2018 Summer Conference

#2018RiSEconference

Integrating Research and Practice: Using STEM Disciplines to Build 21st Century Workplace Skills

Conference Program

June 24 to June 26, 2018 • University of Maine • Orono, Maine

Hosted by the Maine Center for Research in STEM Education (RiSE Center)

Program Contents

Conference Host

Maine Center for Research in STEM Education (RiSE Center)

The Maine Center for Research in STEM Education (RiSE Center) provides an integrated approach to University-based research and professional development in science and mathematics education. The RiSE Center is an interdisciplinary research center with faculty members from the College of Education and Human Development, the College of Liberal Arts and Sciences, and the College of Natural Sciences, Forestry and Agriculture. RiSE faculty members are involved in partnerships with other STEM and STEM education faculty, K-12 teachers and administrators, and members of nonprofits committed to improving STEM education. Their work includes basic and applied research on learning and teaching in science and mathematics; research-guided modifications to introductory and upper level science, mathematics, and engineering courses to include more student-centered practices, establishing content-rich, research-based teacher preparation and professional development, and building infrastructure for ongoing STEM education improvement with teachers, schools, and administrators throughout the state.

The Master of Science in Teaching Program, offered by the RiSE Center, provides a rigorous research-based route to initial certification for STEM majors interested in teaching secondary science and/or mathematics; an opportunity for veteran teachers to build their knowledge of teaching and learning in their disciplines while earning a Master's degree; and a chance for STEM majors to conduct STEM education research, often in preparation for doctoral work in a related field. All MST graduates must complete a research thesis as part of the degree requirements. The University of Maine has recently established a Ph.D. program in STEM Education, offered by RiSE Center faculty members through the College of Education and Human Development.

Since its formation in 2001, the RiSE Center has hosted conferences annually focused on integrating STEM education research and practice. This integration is a significant part of many of the Center's initiatives, including the Maine STEM Partnership, a state-wide K-16+ STEM education improvement community with 160 Maine schools, 100 school districts, 700 teachers, 29,000 students, and over 30 University of Maine faculty members. The Partnership sustains a state-wide professional community that brings educators and education researchers together to support high-quality, evidence-based instruction for students at all levels. More information about the RiSE Center and its programs can be found at umaine.edu/risecenter/.

Schedule-at-a-Glance

Sunday, June 24

Time	Event	Location
3:00-6:00 PM	**Dormitory Check-In & Conference Registration**	Wells Conference Center Lobby
6:00-8:00 PM	**Dinner**	Wells Conference Center, Room 1
	Opening Remarks and Welcome Dr. Susan R. McKay, *Professor of Physics & Founding Director of the RiSE Center, University of Maine*	
	Keynote Dr. Brian Frank, *Associate Professor of Physics & Astronomy, Middle Tennessee State University*	

Monday, June 25

Time	Event	Location
7:30-8:30 AM	**Information Table and Continental Breakfast**	Wells 1
8:30-9:15 AM	**Keynote** Dr. Mackenzie Stetzer, *Associate Professor of Physics & RiSE Center Member, University of Maine*	Wells 1
9:20-10:00 AM	**Talk Session 1**	Wells 1, 2 & 3 See Talk Schedule
10:00-10:20 AM	**Coffee Break and Transition to Workshop A**	Wells Atrium
10:20-11:50 AM	**Workshop A**	See Workshop Schedule
11:50-1:15 AM	**Lunch**	Bear's Den at Memorial Union
	Set-Up for Poster Session	Wells Atrium

Monday, June 25, continued

Time	Event	Location
1:15-1:55 PM	**Talk Session 2**	Wells 1, 2 & 3 See Talk Schedule
2:00-2:40 PM	**Talk Session 3**	Wells 1, 2 & 3 See Talk Schedule
2:40-3:00 PM	**Coffee Break and Transition to Workshop B**	Wells Atrium
3:00-4:30 PM	**Workshop B**	See Workshop Schedule
4:30-6:00 PM	**Poster Session & Hors d'oeuvres**	Wells Atrium

Tuesday, June 26

Time	Event	Location
7:30-8:30 AM	**Information Table and Continental Breakfast**	Wells Atrium
8:30-9:10 AM	**Talk Session 4**	Wells 1, 2 & 3 See Talk Schedule
9:20-10:50 AM	**Workshop C**	See Workshop Schedule
10:50-11:50 AM	**Lunch**	Bear's Den at Memorial Union
11:50-1:20 PM	**Workshop D**	See Workshop Schedule
1:30-3:00 PM	**Panel Discussion**	Wells 1

Keynote Presentations

Dr. Brian Frank
Associate Professor of Physics & Astronomy, Middle Tennessee State University

Sunday, June 24
7:15 - 8:00 PM

Research on problem-solving approaches in specific content areas of physics as a guide for curriculum development

Research on problem-solving in physics has largely focused on general problem-solving strategies and novice-expert comparisons. Most curricular interventions based on this research have sought to improve students' proficiency with problem-solving through explicit teaching of various expert-like strategies. Less attention has been given to students' spontaneous problem-solving in specific content areas and to the identification of productive aspects on which to build. In this talk, I first discuss several experimental and observational studies of students' problem-solving that help to highlight both the promise and limitations of students' approaches. Second, I discuss how this work has shaped an ongoing project to re-imagine physics problem-solving instruction as it has manifested in a multi-year curriculum redevelopment effort at Middle Tennessee State University.

Dr. Mackenzie Stetser
Associate Professor of Physics & RiSE Center Member, University of Maine

Monday June 25
8:30 - 9:15 AM

What does student performance on a physics question really tell you?
Investigating the complex nature of student reasoning*

For more than 30 years, research-based materials have helped transform introductory physics instruction at the undergraduate level. Many of these materials focus on the development of student conceptual understanding, place considerable emphasis on qualitative inferential reasoning, and scaffold that reasoning via carefully crafted sequences of questions. An emerging body of research, however, suggests that poor student performance on certain physics tasks – even after research-based instruction – may stem more from the nature of student reasoning itself than from specific conceptual difficulties. As part of a large, multi-institutional effort to investigate and characterize the nature of student reasoning in physics, we have been developing and testing instruments and methodologies to probe student reasoning in greater detail. A variety of new research tasks and associated results will be discussed. The findings from these tasks continue to provide insight into the extent to which some reasoning phenomena in physics may be accounted for by the underlying nature of human reasoning.

* This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431857, DUE-1431541, DUE-1431940, DUE-1432765, DUE-1432052, and DRL-0962805.

Detailed Talk Schedule

Monday, June 25

Talk Session 1 (9:20 - 10:00 AM)

Talk Title and Presenter	Location	Grades Targeted*
Authentic Student Centered STEM Dr. Robert Mayes, *Professor of Middle Grades and Secondary Education, Georgia Southern University*	Wells 1	6-12
Designing Systems of Support for K-12 Science Education Teachers and Students Dr. Sara Hagenah, *Assistant Professor of Science Education, Boise State University*	Wells 2	9-12
Implementing 3-Dimensional Teaching & Learning Jen Gutierrez, *K-12 STEM Education Specialist, integratedSTEMk12, LLC*	Wells 3	PK-5

Talk Session 2 (1:15 - 1:55 AM)

Talk Title and Presenter	Location	Grades Targeted
An Example of Action Research: Absolute Value Dr. Tim Boester, *Assistant Professor of Mathematics & Statistics, University of Maine*	Wells 1	PK-12
Proportional reasoning and problem solving in middle school Dr. Franziska Peterson, *Assistant Professor of Mathematics Education & RiSE Center Member, University of Maine*	Wells 2	6-8
Using data to distinguish climate vs. weather… Bryn Keenhold, *Masters of Science in Teaching Student, RiSE Center, University of Maine &* Margo Murphy, *Teacher, Camden Hills Regional High School, Rockport*	Wells 3	6-12

***Note:** A target student age range has been listed for each talk. This is meant to serve as a resource for teachers in determining which talks may be most relevant. Any person may attend any talk.

