



Maine Physical Sciences Curriculum Partnership (MainePSP) Sixth Year Implementation Report

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Introduction

For the past several years, our partnership has been thinking about sustainability and sustaining our work. We have always viewed this grant-funded work as a seed that allowed us to create an infrastructure that would continue to support STEM education in Maine into the future. Because of this, we've created intentional structures to support long-term visioning and transition. On the K-12 side of our work, two years ago we formed a transition and vision team (TVT) to begin to plan and lead us into our next phase. This team included staff, faculty, teachers and school-based administrators. We began laying the groundwork for plans and models that would continue the most valuable and successful aspects of our work, and would allow our efforts to continue through distributed financial support. One primary outcome of the TVT was securing a one-year no cost extension for our project, enabling us to continue our work as the MainePSP for another year. Once that extension was secure, we hosted a summer leadership task force focusing on sustainability. This was our first attempt at blending our middle/high school-focused project (MainePSP) with our elementary-focused partnership (MaineESP) to begin looking at the entire system of K-12 STEM education. During this task force, we focused on identifying the most valuable aspects of our partnerships and determining which pieces should be sustained. We also did some brainstorming about unique models that could support our partnership beyond the 100% grant-funded stage. Following this summer task force, we continued to meet monthly throughout the academic year as a Leadership Cohort where we further refined our ideas and began setting up implementation plans.

Some of the significant outcomes and strategies coming from our work on sustainability include a district buy-in model, automating processes to enable on-going, low-touch support systems, a heavier reliance on teacher leadership, and strategic partnerships with districts, government and business.

We have moved forward with the district buy-in model, where districts are responsible for paying a membership fee for participation, and per student fee for materials rental and a per teacher fee for participation in the professional development community. We tested this model last year by having districts pay the membership fee and student fee. This way the transition to paying the additional fee for teacher participation wouldn't seem as daunting. So far this approach has been successful, as roughly 80% of our partners have already signed up for participation in the partnership in our first unfunded year. The remaining funding for supporting this model comes in part from the University through additional grants and base budgeting, which covers staff support and overhead such as office space, warehouse space, etc. One of our future goals is to deepen our partnerships with government and businesses in an attempt to have a third of our funding come from this support stream.

We have also intentionally worked on automating processes to lower the support resources needed to maintain them. For example, we have streamlined and partially automated the process of data collection and feedback from classroom surveys. This has increased our turnaround time with teachers, enabling the teachers to use this data to inform instruction. Finally, we have borrowed strategy from the National Writing Project and have shifted much of our teacher leadership development to include an element of teacher consultant development. This strategy supports both revenue generation and also expansion of our work to new district partners who have not historically worked with us.

One of the most important structural elements related to sustainability has been bringing the MainePSP and MaineESP communities together to form a new entity called the Maine STEM Partnership @ the RiSE Center. This new partnership seeks to support the statewide infrastructure to strengthen PK-16+ science, technology, engineering and mathematics teaching and learning in Maine. The partnership focuses on institutionalizing the connection and pipeline between in-service and pre-service education, as well as providing support for teaching and learning of all STEM disciplines at all grade levels PK-16+. We plan to accomplish this through staffed regional coordinated professional development hubs with centralized oversight, and a support team that would include shared research and data coordinators across hubs. The coordinator at each hub would work together with the team of regional hub coordinators, the team of data coordinators and one centralized director to plan and implement cohesive and coordinated regional professional development and resource support. Each hub is located at a University of Maine system campus, and each hub hosts a blended community of PK-16+ science educators, including researchers, University STEM faculty and pre-service teachers. One of the most powerful aspects of this model is its role as an overarching convener of all STEM professional development in the state. The regional hub infrastructure would create a foundation to bring together all professional development providers across the state into a network and enable us to combine efforts to offer more cohesive, coordinated and comprehensive support to Maine educators. The model would be funded partially by district buy-in, partially through University of Maine system contribution, partially through grants, and partially through business and government support. We will spend this year establishing operations for the Maine STEM Partnership @ the RiSE Center at existing hubs while also gathering support for expansion and sustainability for this partnership. The goal would be to leverage funding support gained this year to expand our hub infrastructure until we have reach full statewide capacity.

