RISE
MAINE CENTER FOR RESEARCH IN STEM EDUCATION

MAINE STEM PARTNERSHIP

1865 THE UNIVERSITY OF MAINE

Maine Center for Research in STEM Education (RiSE Center)

Annual Report

July 1, 2019 – June 30, 2020

Front cover photos from left to right:

Row 1:

A. Maine middle school students investigate transects as part of an integrated computer science and ecology unit developed through a research-practice partnership as part of the RiSE Center's STEM+C project.

B. Participants pose for a group photo at the end of Dr. Franziska Peterson's popular week-long summer content immersion for mathematics teachers at Estabrooke Hall in Orono, Maine.

C. Teachers, faculty, staff, and graduate assistants collaborate in Estabrooke Hall to integrate computer science into middle school science lessons. Photo credit to UMaine marketing.

Row 2:

A. RiSE faculty and staff collaborate with education research partners from University of New Hampshire and University of Vermont as part of an NSF project (with PI Weiskittel) to expand data collection and modeling of northern forests. The RiSE Center leads the three-state education research team for this project, which involves more than 30 faculty across 3 states.

B. NSF Teaching Fellows, mentors, and program staff pose for a group photo during a summer session to plan Fellowship projects focused on supporting improvements in classroom practices for the coming year.

Row 3:

A. RiSE faculty member Prof. Asli Sezen-Barrie poses with collaborators, teachers from rural Maine and New Hampshire, at the Mount Washington Observatory during work to develop educational units on extreme weather events to support teaching and learning of data practices. Since the pandemic, the group has begun work on remote versions of these lessons.

B. Faculty and staff listen to remarks by President Ferrini-Mundy as part of the first faculty showcase of course modifications made through the FIG-MLA program. This exciting event was organized by Erin Vinson and the FIG-MLA Leadership Team and was an opportunity for FIG faculty to share student and course outcomes resulting from their evidence-based course reforms.

Row 4:

A. Over 100 K-12 and university educators, education researchers, staff, and collaborators, attended the Maine STEM Partnership's annual Summit in Rockport, Maine. This year's Summit provided workshops through the RiSE Center's STEM+C and NSF Fellowship Projects, and the FIG-MLA Program.

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I. Executive Summary

Accomplishments and Highlights. The Maine Center for Research in STEM Education (RiSE Center), with its nineteen faculty members, over thirty graduate students in the Master of Science in Teaching (MST) Program, and six professional staff, has had another outstanding year of research productivity, with 18 refereed journal articles and conference proceedings, 1 book, 2 book chapters, and 4 policy reports published or accepted for publication and over 70 research presentations at conferences and other venues. Graduate and undergraduate students are integral to the center's research and, in the past year, 4 Master's theses and 11 honors theses and senior capstone research projects were completed mentored by RiSE faculty members. Four MST degrees were awarded through the RiSE Center. RiSE faculty are Principal Investigator or Co-Principal Investigator on 11 new and 21 continuing grants totaling over $14.2 million. These grants span the spectrum from basic to applied research in teaching and learning and many involve multi-institutional and multi-state partnerships. RiSE plays a significant part in three newly funded large partnership grants spanning institutions and disciplines, bringing to these projects a focus on discipline-based education research and its applications to teaching and learning. RiSE personnel supported submission of over $7.8 million in new grant proposals in the past year as either PI or Co-PI and also worked closely with new faculty on career grants and through panel presentations to share their grant writing experiences and knowledge.

The RiSE Center has continued to take important steps to sustain and enhance the Maine STEM Partnership at the RiSE Center, a statewide STEM education improvement community for PK-16+ educators, with over 765 Maine science and mathematics teachers actively attending extensive professional learning opportunities in the past year. These PK-12 opportunities were supported by one new and two continuing grants, contributions totaling over $91,500 from school districts, and major donations totaling more than $314,000. With the onset of the pandemic and the closing of school buildings, RiSE expanded its work with teachers, convening groups of teachers to share strategies and develop plans for teaching remotely. It also worked closely with the MST student teachers and their mentors, to ensure that all would be able to meet Maine Department of Education requirements for a fifteen-week internship even with school building closures. Virtual professional learning opportunities were very well received by teachers, and RiSE has planned and begun summer offerings totaling over 5000 teacher-hours of summer professional learning, all of which includes strategies for remote and hybrid modes of instruction. The Maine STEM Partnership also includes the Faculty Course Modification Incentive Grant – Maine Learning Assistant (FIG – MLA) Program which, in the past year, involved 42 University of Maine faculty across 15 STEM departments, offering 142 MLA positions and enhancing 38 course offerings with total enrollment of over 5,500 students. Supports were provided to faculty and MLAs in this program during the transition to remote instruction, and end-of-semester student and faculty surveys indicated the strong value of MLAs in the spring semester, with its combination of face-to-face and remote learning.

