Increasing STEM Engagement & Knowledge Among K-8 Students

Effective Practices & Artifacts from the Massachusetts STEM ELT Network

EMPOWER schools

PROJECT OVERVIEW

In 2016-2017, through the **STEM Expanded Learning Time (ELT) Network**, eight Massachusetts schools increased STEM engagement and knowledge among K-8 students. The purpose of this brief is to share effective practices, key learnings and artifacts that emerged from the project. Although these learnings have special relevance for expanded time schools, there is much here for all K-8 schools to discover, regardless of their daily schedule.

Project Background, Goals and Design

The STEM ELT Network was facilitated by Empower Schools with generous support from Overdeck Family Foundation. Each school received a grant of $12,000 to support new STEM programs and teacher professional development and collaboration. A team of STEM educators from each school participated in quarterly network meetings, site visits and additional STEM-focused conferences and events; while Empower Schools also provided technical assistance and school-based coaching.

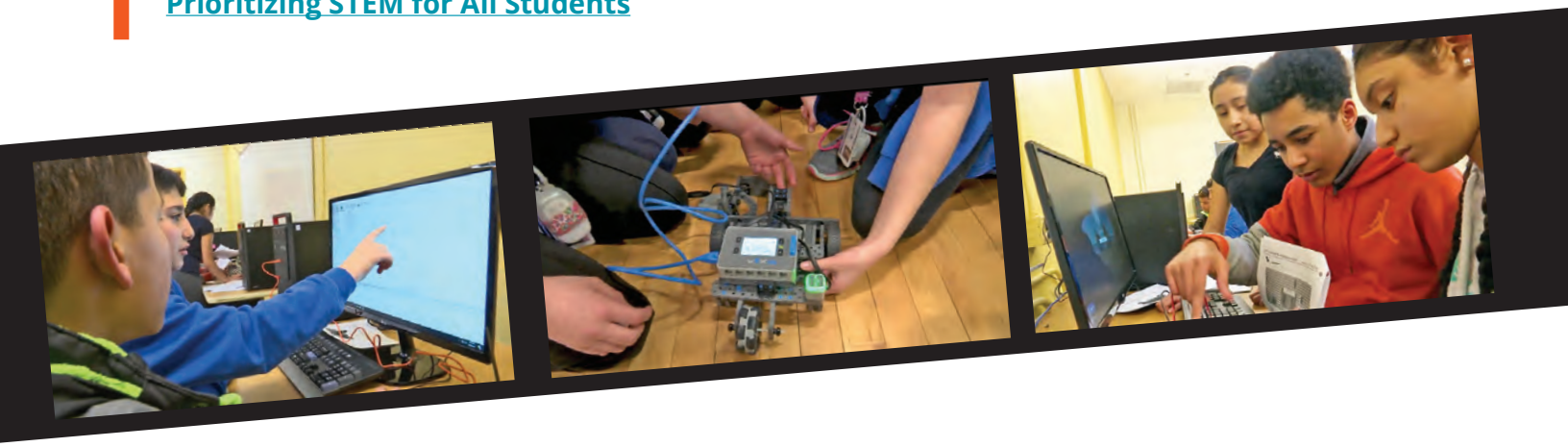
The goal of the network was to catalyze exemplar approaches toward innovation and excellence in STEM education, aligned to new state science standards. Key objectives included:

- Increasing **high quality STEM enrichment and instruction** for all students.
- Prioritizing **project-based, hands-on engineering design experiences** to develop students' 21st century skills.
- Promoting **educator leadership, professional development and collaborative planning**.
- Providing students who demonstrate a high-interest in STEM with **pathways to pursue advanced opportunities** for learning and engagement in STEM fields.
- Creating a **dynamic network of educators and school leaders** to share effective practices through meetings and immersive site visits.
- Developing a **quality diagnostic** designed for school teams to quantify and track their progress in seven key areas: learning setting, curriculum/content, student engagement, pathways for student learning, professional capacity and learning, community engagement and continuous improvement.

Lessons Learned

Key lessons learned are captured in the **STEM Focused Schools Video Series**, three videos that each delve into a key aspect of STEM teaching, learning and engagement:

1 Prioritizing STEM for All Students



2 Building Student Engagement and 21st Century Skills through STEM

3 Fostering Excellence in STEM Instruction

STEM FOCUSED SCHOOLS: Prioritizing STEM for all Students

1. Committed Leadership

KEY INSIGHT: School leaders must be committed to STEM as a top priority. When principals leverage the resources they have at hand – influence, time, human capital and financial support – they can drive the transformation of STEM teaching and learning. Fostering teacher leadership is perhaps the highest impact leverage point for principals interested in fostering excellence in STEM instruction.

