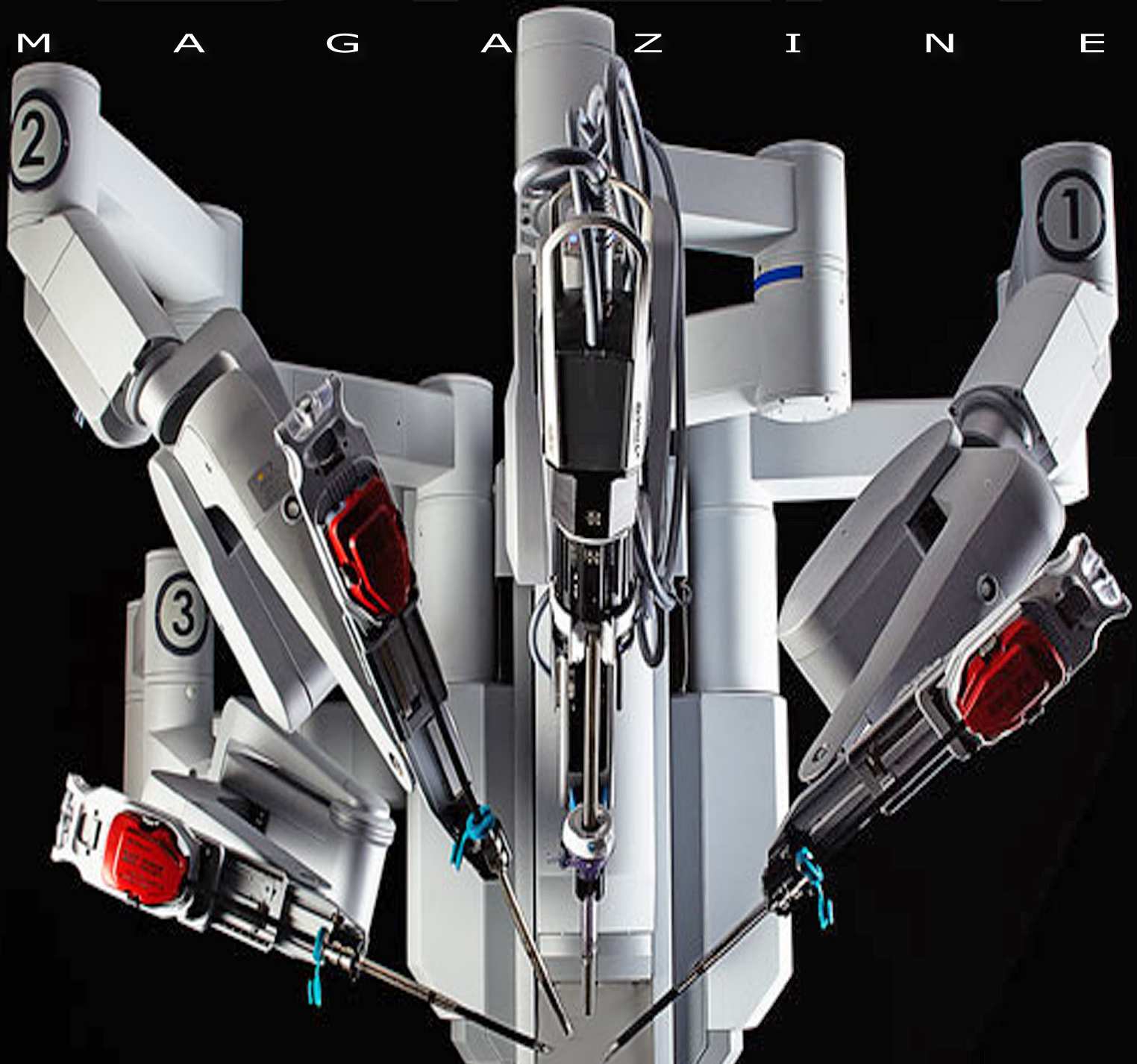
STEM

MAGAZINE



Robotic Surgery

Cutting edge to the precise point

Drones IV

July 2016
\\192V

STEM Innovations

A Math and Science Partnership Initiative in Northwest Indiana

Dear Educators,

For its final year the MSP STEM Innovations Program brought together more than 50 teachers from 12 districts in attendance. Opportunities were provided to improve lessons with a connection to STEM. During the week long institute teachers participated in sessions in engineering, science and math and had time to work with team members. Educators learned more about the process of engineering design by participating in model lessons, they increased their knowledge of Algebra readiness and how it relates to the Mathematics Process Standards and they experienced a STEM integrated science lesson. Based on the daily evaluations the final STEM Innovations Summer Institute was a great success! Thank you to everyone who participated.

A huge thank you to Merrillville High School for the hospitality throughout the week and for the support of our important work to build deep STEM content knowledge and teaching skills.

For a look back at the STEM Innovations Program and past summer institutes visit the STEM Innovations Home Page.

The August issue of *STEM Magazine* will be your last. For information on continuing subscriptions please contact Wayne Carley at wayne@stemmagazine.com.

Don't miss our last cover communication in August where we will wrap up the MSP Grant STEM Innovations Program.

Enjoy your summer!

Your STEM Innovations Team

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New Recreation and Personal Drone (UAS) Technology.....
or is it a new food processor?

July Articles

DRONES Part IV / *Wayne Carley*

Surgery Innovations and Robotics

Afterschool and Summer Learning
By Chris Thompson, Carolyn Perry, and Andrew Burch

A STEM-Literate Citizenry / *Dr. Richard Larson, MIT*

Success on Standardized Tests / *Dr. Judy Willis*

STEM Magazine is a non-profit monthly education publication for teachers, students, their parents. The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

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We believe that the key to success in seeing higher graduation rates, improved testing results, student inspiration, creativity, excitement and career satisfaction rest in the hands of the teacher. The example and inspiration of individual educators carries tremendous weight on a daily basis, greatly impacting the quality and effectiveness of the classroom environment.

Our mission: Encourage curiosity, inspiration and creativity, the foundations of every career passion.

Wayne Carley
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STEM for Women Magazine
STEAM Magazine

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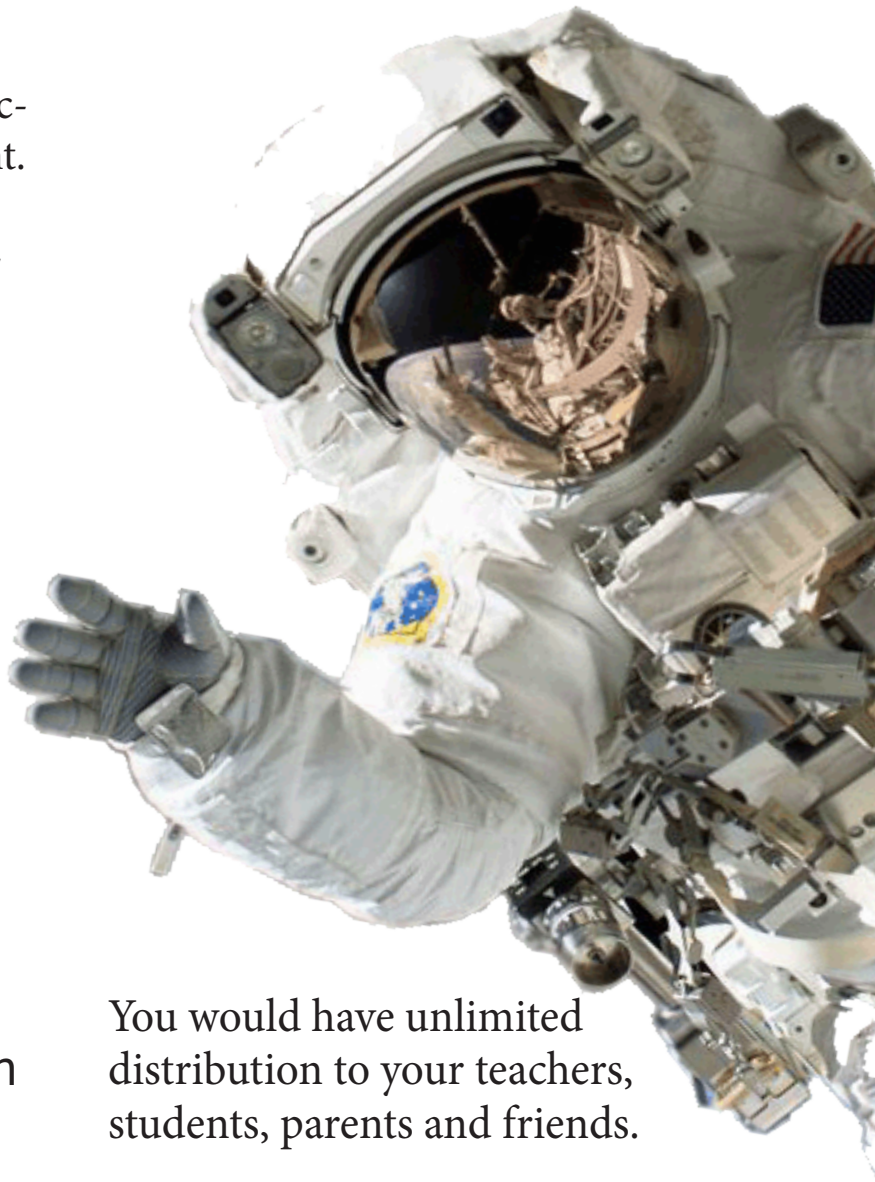
School, district, county and state "customized versions" are available.