Major Programs and Activities of the MainePSP in 2016

Programs and Activities Added in 2015-16

As a result of obtaining supplemental funding from the National Science Foundation, we were able to implement several new programs and activities over the past year, in addition to our many ongoing programs and activities. The new programs and activities begun in 2015-16 are listed below, followed by a detailed write-up of each activity.

- Undergraduate STEM Education Professional (USEP) program
- Master of Science in Teaching (MST) Bridge Program
- Coaching Institute
- Design Week for the Pre-Service Summer Academy
- High School Collaboratives
- Spring Summit

Undergraduate STEM Education Professional (USEP) Program

The Undergraduate STEM Education Professional (USEP) program selected 10 undergraduate STEM students to participate in the year-long program, starting with a six-week intensive program during the summer of 2016. The program is a collaboration between STEM and STEM education faculty, Master of Science in Teaching graduate students, middle and high school teachers, and the selected undergraduate students. Students spend 5 weeks focusing on and implementing an education research project; two days are spent at the RiSE Conference, two of the six weeks are spent in a group with teachers and MST students focusing on a specific discipline (life science, physics, mathematics, or earth science) and developing evidence-based teaching practices and curriculum for teachers to use; the last week is spent attending a Pre-Service STEM Summer Institute at the RiSE Center.

The purpose of the USEP program is to encourage strong STEM students to consider teaching careers as well as expose them to educational research. Interested students go through a formal application, interview and selection process and are chosen on the basis of their performance in STEM courses and a demonstrated interest in teaching. The USEP and MST students work with schoolteachers to enhance the instructional resources that support new teachers as they learn to implement curriculum in the classroom. The intent is to provide teachers with supporting materials, pedagogical insight, and discussions focused on best practices and teaching strategies that will help them improve their teaching. In the process, the students and the teachers help each other strengthen their content and pedagogical content knowledge. The USEP program is one of the campus-based initiatives through which college students may enter the MainePSP community and they will continue that connection by being a part of the Maine Learning Assistant and/or the Teaching Partner programs. These experiences may ultimately lead them to

professional positions as teachers in MainePSP schools, or as members of Maine's larger educator community.

Objectives

Provide professional development opportunities to undergraduate students in education research and in pre-college instructional design.

Encourage their interest in teaching and support their pedagogical development and learning.

Support research faculty by providing assistance of capable undergraduate students.

Encourage partnerships between K-12 teachers and college students.

Results in the Past Year

Ten USEP undergraduates were selected from 32 applicants for those positions and are currently working with 10 MST graduate students, and 6 STEM or STEM education faculty on nine different research projects.

Dissemination of Results

In culmination, the USEP students will deliver presentations about their work to the research community at the end of the summer. At the beginning of the school year, the summer work in the teaching projects will be presented at a meeting with the whole RiSE/PSP community. At the end of the school year, a final presentation of the students' research findings will be presented to a larger audience at UMaine.

Next Steps

Later the Summer, the USEP students will work an additional 5 MST students and with 25 teachers on four different projects related to evidence-guided teaching and improving instruction in middle and high school.

Coaching Institute

The Coaching Institute prepares leading teachers to provide high-quality instructional coaching for pre-service teachers, student teachers and new teachers in their buildings. Our specific purpose was to create and host a professional learning community of classroom-based Coaching Teachers working collaboratively to strengthen pre-service teacher development and support induction of new teachers through one-on-one relationships, research-supported instructional & behavior management strategies and expertise in content and assessment.

Objectives

The specific objectives of the Coaching Institute expand on some of the goals of the MainePSP:

Develop productive partnerships with student teachers/pre-service teachers

Reflect on teaching practice through the lens of the Big 4 (*Instructional Coaching*, J.Knight)

Develop and share tools for observing classroom practice and documenting evidence of the resulting student impact

Reflect in three ways with student teacher: in action, on action and for practice

Discuss data and research findings formatively with student teacher

Observe a teacher using a protocol and provide feedback using effective coaching strategies

Results in the Past Year

8 middle and high school teachers participated in this semester-long coaching institute. We kicked off our work together with two full-day sessions in January and February. We then met as an ongoing professional learning community monthly for the remainder of the year. This institute was designed in partnership with Dr. Anita Stewart-McCafferty from the University of Southern Maine, an expert in education leadership and mentoring, and Ken Akiha, a graduate student with previous experience running a mentoring/coaching program in the Boston Public School System. The program framework was based on the text by Jim Knight called *Instructional Coaching*.