Talk Session 3 (2:00 - 2:40 PM)

Talk Title and Presenter	Location	Grades Targeted*
Service Learning, 3D Printing & Content Standards Patsy Adams, *5th Grade Teacher, Pittston Consolidated School*	Wells 1	PK-8
Exploring 'upside-down teaching' Megan Candelaria, *Instructor of Mathematics, Laramie Community College, NASA Space Grant Consortium*	Wells 2	9-12
How CORE can help chemistry students make connections to the atomic scale in lab Dr. Alice Bruce, *Professor of Chemistry,* Dr. Mitchell Bruce, *Professor of Chemistry & RiSE Center Member,* *and* Joseph Walter, *Masters of Science in Teaching Student, RiSE Center, University of Maine*	Wells 3	6-8

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Tuesday, June 26

Talk Session 4 (8:30-9:10 AM)

Talk Title and Presenter	Location	Grades Targeted*
Investigating the Cognitive Mechanisms that Impact Student Reasoning Caleb Spiers, *Doctoral Candidate in Physics, University of Maine*	Wells 1	6-12
Nature of Science in the NGSS Practices and Inquiry Paths for the Earth & Space Sciences Dr. Nancy Price, *Assistant Professor of Geology, Portland State University*	Wells 2	PK - 5
Examples of Computer-Based Science Instruction in Rhode Island: A Timeline and Lessons Learned Dr. Robert Pockalny, *Marine Research Scientist, Graduate School of Oceanography, University of Rhode Island*	Wells 3	9-12

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Detailed Workshop Schedule

Monday, June 25

Workshop Session A (10:20 - 11:50 AM)

Workshop Title and Presenter	Location	Grades Targeted *
Making effective use of card sorting tasks in the science classroom Dr. Brian Frank, *Associate Professor of Physics & Astronomy, Middle Tennessee State University*	Little Hall, Room 211	6-12
SAIL into Mathematics Dr. Robert Mayes, *Professor of Middle Grades and Secondary Education, Georgia Southern University*	Wells 1	9-12
Moving from Topics to Big Ideas: Modeling in your Science Classroom: Innovation & Creativity Dr. Sara Hagenah, *Assistant Professor of Science Education, Boise State University*	Wells 2	9-12
Creating Critical Thinkers & Problem Solvers Through 3-Dimensional Teaching & Learning Jen Gutierrez, *K-12 STEM Education Specialist, integratedSTEMk12, LLC*	Wells 3	PK-5

***Note**: A target student age range has been listed for each workshop. This is meant to serve as a resource for teachers in determining which workshops may be most relevant. Any person may attend any workshop.

Workshop Session B (3:00-4:30 PM)

Workshop Title and Presenter	Location	Grades Targeted*
The Chemistry Lab Curriculum: what teachers need to know about CORE to help students think at the atomic scale and advice about implementing it in K-12 or college environments. Dr. Alice Bruce, *Professor of Chemistry,* Dr. Mitchell Bruce, *Professor of Chemistry & RiSE Center Member, and* Joseph Walter, *Masters of Science in Teaching Student, RiSE Center, University of Maine*	Aubert, Room 427	6 - 12
Algebraic thinking in the early grades Dr. Franziska Peterson, *Assistant Professor of Mathematics*	Wells 1	PK-5

Education & RiSE Center Member, University of Maine		
From Dataset to Data Story Bryn Keenhold*, Masters of Science in Teaching Student, RiSE Center, University of Maine and* Margo Murphy, *Teacher, Camden Hills Regional High School, Rockport*	Wells 2	6-12
The Mathematics of Change Megan Candelaria*, Instructor of Mathematics, Laramie Community College, NASA Space Grant Consortium*	Wells 3	9-12

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Tuesday, June 26

Workshop Session C (9:20-10:50 AM)

Workshop Title and Presenter	Location	Grades Targeted *
Proportional reasoning and problem solving in middle school Dr. Franziska Peterson*, Assistant Professor of Mathematics Education & RiSE Center Member, University of Maine*	Little Hall, Room 211	6-8
Teaching the Earth & Space Sciences from the Perspective of "Scale, Proportion, & Quantity" Dr. Nancy Price*, Assistant Professor. of Geology, Portland State University*	Wells 1	PK-5
An Introduction to Jupyter Notebooks and Python Programming for Computer-based Science Instruction Dr. Robert Pockalny*, Marine Research Scientist, Graduate School of Oceanography, University of Rhode Island*	Wells 2	9-12
Minding the Gaps: What does Maine data say about how all K-12 students are learning in science and mathematics? Laura Millay*, RiSE Research and Evaluation Coordinator and* Lauren Swalec*, Master of Science in Teaching Student, RiSE Center, University of Maine*	Wells 3	6-12

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Workshop Session D (11:50-1:20 PM)

Workshop Title and Presenter	Location	Grades Targeted *
Using Reasoning Chain Construction Tasks to Support and Explore Student Reasoning in STEM Dr. MacKenzie R. Stetzer, *Associate Professor of Physics & RiSE Center Member and* J. Caleb Speirs*, Doctoral Candidate in Physics, University of Maine*	Little Hall, Room 211	6-8
Launch and learn rocket workshop: Integrate science and engineering concepts in the classroom using probeware and Maker community designs Jake Bogar*, Science & Engineering Teacher, Mt. Blue Campus, Farmington*	Wells 1	9-12
A Workshop on Using Distance to Teach Absolute Value Dr. Tim Boester*, Associate Professor of Mathematics & Statistics, University of Maine*	Wells 2	PK-12
Code for ME, CSP Ken Akiha*, Science Teacher, Old Town High School, Old Town*	Wells 3	9-12

***Note**: A target student age range has been listed for each workshop. This is meant to serve as a resource for teachers in determining which workshops may be most relevant. Any person may attend any workshop.

Talk Abstracts

In Order by Session

Talk Session 1 - Monday, June 25 (9:20-10:00 AM)

Authentic Student Centered STEM

Dr. Robert Mayes*, Professor of Middle Grades and Secondary Education, Georgia Southern University*

How can we increase student engagement and persistence in STEM? The STEM Authentic Interdisciplinary Learning (SAIL) project incorporates five tenets to address this issue. Come hear about the ICARE tenets and engage in a hands-on exploration of the M in STEM.

Designing Systems of Support for K-12 Science Education Teachers and Students

Dr. Sara Hagenah*, Assistant Professor of Science Education, Boise State University*

Spanning both teacher and student learning and their participation in formal science spaces, my program of research works to extinguish historical inequities and seeks to further understand how students can construct and use meaningful science explanations to make change in their lives and communities. Framed by constructs found in improvement science, we will explore stories of shifts in science teaching and learning as stakeholders work towards shared goals and navigate productive tensions across diverse contexts.

Implementing 3-Dimensional Teaching & Learning

Jen Gutierrez*, K-12 STEM Education Specialist, integratedSTEMk12, LLC*

Historically, K-12 instruction has encouraged students to master lots of facts that fall under "science"categories, but research shows that engaging in the practices used by scientists and engineers plays a critical role in comprehension. Teaching science as a process of inquiry and explanation helps students think past the subject matter and form a deeper understanding of how science applies broadly to everyday life. During this presentation participants will engage in and discuss the shifts to consider when implementing a 3-Dimensional teaching and learning experience for all students.

Talk Session 2 - Monday, June 25 (1:15-1:55 PM)

An Example of Action Research: Absolute Value

Dr. Tim Boester*, Assistant Professor of Mathematics & Statistics, University of Maine*

Practitioner-based "action research" is being more widely adopted in schools to help teachers critically reflect on their teaching practices. This in turn can help schools focus on curricular initiatives and build a professional culture of teaching. For those unfamiliar with action research, this talk will examine an action research project conducted by an honors-level undergraduate preservice teacher in an eighth-grade algebra class studying absolute value. While action research is typically reserved for seasoned educators, the benefits for less experienced teachers will also be explored.

Proportional reasoning and problem solving in middle school

Dr. Franziska Peterson*, Assistant Professor of Mathematics Education & RiSE Center Member, University of Maine*

Proportional reasoning is a cornerstone in middle school mathematics and developing a deep understanding is fundamental for students since it builds the foundation for future concepts, such as functions, graphs, and algebraic equations. This is a pedagogical task that includes deepening one's own understanding of different types of reasoning and guiding students from entry level to more sophisticated levels of reasoning (Lobato, Orrill, Druken, & Jacobson, 2011). All components of proportional reasoning, such as for example fractions and rates of change, are also essential for the sciences and solving real-world problems. It is an interdisciplinary concept that can bridge mathematical and scientific content.