The prestigious NSF Teaching Fellowship Program, designed to help meet Maine's workforce need for science and mathematics teachers in high-need districts, completed its recruitment of 21 fellows, with 13 of the fellows teaching in high-need districts and 8 preparing through the MST Program to begin teaching in fall of 2020. These new STEM teachers are working with experienced teachers to co-design engaging, content-packed, remote STEM learning experiences aligned with state and national standards. These lessons will be reviewed teachers, administrators, and faculty, and then broadly disseminated.

RiSE faculty member **Sara Lindsay** was awarded the Presidential Teaching Award and RiSE Research and Evaluation Coordinator **Laura Millay** was awarded a Presidential Fellowship to provide leadership in expanding and supporting research-practice partnerships and attacking structural racism and other barriers to a fully inclusive campus community. MST graduate **Jeremy Bernier** was recognized as the Outstanding MST Graduate in May, 2020.

Challenges. The RiSE Center faces urgent challenges connected with its rapid grant-funded growth as a center. First is the need for an assistant director. This base-budgeted position is essential for RiSE sustainability, growth, and development of a succession plan. Second, RiSE needs budgeted bridge funding to ensure that its excellent, largely grant-funded professional staff members, are retained.

Goals for the coming year. A major goal is to address the urgent challenges above. Additional goals are described below.

II. ACCOMPLISHMENTS: (Numbers in parentheses refer to the subgoals in the University's *Strategic Vision and Values Framework.)*

Goal 1- Support and grow Maine's economy. The RiSE Center continued to make significant contributions throughout the year to Maine's economy through its research, partnerships with educators to improve STEM education, and preparation and professional learning experiences for educators in the STEM disciplines. RiSE adapted quickly to the pandemic, resulting school closures, and work-from-home requirements, maintaining its regular academic and research schedules using virtual platforms. It also immediately began convening groups of teachers to co-develop strategies for on-line instruction and to learn from each other. Through its Faculty Course Modification Incentive Grant – Maine Learning Assistant Program (FIG-MLA Program), RiSE provided support to STEM faculty transitioning to remote instruction and provided strategies that MLAs could use to help them. Convening these groups and providing targeted resources for STEM teaching and learning were invaluable to Maine STEM educators PK-16+. All 60 undergraduates and 15 graduate students employed by the RiSE Center were able to continue working without reduction in hours even after the transition to remote instruction and work. RiSE supports all of its full-time Master of Science in Teaching students with graduate assistantships, thus reducing student debt, and has awarded 21 NSF Teaching Fellowships, eight new ones this year, ($50,000 per fellow over five years) to MST students who commit to teaching in high-need Maine districts for at least four years after graduation. (1.1.4, 1.1.5, 1.1.6)

RiSE faculty, professional staff, and students published or have had accepted for publication 18 refereed journal articles and conference proceedings, 1 book, 2 book chapters, and 4 policy reports in the past year. Of these, 44 % include UMaine students as co-authors (names bolded in Appendix I). **Prof. Natasha Speer** co-authored, with David Kung, the book What Could They Possibly Be Thinking !?! Understanding your college math students, published by the Mathematical Association of America. MST graduates **Rachel Short** and **Marina Van der Eb**, along with **Prof. Susan McKay**, published their findings in the Journal of Educational Research showing the positive effects of productive talk on students' subsequent explanations of claims, evidence, and reasoning. **Profs. Justin Dimmel and Eric Pandiscio** published three manuscripts contributing to understanding of spatial inscriptions as mathematical representations. (1.1.1, 1.1.3, 1.1.4, 1.1.5,1.2.1, 1.2.3, 1.2.4)