Dissemination of Results

We have shared the structure and content of our coaching institute with the Maine Department of Education's mentor training program team and they will be integrating some of our strategies into their training curriculum.

Next Steps

We plan to integrate our work preparing veteran teachers as coaches into our Pre-Service Summer Academy this upcoming summer, utilizing the expertise of these veteran teachers to provide coaching and feedback to pre-service teachers.

Design Week for Pre-Service Summer Academy

This summer we will be running a new Summer Academy for pre-service middle and high school STEM teachers. We will be working with veteran leading teachers to share experiential information and workshops with the pre-service teachers during this week-long institute. The Design Week for the Pre-Service Summer Academy was a three-day work session bringing these veteran teachers together to create and prepare workshops and instruction for the upcoming Summer Academy.

Objectives

The specific objectives of the Design Week for Pre-Service Summer Academy expand on some of the goals of the MainePSP:

Prepare workshops to lead pre-service teachers in core curriculum: talk science and assessment for learning

Prepare workshops to lead pre-service teachers in core topics: inquiry instruction & student engagement

Prepare workshops to lead pre-service teachers in electives: workshops by teachers for teachers

Prepare workshops to expose pre-service teachers to special topics: poverty & gender

Prepare leading teachers to support demo teaching and providing feedback to pre-service teachers

Results in the Past Year

A total of 8 middle and high school teachers participated in the Design Week, and will be part of the leading teacher team at the Pre-Service Academy in July. We began our design week by brainstorming topics that we thought would be important to share with pre-service teachers as part of this institute. We then co-developed a rubric to provide feedback on the workshops and discussions that will be presented by leading teachers. Using our rubric and workshop topics list, teachers worked independently and in pairs to create 45 minute workshops on a variety of topics and 30 minute lunch discussions. Each of these workshops and discussions was presented to the entire design team for feedback and polishing. Using the rubric we created, we provided each leading teacher with a collection of feedback to inform the next iteration of their workshop and discussion design. We also worked together on coaching skills to enable veteran teachers to provide strong feedback to pre-service teachers as they demo lessons.

Dissemination of Results

This design week was observed by one of our researchers and data collected during this week will be combined with data from the full Summer Academy to create a full picture of the interactions between veteran teachers and pre-service teachers when it comes to teacher preparation. Information from the veteran teachers during this week was also incorporated into the design of the Summer Academy week to help improve that program before we begin in July.

Next Steps

Our leading teachers will co-lead the Pre-Service Summer Academy in July, sharing the workshops and discussions they created and refined during this design week with the pre-service teachers.

High School Collaboratives

High School Collaboratives have allowed us a platform to expand the MainePSP into 10-12th grade and from physical science into life science and mathematics.

Objectives

The specific objectives of the High School Collaboratives expand on some of the goals of the MainePSP:

Deepen content knowledge and pedagogical content knowledge for high school teachers

Strengthen proficiency with high-impact instructional strategies
Support regional professional learning communities

Results in the Past Year

A total of 137 high school teachers from 60 high schools participated in collaboratives at 3 locations around the state: Central Maine, Southern Maine and Downeast Maine. We offered 4 collaboratives in the spring semester as a pilot for a broader program we plan to offer in the 2016-2017 academic year. In our pilot round of collaboratives, we hosted groups for Algebra I, Physics and Biology. At each collaborative meeting, teams of teachers from a region gathered together around a particular topic/standard from NGSS or CCSS-M. Each teacher brought artifacts and a demo unit from their classroom to share with their colleagues. Discussions then followed to address instructional strategies, assessment and outcomes.

