INTRODUCTION

In 2007, with seed funding from the Noyce Foundation, TASC (The After-School Corporation) launched Frontiers in Urban Science Exploration (FUSE), a two-part strategy designed to create conditions for STEM learning and to boost capacity of science educators. In 2010, Every Hour Counts joined with TASC to expand FUSE nationally. Building on the successes of FUSE and responding to 1) the creation of the Next Generation Science Standards (NGSS), and 2) the increasing recognition of social and emotional learning (SEL), TASC and Every Hour Counts have now developed FUSE: Next Generation, a new instructional approach to science learning to be piloted in Boston, Providence and New York. In order to strengthen the FUSE core strategy, TASC and Every Hour Counts engaged the consulting firm ORGE Innovation to facilitate a design process. A diverse group of thought leaders in science education joined in an engaging, day-long design workshop. This brief is the end product of that design process, intended to help the three FUSE: Next Generation cities integrate NGSS principles with social and emotional learning skills to engage students in meaningful, project-based STEM education.

This brief presents a strategy to create real-world science learning experiences that integrate NGSS and SEL principles. This is a complex challenge with objectives that cannot be achieved without a system-wide view and a holistic approach. Leveraging external experts, community integration and project-based learning, the model builds flexible science programs in both formal and informal settings. The model uses cross-cutting concepts, activities to build social and emotional competencies, science rich environments and diverse bodies of educators in an effort to positively impact student outcomes. The Next Generation strategy addresses the material and tangible resources and support elements that promote the principles of NGSS and SEL than solely the principles that define them. To build successful learning experiences, the model endeavors to marry auxiliary support systems—like technology, public support systems, youth development opportunities, assessment tools and policy implementation—into a cohesive unit.

FUSE: Next Generation seeks to:

1. Build the capacity of community educators and teachers to deliver rigorous and engaging instruction aligned to the Next Generation Science Standards;
2. Demonstrate that explicit and integrated instructional focus on the development of social and emotional skills will improve competency as defined by the NGSS; and
3. Establish city, district, community and national support for school-community partnerships as a necessary ingredient in science education.

To set the stage, we first draw from the NGSS and the Collaborative for Academic, Social, and Emotional Learning (CASEL), the leading organization in SEL, for definitions of the fields; see page 3 for more. Then, we examine the current landscape of STEM learning and SEL development as facilitated by formal and informal educators (see page 7). From there, the FUSE: Next Generation strategy takes shape, leveraging local partnerships, leadership supports, and domain-specific and professional development experts to create a student-centered model of experiential learning, community engagement and field experience (see page 10). We offer through this brief a vision of science learning that integrates NGSS and SEL and facilitates collaborative planning and strategic implementation. As sketched during the design workshop, we describe moments of learning that might exist in a FUSE: Next Generation model (see page 12), with the Appendix outlining activity-specific concepts developed during the meeting. It is a national priority for all students to be STEM learners. FUSE: Next Generation offers an innovative strategy for integrating strong inter- and intra-personal skills to deepen science education. Beyond the FUSE: Next Generation cities, we hope that STEM educators, community partners and district leaders nationwide might use this brief to help forge new paths.
Laying the groundwork for a new instructional approach employing community partners in collaboration with formal educators to create real-world STEM learning experiences that integrate the principles of the Next Generation Science Standards as well as social and emotional learning.
DEFINITIONS

Social and Emotional Learning from CASEL

“Social and emotional learning (SEL) involves the processes through which children and adults acquire and effectively apply the knowledge, attitudes and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions.

“Social and emotional skills are critical to being a good student, citizen and worker.”

Developing a child’s social-emotional foundation can be done through:

- Effective classroom instruction
- Student engagement in positive activities in and out of the classroom
- Broad parent and community involvement in program planning, implementation and evaluation

Next Generation Science Standards

“The National Research Council (NRC), the staff arm of the National Academy of Sciences, began by developing the Framework for K–12 Science Education, a critical first step because it is grounded in the most current research on science and science learning. States lead the development of K–12 science standards, rich in content and practice...to provide all students an internationally-benchmarked science education...The NGSS was developed collaboratively with states and other stakeholders in science, science education, higher educations and industry.

“NGSS will prepare students for college and careers.”

The Three Dimensions:

- “Practices are behaviors that scientists engage in as they investigate and build models and theories.” This dimension elucidates “what is meant by ‘inquiry’ in science and the range of cognitive, social, and physical practices that it requires.”
- “Crosscutting concepts have application across all domains of science.” These “need to be made explicit for students because they provide an organizational schema for interrelating knowledge from various science fields into a coherent and scientifically-based view of the world.”
- “Disciplinary core ideas have the power to focus K–12 science curriculum, instruction and assessments on the most important aspects of science.” Core ideas have broad importance, a key organizing concept, a key tool for understanding, the ability to relate to students’ life experiences, a connection to social or personal concerns, and are teachable and learnable.