RiSE faculty have served as PI or CoPI on 11 new grants, totaling $3,873,462, and 21 continuing grants, totaling $10,296,948. Four new grants launched in the past year involve large, multi-institutional partnerships: **Prof. John Thompson** was awarded a grant, with colleagues at California State University – Fullerton and North Dakota State University, to study student reasoning about mathematics in physics. **McKay** has provided leadership for RiSE work in the Maine EPSCoR eDNA grant (with **Speer** and **Stetzer**), in the tri-state INSPIRES Track II grant (with **Millay**, **Van der Eb, Lindsay** and **Peterson**, and colleagues from UVM and UNH), and a USDA grant to bring active learning to an important, common, difficult course for undergraduates in food science and engineering, leveraging PI Balu Nayek's experience in the FIG-MLA Program (with **Millay, CITL,** and colleagues from U. of Idaho, Washington State U., Pullman, Iowa State, Virginia Tech, and U. of Kentucky). **Speer** and RiSE faculty member **MacKenzie Stetzer** launched a successful seed grant program through the eDNA grant to encourage faculty, especially in undergraduate courses, to include eDNA content in their courses, with four grants awarded. **Prof. Mitchell Bruce** continued to contribute research findings from his NSF CORE grant to the improvement of students' introductory chemistry laboratory experiences. In addition, RiSE faculty and staff were PI or Co-PI on 20 grant submissions during the year totaling $7,824,635. These grants support the full spectrum of basic to applied research in teaching and learning in the STEM disciplines. Findings are disseminated and discussed within the Maine STEM Partnership at the RiSE, coordinated by **Van der Eb** and involving over 800 educators**.** This group gathered last November at the Samoset Resort for its annual summit, attended by over 100 participants, to share findings and lessons learned and identify priorities for work during the coming year. RiSE faculty member **Asli Sezen-Barrie** began a new collaboration with rural teachers in Maine and New Hampshire and the Mount Washington Observatory to design educational units related to using data to interpret extreme weather events. **Speer** and **Prof. Bob**

Franzosa worked to place and mentor MST students and teaching assistants to build their knowledge and skills in teaching. (1.1.1, 1.1.2, 1.1.4, 1.1.6, 1.2.1, 1.2.3, 1.2.4, 2.1.1, 2.1.2)

In addition to raising funds from grants and contracts, the RiSE Center has actively pursued donations to support its work, in collaboration with the University of Maine Foundation. In the past year, RiSE raised over $314,846 in private philanthropy, including successfully meeting a $50,000 matching gift challenge for PK-12 instructional resources. It also received over $91,500 in payments from schools to support, in part, its Materials Warehouse, which provides task-force evaluated and recommended instructional resources for K-9 science, and coordinated professional learning for teachers using these materials. These materials are now being used by over 4800 students annually, and now include NGSS-aligned elementary materials and middle level Earth, physical, and life sciences. (1.2.2, 2.1.1)

The FIG-MLA Program, run by the RiSE Center, supports faculty in bringing evidence-guided, research-based changes to their instructional practice. By awarding faculty grants, bringing grant recipients together as a community to share strategies, supporting faculty with undergraduate MLAs to facilitate more active engagement, and providing graduate student assistance in data collection and analysis, this program integrates the research and teaching missions of UMaine directly to benefit faculty and students. It is a crucial element of first-year student success, since it has been shown to reduce the DFW rate in courses and improve student retention. It also fosters innovation and provides experiential professional learning for faculty who teach STEM courses at all undergraduate levels; for example, **Prof. David Batuski** led innovations in AST109, a popular general education course, through his involvement as a FIG-grant recipient. This program employed 142 MLAs during the past year and involved 42 faculty from 38 courses with combined enrollment of over 5,500 students. MLAs participate in weekly sessions to build their group facilitation skills and their understanding of relevant research into teaching and learning. **Erin Vinson**, RiSE Campus Programs Coordinator, recruited MLAs for all courses and handled their placements. During the past year, proposals were submitted for administrative consideration to expand this program to non-STEM courses and to additional UMS campuses and the program ran its first showcase to share findings about outcomes of evidence-based course modifications across campus. (1.1.1, 1.1.2, 1.2.1, 1.2.3, 1.2.4)

The RiSE Center runs the MST Program, which requires a research thesis from each student, in addition to integrated courses bringing findings from research into teaching and learning to practice. For example, RiSE faculty member **Prof. Francois Amar** is currently mentoring MST student Anna Tyrina's thesis research investigating high school chemistry teachers' conceptions of differentiation. Full-time MST students are all supported by research or teaching assistantships and contribute positively to the teaching quality on our campus. The certification track of this program had 9 future mathematics and science teachers in student teaching internships this spring, all of whom completed their required 15-week internships despite the pandemic, and six of whom already have accepted positions within Maine. The other three newly certified teachers are also applying for positions within Maine. Of these nine new teachers, eight are part of the NSF Teaching Fellowship Program. RiSE NSF Teaching Fellowship Program Coordinator **Beth Byerssmall** strategically recruited applicants for the fellowships and has led the development of this valuable community of 21 new and 20 experienced teachers into a leadership group in STEM education in Maine. During the summer of 2020, this group is collecting and/or creating engaging, content-packed activities and lessons for remote instruction, aligned with state and national standards, to be used by Maine STEM Partnership teachers, but also disseminated more broadly. Educators found last spring that they were overwhelmed by the volume of resources related to on-line instruction sent to them in emails. They needed something more streamlined and vetted. The NSF Teaching Fellowship Program is going to build an online catalog, sorted by standard, with a review system to be used by teachers who try learning experiences from the catalog. In this way, other teachers will know how the learning experiences work and we can revise them in response to teacher feedback. The NSF Teaching Fellowship grant includes research into the most valuable preparation and supports for new teachers in high-need Maine districts, and factors influencing their retention. **Profs. Franziska Peterson** and **Michael Wittmann** piloted new seminar courses for MST students to strengthen their knowledge and field experiences in PK-12. Wittmann's course, offered in the spring, was designed to offer students opportunities to observe and reflect on classroom practices. With remote learning, video lessons were substituted for observations (1.1.1, 1.1.2, 1.1.4, 1.1.5, 1.1.6, 1.2.1, 1.2.3, 1.2.4)

