A Rational Approach to Proficiency

Partners: Lesley University and Holyoke, West Springfield, and Easthampton Public Schools

Abstract: This project will provide content courses focused on fraction as number, fraction as ratio, and ratio and proportional reasoning. Teachers will develop a deep understanding of rational numbers and strategies that will help their students better understand the importance of identifying the whole when discussing fractions as number. The number line and area models will be used in addition to the familiar pattern block representations. Participants will develop a deep understanding of the difference between a continuous model when working with fraction as number versus the discrete models when working with ratios. Participants will move forward in their knowledge of the importance of multiplicative thinking versus additive thinking. They will be grounded in the appropriate representations to use when dealing with continuous versus discrete representations on the number line, with tape diagrams, and on the Cartesian coordinate plane.

An emphasis will be placed on the use of accurate models when working on computations such as why the computational algorithms for adding, subtracting, multiplying, and dividing fractions work and how they might be represented using arrays, pattern blocks, Cuisenaire rods, and the Cartesian coordinate plane. Identifying the ‘whole’ will be stressed as the size of the whole is crucial when thinking about parts to the whole.

The language used in computing with fractions will be exact with the expectation that participants will think of multiplication of fractions as, for example, taking 1/2 of 3/6. Paper folding will be used to model this computation. For instance, participants will fold a piece of paper into sixths and will shade in three of those sixths. Next they will fold the paper in the opposite direction and shade in a half of the folded paper. When the shading is done, participants will see that 3/12 of the whole is shaded. Participants will also discuss and develop an understanding of why it is not always necessary to simplify fractions into their lowest terms. Division of fractions will use the language of “grouping.” How many groups of ⅔ are there in ¾? Again this will be modeled using pattern blocks, the Cartesian coordinate plane, the number line, Cuisenaire rods, and egg cartons. In working with proportions, cross-multiplication will be de-emphasized as participants explore the use of scale factors and unit rates represented on the double number line when dealing with proportions. This will hopefully eliminate the prevailing misconception students have that you can always cross multiply and make the distinction between the cross multiplication for proportions and multiplying strings of fractions.

Many lessons will include working with percentages, percent tables, representing percentages on the Cartesian coordinate plane, and using scale factors and unit rates. Multiplication with percentages and decimals will be illustrated using various multiplication models. One model
would show the efficacy of halving and doubling and present an understanding of powers of tens. An example would be to explore multiplying 2.6 x 5. Since 5 is half of 10, we would multiply 2.6 by 10 for a product of 26 followed by halving that 26 for a product of 13.

When dealing with ratios, participants will develop an understanding that they may be working with a part to part representation, a part to whole representation, or a whole to whole representation. They will explore when to use the tape diagrams versus a double number line or when to represent the ratio on the Cartesian coordinate plane. By representing ratios on the Cartesian coordinate, participants will recognize that ratios represent slope or rate of change in an equation. The Cartesian coordinate plane is used as a discrete model, one that many teachers have yet to discover. Participants will engage in working on a class-sized grid so they may understand how ratio represents a relationship between two entities and can be modeled on the grid. Using that model participants will solve problems that otherwise cause great angst. For example if Mary and Jose have beads in a ratio of 2 to 5 and if Mary gives Jose 12 of her beads they will each have the same amount. This is a problem that many teachers struggle to solve yet when modeled on the Cartesian coordinate plane becomes very visual with the solution becoming very evident. Following this model, participants will be required to illustrate the solution using a different strategy such as a tape diagram.

The partnership A Rational Approach to Proficiency will work with WGBH in videotaping classrooms that model excellence in teaching and learning. Year one will be a planning year and actual videotaping will begin in the Fall of 2016, year two of the grant.
For more project information, visit the Partnership Webpage or contact the program director: Dr Anne M. Collins, Director of Math Programs, collins2@lesley.edu.

Central Massachusetts Alliance of Secondary Science Educators

Partners: Narragansett Regional Public Schools, Worcester Polytechnic Institute and Ashburnham-Westminster, Ayer-Shirley, Berlin-Boylston, Nashoba Regional, Fitchburg, Hudson, Leicester, and Leominster Public Schools

Vision: The vision of the Central Massachusetts Alliance of Secondary Science Educators is to create a professional learning network in support of high quality professional development; rigorous, standards-based STEM education in middle and high school classrooms where students’ natural curiosity to explore science in the real world is nurtured, science and technology/engineering misconceptions are identified and clarified, and learning plans include opportunities to develop models, use evidence to support reasoning and provide evidence of learning over time through high level demonstrations of knowledge including the science practice standards.

Goal: Secondary science educators participating in high quality professional development secured by the Central Massachusetts Alliance of Secondary Science Educators will increase their subject matter knowledge (the core ideas of structure of matter and energy transfer) and will deepen their understanding of Science and Engineering Practice #2 (Developing and Using Models) in the 2016 MA Science and Technology/Engineering Curriculum Frameworks as measured by the pre and post course assessments and the development of science CEPAs related to the physical science strand.

