

July 2019

# GEORGIA PATHWAYS

M A G A Z I N E

## A Sea of STEAM *(part 2)*

Programming &  
Robots

The STEM of **Go**lf



# IMPROVING CS EDUCATION OUTCOMES



Helping teachers & students go deeper and bring  
computer science concepts to life in the classroom



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Welcome to the latest edition of Georgia Pathways™ STEM Magazine.



Across the country, teachers and students are preparing to return to the classroom. Many will be engaging in STEM education projects and learning experiences that are paving a clearer and stronger pathway to future technology careers.

In the last decade, STEM education efforts have become synonymous with best practices in learning. More schools, teachers, parents and students are engaged in STEM initiatives and employers, in turn, are anticipating a more plentiful workforce pipeline.

Randstad US recently released new data from a survey they conducted showing that U.S. workers see undeniable value in STEM education and skills. According to the survey, if U.S. employees could go back in time to age 18, 68 percent say they would focus on a field of study within science, technology, engineering or math (STEM), the report said.

Employees see companies on the hunt for STEM skill sets and increasingly see the advantages of having or acquiring these skills as they find their place in the modern workforce. The survey also revealed that many employees would like to see their employers invest more in training and developing digital skills and believe more preparation is needed to be equipped for digital jobs of the future.

Growing and developing STEM talent from within an organization is a great way to close skills gaps that some employers are experiencing, the report said. Given that context, think about how important STEM learning has become. Curriculum at the K-12 grade level provides solid building blocks that create students who are prepared for the modern workforce.

As summer break draws to a close, it is exciting to think that the collective support now given to STEM learning will open new pathways this coming school year for all students who will be a part of that workforce of the future.

Each month, this publication, likewise, supports STEM by reaching educators, students, parents and technology fans who want to inspire students and teachers to continue bolstering STEM curriculum.

Inside this edition you will find stories about STEM initiatives that may inspire you to support or start your own. You will also find examples of how students are benefitting from STEM programs.

I hope you will be encouraged to get behind STEM efforts and share this publication. Thanks for your support!

Larry K. Williams  
President  
TAG-Ed

Larry K. Williams serves as the President and CEO of the Technology Association of Georgia (TAG) and President of the TAG Education Collaborative (TAG-Ed). 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.



The Technology Association of Georgia Education Collaborative (TAG-Ed) strengthens the future workforce by providing students with relevant, hands-on STEM 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 2002. Later, the organization's name was re-branded to TAG Education Collaborative to facilitate our role as the leaders for K-12 STEM education in Georgia.

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### From the Executive Director

A new school year has begun and we're truly excited by the new opportunities that are in store. This year legislators have passed legislation that provides tremendous support for students throughout the state - particularly in more rural areas of the state. New opportunities mean greater Computer Science for all initiatives, greater Science for all initiatives and better high speed connectivity throughout the state.

This means increased access to content and resources for both teachers and students. It's exciting to know that collaborative efforts like the CS4GA Policy committee and Science for Georgia are happening every day to strengthen equitable access and exposure to STEM learning experiences throughout Georgia.

The CS4GA Policy Committee worked diligently to enable SB 108 that requires computer science courses in middle school and high school and ensures grants for professional development programs for computer science teachers.

Whereas Science for Georgia is excited to support the new FY2020 funding that will support life sciences education in rural school systems through the Georgia. But here's our encouragement to educators and educational administrators; please remember to engage, reach out and take full advantage of the resources being made available. And as you do, please remember to share your success with Georgia Pathways™.

We'd love to hear and share your success stories and best practices with others in our Georgia STEM Ecosystem. We're a community that enables an "exchange" of ideas and content for the betterment of our students throughout the state. Here at TAG-Ed we operate from the belief that "Small acts, when multiplied by millions of people, can transform the world."


We encourage you to consider Georgia Pathways™ to be the platform that empowers you to be a change agent in our ecosystem. And as change agents we all have the opportunity to impact student success.

Sincerely,

A handwritten signature in black ink that reads "Errika Moore".

Errika Moore  
Executive Director  
TAG Education Collaborative



A full-page background image showing a diver swimming underwater. The water is a deep blue-green color, and a bright, circular light source is visible above the diver, creating a strong glow and illuminating the water. The diver is seen from below, with their head and upper body visible. The overall mood is serene and focused.

# **Swimming** in a **Sea of STEAM Stuff:** How to choose the right STEM product or service to meet your needs (Part 2)

by Scott Davidson



*This article is part 2 of a 3-part series addressing smarter consumer decision making when it comes to STEM programming and services.*

In the last segment, we addressed factors to consider before you evaluate the actual products or services provided by a STEM vendor. Those included your institutional brand and your plan for STEM initiatives. For this installment, we will focus on the quality of products and services by addressing elements of effective STEM implementation in schools.

## Alignment

One of the first things that you will notice is vendor claims about the alignment of products and services to popular frameworks. Since 'STEM' is often a codeword for 'science' in the marketplace, we should probably start with the Next Generation Science Standards (NGSS).

