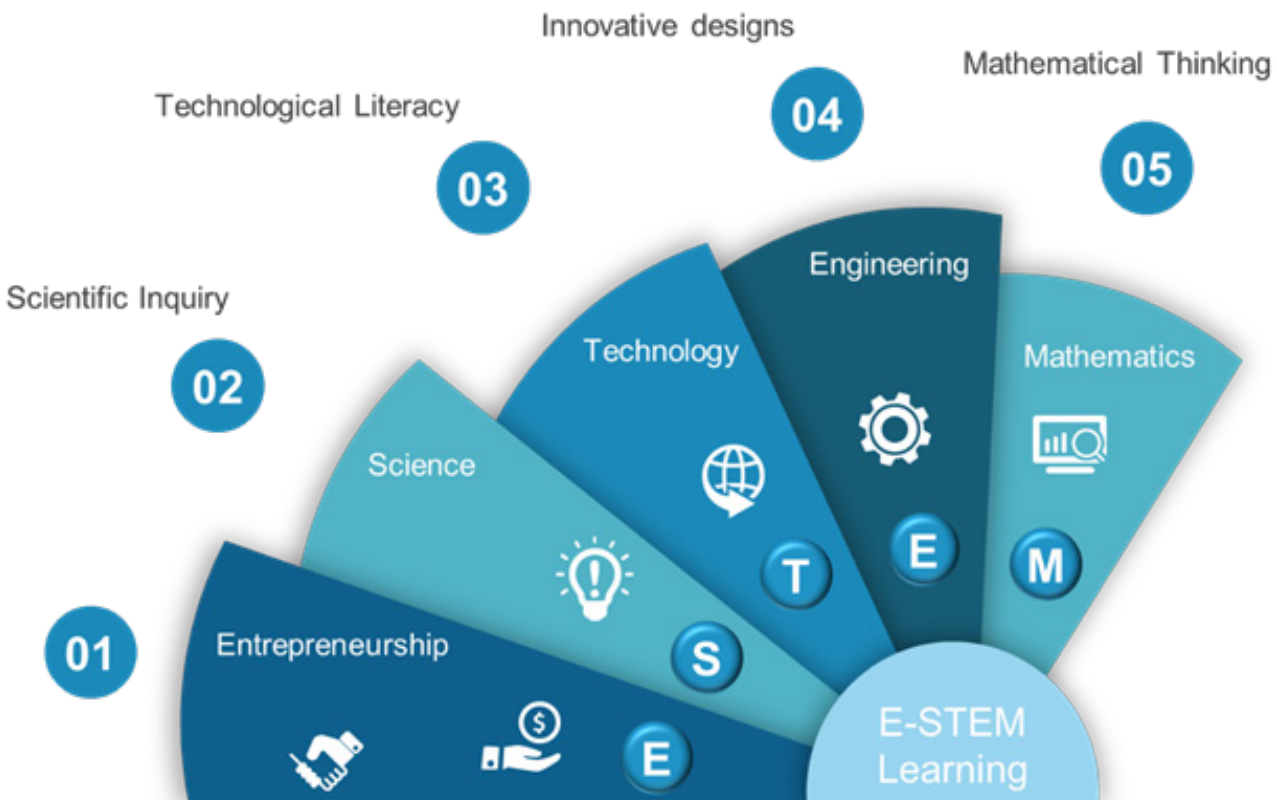
The spirit of imagination, inspiration, and innovation using STEM skills continues as dreams become realities. And now, here is your flying car to enable your dreams to take flight.

# Entrepreneurial-STEM Learning

By **Dr. Marwa Eltanahy**
*Higher Colleges of Technology*

Education has the main responsibility in preparing students for the workplace through acquiring new knowledge, developing skills, and maintaining positive attitude to continue learning. The question is which skills should we focus on? The current society has constant changes which requires new skills to cope with its uncertainty. At the dawn of the industrial age, literacy meant reading, writing and anthemics that enabled peoples to communicate and fulfill their duties.

While, these skills remain essential, they are not sufficient in a fast-paced and a dynamic world where all efforts should be cultivated to serve the community by offering innovative solutions to cope with new and unexpected challenges. That is why, STEM becomes the new literacy of this era. At the same time, acting in an entrepreneurial way and exercising entrepreneurial competencies are essential to open new horizons for students.