Actions:
1. Secondary science educators will be trained in assessment literacy.
2. Secondary science educators will deepen their understanding of the 2016 MA Science and Technology/Engineering content standards (9 content standards), key shifts (how students explain their knowledge of science in the world around them) and practice standards (e.g. develop and use models). 3. Secondary science educators will develop shared curriculum embedded performance-based assessments (CEPA) as demonstrations of student learning regarding the practice of modeling in science and engineering.
3. Central MA DSAC specialists will coordinate lesson study visits in high needs participating districts, administrators will provide structures for MMSP participating partner districts to attend.
4. Course participants will contribute to ongoing discussion via the Google Classroom app.
5. Course participants will participate in collaborative work sessions to design CEPAs aligned to the nine standards identified in the course syllabus.

Benchmarks:
1. Results of pre/post assessments
2. Professional Development Evaluation Results
3. CEPAs and data generated as a result of the implementation of the CEPAs
4. 2017 State Standardized Science Standards by District Reports (CU306 EDWIN or comparable assessment report)

DSAC facilitated Lesson Study and Classroom Observation Meeting Notes.

For more project information, contact the program director Erik Erickson, Director of Curriculum and Instruction, eerickson@nrsd.org.

Diving into the Standards: Using the Hydrosphere as a Theme to Teach STEM

Partner: Westfield State University and Westfield Public School

Westfield Public Schools and Westfield State University have partnered together to develop a systematic professional development program based on district, educator, and student needs. The course is designed to (1) increase teacher content knowledge; (2) support teachers as they integrate new STE standards in their courses and develop interdisciplinary, inquiry-based lessons; and (3) analyze the effectiveness of the lessons by addressing rigorous student outcomes. Measurable course objectives have been defined for the course and are linked to specific evaluation activities that will be facilitated by the UMass Donahue Institute. The high quality professional development is systematic because the activities focus on both content and pedagogy, providing tools to be implemented into the classrooms. The continuous process of educator development begins with a 3-day workshop at Westfield State University and online activities and communication throughout the summer. During the 2016-2017 academic year, a series of 2.5-5 hour workshops will provide an opportunity to learn new content and explore new pedagogical techniques. A series of formative assessments occur throughout the year, allowing for immediate adjustments as necessary. The summative assessment focuses on the student outcomes by requiring teachers to investigate how the content was received in his or her own classroom. Teachers will present the results of their assessment in a poster format and will maintain a portfolio of their work. The summative assessment demonstrates our commitment to sustainability beyond the scope of this project; as compared to a single unit plan that would be narrowly-focused and would not truly demonstrate the increased content knowledge of the teachers, the integration of STE standards, and the potential for systematic change.

For more project information, contact the program director Dr. Jennifer Hanselman, Associate Professor, jhanselman@westfield.ma.edu.
Raising the Bar for ALL: Promoting Student Learning in K-8 Science

Partner: Randolph Public Schools, Bridgewater State University, Fitchburg State University, and Braintree Public School

With the adoption of new science and technology/engineering (STE) standards by the Department of Elementary and Secondary Education, the Randolph and Braintree schools have an extraordinary opportunity to raise the bar for science curriculum, instruction, and assessment. At the same time, the many opportunities for improvement present myriad challenges to science teachers, who may not be sufficiently trained in science content or pedagogy to meet these demands. The proposed project will provide teachers with training in science and technology/engineering content and practices and in effective science pedagogy, readying them to design and implement an enhanced science learning experience for Randolph and Braintree students that is:

- **Rigorous**, building career and college readiness through opportunities to master sophisticated content aligned to the 2016 STE standards, to engage in higher order thinking through inquiry and application of the science and engineering practices, to think creatively and critically, and to collaborate and communicate with others;
- **Authentic**, explicitly challenging students to transfer knowledge from ELA and mathematics to engaging science and engineering problems that motivate learning.
- **Empowering**, so that all students are provided rich opportunities to learn, informed by an understanding of each student’s cultural background, and all, including our most vulnerable subgroups, are given the supports necessary to succeed.

The 2016 STE standards have added greater rigor and complexity into what we expect students to know and be able to do. Along with a clearer vertical progression of learning, the new standards have introduced new and challenging concepts such as the relationship of vibrations to sound at grade 1, of sound waves to the transfer of energy at grade 4, and of wave characteristics and their role in digital information transfer at grade 6. Whole new topics with multiple standards, such as Earth and Human Activity, reflect a new vision of what a student needs to know for the 21st century. In addition to what students learn, the integration of science and engineering practices into each standard, as introduced in the national Next Generation Science Standards (NGSS), places a new emphasis on how students learn and the inquiry and design skills they need for the future. The cross-cutting concepts of NGSS that provide a conceptual framework that span all disciplines of science are also embraced in the MA STE standards. Finally, the grade-by-grade delineation of the standards, with a variety of disciplines assigned at each grade level, offers the potential for integrating the various disciplines of science, as well as the mathematics and literacy standards at each grade level. Clearly, the substantial improvements in the 2016 STE standards offer many opportunities for strengthening science programs K-8.

Not surprisingly, implementing these improvements will require work and training. In many cases, K-8 teachers will themselves not have been trained in the science content or the science and engineering practices they are being assigned to teach. The realignment of curriculum, redesign of instruction, and rewriting of assessments will require considerable time and work.
from teachers on top of their already demanding work load. In addition, teachers are newly charged with developing and using assessment, including district determined measures (DDMs), to monitor student learning, guide instruction, and demonstrate teacher impact. Adding to the challenge, our communities and student bodies are undergoing rapid changes in cultural and economic makeup, with ever increasing numbers of non-English speaking and economically disadvantaged students.

