World Class. Within Reach
Statement: Results and Future Mission

Kaput Center for Research & Innovation in STEM Education

Department of Science, Technology, Engineering and Mathematics (STEM)

Endorsed by:
Lt. Governor Tim Murray
Representative Pat Haddad, Fifth Bristol
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Tuesday, December 1, 2009
Focus: What is STEM Education?

The State of the Nation & Massachusetts

Impact of the Kaput Center

Our Leadership in the Future
What is STEM Education?

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Our Leadership in the Future
There is a general consensus that Mathematics and Science is critical in the education of our children today yet ...

why do we say mathematics is hard and it’s ok not to be good at math?
International Comparisons

Changes in TIMMS science scores for 4th graders from 1995 to 2007

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The 2007 TIMSS results showed that U.S. students' average science score was 539 for 4th-graders and 520 for 8th-graders.

Both scores were above the TIMSS scale average, which is set at 500 for every administration of TIMSS at both grades,

but neither was measurably different than the respective U.S. score in 1995.
Educating our children means educating ALL our children ...
4th Grade Achievement Gap between White students and Black students

In 2007, Massachusetts narrowed the gap between students - gains by 4th grade Black students outpaced those of White students.

8th Grade Achievement Gap between White students and Black students

In 2007, the achievement gap between 8th grade White and Black students was the largest it has been in 15 years.

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Self-efficacy is one of the strongest predictors of student mathematics performance.

In most countries there is also a clear tendency for students in lower performing schools to have less confidence in their abilities to overcome difficulties.


We need to focus on integrating learning and motivation.
National Center for Women & Information Technology. (2009). *By the Numbers.*
Retrieved June 22, 2009
American students are not sufficiently engaged in science and engineering study to replace those who will retire.

The decline in graduates increasingly is felt in industry and government.
The situation is a "perfect storm" of converging trends threatening the American innovation enterprise

- Shirley Ann Jackson, president of Rensselaer Polytechnic Institute
What are the big issues in mathematics and science education?
At the end of the 19th century, barely 3% of the 18-year-old cohort was expected to graduate from high school, so less than 2% were expected to take some form of algebra.

Source: NCES, 1994

100 years later it is necessary for all children to learn algebra in order to graduate from high school.
Result .... abrupt introduction of algebra in high school in superficial ways resulting in high student failure and dropout
Why can we not do algebra sooner ... like, in the elementary grades ...?
Big Issue #2

Motivation and Alienation
problem of student motivation and alienation in the nation’s high schools, especially urban high schools

Source: NRC, 2003

so far the answer is: to incentivize students that math and science is important in life ... well it does not work
Big Issue #3

Unfulfilled Role of Technology
what are we using technology for in our schools?

Source: Cuban, 2001
Exhibit ES-1. Percentage of Students With Access to Computers for Mathematics Instruction in 2004–05

Most 4th and 8th graders have access to computers

Exhibit ES-3. Percentage of Students Whose Teachers Used Computers in Mathematics Instruction at Least Once a Week in 2004–05

When they have frequent access they use computers for simple not conceptual tasks.
Teachers are propping up their old teaching styles with new technology.

Technology is not just a tool but a partner to transform our classroom, to change the way we communicate, and to change the way we interact.
19th century curriculum
20th century methodologies
by the way we are in the ...

21st century
Big Issue #4

How effective are our STEM Initiatives?
On February 15, 2008, the Board of Higher Education announced $3.2 million in three-year grants through the STEM Pipeline Fund.
Andover Public Schools, with partners Brookline Public Schools, Worcester Public Schools, and Northeastern University, will collaborate and expand upon existing engineering curriculum to further implement and integrate the curriculum across districts and grade levels. Students will have access to visits to employers through partners Wyeth and Philips Healthcare.

Boston University, with partners Northeastern University and Wheelock College, receives funding for the for inquiry-based learning opportunities for elementary and middle school teachers from seven area school districts. The professional development will be focused around the theme of Green Energy. Teachers and students will also take part in visits to colleges and employers.

CONNECT, with partners University of Massachusetts Dartmouth and Fall River Public Schools, will hold two week-long summer camps on sustainability and biotechnology with an emphasis on inquiry-based learning.

Framingham State College, with partners the Greater Framingham Community Church, Metro South/West Regional Employment Board, and Olin College, will continue to scale up the LIFT program, to give regional teachers externship opportunities at local STEM companies, and will develop the Saturday STEM Academy. Based on the MIT SEED Academy, the Saturday STEM Academy will bring students and parents to the campuses of Olin College and Framingham State College for hands-on STEM projects, college awareness, and college role models. In addition, the students will tour regional industry locations.