Entrepreneurial-STEM learning (E-STEM) is a new and innovative interdisciplinary approach that combines entrepreneurship with science, technology, engineering, and mathematics (STEM) education. It focuses on the development of a valuable set of students' entrepreneurial competencies, including the desired knowledge, skills and attitude that are essential for success in both entrepreneurship and STEM fields.

These competencies, such as creativity, critical thinking, and problem-solving are important skills for STEM professionals and are highly needed for future entrepreneurs. Additionally, it provides meaningful opportunities for understanding the market needs to create new initiatives, designs or services that can add values to the community. E-STEM strategies encourage students to take entrepreneurial risks in a safe learning environment where mistakes and challenges are learning opportunities that are addressed with a growth mindset.

Although E-STEM integration is a complex process because it requires collaboration and coordination between different disciplines, E-STEM implementation proved successful through student-centered pedagogies that emphasizes hands-on experiential learning, and project-based activities. Therefore, the ongoing process of curriculum development to integrate entrepreneurial practices into STEM education requires significant resources and expertise to scaffold E-STEM learning journeys. Accordingly, inviting business teachers to be involved in the existing STEM practices has a vital role to shift the STEM paradigm to be more business-like. Utilizing real-world problems and scenarios to engage students and to help them apply what they have learned in the classroom is the core principle of establishing a positive E-STEM context.

Instead of creating STEM designs that may easily be lost after educational exhibition, E-STEM learning provides more authentic experiences that have the potential to eliminate the gap between students' outcomes and community needs. Several constructivist strategies are recommended in light of competency-based approach to effectively apply E-STEM learning as follows:

- Project-based Problem Solving (PjBPS): Students work collaboratively on creating projects to solve real-world problems and scenarios that requires developing E-STEM competencies in an experiential learning environment.

- Problem-based Learning (PBL): Students work collaboratively on real-world problems and scenarios that

requires developing their E-STEM competencies.

- Project-based Learning (PjBL): Students work collaboratively on designing projects that requires developing their E-STEM competencies to create innovative products or services.

E-STEM learning can be applied all many educational stages in both basic education and higher education. It might be challenging in early childhood than other stages. However, a variety of practices are applicable to incorporate entrepreneurial concepts into existing STEM learning. E-STEM should provide opportunities to be used to promote entrepreneurial practices by having students design and create a "simple marketing plan" for their projects. This activity allows students to explore the business aspect of design, including branding, pricing, and target audience who might be interested in this project.

Figure 1 shows an example of E-STEM designed through project-based learning applications. Undergraduate students designed a big rocket using c simple materials that can be a valuable tool for enhancing early childhood education (ECE) by providing opportunities to enhance students' mathematical thinking, scientific inquiry, technological application, and entrepreneurial practices.

*Figure 1: Project-based STEM Learning*

Teachers utilized this project to engage students in a variety of activities to develop their design-process skills.

For example: one activity is to have students plan and sketch their own rocket designs using simple materials like cardboard, paper, and tape. This activity allows them to apply their mathematical thinking skills by measuring and cutting materials to specific dimensions, and encourages them to think critically about the design process by testing different designs and making modifications.

Another activity is to involve the use of scientific inquiry, where students can learn about the scientific principles that govern how rockets work. This can be achieved through discussions, reading materials, and hands-on experiments like launching small paper rockets to demonstrate the laws of motion.

Additionally, teachers can incorporate technological applications by having

students use computer software or other digital tools to design their rockets in 3D.

This activity allows students to explore the use of technology in the design process, while developing their technological skills. Finally, students can draw a brand logo for this projects, fill in a sheet with the pieces of each materials involved in the design, and learn how to reduce the cost as an essential concept of entrepreneurship. This project effectively demonstrated how teachers can successfully integrate science, math, technology,  and entrepreneurship in early childhood education to create engaging and meaningful learning experiences for young students.

Figure 2 illustrates an exemplary project that showcases the integration of entrepreneurial-STEM learning into lower-grade education. The project was initiated by undergraduate students of education who recognized the need for regular incorporation of STEM projects into early childhood education (ECE). The students designed a ship capable of carrying multiple vehicles through different doors.

To accomplish this, they had to apply various mathematical and scientific concepts, including the measurement of size and weight, to determine the appropriate location for each vehicle on the ship based on given criteria. In this context, elementary students learned how to apply critical thinking skills and problem-solving strategies to create a solution to a real-world problem.

Furthermore, the project integrated technology and entrepreneurship, allowing students to explore and develop a deeper understanding of concepts such as cost reduction and branding colors. To enhance their understanding, students should also watch videos and scenarios that discuss similar ideas in real-life. After the exhibition, E-STEM projects are used in many classes to improve students' thinking skills with an unlimited number of scenarios.