Dissemination of Results

Experiences from this pilot round of collaboratives has been shared with the leadership team and is being used to influence the design of the expanded version of the statewide high school collaboratives program in the 2016-2017 school year.

Next Steps

We plan to continue running our three locations of collaboratives (central, downeast and south) in the 2016-2017 academic year, and we are also looking to expand locations over the next several years to include the capitol region, mid-coast Maine, western Maine and northern Maine. We also plan to expand breakout groups from the original Algebra I, physics and biology to also include chemistry, environmental science, earth science, engineering and the remaining mathematics topics beyond algebra I.

Spring Summit

New this year, we added a spring gathering for our community that was tied in with an important local event in our area. We ran our spring summit in parallel with the Maine Science Festival as a way to support the festival and bring more teachers to the festival events, while also offering our community the opportunity to focus on the topic of informal science education.

Objectives

The specific objectives of the Spring Collaborative expand on some of the goals of the MainePSP:

Deepen content knowledge and pedagogical content knowledge for in-service and pre-service teachers

Strengthen proficiency with high-impact instructional strategies

Support networking and connections within the partnership and professional learning community

Results in the Past Year

A total of 41 participated in the spring collaborative. This was broken down into 23 elementary, 18 middle and high school...etc. We kicked off the event with a blended panel including teachers, researchers and nonprofit partners discussing informal science. We then worked as a community to create a tool that would help teachers understand how to evaluate informal science opportunities and make evidence-guided decisions about which ones to incorporate into their classrooms. At this point, we integrated with the Maine Science Festival and teachers field tested their tool by observing and participating with various informal science opportunities offered at the festival. We then concluded by discussing next steps for bringing more high-quality informal science opportunities into our classroom instruction.

Dissemination of Results

We are in the process of creating a website to host the resources that were discussed and created at the spring summit. We would also like to work with informal science providers to incorporate elements of our tool and discussions from the formal classroom with their work outside of school. Finally, we shared the results and feedback from this summit with the summit planning committee to inform any programming we might design for next year.

Next Steps

We are still deciding whether we will run spring summit in future years. Turnout was much lower than the fall summit and it might be better to just focus on one large event per year.

Programs and Activities Modified and Expanded in 2015-16

The MainePSP is an innovative, evidence-guided improvement community with a diverse and dynamic set of partners. Each year, we have grown, responded to feedback from our community, and developed our programs and activities to meet the needs of teachers, students, schools, and districts across Maine, while providing rich opportunities for education research and strengthening our partnership. Programs and activities that were significantly modified and expanded in 2015-16 are listed below, followed by a detailed write-up of each activity.

- Evidence-Based Collaboratives and Professional Development
- Leadership Cohort
- Leadership Task Force
- Responsive Data Analysis
- Survey Alignment: Aligning MainePSP Surveys to NGSS and Curricular Materials

Evidence-Based Collaboratives and Professional Development

The collaboratives are designed to connect to all STEM teachers as MainePSP teachers are encouraged to invite colleagues to attend building a broader community network to create a stronger STEM-teacher workforce. The activities involved are centered around classroom strategies, building familiarity with content and materials, and improving teaching and learning. Teachers participate in activities in which learning happens and rich discussions occur this strengthens their pedagogical content knowledge.

Objectives

The specific objectives of the Collaboratives mirror some of the goals of the MainePSP:

- Teachers learn about science content and practices,
- Teachers learn about teaching science content and practices,
- Teachers learn how a science topic fits vertically in physical science, and
- The project will build and broaden the community of science educators and administrators.

Results in the Past Year

Collaboratives were held in two locations in both February and April 2016 on the topic of student misconceptions about thermal energy transfer. The topic was chosen based on survey responses given by students and teachers over time in the MainePSP, that showed a persistent misconception that “Coldness” as a form of energy can transfer between objects in a system. After presenting the data to the teachers participating in the collaborative sessions, we decided to engage them in an activity to trying to model the energy interaction in the given scenarios, as well as a different scenario that uses a thermos with hot water. In small groups teachers worked on generating a diagram to explain the energy transference among the different objects involved in the scenarios. Below are some of the diagrams generated by teachers during the collaborative.