Using data to distinguish climate vs. weather…

Bryn Keenhold*, Masters of Science in Teaching Student, RiSE Center, University of Maine*
Margo Murphy*, Science Teacher, Camden Regional High School, Rockport*

We will use TUVA, an online data tool that can be used to explore a variety of topics. Come see how students can easily turn data into evidence to help understand and explore concepts of weather and climate.

Talk Session 3 - Monday, June 25 (2:00-2:40 PM)

Service Learning, 3D Printing & Content Standards

Patsy Adams*, 5th Grade Teacher, Pittston Consolidated School*

In this Project Based Learning Activity, students investigated a real world situation that they experience daily. There is not enough playground equipment. Within the scope of this year long activity, students created models using a 3D printer, worked together, gave presentations, used measurement and scale standards, and solved problems as they arose.

Exploring 'upside-down teaching'

Megan Candelaria*, Instructor of Mathematics, Laramie Community College, NASA Space Grant Consortium*

In a time-limited, standards-driven classroom, how do we teach 21st Century Workplace Skills such as critical thinking, problem solving, innovation, and perseverance? How do we engage students who don't want to be in a mathematics classroom? This presentation focuses on the idea of 'upside-down teaching', in which rich mathematical problems are used to engage students and shift the focus from a teacher-centered to a teacher structured approach. We will both explore the idea of upside-down teaching as well as looking at how you can take textbook problems and 'turn them upside-down' with just some simple re-writes. Upside-down teaching: because life doesn't come with a series of step-by-step instructions (or get solved in just one step…)

How CORE Can Help Chemistry Students Make Connections to the Atomic Scale in Lab

Dr. Alice Bruce*, Professor of Chemistry, University of Maine*

Dr. Mitchell Bruce, *Professor of Chemistry & RiSE Center Member, University of Maine*

Joseph Walter*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

It is well known that students studying chemistry have great difficulty in thinking about what is occurring at the atomic scale. CORE (Chemical Observations, Representations, and Experimentation) was created to introduce explicit curricular scaffolding in support of making connections between macroscopic (what we can sense) and submicroscopic (atomic scale) domains. We often expect students to utilize a wide array of representations (including modeling) for making these connections with little formal instruction about how to do this. We will present the "why" and "how" of the CORE strategy with examples of activities that promote making these connections.

Talk Session 4 - Tuesday, June 26 (8:30-9:00AM)

Investigating the Cognitive Mechanisms that Impact Student Reasoning*

J. Caleb Speirs*, Doctoral Candidate in Physics, University of Maine*

The field of physics education research (PER) has worked extensively on understanding and responding to student difficulties in learning physics. This work has led to instructional materials proven to bolster the development of conceptual understanding, usually by stepping students through qualitative chains of reasoning. However, some patterns of incorrect reasoning persist even after research-based instruction. This talk will discuss aspects of cognitive science that offer insight into this phenomenon and will present novel methods of exploring the cognitive mechanisms that impact student performance on qualitative physics questions. Both results and implications for the classroom are discussed.

* This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431857, DUE-1431541, DUE-1431940, DUE-1432765, DUE-1432052, and DRL-0962805.

Nature of Science in the NGSS Practices and Inquiry Paths for the Earth & Space Sciences

Dr. Nancy Price*, Assistant Professor of Geology, Portland State University*

The Next Generation Science Standards (NGSS) define standards as an integration of the disciplinary core ideas, the crosscutting concepts (CCC), and the science and engineering practices (Practice). How these are combined to form the performance expectations communicates a lot about the Nature of Science for each subject domain. Although the Practices and CCCs are not domain-specific, some Practices and CCCs, and their pairings, are more closely connected to one scientific domain than the others. For the Earth & Spaces Sciences (ESS), the following Practice-CCC combinations are most common: “Developing & Using Models + Systems”, “Constructing Explanations.. + Stability & Change”, and “Analyzing & Interpreting Data + Patterns”. These communicate aspects of authentic scientific inquiry that are unique to the ESS. The “Data + Patterns” pairing, for example, indicates that an investigation in the Earth & Space Sciences can involve an investigation of existing data that students will not directly collect (e.g. satellite data). There is much in the geoscience education literature that is not well known to the larger K-12 community. This talk will address how we can use the language of the NGSS and inquiry paths to communicate “the nature of the Earth & Space Sciences” to non-ESS trained teachers. Inquiry paths, or the order in which students engage Practices in a lesson, have strong potential to leverage what is known about novice-to-expert progressions in helping students authentically build critical thinking and problem solving skills around the Practices.

Examples of Computer-Based Science Instruction in Rhode Island: A Timeline and Lessons Learned

Dr. Robert Pockalny*, Marine Research Scientist, Graduate School of Oceanography, University of Rhode Island*

Over the past decade, several programs have been developed to enhance science instruction and computational thinking for pre-college and college students in Rhode Island. Our initial foray was a 5-year NSF-funded Rhode Island Technology Enhanced Science (RITES) program that supported the development of science curriculum and on-line resources created by teams of middle and high school teachers with STEM faculty/researchers. This program transitioned into a follow-up 3-year NSF-funded project (RITES+C), which focuses on developing NGSS science class modules for Earth Science, Physical Science, and Life Science that incorporates computational thinking by having students work with large datasets to help develop inquiry-based learning in science. A more recent 3-year program funded by the Office of Naval Research focuses on training college students for the future workforce to develop computational thinking and programming skills in support of national security. I will describe each of these programs, how they evolved, and most importantly…the lessons learned. I will also discuss the potential scalability and portability of these programs for various geographic regions and levels of learners.

Workshop Abstracts

Organized Alphabetically by Presenter by Day

Monday, June 25

The Chemistry Lab Curriculum: what teachers need to know about CORE to help students think at the atomic scale and advice about implementing it in K-12 or college environments.

Dr. Alice Bruce*, Professor of Chemistry, University of Maine*

Dr. Mitchell Bruce, *Professor of Chemistry & RiSE Center Member, University of Maine*

Joseph Walter*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

The CORE approach was created as a laboratory strategy employing Chemical Observation, Representation, and Experimentation to introduce explicit curricular scaffolding to help students create ideas about what is occurring at the atomic scale where bonding and molecular forces shape chemical results. Scientists and science educators have emphasized the vital role that analogical reasoning (including modeling) plays in the creation of these ideas, and the CORE approach is designed to help students develop this skill. The goal of this workshop is to demystify the development and use of analogical reasoning and provide information about an instructor's focus in lab when helping students develop these ideas. This will include an introduction to the CORE curriculum, several hands-on activities and some actual examples of K-12 and college students performing a CORE experiment.

The Mathematics of Change

Megan Candelaria*, Instructor of Mathematics, Laramie Community College, NASA Space Grant Consortium*

Almost everything of importance in our world is moving or changing, and calculus is the mathematical language of motion and change. Calculus provides us with the conceptual framework and many of the computational tools for the quantitative and qualitative measurement of rates of change. How do these concepts fit into a pre-calculus high school curriculum and the Common Core Standards for Mathematics? This hands-on session focuses on the essential concepts of functions and calculus and their role in high school mathematics. We will look at how we can introduce calculus concepts in a high school classroom along with critical thinking and problem solving as we investigate rich problems that explore topics from slope in context and the volume of a sphere to the Intermediate Value Theorem, Riemann sums, geometric sequences and more!

Making effective use of card sorting tasks in the science classroom

Dr. Brian Frank*, Associate Professor of Physics & Astronomy, Middle Tennessee State University*

In this workshop, participants will be introduced to a variety of card sorting tasks from our introductory physics course sequence at Middle Tennessee State University. Each task presented will highlight a different aspect of the research that informed its design, including research on student learning from multiple representations, contrasting cases, and ranking tasks. Strategies for effective facilitation will focus on making student thinking visible and making meaningful connections to prior and subsequent learning activities.