This project effectively demonstrated how teachers can successfully integrate science, math, technology, and entrepreneurship in early childhood education to create problem-solving opportunities in an active learning environment.

*Figure 2: Problem-based E-STEM Learning*

As students progress to higher grades, their capacity to integrate more advanced entrepreneurial concepts and experiences increases. These concepts include business plans, financial awareness, customer development, design functionality, market analysis, modeling and prototyping, competition, and positioning.

Figure 3 showcases a prototype created by a group of college students who applied E-STEM practices in the college. They developed an "Autism Control Device" to safeguard individuals with autism. This application tracks their heartbeat, blood pressure, and medication schedule. It can also be used during emergencies when a caregiver is not present. The students integrated different E-STEM disciplines to design their projects, including the application and the prototype. Educational exhibitions offer rich opportunities for students to present their ideas, business plans, and receive constructive feedback to improve and develop their projects, ultimately achieving the main E-STEM goals.

E-STEM learning creates a dynamic environment where students learn to analyze, criticize and, rationalize their decisions to play effective roles in their communities. Thus, professional development programs should be prepared to train teachers in both entrepreneurship and STEM education.


*Figure 3: Project-based Problem Solving*

Constructivist alignment between the intended outcomes of E-STEM learning, teachers' instruction, and possible assessment practices should be emphasized to effectively implement Entrepreneurial-STEM learning.

However, developing both formative and summative assessment practices that accurately measure students' progress and improve learning outcomes is challenging. Research community concerning E-STEM learning works tirelessly to create new valid and reliable tools of authentic assessment that allow teachers to identify students' strengths, their needs and how to improve their entrepreneurial companies. Moreover, E-STEM assessment tools should draw a visible roadmap for students to become assessment-capable learners.

Entrepreneurial-STEM learning offers several benefits to both students and the economy, including improved career prospects, enhanced skills,

promoted entrepreneurial activity, and economic growth. Thus, the implications of E-STEM learning are very promising because it can contribute to the work place development through preparing more students for of careers in high-demand fields such as engineering, technology, entrepreneurship and any business-based STEM careers to better enhance the economic growth of the countries.

Additionally, it can promote sustainability, social and environmental responsibility by encouraging students to develop solutions to real-world issues that have a positive impact on society and the environment.

In conclusion, education system should be responsive to the world' demands through producing a new generation of students who are scientifically, mathematically, technologically and entrepreneurially literate. Consistent efforts are done in education for a change to the better. E-STEM learning offers tangible solutions to reduce the skill gap between what we are able to do, and what future unknown careers need.

Yet E-STEM learning opens up completely new learning spaces to launch our students in the direction of their new world.

**Dr. Marwa Eltanahy**

# Black Women In Tech:

## *Not Just a Black Woman Problem*

By Andrea P. Miller

Imagine…you live in a seemingly nice neighborhood that conveniently has a playground where all the neighborhood children can play. Unfortunately, it has come to your attention that your child is constantly being pushed down every time they go. So what does one do? Well – with no other playground in sight, you spend your time preparing your child – ensuring that he/she is strong enough to withstand any attempt from the neighborhood children to overtake them. You know that you won't always be around to protect them so you teach them to protect themselves. But is this enough?

Photo credit: Christina @ wocintechchat.com

As a Black woman working in the K-12 and greater Atlanta STEM space, the underrepresentation of Black women in technology is top of mind for me - especially as I engage with young Black girls in my school.

According to data from the National Center for Women & Information Technology (NCWIT), women make up 47% of employed adults but hold only 25% of computing roles. Furthermore, of the 25% of women holding these roles, only 3% are Black women according to a report from the Pew Research Center. Recently in a conversation with Ms. Kemby Ross-Jones, CEO and E-Learning Director of RentMyTutor, she asked for my thoughts on how we can change this reality. My response? *"Black women can't be the only people who see this disparity as a problem worth solving."*

We are seeing efforts from individuals and corporations to make space for underrepresented persons or sharing their space to allow for the amplification of valuable voices. On June 5th, 2020, Alexis Ohanian resigned from Reddit's board of directors, urging the remaining board members to fill his spot with a Black candidate.

Five days later, over 40 white women influencers shared their social media spaces with a roster of incredible Black women in the #ShareTheMicNow campaign in order to magnify the lives, stories and work of Black talent. Similarly, the inclusion of Black women in tech will not be achieved until the mostly non-Black, predominately male tech workforce creates space for Black women at the tech table.