The folks at Achieve did us all a huge favor last year by publishing a guidance document regarding alignment to the NGSS standards. I actually cannot improve upon the advice and guidance provided by Achieve here, so I will make you aware of it (if you were not already) and leave it to your discretion to read their publication. But definitely read it! These tips apply, whether you are looking at alignment to NGSS, Common Core Math, or the 4C's.





The main point-of-summary on alignment is that all vendors, including my organization, have a vested interest in aligning our work to the most recent movements in education. My hope is that we all do a thorough and complete job, but caveat emptor!

## Technology

I hesitate to address any of the STEM disciplines in isolation, but I would be doing you a disservice if I did not talk about technology. So let's talk edtech! Most of the conversation today is around robotics and coding, but there is so much more to the role of technology in schools. The biggest missing piece that we find relative to technology in schools is a set of clearly-stated goals for student development of a "portable" set of skills. While some skills frameworks have been adopted by systems and states, especially at higher grade levels, there is limited consistency in this area. At a minimum, your team should be evaluating the nature of

student engagement with tools for learning (inclusive of digital technology) within vendor programs.

Ask yourself what skills students will take away from the experience and to what extent these skills are relevant. If you are feeling a bit intimidated by the recent conversations around computer science, coding, and robotics, start with a simple paradigm for student technology use. The SAMR model, developed by Dr. Ruben Puentedura, is a widely-known and well-respected model.

If you have already been there and done that, has your school adopted a set of technology skills that all students should develop by the time they leave? Make sure to clearly understand the role of technology and tools for STEM learning within a vendor's offerings. Students working passively with software applications are not developing STEM skills, and many kit-based "technology" projects are little more than paint-by-number activities.

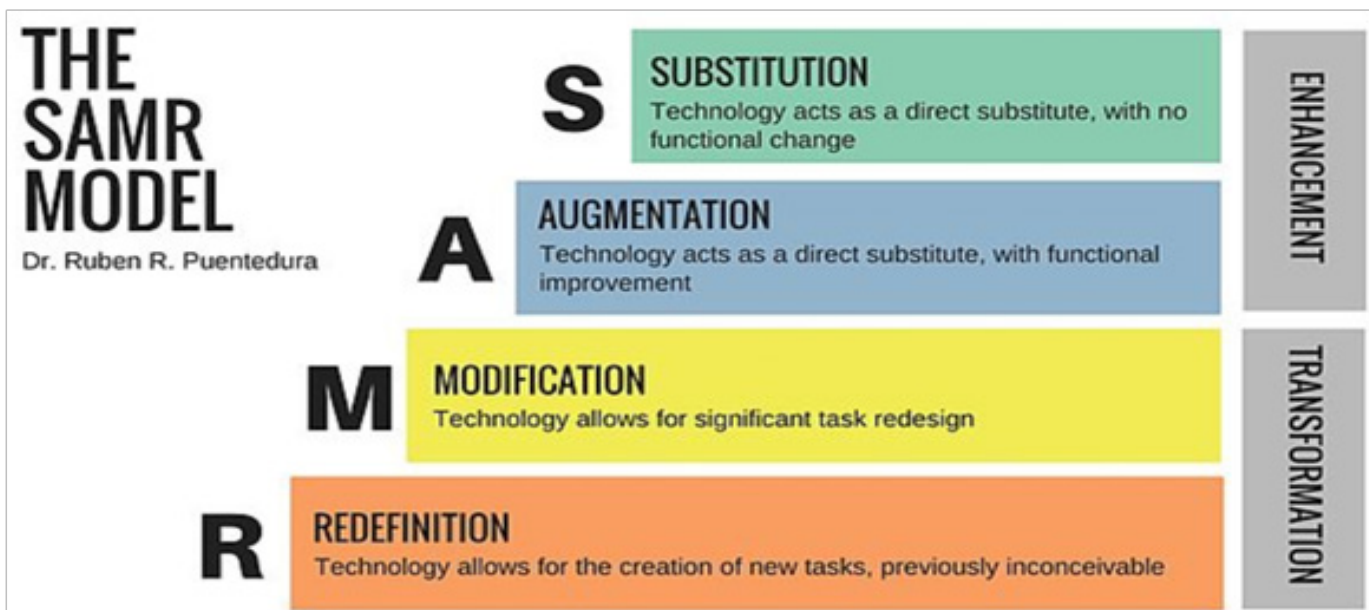


Image Source: Wikimedia Commons





While I cannot help you to settle any of the major debates regarding edtech within this article, I do advocate that you keep the dialogue alive in your school. Make sure that the discussion around the role of technology in vendor offerings addresses your teaching and learning needs.

## STEM Discipline Integration

The ‘STEM’ label on products or services can be deceiving. Because STEM is a buzzword, marketers use the acronym quite freely with products that may address any one (or none) of the content areas in an authentic way. Real world problems require us to determine an effective approach to problem-solving and to apply skills from a range of disciplines. If we want students to be successful in addressing complex tasks in unfamiliar settings, learning experiences must build a context for these cognitive processes.

