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The STEM Ambassador Guide

Prepared by:
STEMTech Alliance

**A Collaboration of Six Massachusetts
Science and Technology Associations**

**To increase middle school students' awareness of science,
technology, engineering and math (STEM) careers**

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BACKGROUND

What is STEM?

STEM is an acronym created by the National Science Foundation that stands for **science, technology, engineering and math**. It is widely used in relation to STEM subjects (math and science) and the shortage of workers in the **STEM** Pipeline.

Project Summary

Funded by the Massachusetts Department of Higher Education STEM Pipeline Fund, this initiative has undertaken four major activities to increase the awareness of and interest in STEM careers by sixth grade students. The activities include:

- **Research on middle school students** –what they think about STEM subjects and careers, how they learn, and their view of what constitutes a “good job.”
- **Branding campaign** – a comprehensive communications strategy that includes the design and development of a brand, logo and set of activities that will spark the interest of sixth grade students in STEM careers
- **Recruitment of STEM Ambassadors** – a corps of STEM professionals who volunteer to visit classrooms across the state to tell their personal stories and deliver the messages of the campaign
- **Development of a STEM Ambassador Guide** – to provide participating volunteers with suggestions and best practices that will enable them to maximize their opportunities for success in the classroom

Year One of the grant was dedicated to the planning and design of the overall project and all its elements. Year Two started with a pilot project of 10 schools across the state, a period of evaluation and improvement of the program, and then a full-scale launch of the effort in the fall of 2009. For the balance of the grant period, the project is focusing on recruiting and training STEM Ambassadors, identifying sixth grade classes around the state that are interested in the program, and facilitating the scheduling of classroom visits for the STEM Ambassadors. A third-party evaluator has been hired to measure the impact the project had on students.

Acknowledgements

We would like to acknowledge a number of people who made this project possible. Special thanks go to **David McCauley**, Deputy Commissioner for Workforce, Massachusetts Department of Higher Education and **Keith Connors**, Project Manager, for their willingness to work with us and learn alongside of us. They also intuitively understood that while we had a direction, we had no real roadmap. They gave us the time and space we needed to create our path as we went along. In addition, we would like to thank the **Massachusetts Technology Leadership Council** for enabling President Emerita Joyce Plotkin to serve as Project Chair, devoting hundreds of hours to the effort. And special thanks to the **Arnold Worldwide** team for contributing their outstanding creative abilities that resulted in an award-winning branding and identity for the project.

STEMTech Alliance

The **STEMTech Alliance** is a collaboration of six leading science and technology industry trade associations that came together, for the first time, to work collaboratively to address their common challenge of ensuring a STEM-qualified future workforce. The partnership includes:

MassTLC - (Lead Organization) The **Mass Technology Leadership Council** is dedicated to fostering entrepreneurship, driving innovation, and promoting the success of companies that develop and deploy technology across industry sectors. The Council provides a forum for business, professional and economic development through educational programs, signature events, clusters activities, and networking opportunities; engages in activities to enhance the quality and quantity of the next generation of technology professionals; advocates in favor of technology policies that promote innovation and entrepreneurship; and recognizes leading companies and people.
www.masstlc.org

MassBioED - The Massachusetts Biotechnology Education Foundation is a non-profit charitable organization committed to supporting science and biotechnology education in Massachusetts through school programs, workforce training, and lifelong learning. It is the educational arm of the Massachusetts Biotechnology Council (MBC), which currently consists of more than 600 companies, universities, academic institutions and others dedicated to advancing cutting-edge research. MBC companies are involved in researching diseases and designing diagnostic or drug therapies to address these diseases. www.massbio.org.

MassMEDIC - The Massachusetts Medical Device Industry Council is the voluntary grassroots association of medical device manufacturers and associated companies in the Commonwealth. MassMEDIC is the only organization in New England dedicated solely to promoting the unique interests of the medical device industry. MassMEDIC strives to create a positive environment which will nurture developing companies, retain and help established medical device companies to grow, and attract new companies to Massachusetts. MassMEDIC provides services, programs and collaborative initiatives with the goal of making Massachusetts the medical device research, development and manufacturing capital of the world. www.massmedic.com

MassNetComms - The Massachusetts Networks Communications Council promotes Massachusetts as a global center for telecommunications and networking. As the market has expanded to include a multitude of new business ventures poised to capitalize on opportunities for hardware and software products, MassNetComms ensures that these businesses receive the support necessary to succeed in a competitive international market. Driven by growth in demand for voice, data, and video services, as well as ubiquitous wireless and wire line networks, telecommunications products and services offer enormous potential for suppliers and consumers in Massachusetts and worldwide. www.massnetcomms.org

The Engineering Center - The Engineering Center is a collaborative organization that advances the goals of its member associations with greatest impact, and provides the environment and energy to successfully promote the importance of the engineering and land surveying professions, engage the public on matters relating to the natural and built environment, and secure our place as leaders of our communities. www.engineers.org

New England Clean Energy Council – The New England Clean Energy Council's mission is to accelerate New England's clean energy economy to global leadership by building an active community of stakeholders and a world-class cluster of clean energy companies. The Council represents a diverse set of stakeholders, including clean energy companies, venture investors, major financial institutions, local universities and colleges, industry associations, area utilities, labor and large commercial end-users. The Council's ranks include 50 clean energy CEOs, representatives from most of the region's top 10 law firms, and partners from over a dozen of the region's top venture capital firms (with a total of over \$8 billion under management). Working with our stakeholders, we develop and execute a wide array of programs in five key focus areas: Innovation, Growth, Education and Training, Adoption, & Policy. www.neccec.org

The STEM Challenge

Importance of STEM

The Massachusetts economy is dependent upon the growth and success of its science and technology-based companies. These include businesses that work in software and Internet, telecommunications, biotechnology, medical devices, engineering, clean energy. An educated and available STEM workforce is the very life blood of these companies, now and in the future. But these companies are increasingly concerned that they will not have the quality and quantity of workers they need to innovate, grow, and succeed in global marketplaces.