Goal 2 – Continue to provide accessible and affordable education, research and service. With the leadership of **Marina Van der Eb** and the managerial skills of **Beth Muncey**, the Maine STEM Partnership at the RiSE Center has expanded to support teachers in providing high quality hands-on science instruction to over 4800 Maine students during the past year. **Van der Eb** and **Muncey** tested a new model for professional learning for elementary science teachers last year, using school release days, rather than evenings and weekends, making it easier for all teachers to participate. Schools pay part of the cost of this service, which takes advantage of economies of scale and efficiencies to provide high quality, task-force selected instructional resources across the state at very low cost. Task forces, comprised of teachers, PK-12 administrators, RiSE faculty and staff, graduate students, and postdocs evaluated and compared available instructional resources, considering factors such as student learning, active engagement, alignment with NGSS, and quality of teacher resources. During the past year, **Maureen Raynes,** RiSE Financial and Personnel Manager, recruited three upper level business student interns who brought their perspective and knowledge to Center management, such as developing a sustainable business plan for the Maine STEM Partnership. (2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.3.1, 2.3.2, 3.1.3)

RiSE faculty (**McKay, Pandiscio, and Peterson)** and RiSE professional staff **(Millay, Raynes, and Van der Eb)** prepared a proposal for ongoing statewide professional learning for elementary mathematics teachers and presented it to the University of Maine System's Council of Chief Academic Officers. The proposal would involve professionals and faculty based across the University of Maine System working collaboratively to co-design, implement, and evaluate professional learning experiences designed to build deeper content understanding and knowledge of research-supported pedagogical strategies for teachers. The approach would be modeled after the very successful summer content immersions that have been offered by **Peterson** for teachers at the RiSE Center, supported by private donations, and coordinated with Maine Department of Education programs. RiSE faculty member **Prof. Molly Schauffler** is collaborating with **Peterson** to develop learning progressions for data literacy. RiSE faculty member **Prof. Tim Boester** also led a successful summer content immersion for pre-calculus teachers, with evaluation support from the RiSE Center. (2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.3.2, 2.3.3)

Additional contributions by RiSE faculty members include the following: **Prof. Janet Fairman** co-authored four reports and presented data, evidence, and research findings to the Maine legislature to inform education policy in Maine; RiSE faculty member **Prof. Beth Hufnagel** published three journal articles and a book chapter from her research into emotion in STEM education; **Stetzer** continued to publish ground-breaking research on student reasoning processes; and **Prof. Chris Gerbi** took a leading role in convening and bringing the RiSE Center into the UMaine Arctic Collaboration.

This year, the RiSE Center received funding for a half-time administrative specialist and the position was filled, to start in July, 2020. The applicant selected brings knowledge and skills in marketing and communication, website development, brochure design, and data bases. This new position (replacing a position that was lost in a previous budget cut) will greatly increase efficiency and strengthen RiSE abilities to manage internal and external communications and track alumni and partnership groups. We are very grateful to the VPR for this support. (2.1.1, 2.1.2, 2.3.1, 2.3.2)

With STEM+C funding from NSF, the RiSE Center continued its research-practice partnership to integrate computing and computational thinking into middle school science, piloting and studying lessons developed during the summer of 2019. This project involves 30 middle school science teachers, 5 faculty from the School of Computing and Information Sciences, 3 RiSE faculty (CoPIs **Bruce, Lindsay, and** PI **McKay**), three RiSE professional staff (**Van der Eb**, **Millay**, and **Muncey**), and three graduate students (**Callahan, Jacobs** and **Oesterlin)**. This project, when completed, will yield a graduate course for teachers on integrating computing into science teaching as well as a collection of vetted modules for middle school Earth, life, and physical sciences integrating computing. This summer, this team is gathering to refine the modules piloted last year and co-design remote-instruction options for them, in preparation for their use during the coming school year, regardless of the mode of instruction.