Creating Critical Thinkers & Problem Solvers Through 3-Dimensional Teaching & Learning

Jen Gutierrez*, K-12 STEM Education Specialist, integratedSTEMk12, LLC*

Young children are avid STEM investigators, eager to explore and invent. Supporting and guiding children's natural desire for sense-making can have lasting benefits. This means as educators we can introduce elements of inquiry and explanation much earlier in the curriculum to help our students develop deeper understanding. In this session participants will investigate how STEM teaching and learning using a 3-Dimensional mindset can support all students in becoming critical thinkers and problem solvers. We'll explore connections between the STEM disciplines, examine the science & engineering, math, and literacy practices, and look at some best practices that support a 3-Dimensional, phenomenon-driven learning experience.

Moving from Topics to Big Ideas: Modeling in your Science Classroom: Innovation & Creativity

Dr. Sara Hagenah*, Assistant Professor of Science Education, Boise State University*

This session will focus on rising above just teaching science content to teaching crucial scientific big ideas. Framed around the question of how can we support students in revealing ideas and modeling scientific explanations, we will engage in conversations around: What is the difference between teaching topics and teaching content set within Phenomena?

- What are the big ideas, relationships, and key ideas in the standards?
- What about the big idea would students see relevant to their lives?

From Dataset to Data Story

Bryn Keenhold*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Margo Murphy*, Teacher, Camden Hills Regional High School, Rockport*

Students are comfortable collecting data… observing, wondering…. and then it becomes about making sense of data. Once students have a table of data, chances are good that many of them won't be sure of how to proceed with turning the data into evidence as part of an investigation. In this workshop we'll work with digital tools and pedagogical strategies focused on engaging students through the process of going from a dataset to a data story. We will move through the process of turning data into evidence while engaging meaningfully in NGSS Practice 4. *Analyzing and Interpreting Data*, 5. *Using Mathematical and Computational Thinking*, and 7. *Engaging in Argument from Evidence*. Please bring computers or tablets to the session.

SAIL into Mathematics

Dr. Robert Mayes*, Professor of Middle Grades and Secondary Education, Georgia Southern University*

The workshop will provide teachers an opportunity to engage in the five ICARE tenets of SAIL: Interdisciplinary, Collaborative, Authentic, Reasoning, Education for Understanding. Teachers will participate in interdisciplinary STEM performance tasks within real world contexts such as forestry and population dynamics.

Algebraic thinking in the early grades

Dr. Franziska Peterson*, Assistant Professor of Mathematics Education & RiSE Center Member, University of Maine*

Understanding how to interpret and use expressions and equations including the nature of variables are key aspects to understanding algebra. All expressions and equations in mathematics are used to model and represent real-world problems. In the common core state standards, expressions and equations appear for 6th through 8th grade. The foundation, however, is established K-5 with properties of operations concerning whole numbers, decimals, and fractions. In this workshop, we will discuss the importance of early algebra and the nature of variables through hands-on activities and problem solving. We will also draw connections to high school algebra concepts.

Tuesday, June 26

Code for ME, CSP

Ken Akiha*, Science Teacher, Old Town High School, Old Town*

Computer Science Principles (CSP) is an accessible course designed to introduce computer science to all students. In this hands-on session, learn about code.org's innovative, free curriculum that covers topics including cybersecurity, how the Internet works, data analysis, introductory programming, and much, much more. Beginning with a sample CSP lesson, the session will then transition into an explanation of the curriculum in general along with information about professional development opportunities here in Maine to support teachers using the code.org materials. CSP can be used as an introductory computer science course, or to prepare students for the AP Computer Science Principles exam. Anyone can teach this course - a math teacher, a science teacher, even a humanities teacher!

A Workshop on Using Distance to Teach Absolute Value

Dr. Tim Boester*, Associate Professor of Mathematics & Statistics, University of Maine*

Do your students have trouble solving problems like /x – a/ = b or /x – a/ < b? Students who think about subtraction involving absolute value in terms of distances, by using story problems and number lines, solve these problems more successfully than students who use a procedural, strictly algebraic approach. This workshop will provide opportunities for the group to discuss what subtraction means here, why students have difficulty with such problems, plus examples of problems and real-world contexts that can help students build a distance-based conception of absolute value and connected, multi-representational competence with number lines and symbolism. Also covered will be the results of a study that shows how a distance-based curriculum is more successful than procedurally-based methods that focus on algebraically breaking apart the absolute value into multiple inequalities.

Launch and learn rocket workshop: Integrate science and engineering concepts in the classroom using probeware and Maker community designs

Jake Bogar*, Science & Engineering Teacher, Mt. Blue High School, Farmington*

Practice integrating the engineering design process with science and math concepts through a paper rocket design project. Build, test, fail, learn, succeed and adapt science and engineering practices used in this workshop for your students next fall. Useful, safe, and creative uses of probeware and equipment will be shared.

Minding the Gaps: What does Maine data say about how all K-12 students are learning in science and mathematics?

Laura Millay*, RiSE Research and Evaluation Coordinator and* Lauren Swalec*, Master of Science in Teaching Student, RiSE Center, University of Maine*

In this workshop, participants will review and discuss analyzed statewide data related to the socioeconomic and gender gaps in achievement in mathematics and science on the Maine Education Assessment (MEA) tests. Interest in STEM career data from the MEAs will also be presented. Participants will see ways that the Maine Elementary Sciences Partnership and Maine Physical Sciences Partnership have affected science achievement and career interests in rural Maine schools for both boys and girls. Research-supported strategies to reduce existing gaps and ways to successfully implement them will be discussed.

Proportional reasoning and problem solving in middle school

Dr. Franziska Peterson*, Assistant Professor of Mathematics Education & RiSE Center Member, University of Maine*

Proportional reasoning is a cornerstone in middle school mathematics and developing an understanding is a complex process. In this workshop we will unpack what is meant by proportional reasoning and focus on some of its different components, such as fraction interpretations, relative thinking, and quantities and change. We will work through middle school problems covering the ideas of proportional reasoning using different techniques, such as strip diagrams, ratio tables, double number lines, and graphs.

An Introduction to Jupyter Notebooks and Python Programming for Computer-based Science Instruction

Dr. Robert Pockalny*, Marine Research Scientist, Graduate School of Oceanography, University of Rhode Island*

This workshop will introduce participants to the using Jupyter Notebooks and the Python Language for basic data analysis for in-class purposes. The workshop will include the simple installation of the free software and introduce participants to the “bells and whistles” of the Jupyter Notebook. Participants will be provided basic software and access to public data to calculate sea level change at various locations in Maine, or wherever. If time permits, participants will be provided additional examples and instruction on how to manipulate and possibly write their own Python code. Potential participants are encouraged to download and install the Jupyter Notebook software at the Anaconda website (https://www.anaconda.com/download/#download) prior to attending the workshop.

Teaching the Earth & Space Sciences from the Perspective of "Scale, Proportion, & Quantity"

Dr. Nancy Price*, Assistant Professor of Geology, Portland State University*

The Earth & Space Sciences (ESS) are commonly associated with the Crosscutting Concepts of "Systems & System Models" and "Stability & Change", but the ability to think critically about Earth problems requires an understanding of scale, both spatial and temporal. Based on what is known from the education literature, the activities in this workshop will help you address the challenges and opportunities of incorporating scale when teaching ESS in your classroom.

Using Reasoning Chain Construction Tasks to Support and Explore Student Reasoning in STEM*

Dr. MacKenzie R. Stetzer*, Associate Professor of Physics & RiSE Center Member*

J. Caleb Speirs*, Doctoral Candidate in Physics, University of Maine*

Physics and physical science instructors commonly expect their students to consciously and systematically draw on their formal physics knowledge to construct chains of reasoning that start from established principles and lead to well-justified predictions. If exam performance does not seem to match such thinking patterns, it is often assumed that students either do not possess the requisite conceptual understanding or lack the reasoning skills needed to chain the appropriate ideas together. This workshop will highlight a novel methodology (the reasoning chain construction task) that allows for (partial) disentangling of reasoning approaches from conceptual understanding, thereby providing additional insight into how students reason and how they construct reasoning chains when responding to a given question. In a reasoning chain construction task, students are provided with correct reasoning elements (i.e., true statements about the physical situation as well as correct concepts and mathematical relationships) and are asked to assemble them into an argument in order to answer a science question. Given the many affordances of these chaining tasks for classroom instruction, participants will have the opportunity to collaboratively develop and discuss tasks for use in their own classrooms.