The challenge appears to be that we have spawned a generation of young people who want the latest technological gadgets, cures for diseases that afflict their families and friends, and efficient communications that meet their instant messaging, on-demand lifestyles. But somehow, these young people have not made the connection between what they study in school, what kind of career they want, and what goals they have for their lives. The bottom line is that Massachusetts students are simply NOT choosing to go into STEM fields.

A couple of disturbing statistics demonstrates this clearly:

- Nationally, **28% of high school students taking the SATs** indicate they are interested in pursuing a Science, Technology, Engineering, and Mathematics (STEM) career. But in Massachusetts, that number is only **22%**. In contrast, that number for North Carolina is **34%**.
- A Raytheon study found that **84% of US middle school students** would rather clean their rooms, eat their vegetables, take out the garbage, or go to the dentist – than do their math homework.
- In addition, national research reports indicate that if we do not increase the numbers of the students interested in entering STEM careers in the next decade, it is estimated that **90% of all scientists and engineers will live in Asia**.

Students and STEM

Research shows that the most influential time for increasing student interest in STEM subjects (math and science) is in middle school which generally includes grades 6, 7 and 8. It is in these three critical years that students either turn **toward** or **away** from STEM subjects. If they turn toward these subjects, they are likely to continue to take math and science classes in high school, which then allows them to continue on this path in college and prepare themselves for STEM careers. But if they turn away from these subjects in middle school, they are most likely lost to the STEM pipeline.

This project is focused on getting **sixth grade students** excited about STEM because, after numerous focus groups with students and teachers, we have learned that sixth graders are more receptive and open to learning math and science, while many seventh graders have already turned themselves off to these subjects.

SECTION ONE

RESEARCH REPORT

Research Goals

As part of this project, the STEMTech Alliance has looked at the existing research on student learning to understand what middle school students already know about STEM careers and to ascertain how best to increase their knowledge. Our findings are included in this report. It is not an academic research report; instead it is a summary of key principles, concepts, and facts that we have gathered through our formal and informal learning. The specific goals of the research are:

- To educate project leadership, staff, volunteers and other important constituencies;
- To provide the foundation for the branding and messaging campaign;
- To enable STEM volunteers to understand quickly the problems and opportunities, as they prepare to go into middle school classrooms to motivate students about the tremendous opportunities STEM fields offer.

Sources of Information

In trying to answer the questions “What do students know about STEM careers?” and “How can we increase student awareness of STEM?” we have turned to the following sources to inform our understanding and the preparation of this report:

- We have done our **own field research**. In June 2008, we held three focus groups and spoke with 18 teachers and nine students. While this sample is small, the comments and observations we received reflected what was in the literature.
- We have reviewed the information and findings prepared by several highly respected organizations and individuals; each has done their own research and based their own program offerings on their research results. These resources include the **Boston Museum of Science, WGBH Television, Tufts University Center for Engineering Outreach, and Sally Ride**, first woman astronaut and President of Sally Ride Science. These organizations are dedicated to changing perceptions and student learning about STEM fields and are working effectively and creatively to address the STEM issue. They have each launched a series of programs for students and provided materials for teachers that are creating considerable interest and excitement. Individually and collectively, these efforts are helping to grow interest in STEM fields.
- We were the recipients and beneficiaries of two literature reviews - by career specialist Dr. **Thomas Harrington** from **Northeastern University** and **Jean Supel** from the **Donahue Institute at the University of Massachusetts**.

We hope this research report provides a useful overview of the problem and opportunity and helps STEM volunteers better understand the critical role they can play in meeting this important challenge.

1. What do Middle School students think of STEM courses?

Middle School students in Massachusetts, in grades 6, 7 and 8, are required to take STEM courses in **biology, physical sciences** (chemistry and physics), **math**, and **engineering/technology**. The content for each grade is prescribed by the State Department of Education and middle school teachers must cover specific subject matter in these four topics in each of the three years of middle school.