Goal 3 – The university will be a rewarding place to live, learn and work. **McKay** has been invited to co-chair the President's Council on Diversity, Equity, and Inclusion. **Millay** has been awarded a Presidential Fellowship focused on research-practice partnerships and anti-racism and inclusion. **Lindsay** was awarded the Presidential Teaching Award for her outstanding work in evidence-based course reform. During the past year, half of the RiSE professional staff members took graduate courses and all have

attended at least one conference or summit related to their work. The RiSE Center provides opportunities for graduate students, faculty, and staff to interact informally in weekly research group meetings, fall picnics, holiday parties, and graduation celebrations. There are also other informal graduate student gatherings to discuss common challenges and learn about opportunities, such as applying to doctoral programs or student teaching. The RiSE Center also includes faculty, students, and staff in RiSE conferences and the Maine STEM Partnership Annual Summit. These events provide chances for all to interact and get to know each other better. (3.1.1, 3.1.2, 3.1.3, 3.2.1, 3.2.2)

The RiSE Center's MST Program and its NSF Teaching Fellowship Program have established ongoing connections between students and teachers in the field. In the summers, these groups work together on lesson design, review student data to guide modifications, and strategize to improve learning for all students. During the school year, MST students spend time in classroom as Teaching Partners, working and learning with teachers, and as student teachers. We use our alumni in important leadership roles, such as advisors or senior personnel on grants, mentors for new teachers, and in other important leadership roles. As part of the NSF Teaching Fellowship Program, we continue to gather graduates monthly for four years following their initial teaching placement. This program provides an excellent window into the supports that are most valued by new teachers as they move through the first four years of the induction phase. (3.2.1, 3.2.2)

III. CHALLENGES: The RiSE Center, now entering its 20th year, has experienced phenomenal growth in productivity, national and international recognition, and personnel. It has developed from a handful of founding faculty advising less than 10 graduate students into 19 faculty members advising over 30 graduate students. It has grown from a center with no professional staff to one with six staff members who are leaders and essential contributors to all aspects of RiSE work. As RiSE grew through grant funding, instead of receiving expanded internal funding for Center infrastructure, RiSE budgets were significantly reduced, along with many other budgets on campus, and have never recovered. **The RiSE Center needs an assistant director and bridge funding** equivalent to one professional position's salary and benefits to sustain RiSE work. These positions are not possible within the existing RiSE budget. The assistant director would bring the capacity to sustain and expand existing RiSE research and research-based educator learning experiences. This position would also support a succession plan for the RiSE Center and improve both internal and external communications. Part of the assistant director's responsibilities are in the MST Program ongoing evaluation, data-guided improvement, and accreditation. RiSE professional staff run the Materials Warehouse, handle data management, bring expertise in IRB compliance, offer specialized professional learning experiences for educators at all grade levels, run the FIG-MLA program, and manage the budgets of numerous RiSE grants and contracts. While many of these crucial professional staff members are paid through grants, contracts, or donations, it is essential that bridge funding be provided to retain them during dips in funding. (1.1.4, 1.1.6, 1.2.3, 2.1.1, 2.1.2, 2.1.3, 2.3.1)

IV. GOALS FOR THE COMING YEAR: RiSE goals, arising from the priorities established through our ongoing strategic planning process, are: **(1)** Develop a long-term funding stream for a RiSE assistant director and fill this position. (A search was begun prior to the move to remote work in March and a strong faculty candidate for a half-time position has been selected, but funding has not been allocated. (1.1.4, 1.1.6, 1.2.3, 2.1.1, 2.1.2, 2.1.3, 2.3.1 **(2)** Use the newly approved administrative specialist for RiSE to improve both internal and external communications, including web and social media, reports, and publicity about events and professional learning opportunities. Also use this position to update our MST alumni database and our partner contact lists, ensuring that communications will reach those who are most interested. (2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.3.2, 3.2.2) **(3)** Develop a RiSE Handbook of Policies and Practices, so that this information can easily be found by all. (2.3.1, 3.1.3) **(4)** Gain approval for and launch: a) two new MST seminar courses that provide additional familiarity and fieldwork experiences in PK-12 for MST students and b) a Graduate Certificate Program in STEM Teacher Leadership, which is in the final planning stages, a revenue-generating professional Master's degree. (1.1.4, 1.1.6, 1.2.3, 2.1.1, 2.1.2) **(5)** Continue to convene campus groups involved in research-practice partnerships and pursue infrastructure to support this collective work. (2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.3.2)

Appendix I. RiSE Publications 2019-20 (RiSE Faculty, Staff, and Students in Bold)

Ahmad, A. A. L., Panicker, S., Chehimi, M. M., Monge, M., Lopez-De-Luzuriaga, J. M., Mohamed, A. A., … Bruce, M. R. M. (2019). Synthesis of water-soluble gold-aryl nanoparticles with distinct catalytic performance in the reduction of the environmental pollutant 4-nitrophenol. *Catalysis Science and Technology*, *9*(21), 6059–6071. https://doi.org/10.1039/c9cy01402k

Barth-Cohen, L., & Wittmann, M. (n.d.). Learning About Crosscutting Concepts as Concepts. In *Proceedings of the 2020 International Conference on the Learning Sciences*.

