Basic Questions about STEM

This document was prepared by Roberta Neuman and John F. Hodgman in 2008 and updated in 2009.

1. What is STEM?

STEM refers to science, technology, engineering and mathematics education and career paths.

2. What does it aim to accomplish?

The Massachusetts STEM talent initiative has three broad objectives:

A. Increase the number of students planning on STEM majors and career paths;
B. Increase the number of qualified[1] STEM teachers; and
C. Improved overall education for all students in math and science as a foundation for STEM studies.

This initiative is based upon the need for Massachusetts to be competitive in the global economy with a highly skilled STEM workforce. STEM skills are required to be a 21st literate person, whether the person decides to be a researcher or a clerk.

3. Does it require a special curriculum as a "stand alone" subject or is it like an octopus and has connections and tendrils into the basic curriculum of the math, science, engineering and technology course of study?

There are the stand alone disciplines: math, sciences, engineering. Technology can be both a discipline and an instructional/learning tool. Reading and writing skills are essential in the STEM academic studies. Writing across the curriculum, as an approach, comes into play here. Technical writing can be offered as an additional value.

Studying careers (and how STEM skills are necessary in every job now and in the future) and the workplace is important as well. Thus, the educational programs should be designed to complement and extend existing curricula and instruction.

STEM is an umbrella for the stand-alone subjects, 21st century skills and

[1] Quality is defined by using the NCLB definition of content as well pedagogical competence and a period of experience such as student teaching or internships.

career guidance.

4. As an individual classroom teacher how can I become part of this initiative?

The classroom teacher has two broad opportunities to participate:

1. to learn about STEM careers and convey to students how what they do in the classroom will help prepare students to enter these fields; and

2. to learn about ways to bring STEM related applications, instruction, immersion and experimentation into their classrooms.

3. to help students understand how STEM learning is necessary to their choice of a profession or occupation. In this area, collaboration with the Guidance Department is suggested.

5. Who would have to be included to make this a systemic program?

In order to accomplish the three objectives mentioned above, it is imperative that the entire school district be involved. There are curriculum, instruction, personnel, facilities and budget issues underlying any efforts to accomplish these objectives. School leaders will need to work with classroom teachers, guidance counselors, parents and employer partners to develop three to five year plans that have quantifiable goals and ways to measure progress.

6. How costly is this program for a school(s) or system to implement?

The program costs are comparable to those that are generally associated with core curriculum and instruction (e.g. teacher time, facilities, equipment and materials). However, they should be addressed by examining how current educational spending could be modified and where marginal additional resources could be secured and applied. The major additional costs at the outset may be in the area of teacher professional development to help them address the opportunities mentioned above.

Capital expenditures may also be required, depending on the condition of the science and technology infrastructure in the schools .

7. Are there area networks that help/work with individuals to provide funding and training?

There are many resources available. The first place to look is the web site for the Massachusetts Department of Higher Education. www.mass.edu, and click

on Pipeline Fund. This site will give you the contact information for your respective regional pre-K to 16 Network, as well as general information about the STEM talent initiative.

Next would be the University of Massachusetts STEM Initiative web site, www.masssachusetts.edu/stem/. This site provides background information about the Initiative, resources and the annual STEM Summits. You are/have beeb on this site so you can explore what is available for your use on ikzadvisors.com.

8. Are some businesses already providing major support and how can we learn about them and replicate their actions?

There are many employers who individually or as collaboratives such as The Mass. Technology Leadership Council, MassMEDIC, MassBioED, The Engineering Center, and the Mass. Networks Communications to identify employer school partnership best practices and provide programs directly to the schools.

This site lists many resources.

9.What advice do you have on how to forge business links with the school and/or teachers and classes that want to participate?

It is always important to identify individuals who can introduce schools to potential employer partners. Parents who work for companies in the community or region are often a good place to start. Community leaders can also be a good source.

Before approaching potential partners, it is important to develop an "inventory" of regional potential employer partners, including both large and small business, health care institutions, colleges and universities. In addition, there needs to be a "menu" of 2 to 4 types of ways schools want their employer partners to help. These should be practical and somewhat modest tactics that employers feel are "doable" in the short term. Knowledge of the particular companies is essential before approaching them.

10. Is this a program that increases the desirability of students who apply to college? Is it an advantage for college admission?

Students who are successful in STEM subjects will have an advantage when applying to higher education programs which explicitly focus on STEM related studies.

If a student needs a stronger foundation in math and science before entering an engineering major, it might be advisable for him/her to start with a community college program and then transfer to a bachelor's degree program.