When evaluating STEM products and programs, determine how problems or tasks are presented. STEM disciplines should not be treated in a checklist fashion whereby students are simply touching on elements of content. Instead, students should have opportunities to deepen skills through application.

This is not to say that all curriculum has to (or should) begin at the highest levels of rigor. However, if students are simply following steps and never have the opportunity to engage in more complex, open-ended thinking, then you will see limited growth in STEM-specific skills. Conversations about STEM discipline integration often get caught up at the level of discrete standards for learning. We should spend more time talking about the opportunities that students have to apply science, mathematical, engineering, and technological processes and practices in the context of authentic challenges.



## Learning Outcomes

College and Career Readiness is an aspirational phrase that, like ‘STEM’, has achieved ubiquity in a few short years. Despite the wealth of resources invested at federal, state, and local levels to improve student readiness, data suggest that real outcomes are fairly stagnant. According to ACT, 20% of 2018 high school graduates met the ACT STEM Readiness Benchmark . The National Association of Colleges and Employers (NACE) provides an excellent point-of-entry to the conversation on career readiness. Based on their research and findings, there is a gap between college graduates’ own perceptions of career readiness and employer assessment of candidate employability.

STEM initiatives play an important role in supporting readiness, as many programs are specifically designed to improve student outcomes relative to success at progressively challenging levels of learning and life. But this can only be achieved through purposeful and strategic development of STEM literacy . This is actually the greatest area of weakness that we have found in STEM schools and programs.

When evaluating products, services, and programs, determine what learning objectives and outcomes are supported. If you are considering comprehensive solutions, such as curricula or project kits, these outcomes should be fairly explicit. However, if you are purchasing hardware, components, or supplementary materials,

it may be up to your team to determine to what extent the resource matches the intended outcome. Vendors are often well-attuned to these needs and can support your understanding, so don’t hesitate to ask for more information or guidance regarding college- and career-ready skills!

To summarize briefly, when you are assessing the qualities of STEM products





and services, ask at least four “big” questions:

- What does alignment mean specifically for this product or service?
- Are students developing “portable” technology skills through this program?
- Do these materials reflect authentic

integration of STEM discipline skills and cross-disciplinary competencies?

- Does this product, service, or program support explicit learning outcomes that reflect readiness for future learning and life?

Check back in the next issue for the final part of this series, where we will discuss potential value-added benefits from STEM programs, products, and services.



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<sup>1</sup> The Condition of College and Career Readiness: National 2018. (2018). ACT.

<sup>2</sup> There is a great deal of literature devoted to defining ‘STEM Literacy’ as a construct, so here are a few recommended readings. For a philosophical perspective on STEM Literacy, see: Zollman, A. (2012). Learning for STEM Literacy: STEM Literacy for Learning. *School Science and Mathematics*, 112(1), 12-19. For an in-depth look at STEM Literacy as a construct, see: Tang, K., & Williams, P. (2018). STEM literacy or literacies? Examining the empirical basis of these constructs. *Review of Education*. For a more concrete evaluation of what kids need for future success, see: Prince, K., Saveri, A., & Swanson, J. (2017). *Redefining Readiness from the Inside Out*. Knowledgeworks.

Scott Davidson is the Director for STEM Services at AdvancED/Measured Progress. His team provides support and thought leadership for PK-12 STEM education across AdvancED/Measured Progress’s network of over 36000 institutions in more than 80 countries. You can reach Scott via email at [sdavidson@advanc-ed.org](mailto:sdavidson@advanc-ed.org).



# Expanding Proprietary STEM Solutions to Programming and Robotics



By Steve Barker

Educators know how important STEM learning is to ensure students succeed not just in the classroom, but out in the real world as well. Students need to develop skills that will prepare them for life beyond the classroom, enabling them to be tomorrow's engineers and innovators.

Based in Lawrenceville, GA, Boxlight offers engaging, easy-to-use solutions to help improve student outcomes. The products are designed to help students learn more effectively and develop the essential skills they need for success. Students respond to this enhanced way of learning, and teachers find it allows them to do more in the classroom with less time and hassle. These solutions open the door to inquiry-based learning and help students connect and engage with STEM from wherever they are.

## Supporting Local STEM Efforts

Boxlight supports many local STEM-based initiatives, such as the Georgia Girls STEM Collaborative. Research has shown that women make up only 28 percent of the science and engineering workforce, and the Collaborative strives to increase girls' participation in STEM classes and careers.



This statewide network of professionals, researchers, and practitioners focuses on expanding and strengthening STEM-related career opportunities for girls. Boxlight aids in their mission by encouraging collaboration and improving inter-program communication, helping various organizations and individuals come together to share best practices and resources as well as develop new collaborations.