Biddle, C., & Hufnagel, E. (2019). Navigating the "danger zone": Tone policing and the bounding of civility in the practice of student voice. *American Journal of Education*, *125*(4), 487–520. https://doi.org/10.1086/704097

Bock, C. G. (2019). *Pre-service Elementary Teachers ' Use of Spatial Diagrams: Investigations of Unbounded Shearing on Solid Figures*. University of Maine.

Case, J., & Speer, N. (2019). Calculus Students' Deductive Reasoning and Strategies when Working with Abstract Propositions and Calculus Theorems. *Primus*, *0*(0), 1–20. https://doi.org/10.1080/10511970.2019.1660931

Dimmel, J. K., & Pandiscio, E. A. (2020a). Continuous Directed Scaling: How Could Dynamic Multiplication and Division Diagrams Be Used to Cross Mathematical Borders? In N. Radakovic & L. Jao (Eds.), *Borders in Mathematics Pre-Service Teacher Education* (pp. 21–45). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-44292-7_2

Dimmel, J. K., & Pandiscio, E. A. (2020b). When it's on zero, the lines become parallel: Preservice elementary teachers' diagrammatic encounters with division by zero. *Journal of Mathematical Behavior*, *58*(3), 100760. https://doi.org/10.1016/j.jmathb.2020.100760

Dimmel, J., Pandiscio, E., & Bock, C. (n.d.). The geometry of movement:Encounters with spatial inscriptions for making and exploring mathematical figures. *Digital Experiences in Mathematics Education*.

Fairman, J, Mills, T., Lech, P., & Johnson, A. (2020). *Maine principals' perceptions of beginning teacher preparation*. Orono.

Fairman, Janet, & Frankland, M. (2020). *Assessing and Supporting Students ' Social and Emotional Needs in Maine Schools*. Orono.

Hruby, K, Gerbi, C., Koons, P., Campbell, S., Martin, C., & Hawley, R. (n.d.). The impact of crystallographic orientation fabric on streaming ice kinematics. *Journal of Glaciology*.

Hruby, Kate, Gerbi, C., Koons, P., Campbell, S., Martín, C., & Hawley, R. (2020). The impact of temperature and crystal orientation fabric on the dynamics of mountain glaciers and ice streams. *Journal of Glaciology*, 1–11. https://doi.org/10.1017/jog.2020.44

Hufnagel, E. (2019a). Language, materiality, and emotions in science learning settings. In D. R. Gruber & L. C. Olman (Eds.), *The Routledge Handbook of Language and Science* (p. 9).

Hufnagel, E. (2019b). The "Subtext of Everything": High School Science Teachers' Views of Emotions and Their Related Teaching Practices. *Canadian Journal of Science, Mathematics and Technology Education*, *19*(4), 430–445. https://doi.org/10.1007/s42330-019-00059-5

Jaber, L. Z., Hufnagel, E., & Radoff, J. (2019). "This is Really Frying My Brain!": How Affect Supports Inquiry in an Online Learning Environment. *Research in Science Education*. https://doi.org/10.1007/s11165-019-09884-y

Jessen, S., Fairman, J., Fallona, C., & Johnson, A. (2020). *Considering " Grow -Your- Own " (GYO) Models by Examining Existing Teacher Preparation Programs in Maine*. Orono.

Kryjevskaia, M., Stetzer, M., Lindsey, B., McInemy, A., Heron, P., & Boudreaux, A. (n.d.). Designing research-based instructional materials that leverage dual-process theories of reasoning: Insights from testing one specific, theory-driven intervention. *Physical Review Physics Education Research, Focused Collection Curriculum Development: Theory into Design*.

Kung, D., & Speer, N. (2020). *What Could They Possibly Be Thinking!?! Understanding Your College Math Students*. Washington D.C.: Mathematical Association of America.

Lech, P., & Fairman, J. (2020). *Public Preschool Programs in Maine: Program Design, Capacity and Expansion Challenges*. Orono.