To find out more, simply send your E-mail request to the E-mail address below.



You would have unlimited distribution to your teachers, students, parents and friends.

STEM Magazine is also PDF printable and mobile device friendly.

Drones: Part IV of IV

- Drone STEM Jobs
- Legal Issues
- Multiple uses
- Privacy
- Commerce / FUN

They are here to stay so let's finish up our series of articles about how they operate, helpful uses that benefit mankind and careers that are being created.

Commerce / Security

During the past several issues we've taken a look at a few of the uses of UAS's (unmanned aerial systems), and how they will be beneficial to emergency services, commerce, recreation, personal applications and potential legal issues.

One thing for sure, they are not going away, but rather will be continually improved through technology and materials to meet the emerging market of applications.

Being a pilot, I've always wanted a flying car. The jet engine versions have been very expensive and dangerous.... maybe too far ahead of their time. But a Drone Car may be the solution and just around the corner. It's a fancy helicopter in its own way, but has great potential with the technology in place and the price tag. You might be building these in a few years.

In this final article in the series, lets have some fun and look at the diversity of the technology as well as future jobs.

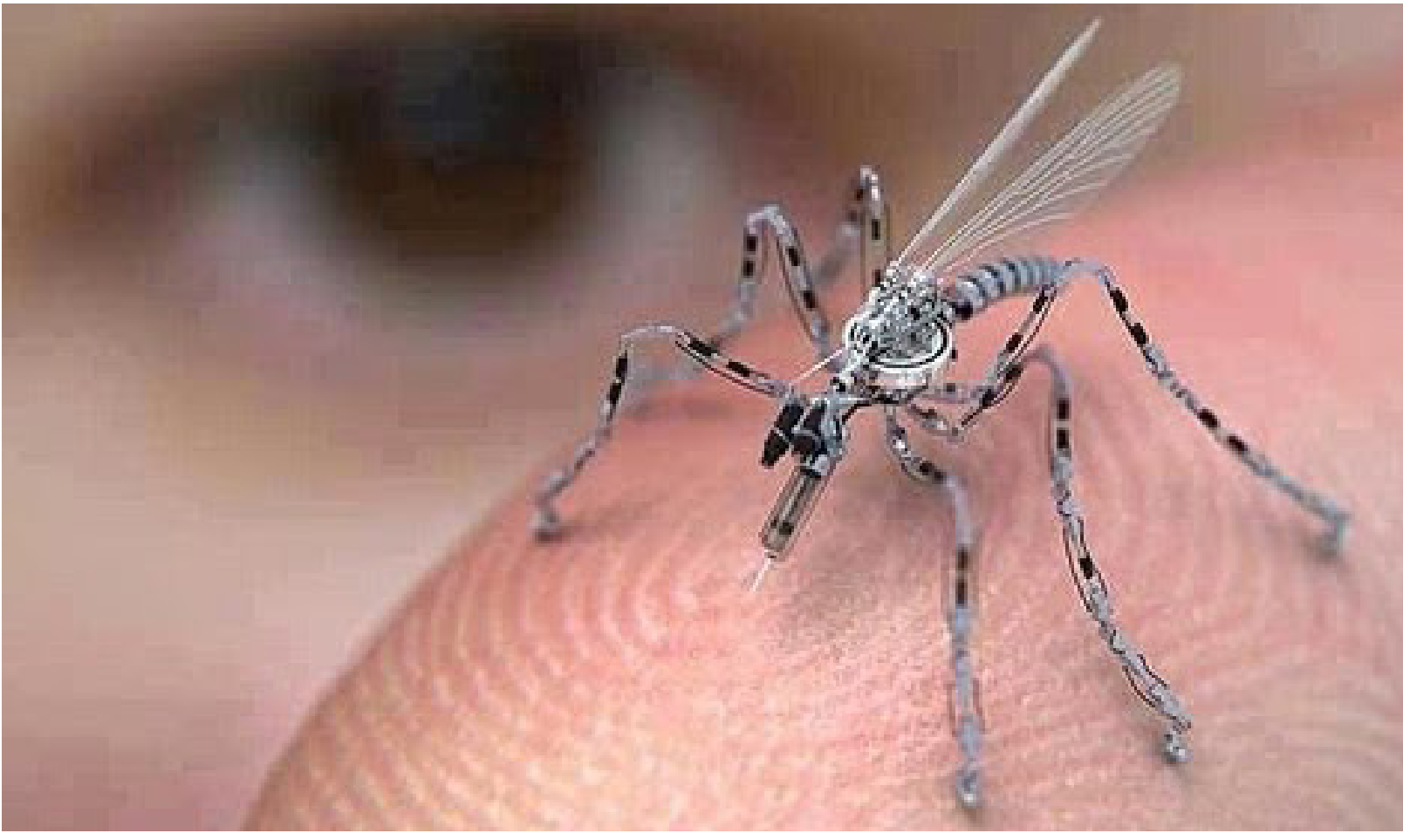
Delivering packages:

It's being tested but has a few practical obstacles to overcome, such as:
- theft
- hitting obstacles when out of sight
- limited payload and flight time

Observation:

This is where privacy and security cross lines. Do I want UAS's watching drug dealers, terrorists, bad guys in general? Sure.

Do I want them interfering in my life? Not really. Existing cameras everywhere already do that.



Cool....right? I know you want one.....

JOBS

Here is a list of just some of the career fields and jobs needed to support a national UAS industry:

- Software developers
- Pilots
- Chemist (new light composite materials)
- Camera technology (lighter / better)
- Mass and custom manufacturing labor
- New battery development and research
- GPS components and software
- Electronics: Transmitters and receivers and related components.
- Monitoring and policing of UAS use. (yes....the drone police)
- Repair services
- Web development and marketing
- Motor design and construction
- Designers and artists
- and all the stuff we haven't thought of yet.

Life Saving:

This is one of the more practical and inspiring applications I've seen. Getting to victims fast and saving lives.

Firemen and first responders are eager to include UAS's in their bag of tools to keep everyone safe.

Jobs: Someone has to build them, fly them and use them.

Agriculture:

This is a great application. A farmer can look over hundreds of acres of crops to check for bug infestations, water shortages, damage, growth.... total management overview that cannot be seen as quickly or comprehensively from the ground.

This saves time and money keep food cost down while increasing production.

It is not difficult to understand why drones are so popular. Flying a drone is a cool thing to do. The technology is amazing, the flying is exciting, and if there was ever a gadget that appealed to people's imagination, drones would have to be near the top of the list.

Drones and quad-copters are also relatively inexpensive and easy to operate. But just as they are fun to fly, they are more than just cool toys. They represent a quantum leap in how technology can be used not just for personal enjoyment and enrichment, but also to expand human knowledge, aid research, fight environmental threats, save lives and much more.

There may be challenges ahead related to public flying of drones in parks, but there are also tantalizing opportunities for park agencies to utilize drone technology to fulfill important conservation, natural resource management and public-safety responsibilities.

Drones may be able to provide agencies substantial time and cost savings for a wide variety of tasks. There is no doubt that drones are already stimulating interest among park planners, GIS specialists, park managers, rangers and even recreation program staff. Some agencies are already making plans for how they might use drones.

Just for *Fun*

The recreational and personal use of drones drives the market in ways we can only imagine.

Take family photos.

Take yours on vacation.

Play around.

Dance

Orthopedics....a variety of STEM

Surgery Innovations and Robotics

Careers

Your students will invent it.

or·tho·pe·dics [awr-thuh-pee-diks] noun

(used with a singular verb) the medical specialty concerned with correction of deformities or functional impairments of the skeletal system, especially the extremities and the spine, and associated structures, as muscles and ligaments.

There are about 350 joints in the human body. A joint is best defined as the point where 2 bones meet. Damage to joint can occur for many reasons, but we can relate to sports related injuries easily.

Most athletes that participate in athletic activities will experience injuries from time to time. We are going to discuss the most common types of athletic injuries, the areas the injuries affect, symptoms of these injuries, and the treatment and prevention of the most frequent injuries experienced by athletes.

Here is a list of the most common types of athletic injuries athletes may experience and the area of the body that will be affected. Notice that most of the injuries athletes will experience will be to the extremities of the body.

- **Carpal Tunnel Syndrome** - ***Wrist***

A condition characterized by pain and tingling in the fingers, caused by pressure on a nerve as it passes under the ligament situated across the front of the wrist

- **Tennis Elbow** - ***Outside of the Elbow***

A painful inflammation of the tissue surrounding the elbow, caused by strain from playing tennis and other sports.