Efforts to increase Black women in tech are mostly led by Black women and focus on cultivating a pipeline of elementary, middle and high school aged Black girls who may one day aspire to pursue a role in a tech industry. They come in the form of initiatives, programs, camps and internships and often include the provision of mentorship and the development of critical dispositions necessary to survive in a primarily White/Asian male environment.

There is nothing incorrect about this approach, but the cultivation of Black girls to pursue technology must become a priority for any entity or persons who develop K-12 tech talent. Furthermore, parallel efforts should be made to educate K-12 students who do not identify as "Black" and "female" regarding how to make space for those who do.

Because the fact of the matter is that children will inevitably grow up. These young Black girls will become fortified

women hopefully pursuing roles in a tech field and their non-Black and/or male counterparts will become adults as well.

We cannot expect that the latter group will miraculously become adults who value the inclusion of Black females in the tech workspace unless they were groomed to do so throughout their educational tenure. Therefore I ask you to consider – while we build young Black girls to one day prosper in a currently White/Asian tech work space, how do we build the efficacy of those who do not identify as a Black female to one day modify environments that do not require Black females to be so armored up?

We must simultaneously build up our young people to succeed the presence of inequity.

For those who teach or lead K-12 technology instruction in schools or ancillary programs, here are some ideas about how to encourage students to be observant and thoughtful about their peers (such as Black girls) who are underrepresented:

- Workplace diversity and inclusion (including barriers to these ideals) should be written into the required learning targets of any computer science or technology K-12 curriculum.

If it is not included - add it. In some

instances, if diversity is included in technology or computer science curriculum, it is in reference to addressing the needs of diverse end users of technology - not the diversity of the team(s) who created the technology. Students of all demographics should embrace all tech learning experiences and understand current job-place challenges.

- Intentionally craft learning experiences that push students out of their comfort zone to partner with students who are different from themselves. Are participants in your technology course or program mostly male and/or mostly White or Asian?

Find a school or program that serves Black girls interested in technology and host joint learning events. Place students into learning groups paying close attention to group composition. Choose group captains for student groups and ensure that Black girls are part of the rotation.

- Invite students to evaluate the participation rate of Black girls in the computer science, Advanced Placement STEM courses, technology clubs and summer technology internships that their school or program offers.

These are not concerns and conversations that should only be had by adults. Share current marketing and recruitment practices with them and allow them to provide critical feedback - particularly Black female participants. Remain open and willing to change.

Not only can these suggestions help to create welcoming learning environments for Black girls interested in tech but they can ultimately aid in the promotion of ANY underrepresented group. Having to consistently exercise strength and resilience because you're always on the defensive can be tiring, but if we knew that a Black woman in tech could enter that space without survival as their main priority, maybe – just maybe – those working with our future Black women in tech can help them to focus their energies on thriving and not surviving.

The presence of Black women in tech is poor across a variety of industries. We must continue to equip our young Black girls to prepare for the realities of a competitive and diverse workplace and encourage others to reshape their reality.

So maybe training your kids to defend themselves on that playground isn't the optimal solution. It would be nice if we didn't have bullies anywhere. Standing up for one's self on the playground or in the workplace is a valuable and necessary quality to be encouraged.

About the Author

After receiving her Bachelor of Arts in Economics, Public Policy and Marketing from Duke University and working for one year as a Corporate Account Marketer, Andrea P. Miller began her 16 year tenure in K-12 public school education as a secondary Mathematics and Social Studies instructor. She went on to receive her Masters Degree in Urban Education Leadership from Columbia University and an Education Specialist in Education Leadership from the University of West Georgia.

Currently, she serves as a STEM/STEAM Instructional Coach and Specialist in Atlanta Public Schools and has launched an education strategy firm, Twelve12 Group | Consulting, through which she successfully leverages her diverse areas of study and work experience to de-construct and redesign traditional approaches to K-12 STEM/STEAM education for schools and spaces that seek to increase the participation of African-American and Latino students.

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# Museum Unveiled Solar System Trail

By Shelly Humble

Visitors to Tellus Science Museum in Cartersville, GA are now able to "travel" from planet to planet as the museum unveiled its outdoor Czahor Solar System Trail the evening of April 29 during National Astronomy Day.