Lee, I. R., Hawley, R. L., Bernsen, S., Campbell, S. W., Clemens-Sewall, D., Gerbi, C. C., & Hruby, K. (2019). A novel tilt sensor for studying ice deformation: Application to streaming ice on Jarvis Glacier, Alaska. *Journal of Glaciology*, *66*(255), 74–82. https://doi.org/10.1017/jog.2019.84

Meaders, C. L., Lane, A. K., Morozov, A. I., Shuman, J. K., Toth, E. S., Stains, M., … Smith, M. K. (2020). Undergraduate Student Concerns in Introductory STEM Courses: What They Are, How They Change, and What Influences Them. *Journal for STEM Education Research*. https://doi.org/10.1007/s41979-020-00031-1

Meaders, C. L., Toth, E. S., Kelly Lane, A., Kenny Shuman, J., Couch, B. A., Stains, M., … Smith, M. K. (2019). "What will I experience in my college STEM courses?" An investigation of student predictions about instructional practices in introductory courses. *CBE Life Sciences Education*, *18*(4), 1–14. https://doi.org/10.1187/cbe.19-05-0084

Sezen-Barrie, A., Stapleton, M. K., & Marbach-Ad, G. (2020). Science teachers' sensemaking of the use of epistemic tools to scaffold students' knowledge (re)construction in classrooms. *Journal of Research in Science Teaching*, (December 2019), 1–35. https://doi.org/10.1002/tea.21621

Short, R. A., Van der Eb, M. Y., & McKay, S. R. (2020). Effect of productive discussion on written argumentation in earth science classrooms. *Journal of Educational Research*, *113*(1), 46–58. https://doi.org/10.1080/00220671.2020.1712314

Song, B. R., Johnson, S. E., Song, W. J., Gerbi, C. C., & Yates, M. G. (2020). Coseismic damage runs deep in continental strike-slip faults. *Earth and Planetary Science Letters*, *539*, 116226. https://doi.org/10.1016/j.epsl.2020.116226

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Appendix II. Grants Awarded to RiSE Faculty in 2019-20

PI	PI % Credit	Project Title	Sponsor	Sponsor Indirect	Sponsor Total	UMaine Total	Project Total	Grant Total
Fairman, J.	100%	Maine Education Policy Research Institute (MEPRI) FY20	Maine State Legislature	$ 17,704	$ 125,000	$ 62,500	$ 187,500	$ 187,500
Fairman, J.	50%	Math4ME 2019 (supplement)	US Dept of Education	$ 539	$ 3,805	$ 539	$ 4,344	$8,688
Fairman, J.	30%	Transdisciplinary Predoctoral Training in Biomedical Science and Engineering +$	US Dept of Health & Human Services	$ 1,920	$ 25,920	$ 9,120	$ 35,040	$116,800

Dimmel, J.	30%	A remote multimodal learning environment to increase graphical information access for blind and visually impaired students +$	National Science Foundation	$ 0	$ 4,800	$ 0	$ 4,800	$16,000
Sezen-Barrie, A.	100%	Understanding Extreme Weather with Big Data	National Science Foundation	$ 11,342	$ 36,000	$ 0	$ 36,000	$36,000
Sezen-Barrie, A.	100%	Cultivating Engineering Literacy for Future Science Teachers of Maine	National Aeronautics & Space Administratio n	$ 507	$ 6,987	$ 13,424	$ 20,411	$20,411
Bruce, M.	50%	Proposal Title: Use of Vanadyl Acetylacetonate to Detect and/or Sequester Ethanol in Water +$	American Chemical Society	$ 0	$ 250	$ 0	$ 250	$500
Speer, N., McKay, S., Stetzer, M.	7%	RII Track-1: Molecule to Ecosystem: Environmental DNA as a Nexus of Coastal Ecosystem Sustainability for Maine (e-DNA)	National Science Foundation	$ 39,956	$ 201,449	$ 44,240	$245,690	$2,877,854
Thompson, J.	100%	Collaborative Research: Research on learning and teaching at the physics-mathematics interface +$	National Science Foundation	$ 10,974	$ 39,379	$ 0	$ 39,379	$39,379
Thompson, J.	100%	Collaborative Research: Beyond procedures: a research-based approach to teaching mathematical methods in physics	National Science Foundation	$ 86,546	$ 282,066	$ 0	$ 282,066	$282,066
Amar (Honors), F.	50%	Comparative Functional Genomics INBRE in Maine Yr2	US Dept of Health & Human Services	$ 16,175	$ 81,168	$ 62,964	$ 144,132	$288,264
RiSE contributes education research and a research-practice partnership with teachers to this project, with Susan McKay, Franziska Peterson, Sara Lindsay, Laura Millay, and Marina Van der Eb all contributing.	0%	RII Track 2 FEC: Leveraging informatics to resolve uncertainties in the Northern Forest's carbon budget	National Science Foundation	$0	$0	$0	$0	$3,000,000
TOTAL NEW GRANTS				**$185,663**	**$806,824**	**$192,787**	**$999,612**	**$6,873,462**