From www.nextgenscience.org
ENVISIONING THE FUTURE OF SCIENCE LEARNING

Inquiry, discovery, analysis

Team-based project

Engagement & reflection

Science-rich learning environment

Local, informal education setting

Studying cross-cutting concepts

Accessible STEM materials
REFLECTIONS ON NGSS & SEL

During a day-long design meeting, experts in formal and informal learning sketched out the principles, requirements, and challenges for successful integration of social and emotional learning (SEL) and Next Generation Science Standards. Reflections on the potential of FUSE: Next Generation were extracted from further examination of these principles.

Reflections on Social and Emotional Learning (SEL)

There are multiple facets to social-emotional competencies:

- Self-esteem, self-efficacy, confidence
- Self-perception, Self-regulation, Self-control, Managing Emotions
- Grit, Perseverance, Persistence, Resilience, Ability to withstand conflict and failure, Motivation
- Teamwork, Collaborative Skills, Interpersonal Skills, Communication with Peers and Adults, Interpersonal and Intra-personal Skills and Awareness, Engagement

SEL instruction benefits from:

- Safe and inclusive learning environment in a diversity of contexts
- Systemic as well as individually based integration of instruction connected to other learning outcomes
- Focus on developmental timing
- Acknowledgment of progress and success
- Support for explicit SEL instruction
- Utilization of community-based organizations skilled in helping address the social, emotional, and life challenges for children within context of their families
- Open communication among various stakeholders, including teachers, out-of-school time providers, and families
- Use of techniques that allow children to understand progression of skills

What are the challenges that SEL faces?

- Stakeholders’ agreement on a shared vision for effective instruction
- The variety of assessment measures can create complications
- Specific professional development and training to build educators’ capacity to successfully integrate instruction
- Identification of core competencies necessary to allow for consistency in instruction
Reflections on Next Generation Science Standards

NGSS encourages diverse methods of learning and emphasizes development of science skills. These include:

- A developed science vocabulary for writing and discussing science processes and outcomes
- Observation and inquiry
- Direct application from problem to problem
- Critical thinking
- Experimentation, trial and error, and analysis

NGSS instruction benefits from:

- Understanding that most effective method of instruction would be direct facilitation
- Ability to weave science education with K-12 learning
- Vertically aligned science instruction that connects multiple players
- Cross-cutting concepts that engage students by connecting various domains of science education at once
- Broader skill acquisition across formal and informal learning spaces
- An eye towards curricula aligned with college- and career-readiness needs
- Evaluation tools that assess acquisition of knowledge as well as skills and techniques
- Students build strong knowledge base necessary to support learning
- Use of techniques that allow children to understand progression of skills
- Consideration of the use of badges to spark students’ excitement and sense of accomplishment

Implementing NGSS is challenged by:

- Varying commitment to NGSS adoption and implementation
- Need for an expanded network of partnerships to deliver the diversity of learning opportunities to meet the NGSS
- Lack of adequate funding to shift science-learning approaches
Formalized science education and informal social and emotional development are relatively common. Promising areas of growth include formalized SEL (using evidence-based curricula) and informal STEM (via project-based learning), in addition to a convergence of all four areas.

**To Identify New Opportunities**

- Recognize strengths of existing practices
- Leverage partnerships to use funds and other resources creatively
- Adopt and implement NGSS standards ahead of State adoption
- Deliberately and explicitly integrate SEL into STEM
FUSE: NEXT GENERATION—CONVERGENCE MAP

**Formal Education**
Formal education is classroom-based curriculum, provided by formally trained educators.

**Social and Emotional Learning**
Social and emotional learning is the process of developing personal and interpersonal skills for success in life.

**Informal Education**
Informal education happens outside the classroom. Education is provided by educators from the community both with and without formal training.

**Next Generation Science Standards**
The Next Generation Science Standards (NGSS) are new education standards that focus on content and practice, arranged in a coherent manner across disciplines and grades to provide students an internationally benchmarked science education.
SHIFTING THE APPROACH

FUSE: Next Generation would leverage unique systems—including school and community leaders, NGSS and SEL experts, professional development facilitators and partnering stakeholders—to promote the integration of NGSS and SEL principles and instructional practices. This student-centered model would increase opportunities for field experience and engagement via a project-based design of experiential learning that fosters understanding of cross-cutting concepts in science.
The core strategy for FUSE: Next Generation relies on individuals working directly with young people to create a science-rich environment for students by extending the classroom into the community and vice versa. Teachers and community educators work together in a collaborative approach to learning to:

- Deliver evidence-based, standards-aligned science curricula
- Offer experiential learning in STEM-rich environments, such as trial and error testing of a roller coaster model using a small car in an engineering lab
- Teach social and emotional skills explicitly as part of STEM learning
- Reinforce social-emotional skill development through science learning activities, such as activities that require teamwork and communication and scientific testing that requires perseverance.