Since there is a need for more women and minority students to enter computer science and engineering fields with those majors, it may advantageous for these students to prepare for and apply to colleges and universities in these fields.

Guidance programs in schools have a responsibility to make such distinctions and challenges clear to students and help them become prepared with appropriate STEM courses.

11. Are the colleges working to connect their STEM fields/programs with those fields/programs in the high school and vice versa?

Some institutions in both arenas are working together to "seamlessly align " or articulate their programs. The Pipeline Regions (see website in #7 above) have a number of those articulations.

12. Is this a federal or state initiative and, if federal, how are the links made among the different states?

This is a Commonwealth of Massachusetts initiative. However, there are federal and many state efforts to address this issue. A major element of the Massachusetts initiative is to leverage these federal programs, such as those funded by the National Science Foundation. Check this website for the plans of several states which are Engaged in STEM initiatives.

Recently the Lieutenant Governor, Tim Murray, has announced he is commissioning a high level advisory council about STEM. For more information check out http://www.timmurray.org/.

13. Are there any connections that apply to the standard AP classes in math and science?

AP classes can be considered disciplines as explained in question 3. They contain many challenging learning opportunities for students who want and are able to move ahead and more deeply. There are some studies that indicate that AP course and test experience help students become more successful in college studies. To the degree these courses help strengthen students' preparation for STEM college majors, they might help with both

admission and retention at the college level.

14. Does this program address or even enhance the introduction of minority students into the scientific professions. specific emphasis on women, African Americans and Latinos ?

As mentioned above, there is a need for more women and minority students to prepare for and enter STEM fields. This is driven by

A. Equity
B. Demographic factors
C. The value added to the education of all students when they learn within a diverse community
D. The development of the high quality workforce

Since our general high school graduating population is projected to begin to decline in 2010, we will need to attract to STEM every young person who is able and motivated.

Specific strategies to increase awareness and interest in STEM among these students need to be incorporated in school district plans.

There are many best practice programs that can be used as models.

This reason has to do with our future economic wellbeing and our global competitiveness. One of the PK-16 central purposes is to prepare students for citizenship and careers; today that preparation must take into account the growing diversity of people and cultures that comprise our global society.

The significant demographic change is that more than 80% of the new entrants to our labor force are women or minorities. Hispanic and Asian populations are increasing 10 times faster than the white population. The African American population is growing more than 5 times faster than the white population. Diversity in the American workplace won't be a goal, it will be a reality.

Our challenge is not just to prepare enough women and minority students in this new environment. The challenge is to prepare students from all races and backgrounds to work effectively in more diverse workplace.

15. On the practical level, what does this look like in grades 3 to 8, 9 to 12 and 13 to 14?

At grades 3 through 6, it means teaching science in a hands-on manner, either by classroom teachers who have been trained in science or by specialists who teach those classes while the classroom teachers watch and learn. The same applies to engineering since the two are closely aligned at that level. It also means providing ubiquitous access to technology for both students and teachers. (This latter is the case 3-12). It means also supporting with the appropriate amount of attention, girls and minority students, whose attention and interest we need to capture at that time or it becomes too late later.

At middle school, it means that every student should take math and science, again, with a hands-on approach. In middle school having teachers integrate the STEM suggest in an occasional but regular manner is very helpful.

At the high school, it means increasing the STEM requirements for graduation, ensuring that every student has four years or math and science (perhaps physics first), and has the opportunity to take engineering courses.

In community college, it means meeting the requirements for a certificate or associate's degree in one of the STEM subject areas and if it is possible participating in ITAC (Information Technology Across the Curriculum). This approach gives students technology skills for any discipline or study.

16. Why do we need a coordinated statewide plan?

21st century skilled employees start in elementary school. Everyday you read or hear about the need for STEM trained workers—from researchers to clerks—to maintain the health of the MA economy… For six years there has been a concerted effort to improve STEM education from elementary to graduate school through a variety of approaches and supports, most of them independent of each other:

- **Legislation: the Pipeline Fund (Economic Stimulus) CITI, BATEC, CAITE**
- **Vendors and their associations: MassBioTeach**
- **Individual school districts: Brookline HS and Andover MS engineering programs**
- **Institutions: Museum of Science**

- **Universities: UMass, Tufts, Northeastern, BU, WPI, etc.**

All this effort and attention, especially in Middle School where a number of recent legislative grants were focused, are beginning to pay off, although the big picture is still falling short compared to 1999. As a result of the plan there will be a common and accepted direction for all of us: a goal, specific strategies and outcomes and appropriate roles indicated for all of the stakeholders, private and public.

We still have a long way to go but we have made a good start. Many people have contributed and will want to continue to do so by working with every other interested party