The general rule of thumb appears to be that if students are good in a subject they like it but if they do poorly in the particular subject then they don't like it. But the overriding message students share is that STEM courses are somehow "hard" and only for "very smart students" and they feel that even if they do well in the subject now, it will become more difficult in the future and they will fail. (3)

Students like **engineering** because they get to do hands-on activities, work together and build things. They like the visual and tactile impact of being able to create something that they can see and touch and move. Boys, in particular, like the competition of building something better than their classmates. (3)

The **physical sciences** also hold interest for them as do the life sciences (biology). Actual science achievement is related to expected achievement, motivation, "field experiences, quantity of courses taken, science-related experiences outside of school, mentors and role models, often tracking socioeconomic status, parental education, social and cultural 'capital' and learning behaviors." (3)

Math is a more complicated subject. Many students like math because they can get the "right" answer – math is either right or wrong and they like the finality of that. If they get the 'right' answer then they consider themselves good at the subject and 'like it'. However, even students who know they are good at math say they do not want to work in a career that has math in it because it is also viewed as "hard" and is perceived as something only for "smart" people. Their perceptions about liking or disliking math tend to solidify at about 7th grade and it is difficult to change their perceptions, motivations and success after that. (3) (5)

Technology to middle school students generally relates to computers. Students have little understanding of how technology is used or created. What they are taught in school is instructional technology. They, of course, would prefer video games and surfing the web.

2. How do Middle School Students learn?

Middle school students have specific learning styles, which differ from how elementary and high school students learn. (7)

In elementary school, students pay attention to the teacher's norms and follow them closely; in high school, students are increasingly self-motivated and able to make their own decisions, beyond what the adults in their lives tell them to do.

But middle school students are different.

- They have a **clear understanding of their abilities** in school and know, early on, which subjects they are ‘good at’ and ‘bad at’. This can become a self-fulfilling prophesy: if they “succeed” in a subject, they think it is because they are “good at it”. If they do poorly in a subject, they ascribe this to the fact that they are “not good at it” rather than understanding that if they worked harder they could, in fact, succeed. Middle school students move towards subjects that require abilities they think they either have or can develop and move away from subjects that require abilities they think they don’t have or about which they have self doubts. (3)
- They **have not yet developed the ability to think abstractly**. They learn much better by “doing”, by working in groups or teams and by being rewarded for their success. Middle school students need concrete examples of things and not theoretical abstracts. They learn better by engaging in an interactive exercise, rather than just listening to someone talk to them. Too often they learn math, science, technology and engineering by reading a book, or doing work sheets or talking about the subject. Many of them have almost no chance to “do” these very same subjects which would bring them to life and increase their interest. (3)
(6)
- They become **increasingly focused on their social standing among their peers**. They want to “fit in” and “be cool” and judge their ability to meet these two goals on a daily basis. They are very concerned with “self awareness” and therefore move towards subjects and friends that make them “cool” and turn away from things that make them stand out and appear different. (8)

This is where the clash with STEM subjects starts to occur. In middle school, many students become aware of the concept of a “Nerd.” Nerds are seen as being academically strong in science and math, the very basics of the STEM field, but they also are presumed to have many bad attributes, including being unattractive, un-athletic, not sexy, and not fun – the very qualities that early adolescents are looking to avoid at all costs. (8)

One of the major goals of this project is to introduce middle school students to a group of STEM professionals who counteract the stereotypes, who are engaging, fun and socially acceptable, and who happen to work in and are good at STEM subjects.

3. What do Middle School Students know about STEM Careers?

Middle School students, in grades 6, 7 and 8, know very little about careers in general and even less about STEM careers. Their concept of “jobs”, “work,” or “careers” comes from two sources:

- The **popular culture** they see all around them which includes both traditional (TV, movies, magazines) and on-line media (World Wide Web, social networks).
- The **adults in their lives**, specifically parents, caregivers, relatives, neighbors, and teachers.

Despite these two influences, students have a very limited understanding of careers. Television shows them what a lawyer or doctor does and they can see how these professionals spend their days.

However, other than forensic scientists on CSI shows and some engineering shows on public television, students don't know or learn from television what a biologist, research scientist, mechanical engineer, or software programmer does. And, when it comes to describing what their parents do in their jobs, most middle school students know very little. They say their parents "go to the office" or "are in meetings a lot" but show little understanding of these jobs or work activities.(3)

When students are asked to describe either STEM professionals or STEM jobs, their responses are often negative and based on common stereotypes, giving them reasons for not pursuing STEM careers: (3)

Science often means "medicine" to middle school students. They have a general concept of what doctors and nurses do, but being a "scientist" is a far more abstract concept to them. They cannot make an easy connection between what scientists "know" and "do" or how they spend their days 'doing science'.

Technology generally means computers to middle school students. If pressed, they understand that cell phones, iPods, the Internet, YouTube, and My Space, represent technology, but their general understanding of what technology is and how it is used in a career is very limited.

Engineering means designing and building things – bridges, roads, buildings, water systems etc. Middle school students are intrigued by the process of "building things."

Math, and its relationship to careers, means nothing to them. In fact, students generally cannot think of any careers where math is used except "math teachers."

Over and above the lack of student interest in STEM subjects is the fact that middle school students do not have basic knowledge about careers and how 'learning' connects to 'working'. When pressed to give their perspective on STEM careers, students generally have a negative perception of them. Students say these careers are:

- 'hard,'
- only for 'really smart people,'
- 'lonely jobs,' and
- lack diverse role models (don't see people like them).

Middle school students will internalize these various messages and turn away from STEM careers if STEM Ambassadors, teachers, and other professionals do not intervene. (4)

Finally, when asked to draw a picture of a STEM professional, they draw the stereotype of an aging white male, often with glasses, sitting at a desk doing math problems. They don't generally have positive role models for STEM careers and this creates yet another barrier to their interests because students need to know that STEM people are "normal" and "look like them." (3)

4. What constitutes a Good Job in the minds of Middle School Students?

While middle school students have little understanding of general careers and specific jobs, the research data is clearer on what students think is a “good” job and what social characteristics are important to them as they think about their future. The research shows that a career’s perceived value is comprised of both intrinsic factors (i.e. does the student have a personal interest in the job) and extrinsic factors (how much does the job pay, how many years of school are needed, etc.)