These collaborations among educators are reinforced by:

- Commitment from leaders for FUSE: Next Generation
- Robust collaborations between schools and community partners
- Joint professional development and planning
- Engagement of community resources, such as STEM-rich institutions and environments for inquiry and experimentation. For example, some students in Boston spend the summer on Thompson Island, conducting field research
- Access to experts in NGSS and SEL to enhance quality
- Recognition of families as critical part of STEM learning ecosystem

Through the design meeting, we noted two opportunities for FUSE: Next Generation:

- Recognition and application of cross-cutting concepts, such as patterns, models and energy flow, which the NGSS describe as critical to build deep understanding of STEM across disciplines.
- Increased focus on emotional facets within SEL, often overlooked in favor of teamwork and other social skills that encourage interpersonal functioning. For example, students might reflect on and share stories about personal experiences before selecting an inquiry project area, e.g., water pollution or local crime. Such a project, in weaving engaging narrative and storytelling with multi-disciplinary trial and error and real-world problem-solving, would foster critical thinking and empathy and teach the value of collaboration, hard work and civic engagement.

The elements are designed to bring science education into students’ everyday communities, allowing them to deepen their understanding of their neighborhoods’ needs and mechanisms for growth. Next Generation’s use of community partners encourages these connections and ensures that the model remains rooted in each city’s unique resources. Next Generation learning can also continue at home, where students’ newly learned skills can be shared with family and employed during weekend projects. Parents can support out-of-school learning via family field trips or attendance at events. Family engagement ensures that youth remain engaged in their learning, strengthening not only STEM comprehension but also their perseverance to succeed.
MOMENTS OF LEARNING

While by no means an exhaustive list of moments of student learning, the illustrations below depict moments that should exist in a Next Generation model regardless of its final configuration. Whether an urban agriculture initiative partnering with a local farm or a team tackling a design challenge, similar learning outcomes should occur.

Students work in science-rich environments to learn observation and inquiry, critical thinking, direct application from one problem to the next, experimentation, trial and error, and analysis. These experiences are the result of robust partnerships between schools and community organizations.

Students engage one another and relate personal stories, building empathy and self-awareness as well as establishing skills in teamwork, collaboration and communication.

Students conduct themselves in an iterative process that includes spending time problem solving, planning, making prototypes, observing results, and conducting analysis. Reflection on both one’s solution and oneself leads to continuous improvement and refinement.
NEXT STEPS

Through leveraging community partners, harnessing the collaboration of formal and informal educators, and integrating SEL instruction with NGSS-aligned curricula, FUSE: Next Generation seeks to improve students’ STEM achievement throughout their lives. The FUSE: Next Generation cities—as well as those interested in advancing the model in their own districts—are poised to create learning environments that are both engaging and multidisciplinary. This may serve to accelerate NGSS adoption across the country by providing strong examples of implementation.

In **Boston**, Thompson Island Outward Bound Education Center will deliver an experiential learning science class at two Boston middle schools, in collaboration with classroom teachers and the National Park Service. Meanwhile, MathPOWER will implement new curriculum that emphasizes connections between math and science in its after-school program that serves students from six additional Boston middle schools. Boston After School & Beyond will focus on how to improve SEL outcomes while supporting the delivery of the Boston Public Schools’ science and math curriculum. Boston After School & Beyond would like to create a training program that combines NGSS standards and SEL that can be used by the school district in anticipation of NGSS adoption.

In **New York**, TASC will integrate SEL and STEM efforts at two schools, MS 206 and PS 182. Both schools have recently launched character-building initiatives and are also taking part in the NYC STEM Educators Academy with TASC and the New York Hall of Science. At MS 206, the principal has asked all teachers to highlight and actively reinforce academic and personal behaviors needed to succeed in college and career. At PS 182, the principal has launched a school-wide campaign to inculcate mutual caring and better “habits of mind.” For example, students engaged in collaborative projects or discourses are regularly reminded to listen to and explicitly acknowledge one another’s ideas before contributing their own thoughts. TASC will work closely with the principals, science teachers and community educators at MS 206 and PS 182 to ensure that the sought-after SEL skills are practiced and reinforced in all STEM classes, both during the school day and in the after-school hours.