The Randolph and Braintree public school districts are excited to embrace this challenge of re-inventing our K-8 science experience to be one of high standards and high expectations that meets the needs of ALL students. Along with higher education partners Bridgewater State University and Fitchburg State University, we propose to work collaboratively to provide teachers with the science knowledge and pedagogical skills they need to challenge all students to high standards and support them in reaching their goals. To support them in their work, we have planned the following:

- **The course “Integrating Engineering into Science Instruction Through Project Based Learning,”** in the summer of 2016 will similarly set the stage for all the work to follow. Offered through Teachers 21 and Fitchburg State University (FSU), this graduate course will raise the bar for rigor and engagement by training teachers in the 2016 technology/engineering standards and engineering practices, as well as in the creation of student-centered, culturally relevant projects that integrate technology/engineering into science instruction. In subsequent science courses, teachers will draw on this engineering foundation to build technology/engineering into instruction in various science content areas. Importantly, it will also train teachers in Understanding by Design, the backwards design of curriculum, which they will continue to use for all curriculum design throughout the project period.

- **Three content-focused graduate courses, “Forces, Fields, and Energy,” “Matter: from Atoms to the Molecules of Life,” and “Earth and Human Activity,”** will be offered in Year 2 at Bridgewater State University (BSU). Course content will address the specific knowledge gaps of the participating teachers related to the 2016 standards. In all these courses, as in the preceding engineering course, the instructor will model the same instructional approaches that the K-12 teachers are asked to implement in their own classrooms. Specifically, instructors will (1) provide opportunities for active, inquiry-based learning that incorporates the science and engineering practices, (2) highlight the NGSS cross-cutting concepts that unite core ideas across the science disciplines, (3) identify opportunities for transfer of mathematics knowledge, that is, areas in which students' developing math skills can be applied to their own real science data, and (4) make use of science notebooking as a tool to guide inquiry-based thinking and to develop literacy skills.

During the 24-hour follow-up period for each course, teachers will work together in Professional Learning Communities (PLCs) to extend the pedagogy work begun in the content courses and, ultimately, to design updated curriculum, instruction and assessment that brings their new training to bear in the classroom (Dufour, R., et al., 2010).
Teaching Proportional Reasoning within a Cultural Context (TPRCC)

**Partners:** University of Massachusetts Boston, Boston Public Schools and Harvard University

Ratios and proportions top the list of “hard to teach” and “hard to learn” topics in upper elementary and middle school. To address this need, Boston Public Schools, the University of Massachusetts Boston, and the Graduate School of Education at Harvard have partnered to develop a course for in service teachers focused on ratios and proportional reasoning. The course will use high cognitive demand tasks to improve participant’s conceptual understanding of proportionality and will emphasize the need to establish sociomathematical norms and culturally appropriate strategies to increase classroom discourse and student engagement. By attending to classroom discourse and teacher student interactions teachers can begin to make sense of the normative cultural behaviors that occur in the mathematics classroom and which contribute to students’ emerging identities as autonomous individuals within school and the broader community.

Another exceptional feature of this project is the involvement of UMass Boston’s UTeach student teachers. UTeach is an undergraduate program that provides STEM majors with the opportunity to earn a teaching license along with a BS or BA degree. We will adapt and integrate the ratios and proportional reasoning materials to the UTeach Knowing and Learning course taught each spring. Doing so will ensure UTeach graduates will have a similarly deep understanding of ratio and proportional reasoning and are prepared to teach in Boston Public Schools’ richly diverse, urban contexts.

For more project information, contact the program director Michael Gilbert, Assistant Professor and Project PI, mike.gilbert@umb.edu.

Cohort 8 – Year 2

Assessing Science Performance Expectations: Integrating Science Content and Practices in the 5 District Partnership (5DP)

**Partners:** Chelsea Public Schools, Everett Public Schools, Malden Public Schools, Revere Public Schools, Winthrop Public Schools and UMass Boston (The 5DP+1 Science Partnership)

Assessing Science Performance Expectations: Integrating Science Content and Practices in the 5DP is a unique project that has brought together five school districts and UMass Boston in order to address the needs of this substantially high needs group of students through teacher professional development. With the recent release of the Draft Revised Massachusetts Science and Technology/Engineering Standards based on the next Generation Science Standards, the...
five school districts in the partnership recognized the need for professional development. Grades 6-8 science teachers need assistance in making the transition from middle school STE standards that were previously content-based and defined by grade spans to the Draft Revised STE standards. These new standards require a significant shift in teaching and learning. It will require that teachers align their teaching practices, learning goals, instructional activities, and assessments to standards that integrate science disciplinary core ideas (content) and science & engineering practices, are more cognitively demanding, are integrated (multi-disciplinary) and specified at each grade-level.

The vision of the partnership is that once teachers are provided with the opportunity to dive deeply into some of the standards in each of the disciplines by engaging in lessons from exemplary published middle school science curricula that frame science and technology/engineering curriculum around interesting, relevant, and real-world interdisciplinary questions (e.g. FOSS, IQWST, PBIS), middle school science teachers will better understand and come to embrace the Draft Revised MA Science Standards. They will better understand that the STE standards are “outcomes to be learned, not the method of instruction (MA DESE).” They will learn to recognize and implement components of lessons and units that address and allow students to meet the performance expectations of the Draft Revised MA STE standards. They will understand and implement core science teacher practices that are vital to student achievement. They will also learn how to “infuse” engineering in the other disciplines. As a result, they will then be well poised to better understand, write, and implement new District Determined Measures (DDMS).