Characteristics of a ‘Good Job,’ as viewed by middle school students, include:

- **Money** is a motivating factor for all middle school students; they are curious about what jobs pay and want to find a job where they can earn a lot. They know that sports figures and TV stars earn good money and that factor, plus the star quality of these individuals, puts these careers high on their list.
- **Being part of team** is important. Most students make it clear that they do not want to work “alone.” They want to work with a group of people that they like.
- **Using creativity** is seen as an added value to a job. Middle school girls, in particular, are interested in this aspect of a job.
- Having a **flexible schedule** is a job characteristic that is mentioned by middle school girls as critical to their future career. Flex time, working from home, being able to care for sick or elderly family members on occasion are all considerations.
- Being able to **travel the world** is an enticement for both boys and girls.
- **Making the world a better place** by doing something like finding a cure for disease, working for a cleaner environment, or making assistive devices for those in need register high on the list of characteristics for a good job.

What middle school students do not know is that all of these characteristics can be found in STEM jobs and careers. It will be important for STEM Ambassadors to make this point and to ensure that students understand that their perceptions and stereotypes of STEM subjects, professionals, and careers are not valid.

The research also shows that **exposure to a work environment** has a big impact on students’ thinking about jobs. Those who have gone on field trips to see what happens in a court room, a hospital or a technology company show an increased interest in all three. It should be noted that, as students think about careers, they “**add**” professions through grade 6; but start “**subtracting**” professions after that. Early exposure to STEM jobs and careers is therefore critically important to forming their opinions. (5)

Finally, when students think of “good jobs” they want to see a **diversity of ethnic role models** – they want to see people who “look like them.” They often perceive that successful people, in general, are white, male, and middle-aged. This perception is even stronger in STEM careers. Generally, students do not think that women, minorities, or younger workers of any race work in these fields. As such, it is hard for them to relate to these jobs or visualize themselves in one.

SECTION TWO

IMPLEMENTING THE STEMTECH SOLUTION

The Project was extremely lucky to have received the support and assistance of **Arnold Worldwide**, a premier advertising agency based in Boston, to create the campaign. It is equally important to note that, because the challenge was so critical – helping Massachusetts keep its scientific and technological edge – Arnold Worldwide provided its services on a *pro bono* basis. We believe the award-winning result is extremely creative and innovative -- a home run for Arnold, the Project, and students.

Arnold's creative team started the process by saying that the words 'career' and 'STEM' would not be used in the campaign because they are not relevant to middle school students. The campaign was going to be based on the fact that the **biggest barrier to STEM subjects was/is math**. So, they settled on a recognizable 'math' word – DIGITS. In focus groups, when students were asked what they thought of when they heard the word DIGITS, they primarily responded with two answers – *math* and *cell phones*. Both responses indicated that we were on the right path.

Overall, the campaign seeks to address the barriers and misconceptions that middle school students have about both STEM subjects in school and future STEM careers. It also communicates to students the positive outcomes – both personally and professionally – that are achievable through working in STEM fields.

Elements of the DIGITS Campaign

In developing this Campaign, Arnold Worldwide and Project leaders created a number of items that reinforce and enhance the DIGITS message:

- Brand
The DIGITS name suggests math, in a subtle format, and reminds students of cell phones and ways in which they use numbers in their daily lives. The use of the word DIGITS does not in itself generate excitement about STEM careers.
- Logo
The logo, however, brought smiles to the faces of students as they recognized the STEM icons in each letter of the logo. To reinforce the industries collaborating on this project, the logo has letters with icons from participating science and technology sectors:

D	bridges	= engineering
I	cell phones	= telecommunications
G	test tube/beaker	= biotech/medical devices
I	robotics	= software and engineering
T	gears	= engineering
S	video game controller	= software