For the past few years, Boxlight has also hosted a STEM Day, where students around Georgia—as well as several locations in Latin America—participate in lessons conducted with the Labdisc portable STEM lab. This hands-on learning event was designed to help students discover critical STEM skills and understand

how STEM disciplines apply to the world around them.

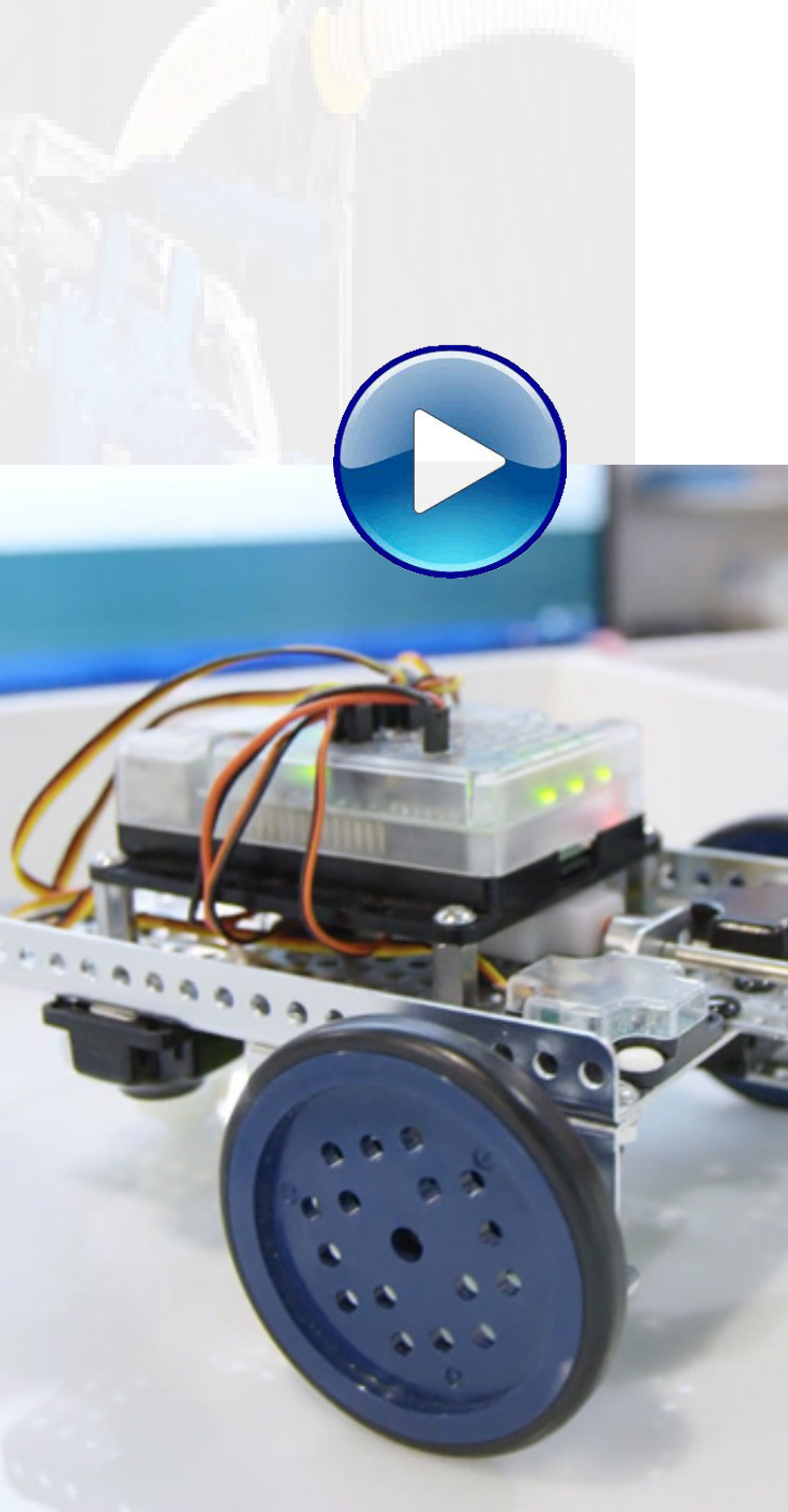
Using the Labdisc, students participate in Boxlight STEM Day from their classrooms, simultaneously performing experiments and sharing the data. The event helps to raise awareness among local schools and the education technology industry about the importance of STEM education and inquiry-based learning.

### Coding in the Classroom

Modern Robotics merged with Boxlight earlier this year, enabling Boxlight to introduce the Mimio MyBot educational robotics system. This system was conceived and developed to fulfill a need in







robotics and coding in the classroom without the added complexity common in most systems. The MyBot system helps students engage in learning experiences, preparing them in emerging STEM fields including software, robotics, and technology.

With Mimio MyBot, students can learn without limits. This flexible, expandable system encourages creativity and exploration while enabling the construction of nearly anything a student can imagine. And since it's built from rugged, aerospace-grade materials, it's made to survive the rigors of classroom use.