- **Rotator Cuff Tendinitis** - ***Shoulder***

Athletes playing sports that require extending the arm over the head commonly develop rotator cuff tendinitis. This is why the condition may also be referred to as swimmer's shoulder, pitcher's shoulder, or tennis shoulder.

- **Chondromalacia Patella** - ***Knee***

The cartilage under your kneecap is

a natural shock absorber. Overuse, injury or other factors may lead to a condition known as chondromalacia patella (kon-droh-muh-LAY-shuh puh-TEL-uh) — a general term indicating damage to the cartilage under your kneecap.

- **Illiotibial Band Friction (ITBF) Syndrome** - ***Knee***

Iliotibial band friction syndrome (ITBFS) is an overuse injury. It happens in the soft tissues in the lower thigh near the outside of the knee. The iliotibial band (ITB) is a thick band of fibrous tissue. It runs from the hip down the outside of the thigh and attaches to the tibia. The tibia is the large bone of the lower leg.

- **Shin Splints** - ***Front of lower leg, along tibia bone***

A painful condition of the front lower leg, associated with tendinitis, stress fractures, or muscle strain, often occurring as a result of running or other strenuous athletic activity, especially on a non-resilient surface.

Almost every sport requires excessive running.

- **Plantar Fasciitis** - ***Heel, bottom of foot***

Plantar fasciitis causes pain in the bottom of the heel. The plantar fascia is a thin ligament that connects your heel to the front of your foot. It supports the arch in your foot and is important in helping you walk. Plantar fasciitis is one of the most common orthopedic complaints.

- **Achilles Tendinitis** - ***Heel and calves***

An Achilles tendon injury affects professional and amateur athletes alike.

The Achilles tendon is one of the longer tendons in your body, stretching from the bones of your heel to your calf muscles. You can feel it -- a springy band of tissue at the back of your ankle and above your heel. It allows you to extend your foot and point your toes to the floor.

Unfortunately, it's a commonly injured tendon. Many Achilles tendon injuries are caused by tendinitis, in which the tendon becomes swollen and painful. In a severe Achilles tendon injury, too much force on the tendon can cause it to tear partially or rupture completely.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SURGICAL SYSTEM
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Careers in medical technology are changing by the day. New innovations in surgical procedures that seem like science fiction now will be antiques by the time you graduate and create the latest approaches to treating and healing patients.

Not all of these opportunities require college degrees, but you have to have the interest and curiosity to explore the possibilities. That starts **NOW.**

Concussions are becoming more and more of a problem but do not fall under the realm of Orthopedics.

With so many joints and so many people injuring them, orthopedic jobs will always be in demand. Having to cut into the human body to get to the joints presents a long list of problems for infections, healing times, damage to nerves, blood vessels and more. Here is where new technologies can really make a difference.

Orthopedic jobs encompass an array of specialties including surgery, podiatry (foot doctor), chiropractic care and veterinarian care. While each of these pinpoints a specific orthopedic specialty, other careers that do not require a medical degree may also be classified as orthopedic jobs.

A few of these include an occupational therapist, an orthopedic nurse or an orthopedic physician's assistant. All jobs within the scope of orthopedics, however, require varying degrees of medical training emphasizing musculoskeletal care.

One of the most common types of orthopedic specialties is the orthopedic physician. These are doctors who specialize in the care and treatment of musculoskeletal injuries or damage to the muscles, tendons and tissue surrounding the joint.

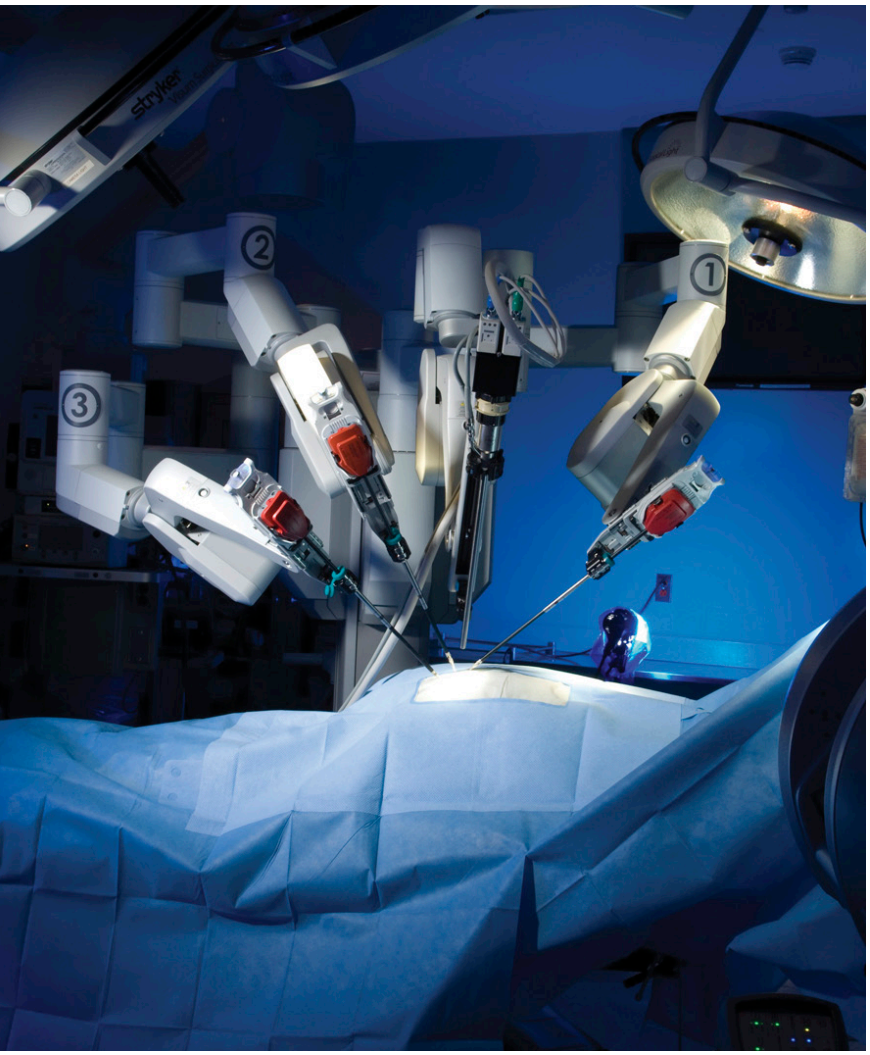
Many physicians working within this field choose to become orthopedic surgeons who specialize in performing surgeries to correct these problems.

Other specialties relevant to orthopedic jobs for physicians include working with elderly adults in geriatric orthopedics and working with children in pediatric orthopedics.

Orthopedic specialties in podiatry are also commonly pursued by physicians and others interested in corrective medicine. Podiatrists may work in general practice and many frequently work with orthopedic physicians and surgeons when necessary. Some podiatrists, however, also specialize in orthopedics. Individuals working in these types of orthopedic jobs are commonly found to work in sports medicine or in pediatric orthopedics.

Some occupational therapists also specialize in orthopedics. Many work in hospital settings or in clinics. Individuals working within these particular orthopedic jobs frequently work with athletes, as well as aging populations.

As a sub-specialty, occupational therapists specializing in orthopedics help patients regain strength, balance and coordination, while also working with doctors to correct other musculoskeletal dysfunctions.



Chiropractors frequently specialize in orthopedic jobs. Many work in orthopedic hospitals and in rehabilitation facilities. While all legitimate chiropractors are trained in elements of orthopedic medicine, some decide to solely focus on this specialty in postdoctoral education before receiving specialist certification in this area.

Besides doctors, other types of orthopedic jobs include orthopedic nurse positions and physician's assistants. Beyond the general training needed for either of these professions, individuals must also be trained in aspects of orthopedic medicine so as to assist other orthopedic specialists. Many begin working in a general practice setting before deciding to pursue additional training or experience in orthopedics.

Not all orthopedic jobs focus on the human musculoskeletal system, however. An orthopedic vet, for instance, is a veterinarian who specializes in the care and rehabilitation of animals with congenital birth

defects, diseases or those that have sustained injury due to an accident. As with doctors who work with humans, vets specializing in this genre of medicine must also undergo extensive orthopedic training before being able to work in this particular field.

Over 210,000 patients die yearly due to hospital mistakes…. human error. Not all of these are surgical mistakes, but how can we ignore numbers like these in light of possible technology solutions?

The main advantages of robot-assisted orthopedic surgery over conventional orthopedic techniques are improved accuracy and precision in the preparation of bone surfaces, more reliable and reproducible outcomes, and greater spatial accuracy. Orthopedic surgery is ideally suited for the application of robotic systems. Robotic systems can be categorized as either passive or active devices, or can be categorized as positioning or milling/cutting devices.

Computer assisted orthopedic surgery is a related area of technological development in orthopedics; however, robot-assisted orthopedic surgery can achieve levels of accuracy, precision, and safety not capable with computer assisted orthopedic surgery. Applications of robot-assisted orthopedic surgery currently under investigation include total hip and knee replacement, tunnel placement for reconstruction of knee ligaments, trauma and spinal procedures.