Middle School Life Science for the Revised MA Standards

Middle School Physical Science for the Revised MA Standards

Middle School Earth Science for the Revised MA Standards

Teachers enrolled in any one of three content courses will be able to:

1. Articulate the key shifts in the draft revised standards so teachers better understand the performance expectations as articulated in the Draft Revised MA STE Standards
2. Identify which science and engineering practices students engage in during different curriculum experiences.
3. Compare and contrast three exemplary NSF developed middle school curriculum in terms of approach, use of investigations, use of problem-based learning, and engagement of teachers in the core science teaching practices.
4. Put into practice some of the “Core Science Teaching Practices” such as “Facilitating Classroom Discourse” and “Eliciting, Using and Assessing Student Thinking about Science,” as identified by a Delphi Expert Panel Approach (Kloser, 2014) to guide implementation of the Draft Revised MA Science Standards
5. Create or modify lesson plans that will align to the Draft Revised MA State STE Standards
6. Write assessment items that assess competency in both disciplinary core ideas and science & engineering practices.
7. Evaluate student work in terms the performance expectations
8. Be able to explain science content by answering not only “what does it mean?” but also “how do we know?” This is similar to the link between disciplinary core ideas and science & engineering practices.

For more project information, visit the Partnership Webpage or contact the program director: Arthur Eisenkraft, Director COSMIC; Distinguished Professor of Science Education, Curriculum & Instruction (CEHD); Professor of Physics, College of Science and Math, arthur.eisenkraft@umb.edu.

Intensive Immersion Institutes for Teachers of Mathematics

Partners: Billerica, Dracut, Hudson, Marlborough, Methuen, and Nashoba Regional Public Schools; and EduTron and Worcester State University

The project brings together six districts, five of them high needs, to pursue the common goal of improving student performance in mathematics. The partnership uses the Intensive Immersion treatments as the main mechanism for deepening teacher's knowledge of mathematics content, standards, disciplinary practices and student learning. The work will also include the development and implementation of District Determined Measures (DDMs) to assess student growth and inform teacher development. Various courses developed in the partnership will be integrated into Worcester State University’s offerings for in-service teachers.

The effectiveness of the Intensive Immersion Institutes (I^3), with respect to high-poverty and low performing schools, has been documented in various evaluation reports at the national level. The Intensive Immersion Institute (I^3) approach has been named multiple times by the Abt MSP report (published by Federal DOE 2007, 2010) as the top project among the 12 exemplary MSP Programs out of more than 500 programs nationwide. The intensive immersion approach has successfully helped numerous mathematics teachers deepen content knowledge and improve classroom effectiveness. The project aims to leverage this experience to serve math teachers to produce deep impact—when true standard-aligned mathematics textbooks and support materials are largely nonexistent.

The MMSP courses will reach about 80 mathematics teachers in grades 5-9 and impact more than 4000 students each year. In addition, an eclectic ensemble of follow-up site-based activities will be offered to induce positive changes in teachers’ classroom practices. These activities will reach even more teachers and students. Through these courses and activities, participants will develop their capacity as teachers by applying the newly-learned concepts and strategies in job-embedded assignments related to their own teaching and reflecting on results in terms of student learning in the context of developing and piloting DDMs.

Through the courses and follow-up activities, this partnership plans to challenge teachers in fundamental ways so that they will become more effective in teaching (middle school) mathematics. First of all, Participants will acquire/deepen/widen necessary content knowledge through intensive immersion in authentic content-based challenges. These highly customized courses routinely integrate content and practices through which meaningful connections will be
made explicit. Massachusetts Standards and Indicators of Effective Teaching Practice will be modeled organically in the interaction so that participants can also experience the Standards for Mathematical Practice firsthand. The PD activities will explicitly connect math topics and their applications to the grades 6-8 science standards. Therefore although this partnership focuses on serving teachers of mathematics in grades 5 to 9, some science teachers will be encouraged to participate to enhance the learning experience and to build learning communities in the districts.

In addition to the measurable content gain, the chemistry/dynamics and positive peer pressure fostered in the intensive immersion experience will trigger qualitative changes in individual teachers to such an extent that some of them may become catalysts to transform their local communities into learning machines. These transformations are expected to play a pivotal role in sustaining peer-based learning beyond the project span.

For more project information, visit the Partnership Webpage or contact the program director: Cathy McCulley, K-8 STEM Coordinator, cmcculley@billerica.k12.ma.us.