Figure 1. Representations focusing on thermal energy transfer as flow.

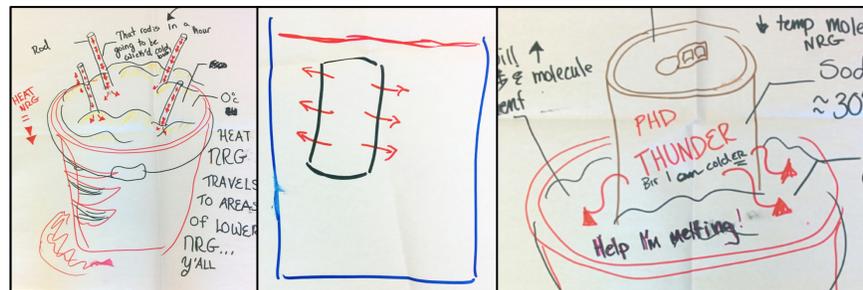
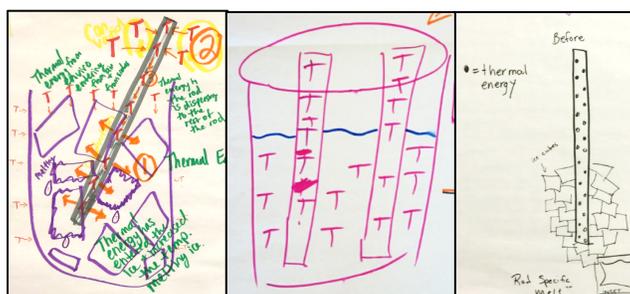


Figure 2. Representations focusing on thermal energy as molecular vibration.



Figure 3. Representations focusing on thermal energy as units.



Through modeling and discussing these models, teachers and researchers explored students' ideas, students' difficulties, and ways in which we might use instruction to address prevalent misconceptions.

Next Steps

Ideas generated in the Collaborative will inform ongoing work to modify the PBIS Energy curriculum to better meet the needs of teachers and students. We hope to add one or more activities to specifically address student difficulties with thermal energy transfer.

Dissemination of Results

Experiences from the collaborative structure and design has been shared with the K-12 Research Implementation Group (K12RIG) and leadership team and used to inform improvements to future professional development plans.

Leadership Cohort

Any teacher from our partnership who participated in any of our leadership development programs was invited to join a leadership cohort that met monthly throughout this past academic year. The purpose of this cohort was to support the collective work of teacher leaders in our community, support the individual work of teacher leaders back in their home schools and

districts, and provide oversight and teacher voice during the period of transition from the MainePSP and MaineESP into the Maine STEM Partnership @ the RiSE Center.

Objectives

The specific objectives of the Leadership Cohort expand on some of the goals of the MainePSP:

- Support the role and work of teacher leaders within our community
- Support the work of individual teacher leaders in their home district and schools
- Provide teacher voice, feedback and oversight during our period of project transition

Results in the Past Year

A total of 24 teachers participated in the Leadership Cohort throughout this past year. Through monthly meetings, this structure provided support, skill building and networking to teacher leaders enabling them to take empowered action within our community and their school-based communities.

Dissemination of Results

This work is a part of a larger study within our project on teacher leadership. Researchers collected data and observations from these meetings to add to the body of data being collected about the emergence and facets of teacher leadership within our project as a whole. These researchers will disseminate findings in the broader public through conferences and journals, and we are also receiving preliminary findings and feedback to be used formatively as we continue to strengthen our structures to support leading teachers.

Next Steps

Teacher leadership will always be a core component of the work we do at the RiSE Center. We have also learned that professional learning communities are a powerful way to provide leading teachers with the support they need as leaders. In light of this, we plan to continue focused support for leading teachers this summer and into the next academic year as we transition to the Maine STEM Partnership @ the RiSE Center.

Leadership Task Force

The Leadership Task Force was our first attempt to blend leading teachers from the Maine Physical Sciences Partnership with leading teachers from the Maine Elementary Science Partnership. Our goal was to bring these leaders together to create a vision for the future K-12 partnership supporting STEM education in Maine.