Robot-assisted orthopedic surgery is still very much in its infancy but it has the potential to transform the way orthopedic procedures are done in the future.

Precise!

Doing what could not be done before by surgeons.

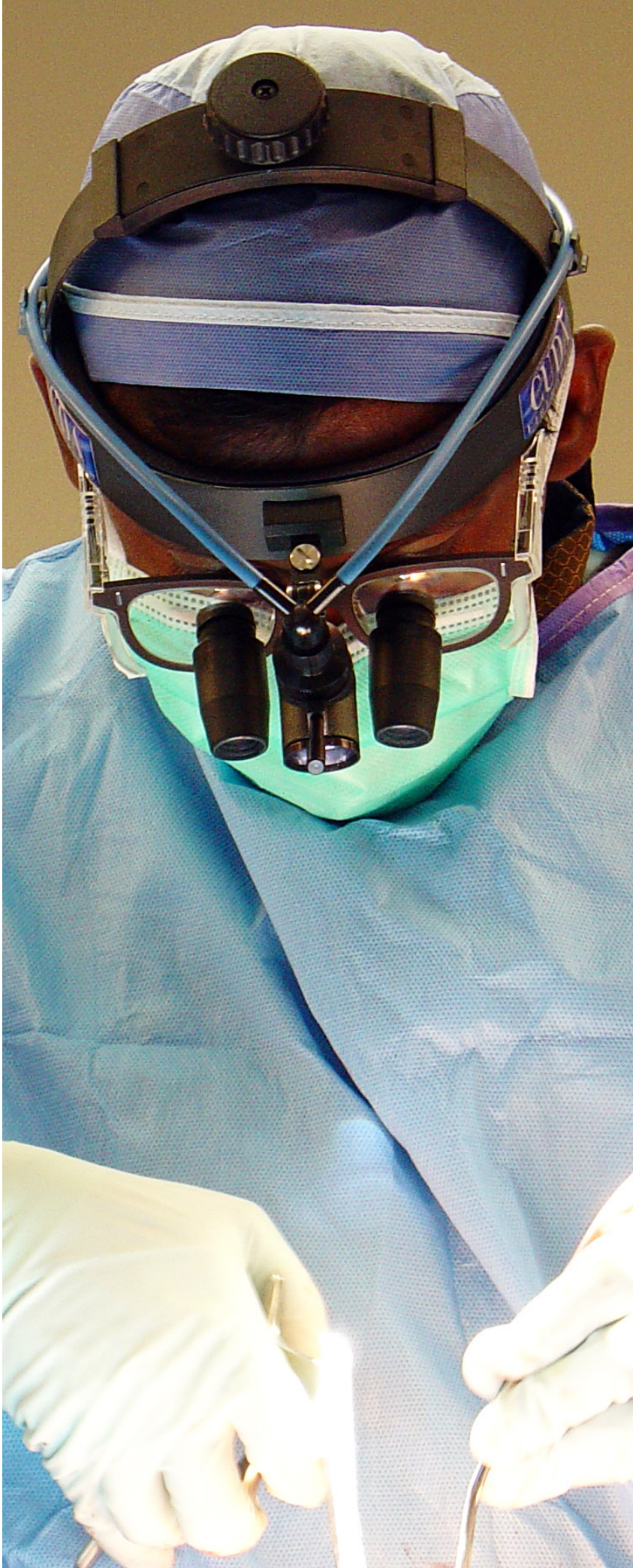
What robotic and computer-assisted technology is capable of now.

Currently, there are only a few orthopedic procedures, such as partial knee and hip replacements that have robotic or computer-assisted technology to help facilitate the surgeries. As the technology advances, companies have gone from developing facilitating technology to enabling technology. "Now, we are starting to see more programs that are enabling, which means making it possible to do surgeries that surgeons couldn't do before."

The robot is only able to follow the surgeons' plans and guide them. "Some surgeons think that a robot will make a bad surgeon good. If you don't understand the indications, biomechanics and musculoskeletal anatomy, it doesn't matter what tools you have in your hand, you won't do a good job", remarks Dr. Michael Jenkins.

Students.....either be a better doctor or build us a better robot.

Does this interest you?



Afterschool and Summer Learning:
Key Ingredient in STEM Success

By Chris Thompson, Carolyn Perry, and Andrew Burch

Science, Technology, Engineering, and Mathematics (STEM) skills are increasingly necessary to survive and excel in the global economy of the 21st Century. In recent years the United States has experienced renewed interest and a dramatic call from industry to improve learning and the number of STEM qualified candidates available to the workforce. To date the majority of the national strategies and government policies put forth to improve STEM education focus mainly on the school year classroom.

While no one would disagree that the school day is essential to mastering STEM content,we cannot ignore the fact that most students spend less than 1/4 of their waking hours studying in schools each year.

And with the recent economic pressures and subsequent reduced tax revenues the time in school has decreased for many. Clearly, education reform efforts cannot start and stop at the school door.

Afterschool and summer programs all over Georgia and the U.S.A. offer engaging, hands-on learning opportunities that not only excite students and teachers about STEM topics, but equally important build real-life 21st Century problem solving and critical thinking workforce skills. A recent analysis of several afterschool evaluation studies by the AfterSchool Alliance revealed that high quality programs often lead to increased interest and

"Summer learning is the key to changing our American educational system."

-Dr. Milton Chen, Keynote Speaker, National Conference on Summer Learning, National Summer Learning Association, November 2011

improved attitudes toward STEM fields and careers, increased STEM knowledge and skills, and an increased likelihood to pursue STEM majors and careers (Afterschool Alliance, 2011).

The importance of attitudinal changes in students is often overlooked or down-played because of the increasing emphasis on high-stakes testing.

However, if one reviews the literature objectively one find a long history of research that has repeatedly shown that students' attitudes within the learning process are closely related to learning and achievement outcomes(Alsop & Watts, 2003; Koballa& Glynn, 2007). In STEM, attitude may be particularly critical because of the growing need to attract young people to study and pursue careers in STEM fields (Bonvillian, 2002).

Other recent research has demonstrated the importance of afterschool and summer enrichment for long-term success in STEM education. Tai, Liu, Maltese, and Fan (2006) found that early exposure to STEM fields is very important to college selection and completion. Their research uncovered a link between interest in STEM careers by eighth grade and the likelihood of completing a science-related college degree. In fact, this interest turned out to be a more accurate predictor STEM college completion than were math and science test scores.

It would certainly appear that early encouragement of elementary and middle school students in STEM related fields can be very a powerful influence in the later choosing of a STEM related college major. Additionally, Wai, Lubinski, Benbow, and Steiger (2010) found that students who had more opportunities to participate in hands-on STEM learning (including afterschool and summer enrichment programs) were more likely to choose STEM careers and persist in them.

Afterschool and summer enrichment programs are well suited to STEM-learning since they provide additional time to deeply engage in the topics.

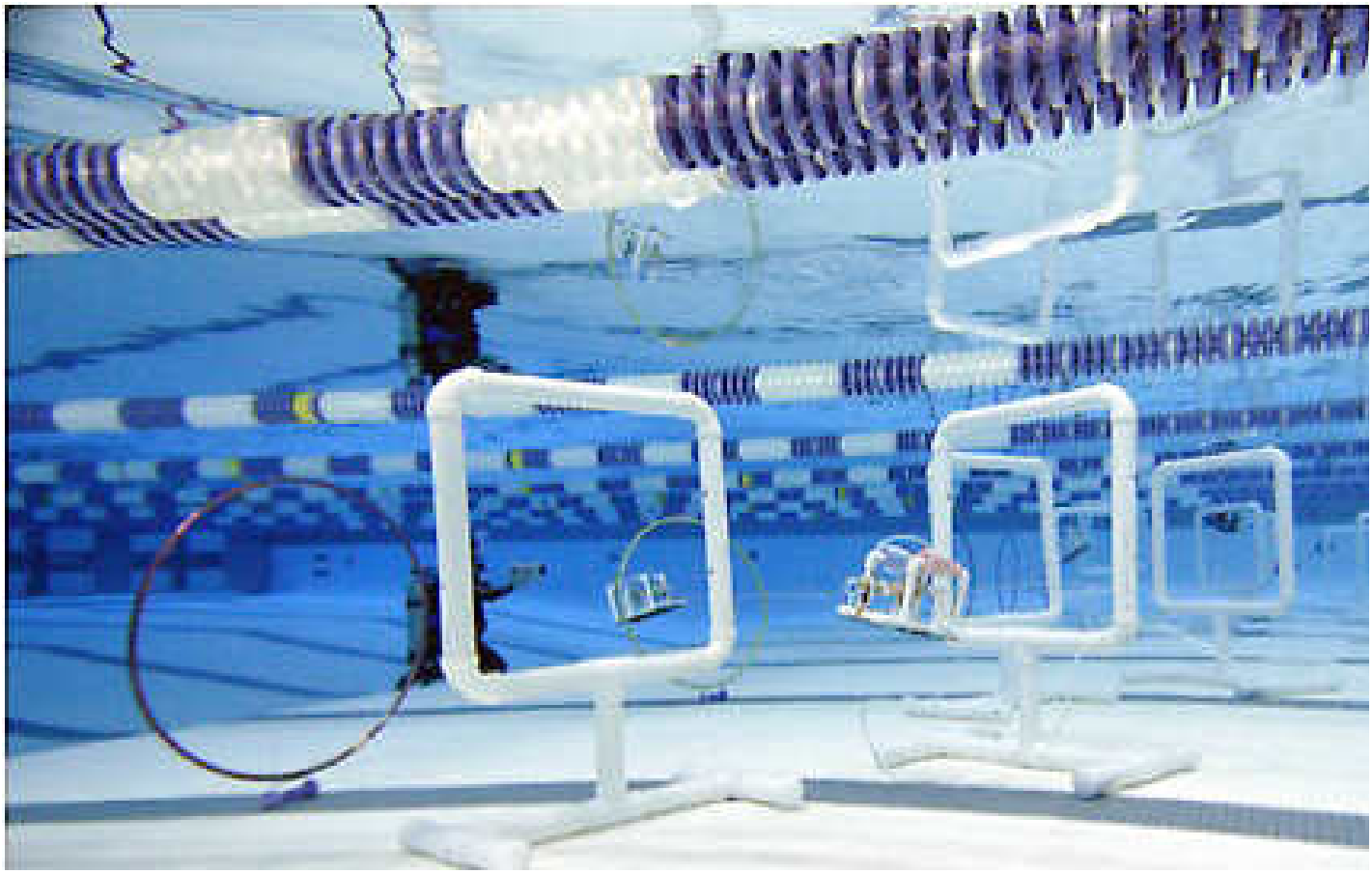
These non-traditional programs also offer an opportunity to employ methods and activities that are not bounded by the limitations of the typical classroom and engage learners in new and exciting ways. Well-designed quality programs can also be effective in improving access to STEM fields and careers among populations that are currently under-represented in STEM fields including women, African Americans, and Hispanics (Beede et al., 2011a; Beede et al., 2011b).