Mary Beth O'Brien, principal of Gilmore Elementary in Brockton, explained, "in order to make STEM a priority for all of our students, first and foremost we made sure all of our teachers were on board."[1]

> **"In order to make STEM a priority for all of our students, first and foremost we made sure all of our teachers were on board."**
>
> — Mary Beth O'Brien, Principal
> Gilmore Elementary, Brockton

SPOTLIGHT

SILVIA ELEMENTARY SCHOOL, FALL RIVER

In the fall of 2016, principal Jean Facchiano spearheaded an effort to ensure that every child pre-K through 5th grade at Silvia would be engaged in engineering design through the Engineering is Elementary program. Teachers participated in professional development and were required to spend a minimum of nine hours per trimester on engineering design with their students.

In addition, Facchiano led her teachers to explore interdisciplinary connections to STEM throughout the curriculum. For example, the physical education teacher worked with grade-level classroom teachers to develop a PE unit requiring students to create and perform dance moves representing the functions of simple machines.

Said Facchiano: "I want kids to know what the engineering design process is, and I want them to know it like they know addition and subtraction, and that anybody can be an engineer...I think that's a message for elementary kids because they don't really know what engineers do, and how many different types of engineers there are, so we want to expose them to that so that when they get to middle school and high school, they have a sense of a direction.

"We have done engineering for a long time but we were not consistent. Now we are. Now we have the scheduling strategy, the kits and the supplies, and the dedicated professional development time to make it work."

2. Time for STEM

National trend data show a decline in instructional time in the elementary grades on science instruction over the past two decades; research confirms a positive relationship between the amount of class time and student achievement scores in science. The 2012 NAEP report found only 20% of grades K–3 classes and 35% of grades 4–6 classes receiving science instruction all or most days, every week of the school year. Many elementary classes receive science instruction only a few days a week or during some weeks of the year.[2]

KEY INSIGHT: Increased time on science for elementary students is critical and must be accompanied by more time for teachers to improve their practice through effective professional development and collaborative planning. Elementary school leaders in the STEM ELT Network leveraged their schedules in creative ways to identify more time for STEM, including:

- providing flexibility for teachers to decide when to deliver STEM instruction while meeting an overall requirement of hours over a trimester;
- departmentalizing upper elementary grades to give teachers flexibility in teaching science and social studies units;
- inserting STEM enrichment blocks in the schedule to ensure teachers have the time to extend core STEM concepts in engaging ways;
- creating electives that can be taught by partner and support staff to free teachers for professional learning and collaboration.

The STEM ELT Network schools serving grades 6-8 build on their core academic science and math curricula by offering engineering design and other STEM-focused electives designed to deepen students' STEM engagement and competencies.

SPOTLIGHT

MORTON SCHOOL, GRADES 6-8 FALL RIVER

In addition to their core math and science classes, all students at the Morton School choose a technology "gateway":

- Technology, media and fine arts
- Technology, engineering and design
- Technology, science and social service
- Technology, business and finance

Students enroll in a set of STEM enrichment courses tailored to their gateway, and further connected to after-school and summer programs, and mini-enrichment camps during February and April breaks. The gateway strategy enables students to build mastery of STEM practices and content over time by engaging in learning experiences over time and across settings.

"It's good that all of us have STEM. It's really fun. We are making something we care about."

— Marcus, 8th grader, Morton Middle School, Fall River

3. Curriculum Alignment and Integration

KEY INSIGHT: Schools in the STEM ELT Network are increasingly planning and teaching with an interdisciplinary lens – noticing and drawing out connections across subjects, and integrating content across subject areas. This strategy, especially at the elementary level, counters the lack of time on science.

SPOTLIGHTS

- Fifth grade teachers at A.C. Whelan Elementary School in Revere have extended the core story of an **Engineering is Elementary unit** connected to Nepal to engage their students in additional reading, writing and other activities across the curricula. Extending the curricula builds the students' background knowledge and increases their engagement.

- Third grade teachers at Silvia Elementary School in Fall River are identifying both fiction and non-fiction texts that support and extend STEM projects. For example, they connected a class reading of *Charlotte's Web* to a science unit on life cycles.
- STEM teachers at Collins Middle School in Salem integrate reading, writing and mathematics strategies to build students' skills in their **Project Lead The Way** classes. For example, guiding students to 'chunk' a non-fiction text, convert measurements, and gather, organize and present evidence.