- Tag Line - **“Figure This. Imagine That”**
This tagline refers again to a math term by using the word “figure” and then starts to subtly suggest that comfort and success in math will allow them to imagine a positive future for themselves.
- Program Descriptor - **“Opening minds to math and science”**
This phrase reinforces the tag line and provides a brief description to students and adults alike on what DIGITS is all about.
- Sticker Sheet of Alphabet and Numbers with STEM icons
One of the most innovative elements of the DIGITS campaign is the development of a creatively designed alphabet (and set of numbers 1-10), in which each letter and number serves as a backdrop for STEM icons from the six industry sectors represented in the project. The alphabet and numbers are presented on a sticker sheet that STEM Ambassadors give to every student in every classroom they visit. Students get to keep their DIGITS sticker sheets and take them home. The icons represent tools used or products developed by STEM professionals in their work. The letters/numbers were created with icons/images that are recognizable to students. We know that middle school students like to own the latest technological gadgets (smart phones, iPods, video games) but they do not understand that they are produced by people who are good in STEM subjects. This alphabet tries to make the connection between STEM subjects and STEM jobs.
- Interactive Names Exercise
The reason the alphabet is so compelling is that it affords each student the opportunity to engage in a personalized DIGITS experience. During the STEM Ambassador classroom visit, each student is asked to peel off the stickers that spell his/her name and put them on the ‘Names’ line at the bottom of the sticker page. Then, the STEM Ambassador engages students in a dialogue about the jobs represented by the icons in their name. By doing this simple, personalized activity, students can begin to ‘imagine’ a career that they can pursue, based on what they see in their own names. This may be the first time that students envision themselves in a STEM career.
- DIGITS Poster
The DIGITS poster has several elements – the complete DIGITS alphabet and set of numbers 1-10, a multi-cultural picture of students engaged in STEM activities, and a set of ‘color bars’ that list six attributes/benefits available in STEM jobs and careers. The attributes are also the same characteristics that research has shown are desired by middle school students in a job/career. The discussion of this poster, led by the STEM Ambassador, makes clear to all the students that the characteristics they want in a job -- travel, teamwork, flexible schedules, good money, creativity, and making the world a better place -- are all available in STEM careers. To reinforce this message, the poster is given to the teacher to display in the classroom.
- Interactive Cluster Card Exercise – An additional activity created for this campaign was based on teacher feedback. Teachers indicated that sixth graders often learn by taking things that are similar and sorting them into groups/clusters. So, the Project created a sorting exercise in the form of a deck of cards. Each DIGITS letter and number was placed on its

own card. STEM Ambassadors give students a random group of cards. Students are asked to sort them into the four categories of STEM jobs represented on the cards:

- Information Technology (Computers, Software and Telecommunications)
- Life Sciences (Biotechnology and Medical Devices)
- Engineering
- Energy

Identifying which icons relate to which category reinforces the students' knowledge of STEM careers.

STEM Ambassadors

While the DIGITS name, brand and set of activities are designed to capture students' attention, the mechanism for delivering the message is a corps of STEM professionals or **STEM Ambassadors**, as they have been named by the Project, who will visit sixth grade classrooms across the state. It is important for students to meet and talk to a scientist, engineer, programmer, etc. to see who these people are and what they do. The STEM Ambassadors, recruited from companies representing all six industry sectors, will have a chance to tell their stories – including who inspired them, what they find interesting/fun/creative about their jobs, and why they like what they do. They will bring to life the DIGITS campaign by injecting their own personalities into it.

They will also deliver the message that is central to the campaign –**if students take math and science in middle school, high school, and beyond, they will have many good career options available to them.**

It is the personal presentations made by STEM Ambassadors that can help students lose their fear of STEM subjects, encourage them to be more open to math and science, and stimulate the ability of students to visualize themselves in STEM jobs and careers. STEM Ambassadors can work to counteract the negative stereotypes associated with STEM professionals, leaving students with the impression that people can be good at STEM and also be engaging, fun and socially 'cool'.

The Project will make a special effort to recruit a diverse corps of STEM Ambassadors. It is critical that students see role models of every gender and ethnic background. With the large number of cultures and languages heard in schools throughout the state, students need to see, in a very concrete way, that STEM careers are possible for them.

In addition, the Project will encourage STEM Ambassadors to build relationships with and stay connected to their school. Reinforcing those relationships and connections will be mutual beneficial. If STEM Ambassadors are interested in staying connected, they should understand what they can offer schools and what schools are interested in. Generally, schools are looking for:

- **Speakers** – a return visit by the STEM Ambassador;
- **Materials and Equipment** – used by STEM Ambassadors in their work that could enhance classroom lessons and/or activities and show students tools and materials(engineering supplies, lab coats, printouts of computer programs, etc.) used in STEM companies;

- **Time and expertise** - to advise Science Clubs and After School Programs, perhaps serving as a judge for student projects at Science Fairs; and
- **Cash** - to help teachers buy subject specific materials and supplies.

Beyond the classroom, schools look for:

- **Company visits and tours** – exposing students to new and different work environments makes a positive impression on students.
- **Job shadow experiences** – following a STEM professional around for a day is an extremely meaningful and concrete way to open the door to STEM fields.
- **Summer internships for students** – engaging in a meaningful work experience is often the turning point for students.
- **Summer externships for teachers** – enhancing the professional development of teachers by having them work in a company environment pays benefits over many years and across many classrooms. Having teachers understand how their subject matter applies in the real world enables them to be enthusiastic and experiential when they return to the classroom.

Best Practices for presenting information on STEM careers to middle school students

Given all this information, the question to be answered now is ... How can individuals who work in STEM careers communicate the variety and excitement of the work they do? How can they overcome the perceptions and misperceptions that middle school students have about STEM fields? **How can they help to increase students' awareness of STEM careers and make a difference in the classroom?**

Both the research conducted and discussions held with students and teachers suggest that STEM visitors to a middle school classroom should keep the following best practices in mind: (3) (6) (9)

Messages:

1. Students want to hear **personal stories**. STEM Ambassadors should therefore talk about how they got into their work, what they do every day, who motivated them to enter a STEM career, and why they like their jobs. They should talk about the kind of normal lives they lead. They should talk about the hobbies, sports, or other avocations they enjoy. The bottom line is that **STEM professionals should help students understand that careers in STEM fields afford people with interesting jobs and interesting things to do outside of their jobs.**
2. Students need to hear that **STEM professionals are not always geniuses**, did not have perfect school records, have tried different careers, have had some successes and failures but have now found work they are truly excited about and good at. **It is very important to mention that students need to take math and science all through school. And, if students experience difficulties with these subjects, they should ask for help. A little extra work can make a big difference.**