Perhaps the greatest opportunity to increase learning comes when afterschool and summer enrichment align with state standards and support classroom learning through relevant application of core STEM concepts and knowledge. Finally, teaching in such programs offers STEM teachers a low stress professional development

opportunity to pilot new activities and increase their knowledge of real world applications of core STEM concepts.

For all of these reasons the importance of in-depth project-based afterschool and summer enrichment hands-on STEM learning cannot be ignored.

Finally, most adults who enter STEM fields can recall interesting experiences they had as kids that made them know they wanted to be a scientist or engineer. "My dad let me take a toaster apart," recalled Paul Work, Associate Professor of Civil and Environmental Engineering at Georgia Tech Savannah. "I was always allowed to experiment and try new things." The next generation of scientists and are getting that type of opportunity through afterschool and summer learning experiences. Georgia Tech, like many other universities, offers numerous opportunities for afterschool and summer STEM enrichment experiences through CEISMC, the Center for Education Integrating Science, Mathematics, and Computing, and other colleges on campus such as the College of Engineering and College of Computing, GT conducts Saturday workshops (KIDS Club, Introduce A Girl (IAG) to Engineering), STEM focused competitions



(FLL/FIRST Robotics), and week long summer enrichment (Summer PEAKS, ICE Camp, Hot Days).

In recent years attendance at these STEM programs has grown substantially as parents and schools become increasingly aware of the importance to encourage and motivate young students to explore STEM topics beyond the classroom.

Georgia Tech's Kids Interested in Discovering Science (K.I.D.S.) Club is a

program conducted by CEISMC designed to enhance and encourage curiosity and enthusiasm for science, mathematics, engineering and technology. Students in grades 2 through 12 are invited to join student-centered, hands-on discovery sessions on Saturday mornings from 9 am to 12 noon. During each session, elementary students rotate and experience three different hour-long activities.

Summer learning is another important ingredient to STEM success. At Georgia Tech a variety of week-long programs are offered such as:

Career Discovery in Architecture: *Taught by Georgia Tech faculty and Atlanta architects Students draw and build in the College of Architecture's Design Studio, take field trips to an award-winning architectural firm, and visit a local construction site. Students leave with an understanding of the path to a career in architecture, as well as a design project ready for inclusion in their own portfolio.*

"We've taken the Next Generation Science Standards, which focus heavily on engineering as well as content and created projects for kids to work toward solving," says Carolyn Perry, Program Director for CIESMC in Savannah. *"We've worked on cleaning water, creating structures, and exploring ways the world works. The projects don't have right or wrong answers, just ways that will work more efficiently than others. And every idea is a good idea- you just have to find the ways to put those ideas together."*

One of the most exciting concepts students work on are forces and motion. Campers conduct hands on investigations to learn the relationships between force, mass, and acceleration. Newton's Laws of Motion as well as concepts like gravity and inertia are also examined. Students explore the connection between these variables in ways that bring science to life.

In Full STEAM Ahead, kids take a problem and engage with materials, found objects, common elements and household objects. One task kids worked on was the idea of floating cities. Groups of engineers are currently at work on designing and developing

ideas for ways people could live successfully on the oceans. This concept, called Seasteading, has influenced the cruise ship industry, shipping around the world and oil platforms and bridges.

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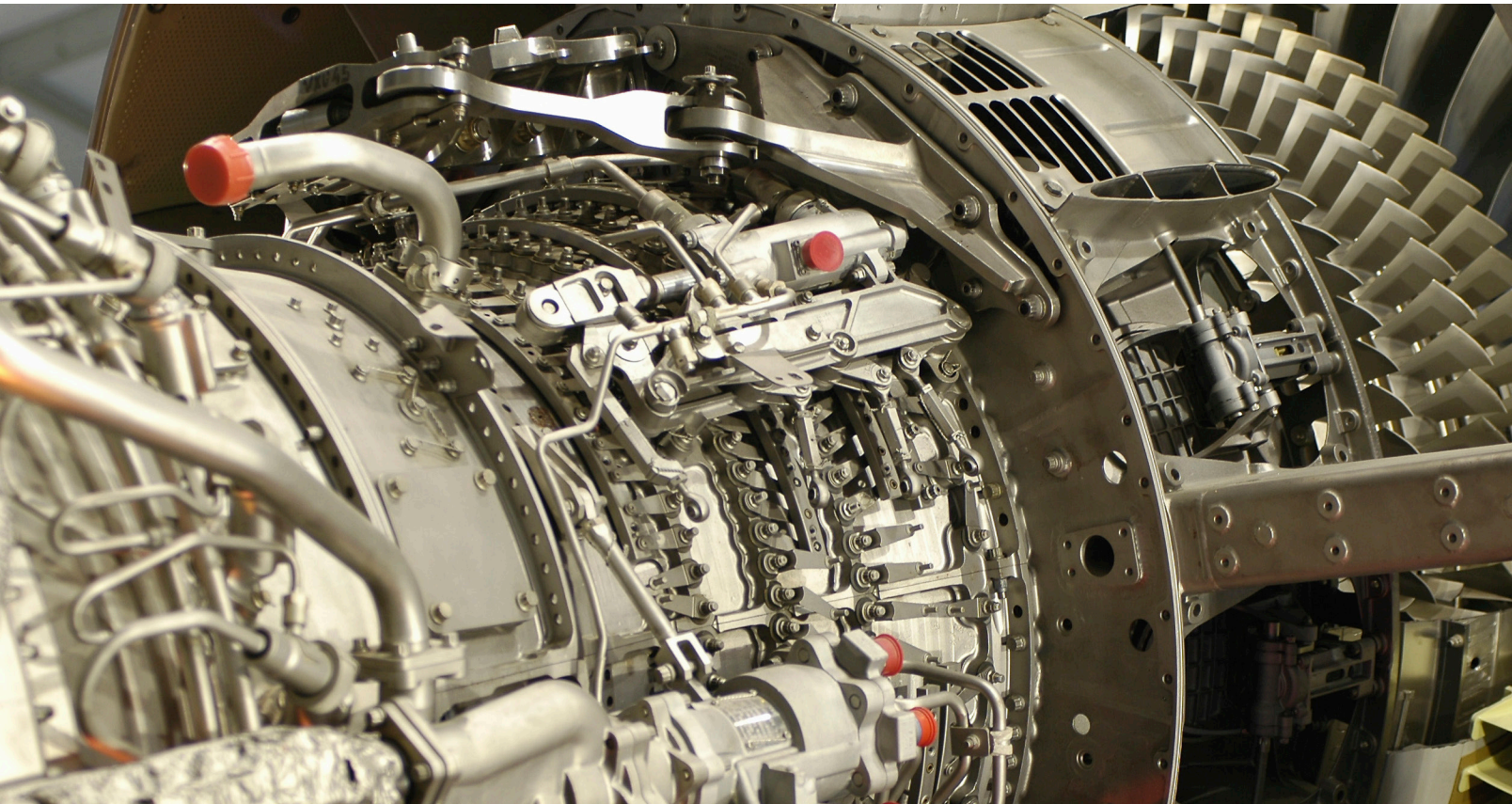
"I do not plan to be an engineer or scientist."