In **Providence**, Providence After School Alliance (PASA), building upon the success of its science-rich AfterZone Summer Scholars Camp, will grow Rhode Island’s STEM education practices by creating a learning community with key partners to help shape and expand PASA’s training and coaching. Part of this process calls for participation by school administration, teachers, community partners and AfterZone staff to serve and operate as a “learning lab team” for improving and expanding training and coaching of the AfterZone Summer Scholars Camp. Lessons learned from this process will be piloted at two Providence middles schools, Roger Williams and Nathan Bishop, during the regular academic year, in partnership with the Providence Public School District.
APPENDIX
**DESIGN PROCESS**

**Creating Concepts**

To strengthen the foundation of the FUSE: Next Generation strategy it was essential to flesh out core elements needed to create concepts for learning experiences. By identifying specific stakeholders and resources - including students, educators, policies and materials - we created innovative ideas that could be used both holistically and in distinct elements.

**Using Expertise**

TASC and Every Hour Counts identified national leaders in formal and informal education to form a group of experts and practitioners that would help to further define the model. NGSS policymakers, educators, social and emotional learning/youth development experts, researchers, and intermediary leaders met to identify new insights, criteria, and guidelines for the model.

**Designing**

The design process for the model was facilitated by a design thinking process and workshop. This approach, employing Open Innovation and powered by design strategies, allowed for expert knowledge to flow and cross-pollination to occur in order to produce innovative concepts and ideas. Stages of the design process teased out relevant knowledge and insights from the experts.
CULTIVATING A LEARNING SYSTEM

At the design meeting, experts in NGSS, SEL and STEM learning sketched six concepts, then built a platform identifying stakeholders and resources needed for successful implementation.

**Concepts**
See page 20 for a more detailed rendering of the six concepts created at the workshop.

- The use of Professional Learning Communities
- The importance of the Home as an Informal Learning Environment
- The need for Science Rich Environments and Cross-cutting Concepts
- The usefulness of Challenges (preferably through Corporate Partnership)
- The creation of Empathy through Storytelling
- The application of Trial and Error

**Platform**
See page 21 for a visual representation of the platform.

**Sticky User (Stakeholders)**
These are key contributors with a vested interest in the success of the model.

- Students
- Families
- Teachers
- Community Educators
- School and District Leaders
- Community Organization Leaders

**Resources**
These are necessary inputs—including tools, policies and materials—that are required by stakeholders to successfully participate in, contribute to, and/or benefit from the model.

- STEM-rich Environments
- Curricula and Professional Development
- SEL, NGSS and STEM experts
- Funds and Flexibility
- SEL and STEM assessment tools
- Incentives
- Technology
- Public Support and Demand
- Public Policy Conducive to Collaboration
- Family Engagement Tools
- Materials for Scientific Inquiry in Field
- Community Engagement
Subtraction with Renaming

Team Ravens

189
-44
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145

2) 512
- 323
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189

Team Orion

3) 585
- 393
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192

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POSSIBLE CONCEPTS FOR FUSE: NEXT GENERATION

CONCEPT A
Professional Learning Community
Develops integrated NGSS/SEL curriculum into a scaffolded approach to learning over multiple years.

CONCEPT B
Afternoon at the Museum
Uses science-rich environments and classrooms for concentrated science education with cross cutting concepts.

CONCEPT C
Zero Robotics
Envisions a 5-week summer program for middle school kids to learn to program satellites aboard International Space Station and compete against other schools.

CONCEPT D
Going Through the Ups and Downs
Encourages use of trial and error experimentation via an informal learning activity inspired by roller coasters.

CONCEPT E
The Bread of Learning
Explores emotional development through the “bread of learning,” with ingredients like inquiry, personal relevance and empathy.

CONCEPT F
Science Apps for Parents
Builds capacity of parents to teach SEL skills and talk about science with their kids using apps.
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ABOUT

ORGE Innovation Consulting offers capacity building in design strategies for organizations facing the challenges of being innovative. We use expertise in design-thinking to reliably draw out tacit knowledge and capture innovative ideas and solutions.

Founded in 1998, the mission of TASC is to expand the school day to give disadvantaged students more opportunities to discover and develop their talents; more support to overcome the challenges of poverty; and more time to achieve at the high levels essential for success in the global workplace. www.expandedschools.org

Every Hour Counts, formerly the Collaborative for Building After-School Systems (CBASS), is a coalition of citywide organizations that increase access to quality learning opportunities, particularly for under served students.

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All photos in this brief courtesy of TASC

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