3. STEM Ambassadors should **talk about the interesting, fun, or unusual things they do in their STEM jobs** and try to relate what they do to the world of sixth-grade students. If they are working in drug discovery, they can talk about the disease they are looking to cure; if they work in IT, they can talk about developing products and applications that impact the way people live, work and play; if they are engineers, they can talk about designing and building such things as cars, roads, robots and toys.
4. STEM Ambassadors should explain that **STEM jobs pay well**. They should be prepared to answer the question – “How much money do you make?” And, they should talk about how they have nice homes, drive good cars, and generally enjoy a good quality of life.
5. In addition to making good money, STEM Ambassadors should emphasize that there are **other good benefits of working in STEM careers**:
 - a. Travel the world
 - b. Be a part of a team
 - c. Have a flexible schedule
 - d. Use your creativity
 - e. Make the world a better place.

Methodologies:

1. STEM Ambassadors need to **be enthusiastic, energetic, and excited** about the work they do. It is probably the single most important factor in the success of school visits. It is important that students pick up on this energy. It enables them to stay engaged throughout the classroom visit and ‘hear’ the important messages that are being delivered.
2. STEM Ambassadors should **begin their classroom presentations with an interactive exercise** to get students’ attention. Middle school students learn best by “doing” and hands-on activities will get and keep their attention. The DIGITS Campaign has provided STEM Ambassadors with two interactive exercises.
 - The first is the “*Names Exercise*” in which students get to peel off the stickers in their names and see the STEM icons embedded in each letter.
 - The second is the *Cluster Card Activity* and it involves handing out a set of cards (with DIGITS letters or numbers on each card) to students in the classroom and asking them to group the cards by industry sector.

These activities are designed to increase awareness of STEM careers and help students visualize themselves in STEM jobs.

3. When coming into classrooms, STEM Ambassadors should be sure to **bring some of the “tools of the trade”** to let students see and touch these utensils – and to create interest and generate the “wow” factor that middle school students like. Most middle school students like the “icky and gross” factors, so if STEM Ambassadors have anything in those categories to bring in, they will be very well received. Scientists may be able to bring a lab coat and goggles with them; engineers can bring models or measuring equipment; professionals in the software and IT industry might bring in a programmable robot.

4. Middle school students **need to understand why they are learning math and science** and how it relates to the world around them. STEM Ambassadors can use this as a jumping off point. An example would be “You are currently doing fractions – let me tell you how I use fractions in the experiments I am doing.” One school reported that a football player once talked about the quarterback throwing the football to him and how he used the Pythagorean Theorem in estimating where he needed to be to catch the ball.
5. STEM Ambassadors should stress the **broad variety of careers** in their company and field. For example, people who are good artists may very well enjoy careers as web site or video game designers. If students like animals, they might want to work in a laboratory taking care of lab animals.
6. **And they should do all this without using power point! Because power points are not a good way to engage with sixth graders.**

We hope this guide has provided a greater understanding of the issues and approaches to stimulating interest in STEM careers. We believe it provides all the relevant information STEM Ambassadors need before they step into a classroom.

PROPOSED SCRIPT FOR STEM AMBASSADORS

Thank you for agreeing to be a STEM Ambassador and to visit a sixth grade class to tell your own personal career story. During your classroom visit, we are asking that you use the DIGITS materials we have prepared to support the message that STEM careers are **varied, exciting and available to any student who continues to study math and science.**

This Script is divided into 6 sections to cover the critical items that should be presented during your classroom visit. In addition, since a class period is usually between 40 and 50 minutes, the script is annotated to provide you with the recommended amount of time to allocate to each section. We are asking you to use this Script as a guide so that we can achieve our key goal: to have all STEM Ambassadors, no matter which science or technology industry sector they represent, deliver a consistent message to every sixth grade classroom across the state.

In preparation for your visit, we are asking you to bring several things into the classroom:

- First, a tool you use in your work or a product you make in your job that will interest sixth graders. Hopefully, it will showcase how you use science, technology, engineering or math in your work.
- Second, small handouts, if possible, for each student. These can be company pencils, pins or other items your company hands out at various meetings. Students are always excited to get items like these.

When you enter the classroom, please introduce yourself to the teacher and tell him/her that you will need help at several points during the presentation. Please give the teacher the “teacher packet” and have him/her open it. Explain that, for the first interactive **Names** exercise, there are extra alphabet sticker sheets in case students need additional letters. For the second interactive **Sorting** exercise, there are four sheets of paper, each with the name of a category of careers. You will need the teacher to put one sheet of paper in each of the four corners of the room so that students, who will be asked to get up from their seats, can put their cards in the appropriate place. There will also be an “answer sheet” for this second exercise so the teacher will have the right answers.

1. Personal Introduction (3 minutes)

Good morning!

(Give your name and thank them for letting you visit their school. Explain you are excited to meet them.)