Spanning 839 feet across the front grounds of the museum, the exhibit represents the 5.9 billion mile distance between the Sun and the dwarf planet Pluto. Visitors will learn interesting information about each planet as they walk through the trail ¬and see the stations illuminated during evening events. At one foot per 4.4 million miles, each planet is the exact distance scale for the exhibit, and visitors may be surprised at how small some of them may appear in actual scale.

Each station has a hand-painted 3-D model that illustrates what each celestial object looks like. As a special showcase of the newest exhibit, the museum will illuminate each station at dusk during National Astronomy Day.

Patrons gathered around the observatory to witness the ceremonial lighting.

The exhibit was funded by long-time supporters of the museum Tim and Sharman Czahor from Calhoun, Georgia, along with other donors who sponsored a planet. It was designed by John White from INOX Design, the architect who designed the museum and most of the museum's exhibit galleries.

"This is an exhibit we have wanted to do for years," said Tellus Executive Director Jose Santamaria. "When Tim and Sharman expressed interest in getting involved in an exciting project, they really liked the idea of designing a scale model of the Solar System as a walking trail. I think visitors are going to learn a lot about our planetary neighborhood."

"I've never seen any exhibit that looks like ours," said Tellus Astronomer Karisa Zdanky. "Other models I've seen are typically just panels with something

along the lines of 'You've reached Mars' and some basic facts. I really like the design choices that we made with ours, making them actual pillars with the 3D planets inside and a lot of information about the planet."

National Astronomy Day festivities also include all kinds of activities at the museum throughout the day. The Observatory will be open for day and night viewings of our Sun and other celestial objects, weather permitting. With special activities, shows, give-aways and more, this is an event sure to be fun for all ages!

"National Astronomy Day is a relatively recent holiday, started in 1973 by Doug Berger, the president of the Astronomical Association of Northern California at the time," Zdanky continues. "It was started to get the public more interested in astronomy and to make it more accessible to them.

Tellus Science Museum is a program of Georgia Museums, Inc. This Smithsonian Affiliate is a 120,000 square foot science museum located in Cartersville, just north of Atlanta. For more information about Tellus Science Museum call (770) 606-5700 or visit:

**www.tellusmuseum.org**

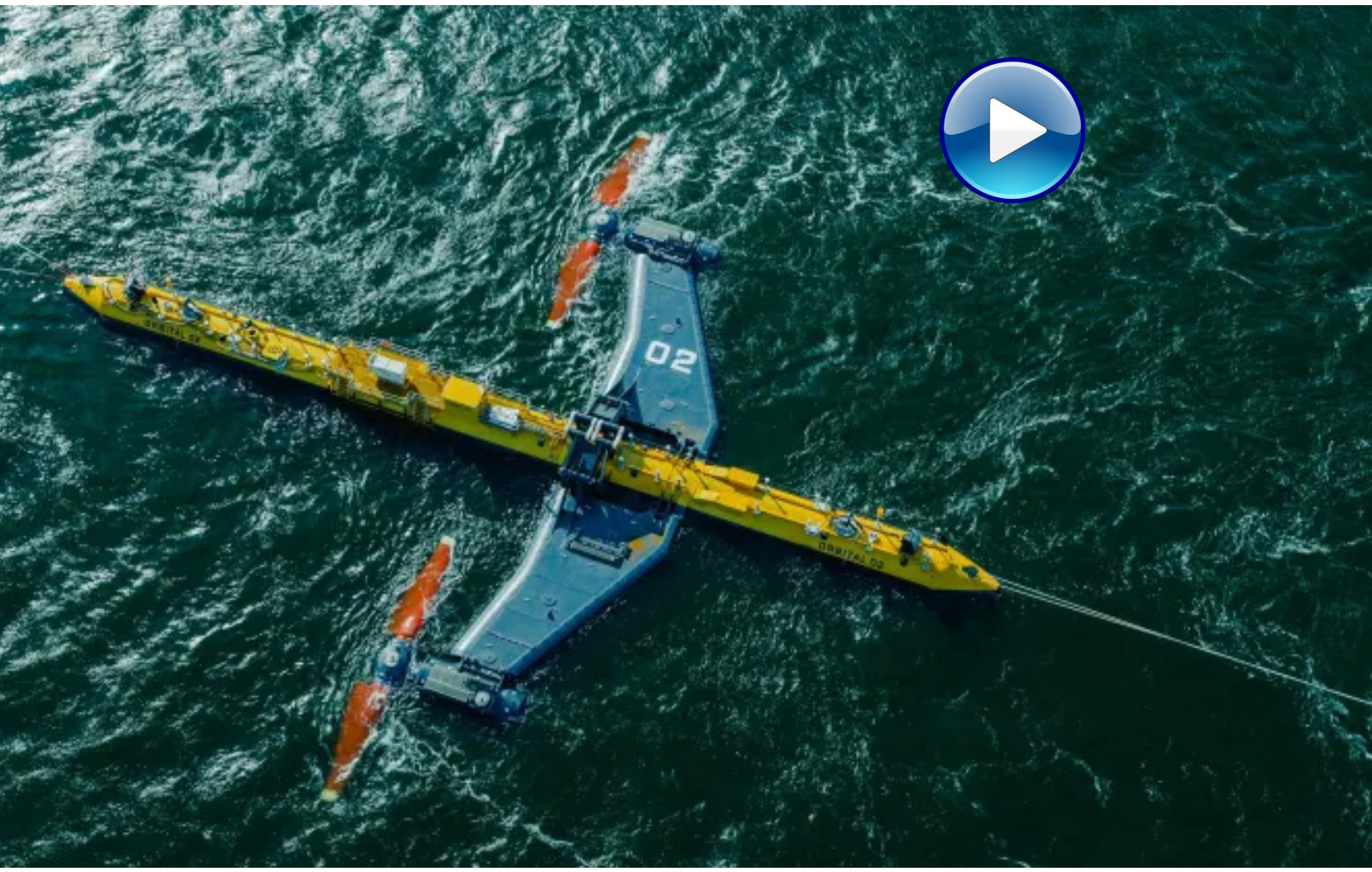
# Tidal Power

by Wayne Carley

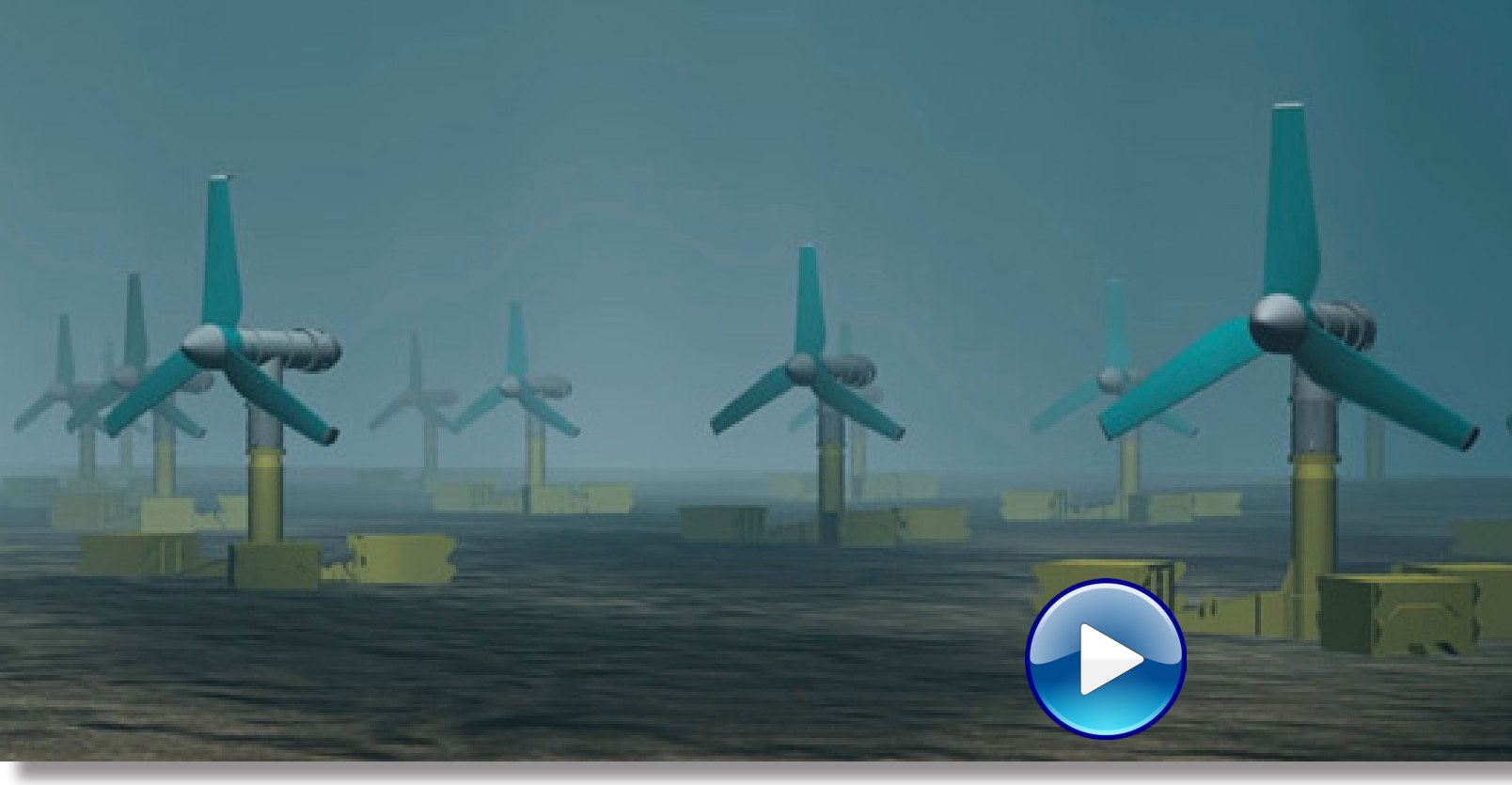
The gravitational pull of the moon and sun along with the rotation of the earth create tides in the oceans. In some places, tides cause water levels near the shore to rise and fall up to 40 feet. People in Europe harnessed this movement of water to operate grain mills more than a 1,000 years ago.