I do not plan to be an engineer or scientist, so STEM is not for me. Becoming knowledgeable about STEM is not about the 0.01% who might become Ph.D. researchers or the 1% who might become engineers. In this data-informed, technology intensive 21st Century the entire populace needs to become STEM literate. ***We all need STEM thinking skills.***

Many apparently non-STEM jobs have become STEM jobs, especially in the trades. Do you know that the average new car has about 50 microprocessors? Forget about crawling under it with a few of your Dad's old tools to fix it and Moore's Law of computers, which has resulted in the iPhone being equivalent to a multi-ton supercomputer of the 1970's, has affected most other trades as well.

But perhaps the most important reason for everyone to become STEM literate is to build a more informed citizenry. In that way we individually and collectively become better decision makers about all the options that our world and we face. STEM is not only for Ph.D. researchers. ***It's for all of us!***

Dr. Richard Larson
Mitsui Professor of Engineering Systems at MIT



A STEM-Literate Citizenry

Dr. Richard Larson
Mitsui Professor of Engineering Systems at MIT

What fraction of seats offered for sale each week by your local movie theater are sold to customers? Think for a minute before proceeding.

Many people estimate 40% or 50%. In fact, many of you might have been turned away recently from an opening weekend of a blockbuster film, so you might even guess closer to 100%. Well, the typical correct answer across the USA is about 5%. That's right, about 5% of all movie theater seats offered for sale during a week are actually sold to paying customers. How can this be, when all we see is nearly filled theaters? The answer is that most of us go to see films on Friday and Saturday nights, when the seats are relatively filled, not the Tuesday 11:00 AM showing when you might be the only customer in the theater.

Your own appearance during busy times creates a significant selection bias. You as customer experience a busy theater. The owner of the theater sees 95% empty seats. Both are correct.

Why do I speak about such a "non-academic" thing in a STEM newsletter? Because this is an academic issue: Our ability to reason properly with numbers and statistics. We need to be knowledgeable interpreters of data-informed situations. We need to read statistics-laden reports with appropriate skepticism.

Recent news articles have created some controversy over the national need for emphasis on STEM education, the reports suggesting that we now have an over-abundance of Ph.D.s' with science degrees and that graduating engineers do not do actual engineering for very many years during their careers.

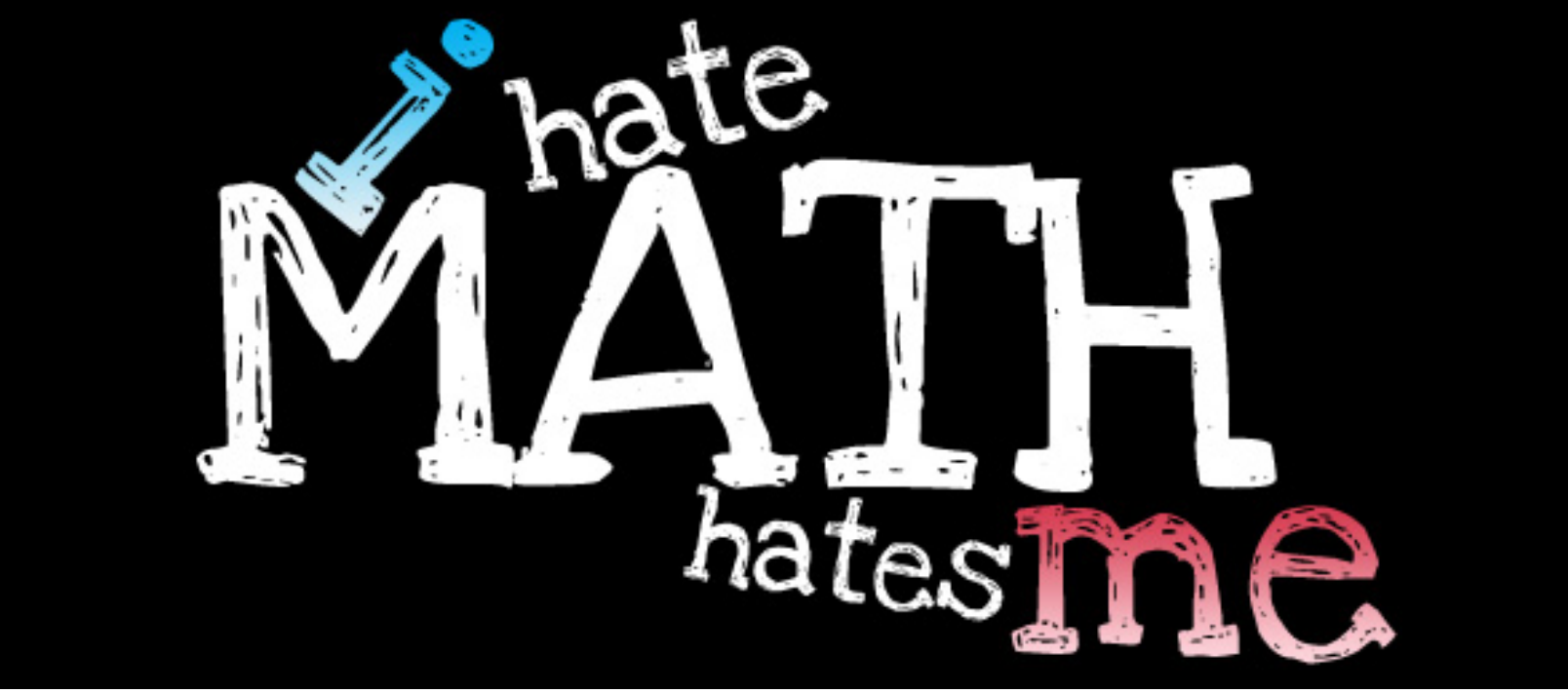
It is true that some science-trained Ph.D.s' are unemployed and that many with degrees in engineering go off and do other things, often within a few years of graduation. It's also true that we currently have hundreds of thousands of STEM-focused job openings.

But my point is this: Becoming knowledgeable about STEM is not about the 0.01% who might become Ph.D. researchers or the 2% who might become engineers. In this data-informed, technology intensive 21st Century, the entire populace needs to become STEM literate.

We all need STEM thinking skills. Many apparently non-STEM jobs have become STEM jobs, especially in the trades. Do you know that the average new car has about 50 microprocessors? Forget about crawling under it with a few of your Dad's tools to fix it! And Moore's Law of computers has affected most other trades as well. But perhaps the most important reason for everyone to become STEM literate is to build a more informed citizenry.

In that way we individually and collectively become better decision makers about all the options that a democracy faces. STEM is not only for Ph.D. researchers. It's for all of us!

"We all need STEM thinking skills."



Why do most kids hate math?

Ask most students what their favorite subject is and the answer is rarely math.

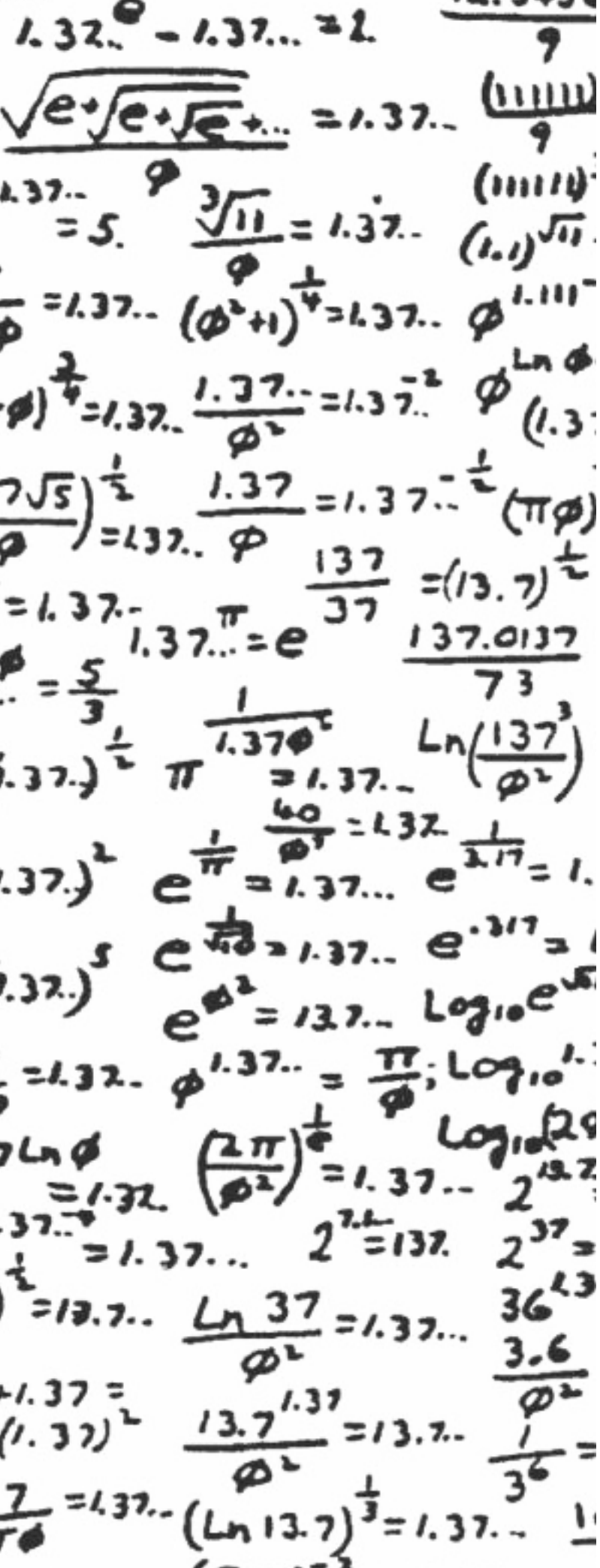
What I have found interesting as I query thousands of students is that if you ask a second grader if they like math, they are likely to say yes. What is happening between second grade and fifth grade to create such a dislike for a subject we use every day at home, school and work?