Here's what Stephen Barker, Boxlight's VP of STEM Education, had to say about this exciting new technology:

### **What Is Mimio MyBot?**

The Mimio MyBot is an innovative K-12 robotics system that helps students develop skills and a passion for coding and robotics. Through the cohesive software platform, educators receive a solution complete with a robust curriculum, STEM lessons, tutorials, and videos.

### **Why Are Coding and Robotics Important in Education?**

There are several compelling reasons why it makes sense to teach all students coding, regardless of where their interests might lie. For one thing, exposing all students to coding as part of the school curriculum might change their minds



about a career in computer science and open the door to new possibilities. Learning what it means to write code could help students overcome stereotypes about who coders are and what they do, perhaps putting them on a path to a promising career.

Why is this so important? Because the nation's economy is going to need more computer programmers. According to the Bureau of Labor Statistics, the need for software developers overall will grow 24 percent by 2026. Additionally, the need for application developers will grow by 31 percent.

### **What's Next for Boxlight and Mimio MyBot?**

We are excited about working with the Buzz Aldrin Family Foundation and ShareSpace Education Foundation in bringing Mimio MyBot to districts, schools, and community learning centers around the United States as early as this summer!

Want to learn more about Boxlight's brand-new educational robotics system? Visit <https://mimio.boxlight.com/mimio-mybot-educational-robotics-system/> today to discover Mimio MyBot.





## Building a Better, Safer Community County Government & School District Create Firefighter & EMT Career Pathway

A collaborative partnership is a state of being a partner or partners working together for a common outcome. These partnerships usually begin with a need to address an issue or issues of key interest or importance. In most cases, one of the parties asks a question -- communicates with someone who involves someone else ... resulting in a unified action to achieve resolution.

This is how our story begins. In Clayton County, a career pathway program available through the county's public schools, enhanced and expanded through the Georgia Department of Education, is at the center of a collaborative partnership involving Clayton County government, the county's Fire and Emergency Services division and Clayton County Public Schools (CCPS). Over the course of the next few years, the partnership is expected to reap benefits for county citizens and communities.

Everything starts with people talking about a need or needs, people such as Commissioner Sonna Singleton Gregory, representing District 1, and Landry Merkison, the county's Fire Chief and Director of Emergency Management.

Their conversation focused on a concept Chief Merkison had been working on for several years.

"I knew I wanted to start a program in our school system to train high school kids to be firefighters and emergency medical technicians so that we could generate a hiring pool from the kids in our own community," he said, adding that he was interested in starting a pilot program at Mundy's Mill High School. This is how Commissioner Gregory, who also the parent/community liaison at Mundy's Mill, entered the picture.

The pair contacted Dr. Eboni Chillis, Coordinator of Career Technical and Agricultural Education (CTAE). She confirmed that there was a Firefighter Pathway at Charles Drew High School. After a review of the existing curriculum through the Georgia Department of Education, it was determined that it needed more.

"The Charles Drew curriculum didn't really meet the needs of preparing kids to come out of high school work ready with a certification at the end of course," Chief Merkison said. The Chief worked with Dr. Chillis to rewrite and rearrange the path-







way's curriculum so that it met the Georgia requirements for Firefighter 1.

Thus, a collaborative partnership resulted in the establishment of the Firefighter & EMT Pathway for Clayton County students. "There is always a need for public safety officials," said Commissioner Gregory. "I see this as our in-house workforce development plan -- growing our own public safety personnel."

"This is how the program was intended from the start," Chief Merkison explained. "Taking high school students who may not have seen college as an option -- those who were looking for something to belong to or be part of, and give them the tools and training to be work-ready at graduation."

"The Firefighter and EMT Pathway program is truly the essence of collaboration," said Dr. Morcease J. Beasley, CCPS Superintendent/CEO. "It is a wonderful example of my desire to build robust, lasting relationships with not only the government of Clayton County but with other governments, both local and regional, to secure the best possible career opportunities for all young people in Clayton's communities."

"The development and implementation of our Firefighter & EMT Pathway offer a perfect example of how communication can provide solutions to community issues," said Chillis. "Bridging that gap is the key to creating and maintaining effective





partnerships that can have far-reaching benefits on our workforce and economic development today, tomorrow and beyond.”

One of those far-reaching benefits, quite possibly one of the biggest this collaboration has provided, is addressing a need to improve the economic development footprint of the county. “One of the challenges we have here in Clayton County is the average income level of our communities,” said Gregory referring to one of the indicators business developers use when evaluating a community for possible locations and franchises. “I believe that we can help build Clayton’s income level through this and other similar programs.”

“We got this pathway program going under Dr. William Greene, who at that time was principal of Mundy’s Mill High School,” said Commissioner Gregory. “There were a lot of early morning coffee meetings involving Dr. Chillis and Chief Merkinson as we worked through the implementation process.”