Today, there are tidal energy systems that generate electricity producing tidal energy economically within the required tidal range of at least 10 feet.

There are a number of ways in which tidal power can be harnessed. Tidal barrage power systems take advantage of differences between high tides and low tides by using a "barrage," or type of dam, to block receding water during ebb periods. At low tide, water behind the barrage is released, and the water passes through a turbine that generates electricity. Tidal stream power systems




A tidal turbine weighing 680 metric tons and dubbed "the world's most powerful" has started grid-connected power generation at the European Marine Energy Centre in Orkney, an archipelago located north of mainland Scotland.



are used around islands or coasts where these currents are fast. They can be installed as tidal fences where turbines are stretched across a channel or as tidal turbines, which resemble underwater wind turbines.

The total energy contained in tides worldwide is 3,000 gigawatts (GW; billion watts). By comparison, a typical new coal-based generating plant produces about 550 megawatts (MW; million watts).

Although total global electricity consumption approached 21,000 terawatt-hours in 2016 (one terawatt [TW] = one trillion watts), energy experts speculate that fully built-out tidal power systems could supply much of this demand in the future.

Estimates of tidal stream power—which uses ocean currents to drive underwater blades in a manner similar to wind power generation—in shallow water is capable of generating some 3,800 terawatt-hours per year.

Environmental concerns raised about tidal power stations are largely focused on the tidal barrage systems, which can disrupt estuarine ecosystems during their construction and operation. Tidal fences and turbines are expected to have minimal impact on ocean ecosystems. Tidal fences do have the potential to injure or kill migratory fish, however, but these structures can be designed to minimize such effects.

Tidal power leverages the rise and fall of oceanic tides to capture potential or

kinetic energy and convert it into other energy forms, often electricity. There are two methods of harnessing tidal power. One method resembles a hydroelectric dam, called tidal barrages, and another relies on underwater turbines that have blades that rotate as water flows by, powering a generator in the process.

Tidal turbines may be installed in water sources ranging from areas with strong ocean currents to tidal streams and estuaries. They may be installed on their own, but larger energy projects commonly install connected rows of turbines, called an array. Variations in wind patterns, weather, and turbulence make it inherently challenging to predict while the benefit of tidal power is its relatively high power output. Because water is roughly 830 times denser than air, tidal or ocean currents can generate more energy per unit area than winds.

Despite these advantages and the skyrocketing demand for clean, renewable energy, tidal power hasn't taken off in the same way that solar and wind energy have. There are only a handful of commercially-operating tidal power plants worldwide, the largest of which is the Sihwa Lake Tidal Power Station in South Korea.

"The fundamental question is one of economics," says Brian Polagye, Associate Professor of Mechanical Engineering and Director of the Pacific Marine Energy Center at the University of Washington. Because of the early stage of the technology, tidal power is an expensive source of energy: according to a 2019 study, commercial-scale tidal energy is estimated to cost $130-$280 per megawatt-hour compared to $20 per megawatt-hour for winds.