If blame has to be placed in order to find a solution (math term), it's spread across several guilty parties. The first culprit is state math standards, determined and required by administrators that would be hard pressed to pass a basic algebra exam to keep their job.

Experts agree that we push our students too fast and too hard to comprehend, memorize and apply basic and pre-algebra math in preparation for middle and high school requirements. Once a student falls behind or fails scholastically in math, their level of confidence in math drops to levels rarely recovered from.

Playing catch up in math or any subject is a tough assignment and would require a very high level of commitment by teachers, students and parents such as summer school, a private tutor or longer hours of homework study.

Does the average math teacher have time to spend one on one, everyday, to help their students keep up? Of course not. Teachers don't get to choose what has to be covered during a semester or how long to spend on a specific chapter. Goals must be reached for testing…. ready or not. The math causalities are high and growing.

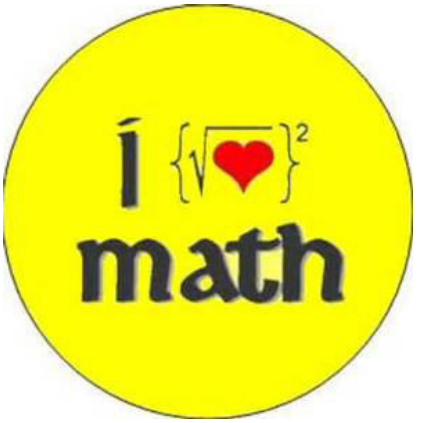


Who is next on our list of suspects? **Adults.**

Ask most parents and non-math teachers if they like math and the answer is almost always a resounding "No..I hate math and always have." I have actually heard adults utter those very words to their students and children. When an influential adult plants the reinforcement of math hatred in the mind of a student, it serves to support the childs confusion about how to feel about math and how much extra effort to exert.

If enough adults and peers support that disdain for math of any kind over the course of years, why should we be surprised by failing grades and lower test scores and a bad attitude about math?

As parents and teachers we regularly fib to our kids about how great they did at the game, how beautiful their art creation is, how talented they are…..no harm, no foul. Why not add math to the list. "I love math…and you should too."



We only have a few choices regarding math success for our students:

- Math isn't that important so don't worry about it.

- Math is important. Let me get you all the help you need to understand it.

- Let's change the standards to allow for a more realistic level of success and understanding for OUR kids.

We can't fairly compare our kids to other nations or their scholastic achievements due to cultural influences and traditions, the role of government in the curriculum in other countries or the framework of the school system that is far different than the U.S.

Regarding S.T.E.M. careers….yes, math is very important and high levels of proficiency are demanded to enter those careers such as engineering, medical science, computer science, many aerospace applications, technology innovation and more.

More general math subjects such as geometry, pre-algebra, the ability to measure and estimate, using fractions or balancing your check book are required for almost any job you can name from carpenter to trash collector, secretary to CEO.

Very few of our students will enter what we perceive as traditional STEM careers, not because they don't qualify, but simply because it doesn't interest them. We too must learn that almost EVERY career choice requires STEM skills.

" The number of Japanese student suicides is up 25% from 2005, the second worst globally."

"Students in southern India, the new technology and economic hub of the country, now have the highest suicide rate in the world."

"Is that a price we are interested in paying?"

You've read my messages before that "Every job is a STEM job and every teacher is a STEM teacher." That's still true in principle since every career uses many STEM applications to some degree, but the reality is that only about 5% of the U.S. labor force works in engineering and science whereas over 20% of the U.S. labor force in engineering and science jobs are held by foreign born professionals. **This is the STEM crisis so many refer to.**

My observations over the last decade point to a lack of interest in these careers by American students due partly to a lack of introduction and curiosity early in life, a pushy testing and curriculum formula designed to fail, and an undermined level of student self-confidence scholastically and personally.

How do we as educators care for and support our students in a healthy way

while at the same time, preparing and encouraging them to excel in school and career to meet the industrial needs of our nation where we need them? What about what they want?

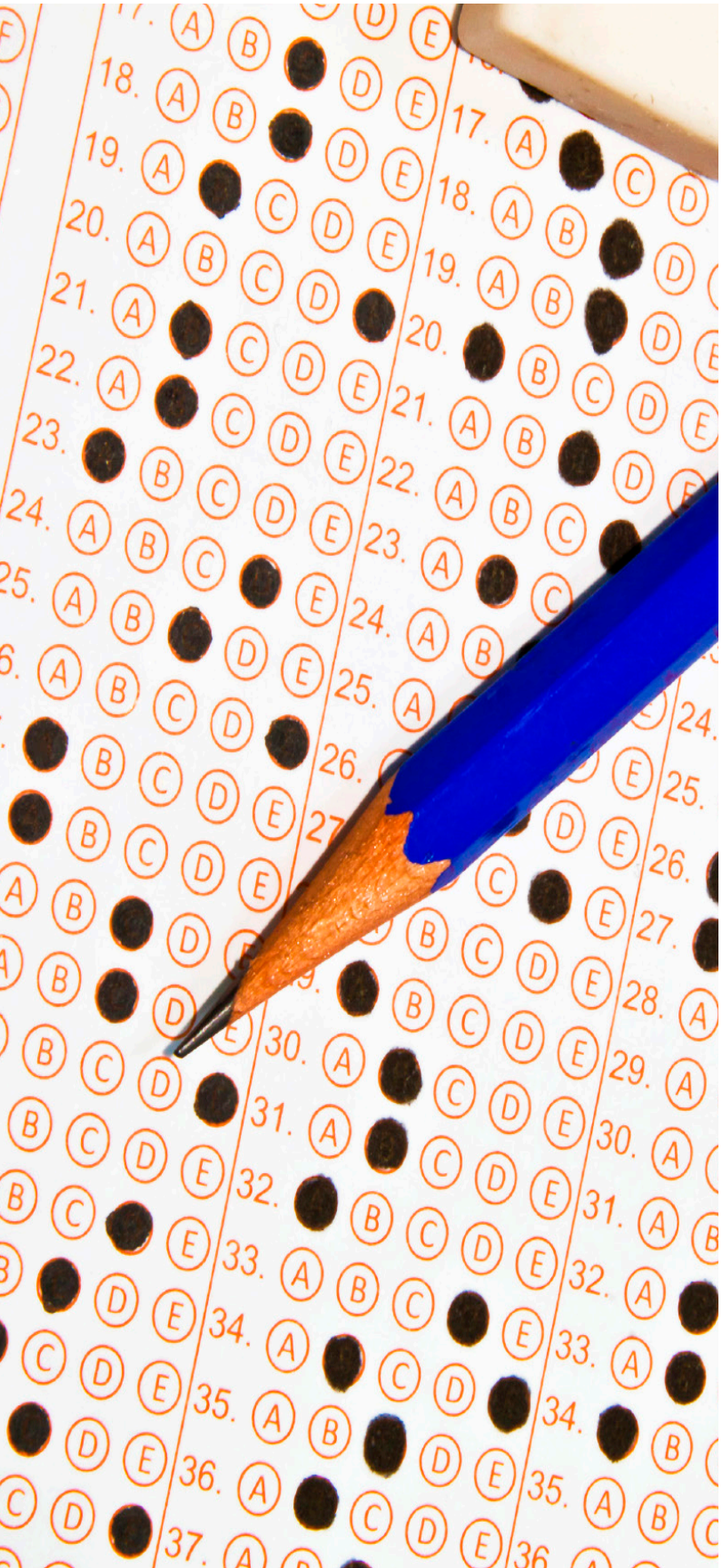
Here's what we can do:

Early exposure to STEM topics, skills and a variety of careers to generate possible interest.

Constant encouragement in personal capabilities.

Promote curiosity.....this is the foundation of everything that follows.

Success on Standardized Tests ***Without*** Sacrificing Authentic Learning



By Judy Willis, M.D.

"Algebra is a way of arranging knowns and unknowns in equations so that the unknowns are made knowable. The three fundamentals involved...are commutation, distribution, and association.