A. State the Objective” of the visit. (*Teachers have requested this.*) You have come to their school to:

- Talk about their future
- Talk about the amazing jobs available to students IF they continue to study math and science throughout school.
- Tell how you got interested in math and science

B. Introduce yourself:

- Your job (You are a scientist, engineer, software developer, etc.)
- Your company (Tell what product/service your company produces.)
- What you like about your job. *(Please list some of the fun, interesting, or unusual attributes of your job that you think students could relate to. Please try to relate what you do to the level and experience of sixth graders.)*

Examples of things to talk about:

- I look at sticky substances called “gels” under a microscope and try to find the genes that create cancer, so I can work on finding a cure.
 - I go to work in jeans and sneakers and get to walk around bridges and roads to figure out how to build or fix them – make them stronger and last longer.
 - I travel around the world talking to companies that want to use the software my company develops for smart phones, Blackberries, and iPhones. The last place I visited was China.
 - I work for a company where robots help to assemble our machines that are used in hospitals to check and monitor people’s health.
-
- Show the technology item you brought with you. Ask students if they know what it is? What you do with it? Pass the item around.
 - Explain how long you have worked at current company and whether you have had several different jobs at that same company.
 - Talk about why you love what you do and what aspects you are good at.
 - Explain what you do in your “off time.”

Travel, play in a band, race cars, am a fabulous chef and make a mean chili, go sky diving, etc....(*anything that is interesting and shows you have a fun life*)

2. Introduction of DIGITS (10-15 minutes)

To start, explain that you are there to talk with them about a pathway to a bright future.... tell them that if they take MATH and SCIENCE in middle school, high school, and beyond, that the door will be open to them to get good jobs in the future.

A. Show DIGITS logo and ask

- What does the word DIGITS mean to you?
- What do you see in each letter?
- For each letter, after students identify the icon, you should ask them if they know the name of the STEM professional that makes/uses these icons. If they don't know, please be sure to state the name of the professionals indicated below:
 - D = Build bridges (engineers)
 - I = Make cell phones (telecom professionals)
 - G = Use test tubes (scientists/biologists/chemists)
 - I = Design robots (engineers – mechanical/software)
 - T = Use gears (engineers)
 - S = Make video games (software programmers)
- Ask if any of the students are familiar with the video game – Guitar Hero? (*Almost all students know this video game.*) Ask if they know that the company that makes Guitar Hero – **Harmonix** – is located right here in Massachusetts!
- Ask if they know anyone who is an engineer, scientist, computer person etc? (*Ask students to raise their hands.*)
- Ask students what are the **two** subjects they take in school that are important to all of these jobs? (*Correct answers are **math** and **science**.*)

B. Names Exercise

- Give each student a sticker sheet. (*Ask the teacher to help you.*)
- Explain that every letter of the alphabet and the numbers 1-10 are on the sticker sheet and that they all have pictures associated with each letter or number, that relate to a math or science job.
- Ask students to peel off those letters that spell their FIRST NAME ONLY and put them at the bottom of the page – on the **Names Line**. Also, if they have room they can add their last name or use the numbers to show how old they are.
- If they need extra letters - ask them to negotiate with a classmate or ask the teacher for help. (*You will recall that the teacher has extra sticker sheets and letters in the teacher packet.*)

You and the teacher should walk around the room and look at what they are doing. Expect the students to be a little noisy as they talk to other students about what is in their names.

- When the students are done, engage them in a dialogue about the icons in their names. Select 3-4 students (*one at a time*) and ask them to tell the class (1) what icons are in their names and (2) which icon represents a career they might consider.
- When the time for this exercise is over, you should tell the students to put the stickers down, take them home – they are theirs to keep, but it is time to move on.

3. Telling your Own Personal Story (10-15 minutes)

Students want to hear your personal story.

Please keep the following in mind:

- *These are sixth graders – 11 and 12 years old.*
- *Do not get into the mechanics of your job; in other words – descriptions should not be too detailed.*
- *Focus on the most ‘fun, interesting or unusual’ parts of your job.*

- ***Do not use a power point presentation; it is not a good way to interact with sixth graders.***

The most important things you can do are to:

- ***Be enthusiastic and***
- ***Send a clear message to the students that you enjoy your job and the quality of life it affords you.***

A. Before you tell your own story, remind students that:

- If they **continue to study math and science in middle school, high school, and beyond, they will have many career opportunities open to them** – like the ones represented in their names and on the sticker sheet.
- **If they take higher level math (like Algebra II), research shows they will earn a higher salary over their lifetime than those who don't take it.**

B. Tell your story – your career path; where you started and how you got to where you are now

Suggested points to cover in your presentation:

- School subjects: Your best subjects in school were.....
You were not very good at
- Smart vs. hard worker You were not the smartest kid; but you studied and did your homework.
- Curious You were curious about
- Math, science & algebra: You took them all
- After school activities: You participated in sports, clubs (computer, chess)
- After graduating from high school you went to: Technical school; certificate program; community college; 4-year college; graduate school
- Your Motivators: Teacher, mentor, parent, relative, friend, etc.
- Your first job: You did/didn't like it; succeeded or failed; you tried this and that until you became a _____
- What you like about your work: Talk about something you really like and are good at
- **How you use math or science in your job.....give them a concrete problem to understand how math is used in your work i.e. how many feet are needed to run and cable from A to B; how you measure the strength that a steel girder must have to support a bridge; etc.**

4. DIGITS Poster (4 minutes)

Please take out the DIGITS poster and show it to the students. The purpose of the poster is to show the attributes middle school students say they want in jobs – all of which happen to be available in STEM jobs. Be sure to leave the poster for the teacher at the end of the class.