Methuen Middle School Science Camp

Partners: Methuen Public School and UMass Lowell

Over the 3 year period of this grant, our goal is to have all science teachers (46 teachers) in grades 5-8 enroll in the Computer Science and Intro to the Engineering Design Process courses through the University of Massachusetts Lowell. We would also like all science teachers to choose at least one to two online science content courses also through the University of Massachusetts Lowell. The Computer Science course will include visual data applications in both middle school math and science classrooms. There will be a concentration on the science practice of analyzing data (Science practice #4). The instructor will also incorporate the Next Generation Science Standards into the course for immediate application in the classroom for teachers. He will also focus on the shift of science practices in the standards. As teachers increase their content knowledge and application of science practice in their classrooms, grade level teachers will begin to create aligned curriculum maps using Atlas software and the draft Science/Technology Frameworks by grade level. Once the standards are unpacked and science curriculum maps are aligned for grades 5-8, teacher groups can begin to create DDMs for each grade level based on their collective content knowledge and the frameworks. At the end of year three, 100% of middle school science teachers will have completed the Computer Science course and the Introduction to Engineering course. These two courses will act as our non-negotiable foundation of content to begin discussion of science practice that all science teachers in all middle school science classrooms should incorporate. The beginning discussion of DDMs will surface from these two courses and the practice of science. The conversation will then focus on standard specific content assessment (DDMs) for each grade level. We envision that by the end of year three, we will have 2 DDMs for every middle school science course.
For more project information, visit the Partnership Webpage or contact the program director: Brandi Kwong, Assistant Superintendent, bikwong@methuen.k12.ma.us.

**STEM in the Garden: Advancing Contextualized STEM Teaching and Learning at Lowell Middle Schools**

**Partners:** Lowell and Andover Public Schools; St. Margaret’s and Franco American Private Schools; and Fitchburg University, EduTron, and MA State Science and Engineering Fair

Lowell Public Schools (LPS’s) strategic framework includes advancing robust PreK-12 STEM teaching and learning, but making the vision a reality in the context of limited fiscal resources in a high needs, level 3, large urban school district is a challenge. LPS students’ test scores, however, make it imperative. For example, LPS students’ MCAS data in Science and Tech/Eng show that only 24% of our grade 5 students and 18% of our grade 8 students are scoring proficient or higher, compared with 53% and 42% in MA overall.

In August 2014, the LPS K-2 STEM Academy opened and is serving 400 students, with plans to add grades 3 and 4 next year. Within the next year, a middle school will be designated a district STEM magnet program, and the overhaul of Lowell High School’s STEM Career Pathways will be complete. Over the past three years, LPS has been the beneficiary of an explosion in “Learning Gardens” (i.e., school gardens that are used in a variety of ways by classroom and/or afterschool programs), and in December 2014, we began a federally-funded “Farm to School” movement. In the schools where gardens have been installed, the gardens are so popular that existing schools are moving to expand and/or enhance their gardens while others have sought supplemental funds to install them. By the fall of 2015, all 8 of Lowell’s middle schools will have a learning garden on-site. Through five private, state, and federal grants, enabled by strong partnerships with local nonprofit organizations (e.g., Mill City Grows), by fall 2015, LPS will also have a Learning Gardens middle school curriculum (gr. 5-8) that promotes the essential skills of creativity and innovation through project-based learning, aligning teaching and learning to the new MA STE standards and providing in-reach contextualized learning in the gardens. As a result, improvements to STEM learning for our middle school students are within reach. The final missing link is that our 40 science and 100 math teachers do not all feel confident in the subject matter knowledge to effectively implement STE standards.

For more project information, visit the Partnership Webpage or contact the program director: Martha Cohn, Curriculum Coordinator - Science, mcohn@lowell.k12.ma.us.

**STEM Standards Through Inquiry and Problem Solving (SSIPS)**

**Partners:** Lesley University, and Brockton and Weymouth Public Schools

**STEM Standards Through Inquiry and Problem Solving (SSIPS)** is a collaborative partnership among the Brockton and Weymouth Public Schools, Lesley University, and the Boston Museum of Science. The **project goal** is to increase student achievement by strengthening teachers’
content knowledge in science, technology, engineering and math (STEM), align content knowledge to grade-level specific units, determine a common and appropriate measure of student learning to these units and ensure these initiatives positively contribute to the professional growth of teachers and increase student learning.

The **vision** for this project is a vision of change for both teachers and students. Our vision is that all teachers of mathematics are highly qualified in their mathematics content knowledge and use effective teaching strategies; that they are proficient in assessing student growth through gathering, interpreting, and analyzing evidence of student learning; AND they are adapting their instructional practices to better engage their students in doing meaningful mathematics, science, technology, and engineering. We envision the participants in this program will improve the teaching and learning of the STEM domains as they engage with the STEM content through nine content courses, many of which entail a trip to the Museum of Science or to the Maker Space at Lesley U to explore Science, Technology, Engineering and Mathematics through an interactive, hands-on approach to teaching and learning. We envision a collaboration among teachers at the middle grades as they incorporate the sciences in their mathematics courses and mathematics in their science courses. We also envision teachers from across the two districts collaborating both in course work and in field work as the courses dictate. Concurrently, our vision is that all students in these districts experience STEM as interactive disciplines that are aligned to the state standards, learn how to become reflective learners, and can assess their own progress along the learning progression set for them and their grade level.

**Goals** for this project are to increase student achievement by strengthening teachers’ content knowledge in science, technology, engineering and math (STEM), align content knowledge to grade-level specific units, determine a common and appropriate measure of student learning for these units and ensure these initiatives positively contribute to the professional growth of teachers and increase student learning and that all teachers of mathematics in these two large, urban districts, become proficient in:

a) knowing the content knowledge specified in the Massachusetts mathematics and science frameworks;
b) understanding and implementing the mathematical practices articulated in the Massachusetts mathematics and the science habits of mind that are incorporated in the science frameworks;
c) preparing effective formative assessment strategies and other effective instructional practices in their lessons;
d) identifying and incorporating DDMs in their assessments as they gather evidence of student growth throughout the academic year; and
e) using the student assessment information to improve their instructional practices.