Objectives

The specific objectives of the Leadership Task Force mirror some of the goals of the MainePSP:

- Gelling as a K-12 leadership team

- Broadening vision of leadership from classroom to beyond
- Sharing and discussing transformative experiences
- Sharing and discussing best practices for professional development
- Brainstorming and sharing ideas for future
- Strengthening communication skills through Crucial Conversations Training

Results in the Past Year

17 elementary and 11 middle and high school teachers participated in this week-long task force held at Schoodic Institute in Maine. We partnered with Outward Bound to launch the task force and deepen our leadership skills and team connectedness. This was especially important as we were blending teacher leaders from two projects that had not previously worked together. We then began a reflective process about transformational experiences where all participants shared stories of personal transformation and we searched for trends and patterns that might suggest common elements needed to support transformational experiences. The goal of this exercise was to create a common language and foundation on which to build and design a future vision for a transformative partnership. We knew we wanted any work we do in the future to be truly transformative for participants, so we wanted to study transformation as the foundation for any design work. Finally, we broke into groups and worked collectively to design proposal for future projects and organization structures. These blended groups included representation from elementary and middle school teachers, and served to bring out and leverage the best elements of the historic work of each partnership. Each group pitched their ideas and the whole group gave feedback and recommendations for moving forward.

Dissemination of Results

The results of this work have become the foundation of this past year's focus on sustainability. We intentionally planned this task force in the summer before our last year to allow the ideas that emerged at this task force to take shape over the year and drive our future directions as a partnership.

Next Steps

This leadership collective has continued to meet throughout the year in order to shepherd the transition from MainePSP and MaineESP into the Maine STEM Partnership, our future K-12 partnership to strengthen STEM education in Maine.

Responsive Data Analysis

Throughout the life of the MainePSP, we've seen a strong demand from teachers to be able to see their students content survey data. Unfortunately, the time and effort involved in making these reports rendered our response to this demand rare. In summer 2015, we decided to pursue the ability to efficiently produce reports of data. Using Excel, workbooks were created that

would automatically produce figures and statistics about multiple-choice data. The figures could then be linked to a Powerpoint template and saved as a basic report. This new auto-analysis tool was also geared toward enhanced research and professional development possibilities.

Objectives

- Develop digital tools to efficiently analyze and report any multiple-choice survey data
- Give teachers the option of receiving reports of their students' data in near-real-time
- Improve the efficiency of analyzing survey data for professional development purposes
- Create tools that could immediately adapt to deeper research questions about student thinking and conceptual growth

Results

On designing the tools: There have been several iterations of the auto-analysis tools. Initially, a new workbook had to be created for every survey with a unique answer key and question set. Though this method of re-creating the tool for every survey was successful, it was very inefficient. The latest version of the auto-analysis tool is customizable. Using the "Design" tab, the headers and answers to a data set may be changed throughout the entire workbook. Furthermore, the latest version may be used for Likert questions, where multiple answer choices can be coded as favorable, neutral, or unfavorable. Lastly, the user can easily apply filters which cause the workbook to omit certain populations when generating statistics and figures.

On reporting to teachers: We've been able to produce and distribute roughly 80 data reports to the roughly 20 teachers that have requested reports of their respective students' 2015-16 content data. The time between receiving the data and sending a report out was almost always within a week, often within several days. The teachers were then using the reports for a variety of educational purposes, such as bringing them to professional development to share and discuss or measuring student learning outcomes (SLOs).

On professional development capabilities: The customizable Likert version of the auto-analysis tool allowed us to thoroughly investigate emergent research questions in near-real-time, which improved the efficiency of planning and preparing for PD sessions. We offered a new format of PD session (the "data session") every week in May, each week for a different curriculum. We were able to prepare the majority of the data and presentations for each of these sessions within a single week using these new tools. Lastly, during the sessions themselves, one researcher had the auto-analysis tool standing by to investigate any additional questions posed by teachers.