High upfront costs of building plants, expenses associated with maintaining machinery that can survive corrosive seawater, and the costly engineering work that goes into them make up a significant portion of that cost challenges. Much of the current manufacturing efforts associated with wind and solar power use hardware and tech that do not work in an underwater environment, so we would have to start fresh manufacturing those physical parts.

## The future

Tidal power is thriving in some countries. In Scotland, a 600-ton turbine anchored right off of the Orkney Islands is already generating power. The turbine, named the O2, is projected to meet the energy demands of 2,000 homes for the next 15 years. Recently, the UK also introduced a new set of incentives that specifically support tidal energy.

The tide may also be turning globally- Countries around the world are investing in research and development around tidal and wave energy technology.

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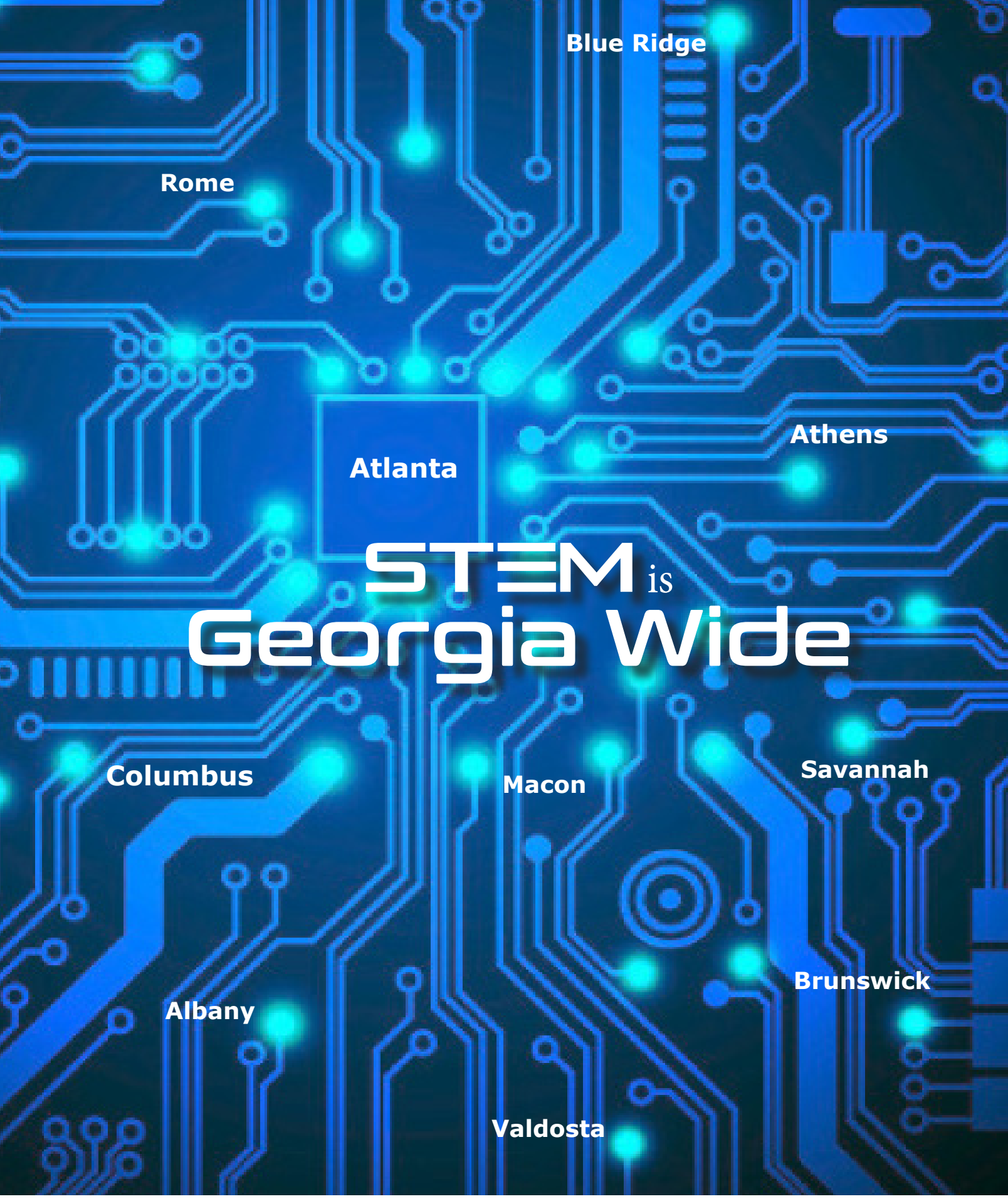


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