* This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431857, DUE-1431541, DUE-1431940, DUE-1432765, DUE-1432052, and DRL-0962805.

Poster Abstracts
Poster Session, Monday, June 25, 4:30-6:00 PM

Organized Alphabetically by Presenter

P1: Shearing of Triangles and Pyramids: Relationships Between Plane and Solid Figures

Camden Bock*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Pre-service elementary teachers (PSETs) have difficulties extending measurement concepts to non-prototypical figures (Tossavainen et al, 2017) which may extend into their presentation of these topics to their students (Murphy, 2012). Immersive virtual environments allow participants to engage with three-dimensional figures in their native dimension (Dimmel & Bock, 2017) and explore limits that aren't otherwise feasible with traditional physical manipulatives or dynamic geometry software (i.e. a triangle with a finite area but infinite perimeter) . We ask: How do PSETs use the affordances of Immersive virtual environments when reasoning about relationships between two- and three-dimensional figures? We report on a pair of PSETs' explorations of a triangle's area and a pyramid's volume from an on-going study.

Dimmel, J., & Bock, C. (2017). HandWaver: A gesture-based virtual mathematics making environment. Presented at the 13th International Conference on Technology in Mathematics Teaching, Lyon, France: International Conference on Technology in Mathematics Teaching.

Murphy, C., & Smith, G. (2012). The impact of a curriculum course on pre-service primary teachers' science content knowledge and attitudes towards teaching science. *Irish Educational Studies*, *31*(1), 77-95.

Tossavainen, T., Suomalainen, H., & Mäkäläinen, T. (2017). Student teachers' concept definitions of area and their understanding about two-dimensionality of area. *International Journal of Mathematical Education in Science and Technology*, *48*(4), 520–532. https://doi.org/10.1080/0020739X.2016.1254298

P2: Calculus Students' Knowledge of Implicit Differentiation

Connor Chu*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Dr. Natasha Speer*, Department of Mathematics and Statistics & RiSE Center Member, University of Maine*

It is well known that Calculus stands as a hurdle to aspiring STEM majors. Among the topics in Calculus, differentiation has been found to be particularly difficult for students. While there is a body of literature available on this topic in general, there is little to no research on implicit differentiation. Implicit differentiation is a process in which one takes the derivative of both sides of an equation with respect to a variable. This allows one to find the derivative of any equation, written explicitly or implicitly, and is necessary later down the road in Calculus, for

example, when finding related rates. The goal of this study is to help fill this void by examining calculus students' successes and difficulties when prompted with implicit differentiation tasks. In order to attempt this, five introductory calculus students were interviewed. Students' verbal and written responses were analyzed. Responses were used to categorize student knowledge of implicit differentiation itself and prerequisite topics. It was found that students' success on implicit differentiation tasks seems to depend on their understanding of derivative concepts.

P3: Secondary Mathematics Teachers' Definitions of Algebra & Geometry and their Implications for Teaching the Usefulness of Mathematics

Jennifer Dunham, *Masters of Science in Teaching Student, RiSE Center, University of Maine*

Dr. Natasha Speer*, Department of Mathematics and Statistics & RiSE Center Member, University of Maine*

Despite both the Common Core State Standards for Mathematics and the National Council of Teachers of Mathematics' Standards calling for integration of algebra and geometry, little is known about how teachers define these areas of mathematics and whether they see them as connected or separate disciplines, and how those definitions impact their strategies for teaching the usefulness of mathematics. One strategy for demonstrating its usefulness is to employ real-world examples and applications in the classroom. This study examines both pre-service and in-service teachers' beliefs and knowledge related to how they define algebra and geometry, and the kinds of connections they draw between each subject and the real world.

P4: Celestial Navigator: A Telescope for the Virtual Universe

Cody Emerson, *Research Assistant*, *Immersive Mathematics in Rendered Environments Lab, University of Maine*

Astronomy education tools have long been limited to 2-dimensional or spherical surfaces, resulting in a lack of immersion in the exploration of space. Immersive spatial displays offer the ability for students to be fully immersed in a three-dimensional space (Dimmel & Bock 2017). This allows students to be "embodied" within a scene, giving native control over both perspective and scale, that could never be obtained in reality yet can be operated fluidly as though they were actually present. (Liu, Dede, Huang, & Richards 2017). How might students use these affordances of immersive spatial displays to make sense of astronomical objects using simulated virtual representations? We will report on the development of a hybrid of celestial body simulation and dynamic geometric interaction software that will allow us to study students' immersive explorations with virtual representations of celestial bodies.

Dimmel, J., & Bock, C. (2017). HandWaver: A gesture-based virtual mathematics making environment. Presented at the 13th International Conference on Technology in Mathematics Teaching, Lyon, France: International Conference on Technology in Mathematics Teaching.

Liu, D., Dede, C., Huang, R., & Richards, J. (2017). Virtual, Augmented, and Mixed Realities in Education.

P5: Relating Perspectives: Continuous Scaling of a Solar System Model

Joseph Haney*, Undergraduate Research Assistant, Immersive Mathematics in Rendered Environments Lab, University of Maine*

Immersive spatial displays (Dimmel & Bock, 2017) have been used to model systems of various scales, from cellular to interplanetary (The Body VR, 2016; Giant Army, 2015). However, few of these environments are designed to relate experiences at different scales. Geometer's Planetarium is a virtual environment where users can explore geometric relationships between the earth and celestial bodies. This environment could be supported by a mechanism for relating perspectives at human-scale on the surface of the earth to perspectives where the entire solar system is within arms reach. We will report on the ongoing development of an environment where we can study students' understanding of continuous transformations of scale in immersive spatial displays using linear, exponential and logarithmic conditions.

Dimmel, J.K., & Bock, C. (2017). HandWaver: A Gesture-Based Virtual Mathematical Making Environment. In G. Aldon & J. Trgalová (Eds.), Proceedings of the 13th international conference on technology in mathematics teaching (pp. 323 – 330). Lyon, France: École Normale Supérieure de Lyon.

The Body VR [Computer Software] (2016). The Body VR: Journey Inside a Cell. Giant Army [Computer Software] (2015). Universe Sandbox.

P6: University Professors' Meanings for Average Rate of Change and their Impacts on Student Feedback

Ian Thackery*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Previous research that has used Thompson's mathematical "meanings" framework has focused on secondary teachers' meanings for mathematics. We examine the meanings that graduate students and professors hold for average rate of change. Further, we attempt to connect meanings to the facets of student work that graduate students and professors notice. This work lets us start to extend the meanings framework and has implications for graduate student professional development.

P7: The Role of Quantitative Reasoning in Science Understanding: An interdisciplinary investigation through Data Story assignments

Bryn Keenhold*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

In a data-driven world, it is necessary that students graduate high-school as quantitative literate citizens who have the ability to interpret quantities within a context to make informed decisions for their lives. Many organizations have called for a greater presence of quantitative reasoning (QR) throughout K-16 education. A critical component of science learning is developing the ability to make sense of data, critically evaluate it, and effectively communicate scientific ideas. Data stories, by nature are interdisciplinary, bringing QR skills into a science classroom and encouraging students to explore authentic, real-world scientific data; thus, bridging many important, and often missing pieces of a students' education together. This research project explores how 9th grade students' QR skills impact scientific understanding during the creation of data story assignments. Two evidence-based learning progressions provided the foundation for the development of two rubrics to score the student data stories. Preliminary results suggest: (1) students who score low on the CER rubric also score low on the QR rubric and (2) students avoid appropriate quantitative accounts or focus on case values that do not represent the data as an aggregate, perhaps suggesting they cannot fully conceptualize the scientific phenomena.