Dissemination of Results

Over the past year, roughly 20 teachers have requested reports of their data. We've been able to fill all of those requests, sending out roughly 80 reports throughout the school year. The reports are almost always produced and sent out within a week of receiving the data, often within just several days. For professional development, roughly 10 teachers were able to attend our data-based sessions in May, which we prepared for in-part using the auto-analysis tools.

Next Steps

At this point, the auto-analysis tools are ready for reporting and PD purposes. However, knowledge and directions on using these tools is not well-disseminated. As such, the major next

step would be to polish the layout of the tools and finalize instructions on how to utilize them. Meeting this objective would facilitate the use of this tool for projects by various parties within and without the RiSE Center.

Survey Alignment: Aligning MainePSP Surveys to NGSS and Curricular Materials

Each year, the MainePSP distributes common surveys to investigate student thinking in each curriculum. Typically, these surveys undergo a process of revisions during summer in preparation for the coming school year. Though these revisions have traditionally included input by teachers, they often focused on important research questions rather than standards or specific curricular content. With sufficient data collected for these research questions, we decided to revise the surveys during the summer of 2015 to better address the evolving needs of our community.

Objectives

- Better align the MainePSP content surveys to NGSS standards
- Better align the MainePSP content surveys to the content of their respective curriculum
- Collaborate with teachers and university faculty to meet the needs of both groups

Results

SEPUP Earth Science Survey: The questions for this survey in 2014-15 were all assembled from MOSART and AAAS. The benefit to this construction was that our results could be compared to those of MOSART and AAAS. Unfortunately, in preparing for 2015-16, we realized that most of the questions were not as relevant to the SEPUP curriculum nor the NGSS standards as we would like. New multiple-choice questions were written by reading each activity in the SEPUP curriculum. Then during data-driven collaborative meetings with SEPUP teachers, NGSS-relevant questions were selected to compose the new SEPUP survey. The new survey covered units B-F (of A-G), with a format per unit of 2 easy/recall questions, 2 medium/reasoning and evidence questions, and 1 misconception-based which often came from AAAS.

PBIS Physical Science Surveys: All three of the PBIS surveys (Energy, Chemistry, and Vehicles-in-Motion [VIM]) had a mix of questions we wished to keep or replace. PBIS is the curriculum with the most active research, while also containing some of the harder concepts to assess with multiple-choice. Informed by the data from past years, we proposed questions—some the same, edited, or new—in a collaborative setting with university faculty and PBIS teachers. In the end, we were able to revise all three surveys in ways that we felt were grade-level appropriate, relevant to the content, addressed the standards, and could provide information about student thinking and learning.

EarthComm Earth Science Survey: This survey remained largely unchanged from the 2014-15 year. There was little ongoing research using the survey and we felt fairly confident with the relevance of the questions. Therefore, only a handful of questions were replaced or edited for the 2015-16 year.

Dissemination of Results

For the 2015-16 year, the surveys had the following number of online student responses pre- and post-instruction:

	<i>Survey</i>	<i>Pre</i>	<i>Post</i>
SEPUP	<i>Whole</i>	637	151
	<i>Unit B</i>	63	324
	<i>Unit C</i>	146	318
	<i>Unit D</i>	91	252
	<i>Unit E</i>	86	203
	<i>Unit F</i>	85	85
PBIS	<i>Energy</i>	727	639
	<i>Chemistry</i>	641	484
	<i>VIM</i>	631	377
EarthComm	<i>Mod 1</i>	344	337
	<i>Mod 2</i>	296	160
	<i>Mod 3</i>	108	150
	<i>Mod 4</i>	134	70
	<i>Mod 5</i>	87	25

Teachers also had the option of administering the surveys on paper and bubblesheets as necessary. We did receive some data on paper, though we greatly encouraged administering the surveys online and therefore the table above reflects the majority of data collected.

Next Steps

Over the year, some revisions have been suggested by teachers and realized during professional development and research. This summer, we'll briefly revisit the surveys to evaluate whether any questions need to be edited, replaced, or removed to better address student learning for the 2016-17 school year.