Progress monitoring is a new concept for many teachers so each content course and follow-up activities will incorporate strategies teachers might use to gather and analyze evidence of student learning in real time.
Key features: This project combines the inclusion of mathematics and science content courses aligned to the Massachusetts frameworks with the development of District Determined Measures (DDMs) to track student growth in real-time and respond to that growth with appropriate challenges and interventions. Each content course has been revised to include the development of two assessment problems or tasks related to the domain for which the course focuses. Within each content course participants will be required to collaborate with teachers from their own grade level and district to write an assessment problem and a performance task that they will be required to pilot in their classroom. They will be required to share the results of student work discussing the evidence in that work and how that evidence will impact their instruction. Participants will be required to make a list of student misconceptions and challenges that become evident through the DDMs and what they might do to help students avoid developing those misconceptions. The participants will be required to assign the tasks or problems at least twice to analyze whether or not their own students are showing progress.

Partnership and recruitment: This partnership is functioning extremely well. Regular meetings are held within the partnering districts and between districts. Attendance in the mathematics course Number Theory was excellent with 22 participants enrolled and completing the course and 30 enrolled for Expressions and Equations being offered this summer. Since the math courses are held in Weymouth and the Science courses in Brockton both districts feel ownership of the need to help with recruitment which to date has been successful. The first technology course was held in Brockton, however despite 21 teachers signing up to take the course only 13 elementary teachers actually participated. Teacher recruitment was done solely within the district, since only Brockton uses the Acer Tablets not Weymouth. The upcoming Science and Inquiry Course for Middle School teachers begins in August and 17 teachers from both districts have signed up to take the course. The teacher recruitment in Weymouth is excellent as is the administrator support at the school and district office level. Coaching in Weymouth occurred at Adams Middle School and Seach Elementary School in year one and will expand to include Chapman and Adams Middle Schools in years 2 and 3. Principal Paul DuPrey at Chapman Middle, Nancy Welch coach at Adams and Chapman Middle Schools, and Assoc. Superintendent Jennifer Curtis-Whipple are completely committed to supporting this program. The three work as an effective team recruiting middle school math teachers plus the support staff who work with mathematics instruction.

Joan Farrington in Brockton was effective in recruiting middle and high school teachers for the Number Theory Course and middle school teachers for the Expressions and Equations Course. DDMs have been developed in mathematics complete with its implementation however it is very evident that revisions must be made on most grade levels. For more project information, visit the Partnership Webpage or contact the program director: Dr Anne M. Collins, Director of Math Programs, collins2@lesley.edu.

The Academic Language, Math, and Engineering Domains of Physical Science

Partners: Fall River Public Schools and Worcester Polytechnic Institute
The program is designed around a cyclical process of building pedagogical and content knowledge of staff, revising units of study, creating assessments and DDMs that support the outcomes of the curriculum units, and training teachers to effectively implement the units and use data from assessments to assess student progress and target instruction. Three courses will be designed over three summers, each highlighting a strand of physical science (Matter and Interactions, Motion and Stability, and Energy). The goal of the summer coursework, taught by WPI staff, is to build teachers content knowledge of the learning progressions of Physical Science, the Academic Language demands of these strands and the mathematical and engineering practices associated with each strand. FRPS staff has worked with WPI professors to start embedding attention to academic language and best strategies for teaching this with content in to the lesson plans the WPI staff will be using. Once the teachers have completed the course, we will create a sub-set of teachers who will revise the curricular units and assessments. These teachers will act as STEM leaders and provide professional development on the new units to teachers who did not take the course. During the school year teachers will continue to receive professional development and feedback as they teach the units. Finally, the networks of teachers will be supported in understanding data from assessments of the revised units. From August 10-17 2015 the first course for 30 Fall River Public Schools science and math grades 5-9 teachers, which connects the NGSS literacy standards (use evidence to support arguments, analyze data, and synthesize complex information), DRAFT 2013 MA Science & Technology & Engineering Standards, WIDA standards for differentiating for ELLs, math, engineering design, and physical science will take place. It is designed as a hands-on experience in which teachers explore the new standards, conducts experiments, develop a pedagogical stance for building science discourse, and draft district science DDMS for the reviewed standards. At this time we foresee no changes to this program for this summer. The 3- year cohort design will be sustainable through district support and training for both the teachers and administration throughout the school year, as well as during summer courses. Additionally, we will be creating and revising curriculum maps and DDMS throughout the three years. Feedback from the course evaluation will be taken into consideration as we plan for year two.

For more project information, visit the Partnership Webpage or contact the program director: Fran Roy, Chief Academic Officer, froy@fallriverschools.org.

Cohort 7 – Year 3

Assessing Student Learning Growth Using Math, Science, and Engineering Practices

Partners: Framingham Public Schools, Marlborough Public Schools; St. Bridget's private schools; and UMass Boston

The MMSP project entitled, “Assessing Student Learning Growth Using Math, Science, and Engineering Practices,” is led by the Framingham Public Schools, in partnership with the Marlborough Public Schools and the University of Massachusetts-Boston. During the implementation of this project, the partners have made a great progress in serving the high
need student population. Certain changes were made in planning the courses to adapt to needs as suggested by participating teachers.