P8: Using Data to Revise Content Surveys in the Maine STEM Partnership

Laura Millay*, RiSE Research and Evaluation Coordinator, RiSE Center, University of Maine*

Adam Rogers*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Each year, the Maine STEM Partnership (MSP) administers science content surveys to students in its three curricula, pre- and post-instruction. Our community uses the data from these surveys to better understand how students think about the content in their curriculum. In part, these surveys help us make curricular and instructional decisions based on our students' thinking. While our community's curricula and instruction change based on these data, so do the surveys themselves. We revise the surveys each year with the goal of developing a deeper understanding of students' conceptual ecologies, while considering our analysis capabilities and evolving needs as a community. Following some examples of revisions from year-to-year, this poster describes the process of revising the content surveys. In each of these examples, the evolution of the questions was driven by a variety of findings from the data analyses.

P9: Understanding Student Development of Science Literacy Skills in an Undergraduate Environmental Science Course

Molly Picillo*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Science literacy is a term that covers the suite of skills pertaining to the use of science in everyday life. These skills are becoming ever more important in a society driven by conflicting data, views, and opinions. As such, it is important to utilize formal education settings to impart these skills upon students to ensure that they become scientifically literate citizens capable of making informed decisions. The aim of this study was to improve students' science literacy skills through the development of science literacy interventions that could be easily inserted into college curricula. The interventions were: (1) An interactive clicker-based lesson involving graph selection methods; (2) Data summits involving graph interpretation and source evaluation; and (3) A role-play, after which students discussed sources of bias. I measured effectiveness of the interventions using the Test of Science Literacy Skills (TOSLS) pre- and post-survey scores, as well as student feedback from post-survey, follow-up interviews. Results indicated no statistically significant changes between the pre-survey and post-survey, which suggests more work is necessary to provide instructors with impactful science literacy interventions.

P10: Calculus 1 at the University of Maine: Incorporating the Characteristics of Successful Programs in College Calculus

Dr. Natasha Speer, *Professor Mathematics and Statistics & RiSE Member, University Of Maine*
Jen Tyne*, Lecturer of Mathematics and Statistics, University of Maine*

Extensive work in MAT126 (Calculus 1) has been underway in our department for the past two years. Starting an effort to provide more coordination for sections, many which were being taught by new rotating faculty, we focused at first in creating learning objectives for the course. The initiative expanded into a broader look at Calculus 1 in the context of the Mathematical Association of America's (MAA) study of "Characteristics of Successful Programs in College Calculus" (Bressoud & Rasmussen, 2015). Seven characteristics were identified in the MAA study: Coordination of instruction, including the building of communities of practice; Construction of challenging and engaging courses; Use of student-centered pedagogies and active-learning strategies; Effective training of graduate teaching assistants; Proactive student support services, including the fostering of student academic and social integration. These characteristics are the focus of our efforts in Calculus 1. The initiative is made possible in part by funding from the Provost's Office through the Digital Fellows Project.

P11: Investigating student reasoning chains via network analysis*

Dr. MacKenzie R. Stetzer, *Associate Professor of Physics & RiSE Center Member*

J. Caleb Speirs*, Doctoral Candidate in Physics, University of Maine*

Dr. Beth A. Lindsey*, Associate Professor of Physics, Penn State Greater Allegheny*

Dr. Eric Brewe*, Associate Professor of Physic and Science Education, Drexel University*

Students are often asked to construct qualitative reasoning chains during scaffolded, research-based physics instruction. As part of an ongoing, multi-institutional effort to investigate and assess the development of student reasoning skills in physics, we have been designing tasks that probe the extent to which students can create and evaluate reasoning chains. We have recently reported on a novel online "chaining" task in which students are provided with correct reasoning elements (*i.e.,* true statements about the physical situation as well as correct concepts and mathematical relationships) and are asked to assemble them into an argument that they can use to answer a specified physics problem. This poster will illustrate the role that network analysis techniques may play in extracting meaningful information about student reasoning from these chaining tasks.

* This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1431857, DUE-1431541, DUE-1431940, DUE-1432765, DUE-1432052, and DUE-0962805.

P12: The High School to First-Year College Instructional Transition: An Investigation of STEM Students' Expectations and Experiences

Emma Toth*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Dr. MacKenzie R. Stetzer, *Associate Professor of Physics & RiSE Center Member, University of Maine*

Dr. Marilyne Stains*, Associate Professor of Chemistry, University of Nebraska-Lincoln*

Dr. Brain Couch*, Assistant Professor of Biological Sciences, University of Nebraska-Lincoln*

Dr. Michelle Smith*, Associate Professor of Biology, & RiSE Center Member, University of Maine*

Recent national reports have cited ongoing issues in undergraduate STEM education. Fewer than half of first-year undergraduate students who start in STEM fields have graduated with a STEM degree six years later. Most of this attrition occurs between the first and second year of college, and students often cite instructional practices used in introductory college courses as a prominent reason for leaving. Furthermore, students from backgrounds that are underrepresented in STEM fields, including first-generation college students, leave STEM majors at higher rates than their classmates. Recent data suggest that the instructional practices used in introductory college STEM courses differ significantly from those used in high school science classes and that incoming college students hold expectations that are often not well aligned with actual instructional practices. To more fully understand this trend, data were collected from online surveys given to students enrolled in large introductory STEM courses. These surveys asked students about their expectations regarding the teaching practices used in undergraduate courses

and any differences they perceived between their high school and college STEM courses. This research will report specifically on whether specific student backgrounds, such as being first-generation, alter these expectations.

P13: The role of metacognition in troubleshooting: an example from electronics*

Dr. Kevin L. Van De Bogart*, Post Doc of Physics, University of Maine,*

Dr. Dimitri R. Dounas-Frazer*, Senior Research Associate of Physics, University of Colorado Boulder,*

Dr. H. J. Lewandowski JILA*, Associate Professor of Engineering Physics, University of Colorado Boulder*

Dr. MacKenzie R. Stetzer, *Associate Professor of Physics & RiSE Center Member, University of Maine*

Students in physics laboratory courses, particularly at the upper division, are often expected to engage in troubleshooting. Although there are numerous ways in which students may proceed when diagnosing a problem, not all approaches are equivalent in terms of providing meaningful insight. It is reasonable to believe that metacognition, by assisting students in making informed decisions, is an integral component of effective troubleshooting. We report on an investigation of authentic student troubleshooting in the context of junior-level electronics at two institutions. Think-aloud interviews were conducted with pairs of students as they attempted to repair a malfunctioning operational-amplifier circuit. Video data from the interviews have been analyzed to examine the relationship between each group's troubleshooting activities and instances of socially mediated metacognition. We present an analysis of a short episode from one interview.

*This material is based upon work supported by the National Science Foundation under Grant Nos. DUE-1323426, DUE-1245313, DRL-0962805, and DUE-1323101.

P14: CourseSource: Evidence-Based Teaching Resources for Undergraduate Biology Education

Erin Vinson*, Campus Programs Coordinator, RiSE Center & School of Biology and Ecology, University of Maine*

Dr. Michelle Smith*, Associate Professor of Biology, & RiSE Center Member, University of Maine*

Dr. Jessamina Blum*, Education Program Specialist & Managing Editor CourseSource, The Department of Biology Teaching and Learning, University of Minnesota*

Fostered by reports such as the AAAS Vision and Change and Engaged to Excel, changes in the way colleges and universities are approaching their undergraduate STEM courses can be observed nationwide. Change has come in the form of initiatives dedicated to advancing evidence-based science education practices, research-based undergraduate courses, and other efforts that aim to provide educators with the tools and strategies needed to transform their classrooms.

One stumbling block in the process of this transformation is the time and energy commitment, which can be substantial, needed to produce evidence-based active-learning materials. In response to this need, and recommended in the Vision and Change report, an effort was undertaken to create a peer-reviewed, open access journal of student-centered biology education resources: CourseSource.

CourseSource is an open-access, online journal of peer-reviewed undergraduate biological teaching materials that:
● Incorporate student-centered, evidence-based pedagogy;
● Focus on professional society-developed learning goals and objectives for the major subfields of biology (e.g., ecology, developmental biology, genetics);
● Are organized and formatted so that transfer and use in other classrooms is easily done.

CourseSource provides biology educators with tested, evidence-based activities designed by fellow educators that make difficult concepts accessible to undergraduates using a variety of strategies. Conversely, CourseSource provides authors with the opportunity to publish teaching materials in a high-quality, peer-reviewed format that documents their scholarly teaching efforts.