About the Firefighting & EMT Pathway Specifically, the Firefighter & EMT Pathway partnership involves the CCPS Career, Technical and Agricultural Education (CTAE) program, students from Charles Drew High School (CDHS) in Riverdale and Mundy’s Mill High School (MMHS) in Jonesboro. Agencies participating in this program include the Georgia Department of Education (GADOE) – CTAE Division, Clayton County Fire &

Emergency Services, the Clayton County Board of Commissioners and CCPS. It is jointly funded by the county and the school district.

“Once we were contacted about the pathway by Commissioner Gregory and Chief Merkinson, I worked to make sure that the Public Safety Pathway was adapted and approved to meet the specifics of the partnership,” said Dr. Eboni Chillis, CTAE Coordinator. “We then made our students at Charles Drew and Mundy’s Mill aware of its availability for the 2017-2018 school year.”

“Through this extended collaborative partnership, we have offered a pathway to provide students with the skills, knowledge and mental tenacity necessary to successfully complete the rigorous academic and physical training that is essential to become a certified Firefighter/Emergency Medical Technician (EMT),” said Dr. Chillis.

“We established the pilot program during the 2017-2018 academic year with 30-34 students,” Dr. Chillis said. “Tenth grade students from Mundy’s Mill High were transported to Charles Drew High School and joined with sophomores there in taking the first course of the pathway: Introduction to Law, Public Safety, Corrections and Security.”

“The cohort has just completed the second year of the Firefighting & Emergency Medical Services (EMS) Pathway at the



Clayton County Fire & Emergency Services certified training facility under that facility's instructors," she explained. "These students will follow that same routine for the third year of the pathway in 2019-2020, in anticipating of graduating the pathway program".

"This is when all the work we have done starts to pay off," Chief Merkison said looking ahead to May 2020. "Once they get their diploma from their principal, the next person they see will be me and we'll give them a formal job offer and a firefighter's helmet at graduation."

"One of the highlights of this program is that participating students are able to learn and to train for a career in Clayton County through the resources of the outstanding, highly reputable team of professionals at the Clayton County Fire & Emergency Services Division," said Dr. Beasley. "Students who emerge successfully from the Firefighting & Emergency Medical Services (EMS) Pathway program will be immediately eligible for employment as a highly trained and qualified professional who will have earned state and national Firefighting certifications such as Fire Fighting 1 & 2, EMT-B and Advanced Level EMT-A," he concluded.

While general recruits start at \$38,657, the successful graduates of this pathway will come to the marketplace as a Firefighter/EMT at \$40,626 annually with potential for advancement and increase

in earnings. With additional certifications (Relief Driver, Paramedic, college degrees, etc) come increases in pay.

"This program provides those students who don't want to go to college immediately after school an opportunity to get into a great career with a really good income right out of high school," Gregory said. "The salary ceiling for these students is almost limitless. The students who complete the Firefighter & EMT Pathway have an opportunity to help their parents, their families and their communities."

While successful graduates of the Firefighter & EMT Pathway will possess state and national certifications that will open employment opportunities on a national scale, Chief Merkison hopes these individuals will choose to remain in Clayton County, serving their respective communities and neighbors.

"Our benefits package is one of the best in the state ... our salaries are extremely competitive ... the things that we offer, the things that we do for our employees to try and ensure that they have not only a long successful career but a healthy life after the fire service," he explained.

"We want to make these students feel that they are part of something and that this is a logical transition for them. We hope it will be a "no-brainer" for them."

Closing thoughts As Dr. Chillis offered, "This pathway opportunity resulted from





communication involving a local government official and the county's public school district speaking a common language and responding to a specific community need. That is the essence of creating an effective collaborative partnership."

"I believe this is one of our greatest collaborations because we are investing in our own citizens, in our kids and in our schools," said Commissioner Gregory. "This shows that we are serious about helping our residents by giving our students opportunities that did not exist prior to this partnership."

"This collaboration of the Board of Commissioners, the Fire Department and the Board of Education has essentially built a model that is capable of being taken from here and placed in any county in Georgia," Chief Merkison said. "We are proving that this model can work and proving that it is worth the time, effort and energy to invest in these kids -- to spend the time to mentor them, develop them and grow

them into employees that will be here for the long haul," Chief Merkison said.

"This pathway is an impressive example of what it means to work in harmony for the betterment of citizens and communities," said Dr. Beasley. "When two or more government organizations communicate and ultimately work together effectively, it is a win-win situation for everyone involved and for all who are affected by the partnership."

"I extend my heartfelt appreciation to Clayton County Fire and Emergency and to the Clayton County Board of Commissioners and CTAE's leadership for demonstrating the true vision of collaboration in making this outstanding program a reality," Dr. Beasley added.

### **About Clayton County Public Schools**

Clayton County Public Schools (CCPS) is fully accredited by AdvancED – Southern Association of Colleges and Schools Council on Accreditation and School Improvement. The district offers a focused world-class program based on a challenging curriculum which is taught from pre-kindergarten through 12th grade. Serving over 55,000 students, Clayton County Public Schools is ranked among the 100 largest school districts in the U.S. and is the fifth largest school system in Georgia.