According to NGSS Appendix L, “During the middle school and high school years, students develop a number of powerful quantitative tools, from rates and proportional relationships, to basic algebra and functions, to basic statistics and probability. Such tools are applicable far beyond the mathematics classroom. Such tools can also be better understood, and more securely mastered, by applying them in a variety of contexts.” Frequently in middle schools, math and science are taught in separate departments, and while science teachers ask students to apply mathematical concepts and skills in order make scientific calculations, they often use language and methods that are not aligned with the mathematics that students are learning in concurrent mathematics classes. It is our vision that through an intensive summer course and ongoing meetings throughout the school year, middle school science teachers from two high needs districts will develop knowledge and skills necessary for students to achieve college and career readiness, and they will develop assessment tools that inform student learning, guide instruction, and evaluate student progress. Further, through including senior district leadership, district leaders in science, math, bilingual and special education, members of the district bargaining unit and school evaluators in the ongoing discussions of student work measured by the assessments, both districts will develop the capacity to use district determined measures effectively to support student learning growth in science and other content areas.

In year one, the grant provided the opportunity to develop and provide a graduate course taught jointly by two UMASS Boston professors of math and science. The course entitled, Strategies to Improve Instruction in Middle School Science, provided middle school science teachers with the ability to understand the underlying organization of the revised science standards and how mathematical concepts and practices serve to support student achievement of the science and engineering standards. There was a focus on the language used to support consistency across math and science, and to improve instruction for English learners. In addition, middle school science teachers developed the capacity to create, use, and refine district determined assessment measures that inform instruction and provide feedback on student learning throughout the school year and vertically across the middle school science content. Through three school year meetings, district leaders, teachers and administrators developed a deeper understanding of how to create tools to determine what science and engineering content and practices look like in student work and classroom observations; and learn how to use assessments to measure student learning growth in science. The partnership will provide the opportunity to develop science teacher leaders through advanced coursework, expansion of the course to all middle school teachers and fifth grade teachers, and developing district determined measures for science in grades 5, 6, 7, and 8. In addition, district and school leaders will develop deeper understanding of what instruction that develops college and career readiness skills in science and mathematics looks like in practice and student work.

Based on the feedback provided by the participant teachers the class titled “Strategies to Improve Instruction and Assessment in Middle Grades Science I” was run as an additional cohort. A new UMASS Boston class titled “Implementing the NGSS Standards in Middle Grades...
Science” was also introduced with the intention of making teachers more familiar with the changes in science standards and how they can be effectively taught to optimize student learning as well as achieve the goal of getting students ready for college and career. Incorporating the NGSS or the MA Draft Revised Science and Technology/Engineering Standards is a big challenge. Learning about science involves more than just learning formulas; it involves learning about how scientists view the world (e.g., habits of mind and modes of thought), how scientific knowledge is developed (e.g., processes of questioning, investigation, data collection and data analysis), and how the different scientific disciplines are connected in describing the natural world (AAAS, 1989; Lederman, 1992; McComas et al., 1998). Through this class, teachers were provided with experiences that led to improved student learning in science. This class focused on scientific practices, which can be explicitly integrated with science standards to give students a deeper appreciation for how scientific knowledge is developed.

The class titled, “Strategies to Improve Instruction and Assessment in Middle Grades Science II” will provide teachers with the tools to understand the underlying organization of the new draft science standards and how these concepts and practices support student achievement. The class will focus on ways to implement the Claims, Evidence, and Reasoning (C-E-R) framework to enhance students’ abilities to speak and write scientific explanations, and support students in crafting evidence based arguments in science and across the curriculum.

The outcomes of this work will be four graduate courses, designed to become a STEM certificate program at UMASS Boston, the development of science leaders in two high needs districts that will be able to provide ongoing professional development, a change in science educator practice that results in student achievement, and DDMs. Tools and protocols are being developed to continue to refine the district determined measures that will be able to be used with other grade levels and content areas. District leaders and evaluators will be able to articulate the components of effective science instruction that lead to student science achievement.

For more project information, visit the Partnership Webpage or contact the program director: Trupti Vora, STEM Coordinator, tvora@framingham.k12.ma.us.

**Engineering Design Process: Developing Middle School STEM Teachers**

**Partners:** Global Learning Charter and Wareham Public Schools; Holy Family Holy Name private school; and Bristol Community College and Museum Institute of Teaching Science (MITS)

This proposed project would pair Bristol Community College's SAGE Program Lending Lab, instructors in the Robotics, Biotech, Physics, Environmental and Computer Science departments, the Museum Institute for Teaching Science with Middle School Teachers from Global Learning Charter Public School, Holy Family Holy Name parochial school and Wareham Middle School's new STEAM Academy over the course of three years to increase teaching competency in robotics, biotech, and computer science.