4. External Partnerships

KEY INSIGHT: External organizations – STEM cultural institutions, community-based non-profits, institutions of higher education or STEM-focused businesses – have tremendous potential to engage students in STEM, increase their knowledge and competency and help them understand the possibilities in their future.

Partnerships require time, frequent communication, resources, a flexible mindset and support from school and partner leadership. The partnerships established by schools in the network reflect effective practices that have been identified by practitioners and researchers in recent years.[3]

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SPOTLIGHT

GILMORE SCHOOL, BROCKTON, MA

Gilmore School in Brockton manages a diverse array of partnerships to enrich students' STEM experiences, including Science from Scientists and a multi-faceted partnership with nearby Bridgewater State University (BSU) that includes:

- **Scientists of the Month**, where BSU faculty extend the Gilmore School third grade science curriculum each month with hands-on dynamic lessons.
- A **STEM-focused summer program** for Gilmore fourth and fifth graders run jointly by BSU and Gilmore faculty that provides a pathway to advanced STEM for interested students who wish to continue after elementary school.
- The **Gilmore Inventors Club**, led by BSU faculty working with about 15 children who are developing a passion for invention.
- Current **BSU science majors** who are Brockton High alumni assist Gilmore science teachers and receive partial tuition reimbursement, with the goal to spark interest in teaching STEM.

5. Family Engagement

KEY INSIGHT: Effective family engagement immerses families in hands-on learning experiences alongside their children. Teachers in the network schools report that their students are excited to share their engineering design skills and knowledge at home, and that they have seen a boost in their students' confidence and engagement in school.

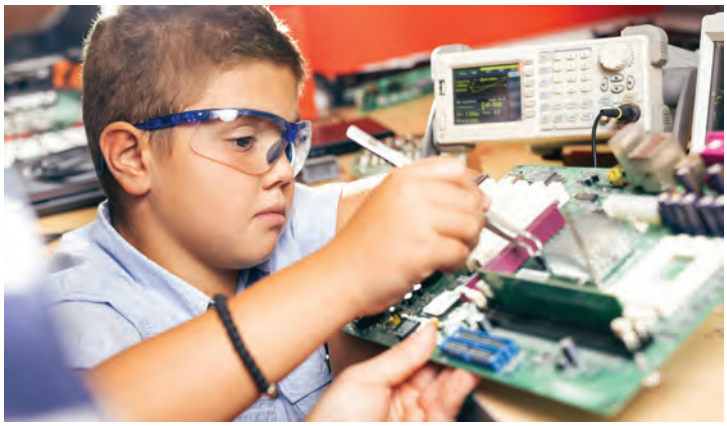
SPOTLIGHTS

- Parents of Silvia School kindergartners problem-solve along with their children as they engage in the engineering design process to construct and test a bridge out of everyday classroom materials.

- In communities where students and families choose which schools to enroll their children, a STEM focus can provide a school with a competitive edge and contribute to increases in student enrollment, as experienced by Collins Middle School in Salem.

STEM FOCUSED SCHOOLS: Building Student Engagement and 21st Century Skills Through STEM

Prioritizing STEM by providing all students opportunities to participate in project-based engineering design results in increased student engagement and improved 21st century skills, including: problem-solving, collaboration, the capacity to learn from mistakes, and the ability to become self-directed learners. Engaging in real-world connected engineering design projects enables students to build their identities as future STEM professionals, and exposes them to STEM career choices.



KEY INSIGHT: Through **Engineering Is Elementary**, **Project Lead The Way**, and teacher-developed units, STEM ELT Network schools immersed their students in engineering design experiences that built key skills around problem-solving, teamwork, persistence and self-directed learning. However, teachers found that they could not teach the Engineering is Elementary or PLTW materials right 'off the shelf' because their students did not yet have the exposure and background knowledge to fully engage with the content and skills presented in the lessons. To ensure that their students could successfully engage with the material, teachers supplemented the kits and units with lessons they developed themselves geared toward building students' background knowledge and vocabulary.

SPOTLIGHTS

Teachers in STEM ELT Network schools spoke about the transformation students experience when they engage in problem-solving using the engineering design process.