Once a student grasps the ideas embodied by these three fundamentals, he is in a position to recognize wherein 'new' equations to be solved are not new at all. Whether the student knows the formal names of these operations is less important for transfer than whether they are able to use them."

Jerome Bruner's The Process of Education, Harvard University Press. 1977

Concepts and Memory

Grasping the structure of a subject is understanding and holding it in a relevant memory category. This becomes a neural network that be used for transfer, where it can link with other networks for application beyond the original learning situation.

Constructing neural networks is achieved not by rote memorization, but by mental manipulation where new input and prior knowledge are related meaningfully. Concept knowledge in math is the authentic way of achieving long-term memory and is best achieved by learning how things are related

Long-Term Memory Building and Maintaining

Repetitive stimulation of the neuronal circuits holding the information is necessary for the memory to be maintained and even for the neuronal connections to remain in place and not be pruned. The mental manipulation and active processing of learned information through the executive functions especially in the prefrontal cortex stimulates memory circuits.

It is these networks, activated during mental manipulation of the new information through prioritizing, comparing/contrasting (similar / different) deduction (constructing new knowledge from existing information), and induction that stimulation of the memory storage areas increase the strength of the neural networks through additional dendrite sprouts, more synapses, and thicker myelin around axons that speeds transmission between neurons.

Practice really does make permanent – as long as the practice involves active mental manipulation, construction of new ideas, and truly using the new information in different ways that it was originally learned. Mental manipulation is not what happens when students passively repeat procedures over and over on worksheets.

For example when students review learned material by solving well designed word or story problems, they are making judgments about what question is being asked, analyzing the data provided to determine what is needed to reach a solution and what is extraneous, and considering the procedures the know to see which might be useful. To carry out these executive functions there is information exchange from the executive function networks to the areas of stored memory in categories deemed relative to the problem.

These stored memories are found throughout the various lobes of the brain depending on the different sensory modalities that carried the input into the brain. If the knowledge was acquired through multi-sensory learning and review, there is activation in the visual, tactile, auditory, and kinesthetic input receptor cortexes when the problem is considered.

Similarly, when learning is reviewed by authentic incorporation in new learning, the storage circuits are reactivated. For example, each time a long division problem is done correctly there is practice of subtraction and multiplication. When learning is examined through follow up lessons using open-ended discussions, students are encouraged to seek multiple approaches to solving problems and to verbalize and communicate with classmates. This provides opportunities for more student engagement.

When classmates add new approaches to the problem solving, the other students extend their established, stored memory patterns and categories to incorporate the new insights. It is not only neuroimaging evidence of multi-centric brain cortex activation (metabolism) during problem solving, but also of activation of emotional networks throughout the limbic system that can be stimulated by problem solving.

These areas that are important in memory consolidation and retrieval such as the amygdala, hippocampus, and basal ganglion can be "exercised" and receive increased blood flow and neuronal network fortification when the stored information is associated with positive emotional experiences. These are the activities described earlier as having a beneficial influence on the amygdala and dopamine release related to pleasure and enjoyment influence on memory when these activities are incorporated in the teaching or review.

These are the powerful lessons you create to incorporate personal interest, prior knowledge, global real world connections, surprising discrepant experiences, and the intrinsic reward of achieving challenges the students feel are significant.

Long-Term Memory Building Through Concept Review

Building and retrieving memories takes place in stages through information encoding, storage in patterns of relational memories, and re-stimulating these neuronal pathways by review each time the memory is accessed and used.

Familiarity increases recall so students with memory-based learning difficulties can preview the coming lesson by skimming the new section in the book before class. In that way, when they hear the new terms they will have had at least one initial exposure to them. When recall seeing a word on the pages they previewed, even if they don't remember any details or understand its meaning, just hearing the somewhat familiar term or procedure will increase activation in their cerebral cortex.

On fMRI scans when the brain even recognizes a word, even without knowing its meaning, there is enhanced activity in the anterior left prefrontal, left parietal, and posterior cingulate regions. This previewing or priming front-loads or preheats the brain's related memory patterns or categories and there is less stress from unfamiliarity when the lesson is taught.

Similarly, in class before the lesson if you write and say the new terms, important concepts, or major themes that will be taught that day in math, students' associated and relational memories connected with the new information will be "on-line" and ready to be retrieved to the hippocampus for consolidation with the new information they encounter in the day's class.

When you help students understand the terms and concepts being discussed throughout the lesson, they can devote more working memory to processing and analyzing ideas, making connections, and actively processing the new information and less working memory will be needed to simply decode new terms.

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established, stored memory patterns and categories to incorporate the new insights.

"Gain student interest with a provocative question..."

When skills and facts are taught and practiced as part of solving complex, interesting, meaningful problems, the learning is richer; confidence and relational understanding develops in a context of meaning. By engaging students through personal interest and real world use of the procedures and rote memory facts that are the basis of future learning, they feel the learning is useful and worth their effort. When students see the value of what they are asked to learn they are motivated to build the foundations they need to achieve personally meaningful goals. Knowing how memorizing multiplication facts so they become automatic helps student motivation because they understand why it is worth their effort to rehearse these facts until they are mastered.

Gain student interest with a provocative question and discussion about the coming unit. At the start of a unit, ask whole-class prediction questions that can be responded to at different, creative levels in personal journals.

Once predictions are written down, students will be more invested in learning more about the topic to see if they are right. Making predictions is a very safe type of "risk-taking behavior" that can stimulate the dopamine-pleasure response and encourage fearful or perfectionist students to take chances without the anxiety (amygdala stress) of being wrong. Emphasize that predictions don't have to be right. They are an opportunity to pose questions and see what the outcome is.

Learning through inquiries and discovery is more motivating, successful, and less threatening when students know what basic arithmetic they need to know at the automatic level. When they participate in inquiries and investigations along with procedural learning they realize how having these tools easily accessible makes the investigations and problem solving more enjoyable and less threatening.

Their affective filters will open up to the pleasure of creative mathematics. Students with limited experience in the mental manipulation that builds relational memory will not build the skills of creative problem solving, concept development and communication, pattern recognition and predicting, and other forms of prefrontal lobe executive function cognition they need to use reason, logic, and extension of patterns and procedures for the daily complexities of life or the professional jobs of their future.

Activities that Reach Executive Function

- Create a webpage or power point presentation
- Design a board game
- Write a book for a younger student
- Create a brochure or advertising materials
- Make predictions based on the knowledge
- Connect to another subject or big idea
- Use the information to try to help solve a meaningful problem.
- Write a letter to the editor of the newspaper about calculations you made about where energy use is high and what changes could result in reductions you mathematically predict.
- Create a newsletter or blog with your position.

Mental Manipulation and Executive Function

Processing time, reflection, and meta-cognition are vital to the learning environment. Thus, much of the effort put into teaching and studying is wasted because students do not adequately process their experiences, nor are they given time to reflect upon them."

Hiebert and colleagues 2003 analysis of videotaped lessons of 8th grade teachers of math in the US compared to countries that score the top scoring in the Third International Math and Science Study. Those countries "not only assigned their students challenging mathematics problems, but also used active questioning and dialogue to help student see and understand the connections among mathematics concept as they solved the problems.

HG Wells predicted that our future would be a race between education and catastrophe. *"We live in very exciting time as educators and with the help of neuroscience and dedicated educators we can seize the moment and win the race."*

Videotapes of US teachers focused on teaching procedures and formulas and telling children when to plug in numbers. "That we understand something if we see how it is related or connected to other things we know." The degree to which one understands rests on the connections or relationships and the richness of these relationships. Understanding a topic provides the foundation for remembering or reconstructing facts or methods. With this definition, understanding is also known as ***conceptual knowledge***. Instruction that builds conceptual knowledge helps students' link old knowledge with new knowledge. This means providing time for reflection and communication.

As an example, students conceptually understand multiplication of two numbers when they have made the connections that two repeated four times is the same amount as four repeated two times. "From that good beginning, students will be most likely to be active participants in their learning. When good beginnings are followed by goal-directed, learning, students see their progress.

Students will increasingly associate perseverance and practice with success, and persevere to achieve these goals with guidance through their interests and learning strengths into almost any topic of study.

Dr. Judy Willis is an authority on brain research regarding learning and the brain. With the unique background as both a Neurologist and classroom teacher, she writes extensively for professional educational journals and has written six books about applying the mind, brain, and education research to classroom teaching strategies, including an ASCD top seller, Research-Based Strategies to Ignite Student Learning.

After graduating Phi Beta Kappa as the first woman graduate from Williams College, Willis attended UCLA School of Medicine where she was awarded her medical degree. She remained at UCLA and completed a medical residency and neurology residency, including chief residency. She practiced neurology for 15 years before returning to university to obtain her teaching credential and master's of education from the University of California, Santa Barbara. She then taught in elementary and middle school for 10 years.

Currently, Dr. Willis gives neuroeducation presentations, and conducts professional development workshops nationally and internationally about educational strategies correlated with neuroscience research.

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