Year One activities included a 45-hour course that utilizes the ROV program as a demonstration for how the Engineering Design Process can be utilized by middle-school classroom teachers to
further scientific investigation. Taking place 6 days, teachers were exposed to EDP content and DDM and Unit Building strategies. For School Year 2014-2015, under the guidance of MITS, teachers are responsible for developing units of study in the Understanding by Design. Teachers would also need to design District-Determined Measures to determine the impact on student learning. Results of this DDM design and initial student learning findings are included in this proposal.

Year Two activities included two 45-hour courses that took place in May, June and July of 2015. These two courses covered topics in Biotechnology and Computer Information Science (CIS). Follow up for these two courses will take place in Fall 2015.

Year Three activities will include two new courses for middle school teachers: Earth in the Universe and Renewable Energy. After discussion among the partners and a consideration of the new DESE Science and Engineering Frameworks, we decided to alter our original plan of offering a repeat of our Engineering Design Process and Biotechnology courses. Earth in the Universe will have an astrophysics focus incorporating physical science standards around forces and movement with Earth science standards focus on the planets, solar system, and the universe. The Renewable Energy course will include the mathematical elements of our Engineering Design Process and Earth in the Universe courses coupled with an exploration of topics relating to renewable energy. Follow up for these courses Major outcomes of the grant continue to be middle school science-based Model Units based on the Understanding by Design framework. Units would contain CEPA and District Determined Measures. Additional outcomes could include filming of the PD sessions for use by other teachers across the Commonwealth and nation. Units and assessments will be presented at NSTA and MassCue.

For more project information, visit the Partnership Webpage or contact the program director: Derek Michael, Director of Curriculum, dmichael@glcps.org.

**Modeling Mathematics Through the Mathematical Practices**

**Partners:** Lesley University, Springfield and Easthampton Public Schools

The purpose of this grant is to provide mathematics content courses primarily to Springfield and Easthampton Public Schools’ upper elementary- and middle- school teachers. Because the project Modeling Mathematics through Mathematical Practices seamlessly incorporates the Mathematical Practices in all their instruction, instructors are being asked to explicitly identify those practices that are being modeled at any given point in time. The use of the Conjecture Board is becoming widespread in participants’ classroom since they, themselves, are using them in the content courses they are taking. Look for and Make Use of Structure is especially critical for teachers to understand since it is the structure of mathematics that is algebra and the algebraic representations for what teachers do and have done in arithmetic.

In response to administrators’ concerns, focus in the content courses has also been on the inclusion of multiple representations. A prime domain for including various models is Ratio and Proportional Reasoning. Tape Diagrams, double number lines, the Cartesian coordinate plane,
ratio and rate tables are all models that make explicit the relationships between and among the ratios and rates.

Additionally, in each content course participating teachers will develop, implement, and revise (as necessary) grade level DDMs. The development of the DDMs will be done collaboratively within each district after conversation by grade level across districts. This means that during any given content course teacher participants from Springfield may work with teachers from Easthampton and develop grade appropriate assessments. Easthampton seventh and eighth grade teachers have built a cadre of DDMs for each CMP2 unit they teach, they have revised them, and are ready to administer them again in the Fall.

The coaching component of this project, designed to support teachers as they work toward changing their practice was very successful in Easthampton this past year and will continue through fiscal year 2016. In Springfield the Mathematics Learning Communities were successful in some schools and needs to become internalized within the district as teachers help teachers.

This project aims to

- Deepen participants mathematics content knowledge as evidenced in pre- and post-inventories, classroom presentations, assignments, and in the manner in which they make or prove or disprove conjectures;
- Enable participants to incorporate the mathematical practices in their instruction and adapt them as habits of mind for both teachers and their students;
- Support participants in their classrooms as they strive to improve their practice through coaching and supporting district coaches through monthly professional development;
- Improve student achievement as evidenced through scores on ANet assessments, DDMs, MCAS and PARCC, and the examination of student work as collected by teacher participants and discussed in individual courses as well as observations of teacher and their students by the external evaluators.

For more project information, visit the Partnership Webpage or contact the program director: Dr Anne M. Collins, Director of Math Programs, collins2@lesley.edu.

**Worcester Mathematics Partnership**

**Partners:** Worcester Public Schools, Clarke University

Worcester Public Schools, a high-need LEA in conjunction with its IHE partner, Clark University proposes a professional development program for Mathematics teachers in Grades 6, 7 and 8. The professional development will consist of a Masters level course titled Curriculum and Knowing in Mathematics (for Middle School Teachers), at Clark University, and 24 hours of follow-up activities during the following school year. The 45 hour course will be administered to Mathematics teachers in middle and elementary schools to 14 educators drawn from public and private schools. It will focus on Mathematics content knowledge and increase educator understanding of the Massachusetts content and learning standards. The 24 hours of follow-up activities will follow the reflective practice cycle model, and a learning community for educators will be formed.
Alongside the implementation of the professional development course, funds will be used for the development of a district wide Mathematics District Determined Measure. There is a need in the Worcester Public Schools for a DDM that complements the two standardized tests administered to all students. The initial DDM will be created by work groups consisting of teachers and administrative staff. Once the DDM has been created, all participants in the course will be able to provide feedback and suggestions on the use and implementation of this new evaluation tool.

For more project information, visit the Partnership Webpage or contact the co-program directors: Mary Meade Montaque, Quadrant Manager, montaquem@worc.k12.ma.us and Albert G. Ganem Jr., Manager of Staff Development, ganema@worc.k12.ma.us.