"We need to have the patience to let them struggle and fail repeatedly. We are working on not being so quick to give them the answers. When kids first experience the classroom this way, they struggle. Most kids fail repeatedly and they have a lot of trouble with it. We teach about the growth mindset and the importance of perseverance. We remind them that scientists fail every day."

— Michael Pacheco, 4th/5th Grade Teacher
Silvia Elementary School, Fall River

"It's not necessarily the highest flyers academically that shine in engineering. Other kids who are visual and spatial learners often get it very quickly and comprehensively. English language learners can perform very well and become classroom leaders. Engineering activities are perfect for showcasing and teaching the growth mindset. Students see that when you go through the engineering design process, they get better at it."

— Briana Tsoupas, Teacher, A.C. Whelan Elementary School, Revere

Pathways to STEM Engagement and Advancement

KEY INSIGHT: Science of learning research tells us that learning results from a confluence of experiences over time and across settings. Students need diverse STEM learning opportunities – some duplicative, some independent, some sequential – to find that spark that will fuel their passion to continue to engage in STEM.[4] Schools in the STEM ELT network are designing multiple experiences and pathways for students to discover their interests in STEM.

SPOTLIGHTS

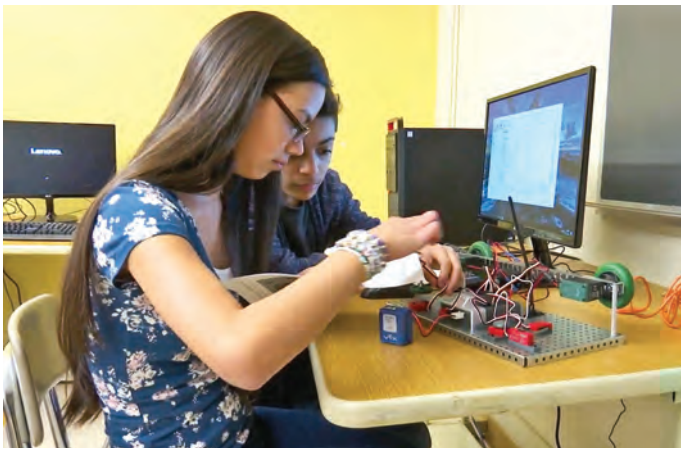
- At Collins Middle School in Salem, all students take two **Project Lead The Way** courses each year from 6-8th grade. The courses are carefully sequenced to build interest, knowledge and skills.[5]
- In 2015, Collins Middle School secured a grant from the **Massachusetts Life Sciences Center** and the Center for the Advancement of Science in Space (CASIS) to support students working on a joint experiment with another middle school focused on tadpole morphology and developmental abnormalities in frogs. Said one 8th grader on the project team: "My family is impressed and proud. They said, 'can middle school kids really do that?' and I said 'We *are* doing it!'"

> **"My family is impressed and proud. They said, 'can middle school kids really do that?' and I said 'We *are* doing it!'"**
>
> — 8th grader, Collins Middle School, Salem

- Several ELT schools are partnering vertically within their districts – for example, elementary to middle, and middle to high, to ensure that as students transition, STEM opportunities connect, expand and deepen. Schools are creating new enrichment activities, and ensuring that students who are highly interested in STEM and their families understand the academic pathways needed to qualify and succeed in post-secondary STEM. As an example, Morton Middle School in Fall River partnered with their high school to pilot an eighth/ ninth grade engineering course at the high school.
- Fourth and fifth graders at Gilmore Elementary School in Brockton are invited to a **two-week STEM summer program** at nearby Bridgewater State University co-taught by BSU professors and Gilmore teachers. Students who complete the program in elementary school transition to the Bridge Partnership Program which provides additional STEM opportunities through middle and high school.

STEM FOCUSED SCHOOLS: Fostering Excellence in STEM Instruction

According to a report of the 2012 National Survey of Science and Mathematics Education, only "39 percent [of elementary school teachers] feel very well prepared to teach science. While higher percentages of secondary school teachers are prepared in content, only about four in ten middle and high school teachers feel well-prepared to encourage low-income students to engage in STEM.Engineering stands out as the area where elementary teachers feel least prepared, with only four percent indicating they are very well prepared to teach it at their grade level, and 73% noting that they are not adequately prepared."[6]



Key insight: Supporting teacher capacity and teacher voice is fundamental to achieving excellence in STEM instruction. The STEM network schools invested in professional development, scheduled consistent common planning time, fostered teacher leadership opportunities and helped teachers leverage resources and supplies for their classrooms.