Appendix III. RiSE Faculty Grants Continuing in 2019-20

Title	Funding Agency	RiSE Personnel	Grant Number	Award Date	Award Amount	Months
A Model NSF Teaching Fellowship Program to Improve STEM Teacher Recruitment, Preparation, Professional Development, and Retention in Rural High-Need Schools	National Science Foundation	Susan McKay (PI), Eric Pandiscio (Co-PI), MacKenzie Stetzer (Co-PI), Franziska Peterson (Co-PI), Elizabeth ByersSmall (Staff), Laura Millay (Staff)	1557320	3/24/16	$1,950,034	71
Fostering Connections between Macroscopic, Submicroscopic, and Representational Levels Using Analogical Reasoning in the Chemistry Lab	National Science Foundation	Mitchell Bruce (PI)	1610086	9/7/16	$275,284	35
Collaborative Research: Research on learning and teaching at the physics-mathematics interface	National Science Foundation	John Thompson (PI)	PHY-1405726	10/14/14	$197,647	59
Thermochemical Conversion of Woody Biomass to Fuels and Chemicals	US Department of Energy	Francois Amar (Co-PI)		10/12/11, continued 8/6/13	$1,889,988	83
Geometer's Planetarium	National Aeronautics and Space Administration through Maine Space Grant Consortium	Justin Dimmel (PI)	SG-18-06	9/28/17	$10,000	18
Collaborative Research: Computational Methods Supporting Joint Seismic and Radar Inversion for Ice Fabrice and Temperature in Streaming Flow	National Science Foundation	Chris Gerbi (PI)	1643301	1/30/17	$195,010	35
Collaborative Research: Influence of Natural Ice Microstructure on Rheology in General Shear: In-Situ Studies in the Alaska Range	National Science Foundation	Chris Gerbi (PI)	1503924	8/11/15	$420,937	47
Improving the Preparation of Graduate Students to Teach Undergraduate Mathematics	National Science Foundation through Mathematical Association of America	Natasha Speer (PI)	3-8-710-953	11/1/17	$38,753	47
Collaborative Research: Examining the development of student reasoning skills through scaffolded physics instruction	National Science Foundation	MacKenzie Stetzer (PI)	DUE 1431940	9/19/14	$169,806	59
Collaborative Research: Establishing a new model for research-based curriculum development in physics aligned with dual-process theories of reasoning	National Science Foundation	MacKenzie Stetzer (PI)	1821390	6/22/18	$863,239	59

Collaborative Research: Promoting instructional change in introductory STEM courses through Faculty Learning Communities focused on the transition from high school to college	National Science Foundation	MacKenzie Stetzer (Co-PI)	1712074	8/21/17	$154,910	23
Research on learning and teaching at the physics-engineering interface: thermodynamics and electronics	National Science Foundation	John Thompson (PI), MacKenzie Stetzer (Co-PI)	DUE-1323426	9/19/13	$599,999	71
Math4ME 2019	US Dept of Education through ME Dept of Education	Fairman, Janet (PI)		12/12/18	$48,292	10
Integrating Computation into Science Teaching and Learning in Grades 6-8: A Diverse Partnership to Develop an Evidence-Guided Model to Serve Rural Communities	National Science Foundation	Susan McKay (PI), Mitchell Bruce (Co-PI), Sara Lindsay (Co-PI), Laura Millay (staff), Marina Van der Eb (staff), Elizabeth Muncey (staff)	1842359	9/20/18	$1,250,000	
The Geometer's Planetarium II: Exploring the connections between geometry and astronomy in an immersive virtual environment	National Aeronautics and Space Administration through Maine Space Grant Consortium	Justin Dimmel (PI)		10/19/18	$24,960	
A remote multimodal learning environment to increase graphical information access for blind and visually impaired students	National Science Foundation	Justin Dimmel (Co-PI)		9/11/18	$747,894	
How do scale and dimension affect students' perceptions of geometric diagrams?	Spencer Foundation	Justin Dimmel (PI)		4/12/19	$49,217	
Enhancing Learning Outcomes In Food Engineering And Processing Courses For Non-Engineers Using Student-Centered Approaches	US Dept of Agriculture	Susan McKay (Co-PI), Laura Millay (Sr. Prs.)		1/4/19	$747,328	
Acquisition of a 500 MHz NMR Spectrometer with Improved Sensitivity and Accessibility to Benefit Research and Education at Umaine	National Science Foundation	Mitchell Bruce (PI)		8/28/18	$535,900	
Proposal Title: Use of Vanadyl Acetylacetonate to Detect and/or Sequester Ethanol in Water	American Chemical Society	Mitchell Bruce (Co-PI)		4/15/19	$2,750	
Maine Education Policy Research Institute (MEPRI) FY19	Maine State Legislature through University of Southern Maine	Fairman, Janet (PI)		7/20/18	$125,000	
Total					**$10,296,948**	