# The **STEM** of golf *(part 1)*

*by Wayne Carley*

Currahee Golf Course  
Toccoa, GA



In the continuing revelation of what STEM really means in our lives, let's continue to explore the STEM skills necessary in participate and excel at a sport so many enjoy. In previous issues of STEM Magazine we've looked at the STEM of football, basketball, soccer, hockey and other sports. In the midst of our summer and in honor of the recent U.S. Open, let's dig into the STEM of Golf.

Golf is intensely mathematical, with strong engineering applications. The math and engineering are personal in application, with the technology being primarily in the equipment. The science of Golf (the systematic accumulation of knowledge) permeates all aspects.

What is really interesting is that we don't actually learn these math applications to be effective at golf. For successful golfers (low scoring), we seem to be born with many of these practical applications and experiential knowledge of the following mathematics.

Math is of course defined as "The science of numbers and their operations, inter-relations, combinations, generalizations, and abstractions". Golf in certainly all of this and includes the math domains of geometry, analysis, topology, combinatorics, number theory, algebra, math physics and more. If you enjoy any sport, but say you hate or don't understand math, this is a real contradiction.

What I hope you will consider and better understand is that you already know so much math, you just don't realize it or see it in your daily life. That being said, let's consider the geometry of golf.

## Geometry

noun

ge•om•e•try |

Definition of geometry

*1a : a branch of mathematics that deals with the measurement, properties, and relationships of points, lines, angles, surfaces, and solids.*

Golf is 3 dimensional and requires 3 dimensional thinking to solve golf's primary problem: Get the ball in the hold with as few swings (strokes) as possible. Geometric considerations include:

- *the flight of the golf ball* ( apex or height reached, distance desired, possible obstacles to be avoided, velocity of ball flight to get from point A to point B).

This geometric problem can only be solved by the golfer by using the **engineering method** that we will cover later, in conjunction with the technology in the golf bag, the golfers ability to use it well, and a dozen questions that need to be asked for each and every golf shot. Golf is a great example of the interrelated use of the engineering method and mathematics.



The golfer must visually determine where they want the golf ball to land (**engineering method**) for the first shot. Once decided, the distance needs to be estimated, usually in yards. A golf club must be chosen with the correct angle of attack for the desired ball flight.

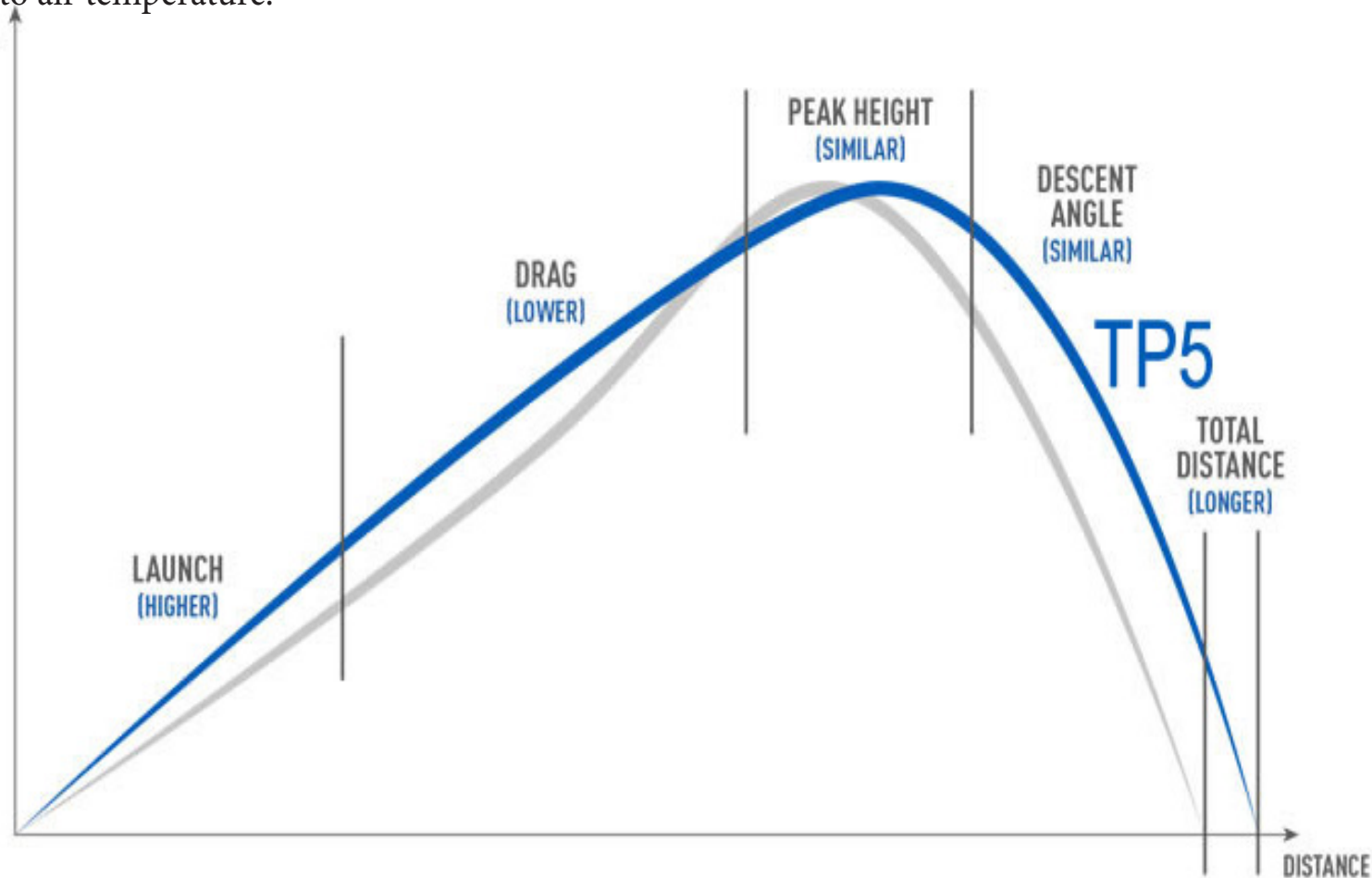
If there is wind, the direction and speed of the wind needs to be evaluated. Will a head wind slow the forward movement? If so, how much? Will a tail wind speed the flight progression? If so, how much? Will a cross wind cause a deviation in the alignment of the shot? If so, how much?