P15: CORE: Using analogical reasoning in lab to foster macroscopic-submicroscopic connections

Joseph Walter*, Masters of Science in Teaching Student, RiSE Center, University of Maine*

Dr. Mitchell Bruce, *Professor of Chemistry & RiSE Center Member, University of Maine*

Prior studies show that many students have difficulty in coordinating ideas across macroscopic, submicroscopic and representational levels. This is problematic in the intro chemistry lab where interpretation requires thinking about nonobservable entities like atoms and molecules. Analogical reasoning is considered an essential skill to connect macroscopic and submicroscopic

domains. The **CORE** laboratory learning cycle (**C**hemical **O**bservations, **R**epresentations, **E**xperimentation) involves: making chemical observations (phase 1); using analogical reasoning to explore a representation (phase 2); and designing experiments (phase 3). This poster presents preliminary findings from the first year of an NSF-sponsored research study, which is designed to answer: 1) How do students use analogical reasoning in constructing scientific arguments related to chemistry lab work? and 2) How does repeated exposure to CORE experiments influence students' abilities to coordinate ideas across macroscopic, submicroscopic and representational levels? A cohort of 27 undergraduate students in a first semester general chemistry lab course were selected to participate. The study employed 3 surveys to characterize 1) prior experience with inquiry-based labs; 2) operational level of thinking (GALT) and 3) meaningful learning in the laboratory (MMLI). Student pre-lab assignments, lab notebooks, and lab reports are being examined and preliminary findings will be described.

Speakers and Workshop Facilitators

Alphabetically Ordered by Last Name

Patsy Adams
5th Grade Teacher
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Patsy Adams has been a 5th grade teacher at Pittston Consolidated School in Pittston, Maine for the past 13 years. She received an Art History Degree from the University of Southern Maine, a MS in K-8, Special Education as well as a CAS from the same university. She has been involved with the RiSE Center PD for the past four years.

Ken Akiha
High School Earth Systems Science/Computer Science Teacher
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Ken has been teaching science and math for 7 years in Boston and Maine. Currently, he teaches Earth Systems Science and AP Computer Science at Old Town High School. Although he never studied computer science formally as a student, he has always been interested in it and getting the opportunity to teach it has helped him discover a passion he didn't know he had. He has used many online resources, including the ones he uses with his students, to teach himself as much as he can about computer science and coding. In addition, he is excited about helping with the work of spreading computer science education at Old Town High School, across the state of Maine, and nationally. To Ken, all of this work feels like it is just getting started and he can't wait to see where it goes. Ken holds a M.S. in Teaching from the University of Maine and is a trained Code.org facilitator. In his free time, Ken trains for and competes in road races from 5ks to marathons, watches his hometown team, the Golden State Warriors, win championships, and builds endless toy train tracks with his two year old son.

Jake Bogar
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Jake Bogar teaches physics and engineering classes at the Mt. Blue Campus in Farmington, Maine. He earned a B.S. in Mechanical Engineering from the University of Maine and a M.S. in Education from the University of Maine, Farmington. He enjoys engaging students in creative, meaningful, integrated projects in and outside of the classroom.

Tim Boester
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After receiving a bachelor's degree in mathematics from the University of Chicago, Tim transitioned to studying mathematics education at the University of Wisconsin-Madison. He received a Ph.D. in educational psychology and a masters degree in mathematics based on his research studying how students conceptualize limits in undergraduate calculus classrooms. His work has taken him to Wright State University, The University of Illinois at Chicago, and starting in Fall 2018, The University of Maine. Tim is also an accomplished puzzle writer, writing the “Knossos Games” column in *Imagine* magazine for 25 years, and enjoys hiking, baking, and watching movies (not all at once).

Alice Bruce
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Alice Bruce is a Professor of Chemistry at the University of Maine. She earned her BS degree in chemistry from Antioch College in Yellow Springs, Ohio and then went on to earn a PhD in chemistry from Columbia University. She took a postdoc position at the University of North Carolina, Chapel Hill, where in addition to research, she had the opportunity to teach introductory chemistry. She will be the Chair of the Chemistry department next year, is interested in improving learning outcomes in introductory chemistry courses and is Co-PI of the NSF sponsored project involving the CORE learning cycle. Alice has a passion for horses and can be seen riding in Orono.

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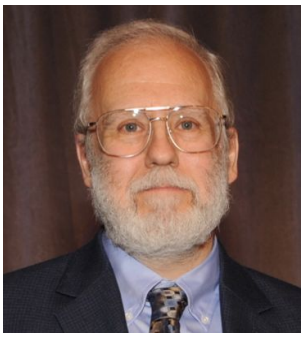

Mitchell Bruce is a Professor of Chemistry and a founding member of the RiSE Center at the University of Maine. Mitchell earned his BS degree in chemistry from Antioch College in Yellow Springs, Ohio. He went on to earn his PhD in chemistry from Columbia University, followed by a postdoc at the University of North Carolina, Chapel Hill. As a chemical education researcher, Mitchell is interested in fostering the skill of thinking at the atomic scale, teacher professional development workshops involving inquiry, and strategies involving active-learning, assessment, and problem-solving. Mitchell plays ice hockey year-round and loves alpine skiing in the winter.

Megan S. Candelaria
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Megan S. Candelaria, a life-long Wyoming resident, grew up in Sundance, Wyoming, the small-town that gave Henry Longbaugh the moniker "The Sundance Kid." Although she began her university career as a pre-law major, reading her first law brief quickly dissuaded her of that idea and she eventually fell into a physics/mathematics major. Mega received a BS in mathematics and physics (2006), a Masters in mathematics (2009), and is currently finishing a PhD in Mathematics Education at the University of Wyoming. Her research focuses on pre-service mathematics courses for teachers and answering the question: How can we encourage deep understanding of (and enthusiasm for!) mathematics in our teachers? Megan is currently a faculty member of Laramie County Community College where she teaches everything from college algebra to differential equations. Megan also works for the Wyoming NASA Space Grant Consortium coordinating STEM outreach efforts in the state of Wyoming. Megan currently lives in Laramie, Wyoming. with her husband, Reynold and 2 year-old son Maxx as well as the family's two dogs, and a crazy cat affectionately nicknamed 'the Monster.' She's an animal lover, an outdoor enthusiast, and a bibliophile. In her free time, she enjoys epically failing at various Pinterest projects.

Dr. Brian Frank
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Brian Frank is an associate professor of physics and astronomy at Middle Tennessee State University. He earned his doctorate degree in physics from the University of Maryland in 2009 and subsequently worked as a post-doctoral researcher at the University of Maine, working in both the Physics Education Research Laboratory and the RiSE Center. As an education researcher, Brian is interested in studying the development of deep engagement in science and how instruction can support students in seeing and making use of science in their everyday lives. As an educator, he is dedicated to the preparation and of future physics teachers and to the pursuit of ethical and responsible physics instruction.

Jen Gutierrez
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"As a teacher and professional development provider I continue to find that all roads in science and STEM education lead back to the classroom teacher." Jen is enjoying a 29+ year career in education which has included K-4 classroom teacher, K-12 district science specialist, and K-12 STEM education specialist. Her passion is supporting educators in their science and STEM teaching and learning pursuits. Jen is a member of the Next Generation Science Standards writing team, including the Diversity & Equity team. She serves on the Arizona Science Teachers Association Executive Board and the National Science Teachers Association Board as Division Director of Professional Development.

Dr. Sara Hagenah
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Sara Hagenah is an Assistant Professor of Science Education in the Department of Curriculum, Instruction, and Foundational Studies at Boise State University. Her research is deeply engaged with informal and formal school-community networked improvement community partnerships and aims to collaboratively advance ambitious and equitable science teaching and learning. Her expertise lies in designing curriculum and leading job-embedded professional development that focuses on responsive science teaching and learning opportunities. Sara received her Ph.D. in Curriculum and Instruction: Science Education from the University of Washington.