Take the poster and walk up and down the aisles in the classroom. Near the bottom of the poster is a set of “6 color bars.” Tell the students that these color bars describe benefits of working in jobs based on math and science. Ask 6 different students to read each one of the color bars. After each color bar is read, talk about how that relates to your job or others in your company or in your sector.

If you are uncomfortable or unable to say that all these characteristics relate to your job, then talk personally about the ones that do relate to your job and please generalize and say the other attributes “generally” relate to jobs in these fields.

- TRAVEL - I get to travel within Massachusetts, to other states and countries. I travel for company meetings or meetings with customers. One of my colleagues just got back from China. It took 22 hours to fly back to Boston but she had a great time.
- TEAMWORK – I work in a team. We get together weekly to generate ideas for the project, to talk about what we are working on and how it fits with what others are doing, what the deadlines are and what kind of schedule we need to meet the deadlines. I enjoy doing my own work but I also enjoy being part of a team. I don’t work alone.
- FLEXIBLE SCHEDULE - Sometimes I can work from home. If my child is sick, I can get time off. I can sometimes go to work late and then work late.
- GOOD MONEY - People in my company earn good money. The salaries in companies that are based on math and science are much higher than the salaries for the average job in America today. *(Please be prepared for some student to ask you how much money you make. If you feel comfortable giving them a range, that would be great; if not, generalize that, with experience, people in companies like yours can expect to make between \$50-100,000 a year.)*

- MAKE THE WORLD A BETTER PLACE - People in my company/sector...are making the world a better place because.....we make it easier to communicate, to live a longer and better life, etc.
- CREATIVE - And, finally...I/People in my company/sector ... get to be really CREATIVE in our work– we get to design products, create logos, develop new services that our company can offer.

5. The Cluster Card Activity (10 minutes)

(We hope you have enough time to do this activity; it is good interactive exercise for the students. If you do not have enough time, simply hold up the cards, describe the activity briefly and say you will leave these with the teacher so they can do the activity another day.)

- Ask the teacher to organize students into TEAMS – of 4-5 students each.
- Pass out about 4-6 of the DIGITS cards to each TEAM.
- Tell the students that the cards relate to one of four kinds of job categories. The four groups are:
 - Computers and Telecommunications (software, hardware, cell phones)
 - Life Sciences (biology, chemistry, health care)
 - Engineering
 - Energy and Environment
- Ask them to work with their teammates and decide which cards are similar/relate to the same job category, and sort them into groups.
- While the students are working in their teams, ask the teacher to put each of the four sheets of paper with job categories on them in four different parts of the room.
- After a few minutes, ask the students to get up and put the cards in the appropriate place in the room that the teacher has identified.
- Then, pick up each pile and, working with the students, read each card and check to make sure it is in the appropriate pile. *There is an answer sheet for both the STEM Ambassador and the teacher in the packets.* If there's a mistake, hold the card and place it in the right pile when you get to it. Also, almost all of the cards can be put in the category of engineering, so engineering can be a “right”

answer but we have designed this to have students identify the “primary” job category.

6. Wrap up and Good-by (3 minutes)

In your closing remarks please summarize the basic “leave behind” messages.

The class is just about over and I have really enjoyed spending time with you. I hope you will:

- **Think about what we have discussed** today
 - What are the two most important subjects that you need to take to have many career opportunities? *Let the kids answer – **math and science.***
 - What higher level math subject should you take if you want to earn more money than kids who don’t take that subject? *Let the kids answer – **Algebra II.***
- **I hope you will consider a job** in a science, technology, engineering or math-based company – it is exciting and interesting work!
- **Remember the wonderful benefits** you get if you DO work in this kind of company.
- **Please feel free to show your DIGITS sticker sheet** to your parents, your friends, and your neighbors. Talk to them about the icons in your name and show them the kind of jobs that you could have when you are out of school.
- **I am leaving the poster and cards with your teacher** so I hope you will have the opportunity to use them again.

Thank you again for letting me visit with you. I really enjoyed it!

RESEARCH BIBLIOGRAPHY

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1 Tapping America's Potential: The Education for Innovation Initiative: Business Roundtable, July 2005

2 Massachusetts STEM Talent Overview, John Hodgman, U Mass Lowell, March 2008

Focus Groups:

3 Middle School Teachers

Wood Hill School, Andover MA (6.4.08)

Pollard Middle School, Needham MA (6.11.08)

5 Middle School Students

Boys and Girls Club of South Boston (6.16.08)

4 Dr. Sally Ride, former Astronaut and President *Sally Ride Science*, (3.27.08)

6 Yvonne Spicer, *Boston Museum of Science*, Vice President for Advocacy and Educational Partnerships, for the Museum's National Center for Technological Literacy

7 Thea Sahr, *WGBH*, Associate Director, Educational Outreach.

Marisa Wolsky, *WGBH*, Executive Producer, PBS Design Squad (4.22.08)

8 Dr. David Anderegg, Professor, *Bennington College*, Author Nerds: Who They Are and Why We Need More of Them Presentation before the Massachusetts Goddard Council (7.2.08)

Christine Cunningham, *Boston Museum of Science*, VP for Research and Director of the Museum's 'Engineering is Elementary'

9 Chris Rogers, *Tufts University*, Center for Engineering Education (9.10.08)