Massachusetts College of Liberal Arts, with partners Berkshire Community College, Williams College and regional school districts will produce a series of STEM career awareness and professional development activities including an after-school family STEM program, visits to colleges and employers, and the continuation of the Starlab professional development program. Several of the programs will become STEM Destinations as part of the Berkshire Compact’s Berkshire Passport program, available to students in Berkshire County beginning in third grade.

Massachusetts Technology Leadership Council, with four other industry associations: MassMEDIC, MassBioEd, The Engineering Center, and the Massachusetts Networks Communications Council, will develop a statewide STEM awareness campaign, a STEM Ambassadors program, and a guidebook for how business and school districts can most effectively work with each other. The collaborative will also sponsor a research report on student motivation.

Northern Essex Community College, with partners Lawrence Boys and Girls Club, Merrimack Valley Workforce Investment Board, Middlesex Community College, Museum of Science, and school districts Billerica, Chelmsford, Methuen, and Reading, receives funding to implement the Engineering is Elementary curriculum in four school districts and to support the Viva Latinas program for young women to learn about computing technology.

University of Massachusetts Amherst, with partners Greenfield Community College and Smith College, receives funding to continue the STEMRAYS program, an after-school science program for districts in Franklin County and currently funded through NSF. The after-school programs connect teachers and students in grades 4 through 8 to topics such as weather and climate, air quality, and sustainable energy. Through the Franklin/Hampshire Regional Employment Board, participating teachers will have access to externships at regional employers; participating students will have access to career awareness activities.

University of Massachusetts Lowell, with regional school district partners, will expand its existing after-school DESIGNLAB program for middle school students and teachers. The DESIGNLAB program seeks to teach mathematics and science concepts using inquiry-based learning and to increase the interest in STEM subjects.

University of Massachusetts Medical School, with partners Colleges of the Worcester Consortium, EcoTarium, Fitchburg State College, Mount Wachusett Community College, Quinsigamond Community College, Worcester Polytechnic Institute, and school districts in Fitchburg, Lunenburg, Worcester and elsewhere will develop a communications plan to increase the awareness of STEM careers and career pathways among middle school students, parents, teachers, and guidance counselors in Central Massachusetts. Students will have access to role models and career mentors and will participate in the development of student-friendly messages about STEM.
do we know the impact of these projects?
What is STEM Education?

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Impact of the Kaput Center

Our Leadership in the Future
Mission

provide a focus and support for sustained investigation of foundational issues in the field of STEM education ....

a place where fundamental problems in STEM education will be studied, discussed and analyzed ...
Transforming communication and expression with wireless connectivity

Early Algebra

Proof & Reasoning
K-16

New curriculum

Scale-up across Texas

Touching, feeling, seeing math & science ideas through new technology

Educational Technology

Randomized trials in SE Massachusetts

Transforming practice across districts

International studies

Massachusetts Department of Elementary & Secondary Education
$16.5m in external R&D funds since 1993

$6.5m in the past 4 years

This investment has begun to yield a significant impact on education
Early Algebra

New research in elementary classrooms shows that children from diverse academic and socioeconomic backgrounds can develop powerful ways of thinking algebraically.
The Early Algebra Project has led efforts to transform research into practical tools teachers can use to build algebra-rich classrooms in the elementary grades.
The Early Algebra project is beginning a new phase of research that focuses on documenting the benefits of algebra in the elementary grades on students’ success in algebra in later grades.
SimCalc MathWorlds® is used by over 15,000 students in 12 countries. Integrates dynamic visualization with wireless connectivity to transform communication in the classroom.
Large scale randomized trials conducted in Texas showed that SimCalc can impact students of varying achievement levels and background.

It can close the gap.
Changes in modes of expression
Gesture, Talk, Action ...
New levels of engagement

Studies in MA showed that SimCalc can impact motivation as well as learning through participation INSIDE the classroom.
Haptics

Recently funded by NSF

working in partnership with KCP Technologies, creators of Geometer's Sketchpad®

Allowing young children to touch and feel math and science

Making connections with undergraduate math & science
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Our Leadership in the Future
Partnerships with School Districts
Integrating mathematics, science and engineering through innovative new technology
Partnerships with International Institutions

- International exchange of graduate students
- Visiting faculty
- Sharing/Collaborating on cutting-edge R&D
- Global perspectives on research, innovation and implementation at scale
- Delivering a Local to Global education

Tuesday, December 1, 2009
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PhD in Mathematics Education

Nurturing independent, innovative, & creative thinkers to attend to the challenges and issues we still face

New approaches to Teacher Quality Education
Research-informed programs

Tuesday, December 1, 2009
How do you see us in your future

We are STEM for MA

Research-informed education

Forward looking

Center of Innovation - new ideas begin here

International network of educators, research and business