SPOTLIGHTS

- Collins Middle School in Salem prioritizes common planning time to enable teachers to work together, build off each other's ideas and problem solve as a group. They rotate roles at the planning meetings to share ownership of the work and foster teacher leadership.
- Gilmore Elementary School in Brockton focuses professional development on student discourse, providing teachers with insight into how probing questions, sentence stems and encouragement of peer-to-peer conversation among students can result in students taking greater ownership over their learning across subjects.
- Gilmore classroom teacher Allison Colarusso has also taken on the role of the school's STEM Facilitator. She led her colleagues to develop a **website** that organizes the school's science curriculum. Said Colarusso: "Now we have all our science materials in one spot to allow us to see what we are teaching each year and plan how we can build off the previous year's curriculum. Organizing the information led us to focus as a school on one science strand at a time, so we can pool our resources. We map out units. What specific standards do we want to teach first within this unit? How can we build upon what our students already know?"

"Now we have all our science materials in one spot to allow us to see what we are teaching each year and plan how we can build off the previous year's curriculum."

— Allison Colarusso, teacher and STEM Facilitator, Gilmore Elementary, Brockton

About the Massachusetts STEM ELT Network Schools

School	District	Enrollment	Grades	First Language Not English	English Language Learner	Students with Disabilities	High Needs	Economically Disadvantaged
Bruce	Lawrence	514	3-8	77.6%	31.3%	17.9%	87.5%	68.9%
Collins	Salem	545	6-8	24%	8.3%	21.3%	59.3%	47.3%
Kuss	Fall River	770	6-8	16.5%	5.2%	19.9%	64.9%	59.4%
Morton	Fall River	662	6-8	16.1%	5.5%	22.7%	71.5%	62.9%
Gilmore (formerly Huntington)	Brockton	552	K-5	50.4%	35%	7.1%	80.4%	63.2%
Silvia (North End)	Fall River	763	PK-5	12.6%	6.3%	21%	65.5%	56.7%
Viveiros	Fall River	725	K-5	16.7%	10.1%	17.2%	81.8%	76.4%
Whelan	Revere	730	K-5	47.4%	20.3%	15.5%	61.%	41.5%

Additional Resources

Project Artifacts

Quality Diagnostic for STEM Education

Gilmore STEAM: Imagine, Invent, Inspire

Curricula, Materials and Partnerships

Engineering is Elementary

Project Lead the Way

Science from Scientists

Massachusetts STEM ELT Network Schools

Alexander B. Bruce School, Lawrence

Francis X. Collins Middle School, Salem

Gilmore Elementary School, Brockton (formerly Huntington School)

Matthew J. Kuss Middle School, Fall River

James Madison Morton Middle School, Fall River

Frank M. Silvia Elementary School, Fall River

Carlton M. Viveiros Elementary School, Fall River

A.C. Whelan Elementary School, Revere

For More Information

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Endnotes

1. The Gilmore Elementary School in Brockton is formerly the Huntington School and is referred to as the Huntington School in the STEM ELT Network videos.

2. Blank, R.K. 2012. *What Is the Impact of Decline in Science Instructional Time in Elementary School? Time for Elementary Instruction Has Declined, and Less Time for Science Is Correlated with Lower Scores on NAEP.* Retrieved from **http://www.csss-science.org/downloads/NAEPElemScienceData.pdf**. October 2017.

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3. Bevan, B. et al. (2010.) *Making science matter: Collaborations between informal science education organizations and schools.* A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education. Retrieved from **http://www.informalscience.org/making-science-matter-collaborations-between-informal-science-education-organizations-and-schools** October 2017.

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4. Banks, J. A., Au, K. H., Ball, A. F., Bell, P. Gordon, E. W., Gutiérrez, K. D., et al. (2007). *Learning in and out of school in diverse environments.* Seattle, WA: The Life Center and the Center for Multicultural Education, University of Washington. Retrieved from: **https://education.uw.edu/cme/LIFE** October 2017.

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Friedman, A. (2013, Sept. 9) *Learning: A holistic view.* Education Week. Retrieved from: **http://www.edweek.org/ ew/articles/2013/09/11/03friedman_ep.h33.html** October 2017.

5. The PLTW course sequence at Collins Middle School is:
Sixth Grade: Design and Modeling
Seventh Grade: Robotics and Automation
Eighth Grade: Computer Science

6. Banilower, et al. (2013).

Overdeck Family Foundation

Thank you to Overdeck Family Foundation for their generous support of the Massachusetts STEM ELT Network.