Bryn Keenhold
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Bryn Keenhold is an MST student at the University of Maine. She earned her bachelor's degree from St. Lawrence University in Geology where she studied the movements of the Laurentide Ice Sheet, north of the Adirondacks. Before returning to school for her masters, she worked as an Interpretive Ranger for the National Park Service, and spent time teaching outdoor education. Currently, she is interested in how students analyze and interpret data in real-world contexts, and is investigating how students use quantitative reasoning skills in a science setting.

Dr. Robert Mayes
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Robert Mayes received his B.S. (1979) and M.S. (1981) in Mathematics Secondary Education from Emporia State University and Ph.D. in Mathematics Education from Kansas State University (1989). He taught mathematics on the high school, community college, and university levels. In his tenures at West Virginia University, University of Wyoming, and University of Northern Colorado he specialized in teaching mathematics for teachers through distance education programs, served as Co-PI on three major NSF grants and an Upward Bound Mathematics and Science grant, and wrote ACT in Algebra, a text for an applied technology driven college algebra course. He has been the Director of four science and mathematics education institutes, the most recent being the Institute for Interdisciplinary STEM Education at Georgia Southern University. He has expertise in interdisciplinary STEM education and quantitative reasoning and is partnering on an undergraduate Quantitative Biology project called QUBES.

Laura Millay
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Before joining the RiSE Center as a Master of Science in Teaching student, Laura grew up in rural Maine, travelled and studied abroad, ran an organic farm business, founded two non-profit organizations and graduated with a B.A. in Development Studies from Brown University. Currently, Laura coordinates education research and evaluation projects. Her personal research interests include knowledge for assessment (K4A); specifically, the knowledge teachers use when planning and implementing classroom formative assessment. This topic is the subject of her in-progress MST thesis. Laura is also interested in using clustered misconceptions-based questions to probe student thinking and learning about various topics in science, developing methods for analyzing and using data to inform classroom instruction in real-time, building professional communities with a capacity to gather and use data as meaningful evidence, methods for measuring learning among students and teachers, and the nature of evidence when making claims about changes (or not) in attitudes, achievement, thinking, and learning.

Margo Murphy
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Margo Murphy is in her 10th year as a teacher at Camden Hills Regional High School, in Rockport, ME. She currently teaches global science, an integrated freshman course focused on a systems approach to understanding the Earth, AP Environmental Science and Sustainable Agriculture. In addition to teaching, Margo has served as advisor to the Camden Hills Windplanners. This student group has helped move CHRHS to becoming one of the leaders in renewable energy and energy efficiency. Prior to coming to Camden Hills Regional, Margo taught science for 22 years at Georges Valley HS where she served as department chair, K-12 science team facilitator, HS-MLTI teacher leader, NCLB teacher quality PD coordinator, and Eisenhower/Title II coordinator. Murphy has served on numerous local and state committees, and was a member of the Board on Science Education at the National Academies from 2004 – 2006 where she was involved with the development of Taking Science to School and Ready, Set, SCIENCE! She has been a member of the Academies Teacher Advisory Council (TAC) since 2011. In 2003 and 2013, she became a national board certified teacher in Earth and Space science. She received the Presidential Award for Excellence in Mathematics and Science Teaching in 1994. In 2013 she received the Presidential Innovation award for Excellence in Environmental Education. In 2017, she received the national Outstanding Environmental Educator from Seaworld and the National Science Teacher's Association. Also in 2017 she was selected as a national NSTA/ NCTM STEM Ambassador to promote STEM education in the USA. Margo has received several additional awards from the Maine Science Teachers Association, the American Geologic Society, Maine Environmental Association, and the Maine Association of conservation districts. Margo received her B.S. in forest management in 1985, and her M.Ed. in secondary science education in 1992, both from the University of Maine, Orono.

Dr. Franziska Peterson
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Franziska Peterson is an Assistant Professor of Mathematics Education in the Department of Mathematics and Statistics at the University of Maine and a member of the RiSE Faculty. She earned her bachelor's and master's degrees in Secondary Education with double majors in mathematics and English in Germany. In 2016, she received her Ph.D. in Mathematics Education from the University of Wyoming. Currently, professor Peterson is investigating pre-service elementary teachers' (PSETs) understanding of statistical representations by engaging PSETs in a semester-long data collection, analysis, and interpretation project. Additionally, she is working on investigating the role of quantitative reasoning in interdisciplinary contexts. Students sometimes display difficulties transferring mathematical concepts to their science classrooms or vice versa. Quantitative reasoning can be an important factor in creating interdisciplinary bridges.

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Rob Pockalny is a Marine Research Scientist at the Graduate School of Oceanography at the University of Rhode Island. He earned a BA in Geology at SUNY Buffalo 1984 and a PhD in Oceanography at the University of Rhode Island in 1990. Rob has participated in over 25 research cruises involving seafloor mapping, ocean drilling, HOV Alvin dives, and ROV Jason deployments. His research interests and experience span a broad range of scientific and educational topics. His scientific interests include plate tectonics, subseafloor biosphere, and coastal circulation. His educational interests include professional development of K-20 educators, developing computer-based science curriculum, and the scalability/portability of science curriculum.

Dr. Nancy Price
Assistant Prof. of Geology
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Dr. Nancy Price was formally trained as a geologist and has come to science education through K-12 STEM education policy. Following her graduate research, she was an earth science consultant for Achieve, Inc., working on NGSS-Common Core sample assessment tasks and advising on the development of the NGSS-ESS evidence statements and model course bundles. She is currently at Portland State University in Oregon doing both research on deformed rocks and supporting science education. Much of the knowledge from the geoscience research and education communities is inaccessible to the larger K-12 science education community at a time when the need for this information is great; Dr. Price is working to bridge the gap. Her projects have focused on communicating the Nature of Science of the earth sciences using the language of the NGSS and bringing an understanding of novice-to-expert progressions to the teaching of "science as practice".

J. Caleb Speirs
Doctoral Candidate, Department in Physics
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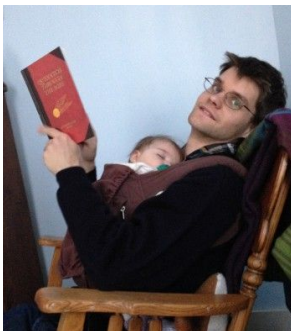

Caleb Speirs is a Research Fellow and Doctoral Candidate in the Physics and Astronomy Department at the University of Maine. He has a M.S. in Applied Physics and a B.S. in Engineering Physics from the Colorado School of Mines, having done work in the field of scanning laser microscopy. He has taught physics at various community colleges in the greater Denver area and at College of the Atlantic in Bar Harbor, Maine.

MacKenzie Stetzer
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MacKenzie R. Stetzer is an Associate Professor of Physics at the University of Maine and a member of the RiSE Faculty. He has been involved in developing research-based and validated instructional materials for undergraduates and K-12 teachers since 2001, while working with the Physics Education Group at the University of Washington as a Postdoctoral Research Associate and then as a Research Assistant Professor. A primary focus of his work has been an in-depth, multi- institutional investigation of student understanding of analog electronics and the associated development of research-based instructional materials. Another ongoing research effort has been examining the roles of metacognition and reasoning in student learning in physics. He has also been involved in observation-based efforts to transform instructors' practices and has extensive experience in the preparation and professional development of undergraduate LAs, graduate TAs, K-12 teachers, and college instructors.

Lauren Swalec
Graduate Student
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Lauren is a Masters of Science in Teaching Student through the RiSE Center and a National Science Foundation Teaching Fellow. She is currently applying for teaching jobs and she hopes to teach high school math or chemistry. Previously Lauren earned a Bachelor's of Science in Chemical Engineering and a Master's of Science in Fire Protection Engineering both from Worcester Polytechnic Institute.

Joe Walter
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Joe Walter is a graduate student studying at the University of Maine with the RiSE Center and working on the NSF sponsored project involving the **CORE** learning cycle. He earned his BS degree in Biochemistry and Human Biology from the University of Southern Maine. He spent a semester working with Mad Science of Maine and intends to join Maine's education system as a teacher in STEM upon graduating the MST program. Joe builds (wobbly) bookcases to house his wife, Karissa's extensive library and watches LCS. In the future, he plans to have a productive vegetable garden and coach a high school e-sports team.