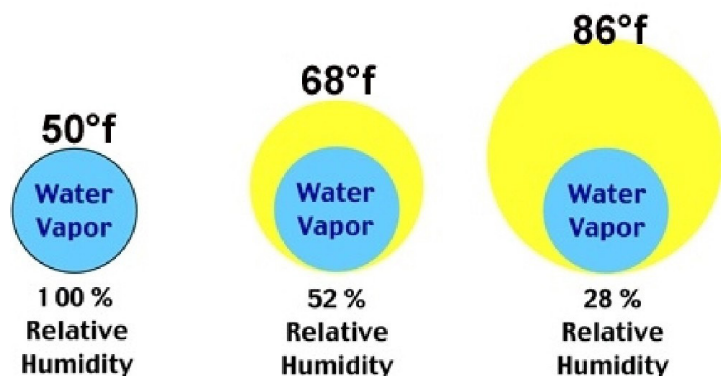
Proper physical alignment toward target must be decided, usually in degrees. The speed of the golf swing must be estimated to drive the ball along the chosen flight path. Just when you thought we were done, other factors must be considered for success.



Air temperature and density directly impacts ball flight and affecting distance and accuracy. Temperature is measured in degrees. The hotter the air, the thinner the air, (loosely packed molecules) thus less resistance to flight requiring another recalculation of club use and strike force required. The humidity of the air is important and often in direct contradiction to air temperature.



Relative humidity is the most common consideration and is the ratio of the current absolute humidity to the highest possible absolute humidity (which depends on the current air temperature). A reading of 100 percent relative humidity means that the air is totally saturated with water vapor and cannot hold any more, creating the possibility of rain.





This doesn't mean that the relative humidity must be 100 percent in order for it to rain — it must be 100 percent where the clouds are forming, but the relative humidity near the ground could be much less. Hot temperatures with low moisture content or low humidity result in thin air, less resistance to ball flight and longer flight distances. Hot temperatures with high moisture content or high humidity result in thick air, more physical air resistance to ball flight and shorter distances.

Let's not forget altitude measured in feet above sea level for golfing purposes. Air density or thickness at sea level is greater than air density at higher altitudes. Therefore, the distance a golf ball travels at the beach is less than the distance it travels in Denver Colorado at 5,280 feet above sea level. Under similar atmospheric conditions using the same club, same ball, and same striking force, the ball in Denver will travel significantly further.

The math and geometry of golf is so very complicated and we've only scratched the surface. When all of the aforementioned aspects are decided, the human golfer must physically execute a golf swing that allows for the calculations to be accurately realized. This is where the challenge really exists. The brain has done its work, and now the body is called upon to execute the mental formula.

This was the first shot of our round of golf. Everything we've just calculated must be done again, an average of 100 times for the typical golfer. Your results may vary.

### - *the golf swing*

This is an article in and of itself to be covered later.





## Golf science -

Golf science, or the-

*“systematic accumulation of knowledge”*  
about golf, is very experiential. With every swing of the club, every hole, every course on every day, your experiences in decision making, weather conditions, course conditions, your physical interaction and more, are building a complex and varied mental catalogue of accumulated knowledge that you can use moving forward. Aside from physics that will be covered later, this science definition and application is the most useful in your golf game.

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This series on golf will continue for a few months as there is significant application of STEM skills in engineering, technology, and science.





Rome

Atlanta

Athens

# STEM is Georgia Wide

Columbus

Macon

Savannah

Albany

Brunswick

Valdosta