Ongoing Programs and Activities 2015-16

Over the past six years the MainePSP has developed several core programs to accomplish our goals that were ongoing in 2015-16. Each of these programs and activities has been modified each year in response to feedback gathered from a variety of sources, including findings from research and evaluation and feedback from participants. Programs and activities that were ongoing with normal annual updates and modifications implemented in 2015-16 are listed below, followed by a detailed write-up of each activity.

- Cohort Meetings
- Faculty Course Modification Incentive Grant and Maine Learning Assistant (FIG-MLA) Program

- Fall Summit
- MainePSP Warehouse
- New Teacher Professional Development
- Summer Academy
- Teaching Partner Program
- UCOP

Cohort Meetings

We continued our long history of MainePSP Cohort meetings as our main vehicle for ongoing professional development and community building within the MainePSP community. The evening and weekend Cohort Meetings brought teachers, faculty and MainePSP staff together to discuss common issues in science education, physical science content, and scientific practices. The foci of the sessions were designed using both teacher surveys and project-collected data to identify areas of need for the MainePSP community. These topics included how to teach students to engage in argument from evidence, energy, force and motion, data literacy, using productive talk with high school students, and infrared radiation and greenhouse gases. Often a teacher leader and/or working group would work with a faculty member to plan the professional development portion of the cohort meeting.

These professional development sessions help to create a sustained and expanding partnership. It is evident that 6-9th grade physical science teachers learn from their peers, as well as faculty, how to extend their understanding of specific content and scientific practice(s), deal with common issues around teaching and learning science, and/or fully utilized the provided resources and materials.

Objectives

The specific objectives of the Cohort Meetings mirror those goals of the MainePSP:

- The project will build and strengthen the science education community.
- The project will improve grade 6-9 physical science teaching and learning through professional development,
- The project will support new teachers in the MainePSP by working through activities in the curriculum, and
- The project will strengthen teacher content knowledge and pedagogical content knowledge by engaging them with data from their own classrooms.

Results in the Past Year

The MainePSP held 4 cohort meetings on the following dates, with the following attendance:

9/15/15 – 49 teachers attended, 10 other members from the community

10/23/15 – 98 teachers attended, 10 other members from the community

1/23/15 – 40 teachers attended, 9 other members from the community

2/11/16* – (Ellsworth Location) 20 teachers attended, 7 other community members

3/20/16 *- (Orono Location) 12 teachers attended, 6 other community members

* The same meeting was held in two different locations.

The evaluations from this year show that teachers value being part of a dynamic community and they gain tangible support and growth from meeting with colleagues to discuss teaching and learning science.

Also this past year, we selected one cohort meeting (Jan 23rd) to serve as an open house for other teachers, administrators and potential district partners who might be interested in joining the partnership in the future. We structured this meeting to give these teachers and administrators a strong overview of what our partnership is all about and what sort of professional development and support is offered at cohort meetings.

Dissemination of Results

Experiences from the collaborative structure and design has been shared with the K-12 Research Implementation Group (K12RIG) and leadership team and used to inform improvements to future professional development plans. In addition, Michael Wittmann and Carolina Alvarado are preparing a series of papers on teachers' use of student and teacher data to discuss content knowledge, knowledge of student ideas, and pedagogical strategies during Cohort Meetings. Michael Wittmann, Carolina Alvarado, Alex Axthelm, and Greg Kranich will be presenting a workshop at the 2015 Physics Education Research Conference to showcase this model of professional development in both energy and force and motion.

Next Steps

The cohort structure is one legacy element of the MainePSP that will continue through the Maine STEM Partnership @ the RiSE Center. We will host another series of cohort meeting during the 2016-2017 academic year, expanding the reach to include the entire PK-16+ STEM teaching and learning community. Breakout groups within these meetings will enable each special interest group to find professional development activities and discussions that are relevant and beneficial for their teaching. The cohort community will expand in the future to include life science, mathematics, engineering and all grade-levels from PK through graduate students and faculty.

Faculty Course Modification Incentive Grant and Maine Learning Assistant (FIG-MLA) Program

The core goal FIG-MLA program is for more undergraduates to experience learning STEM content in courses that make use of research-supported instructional practices. The courses that are modified as part of the FIG-MLA program will create enhanced learning opportunities for undergraduates because of the addition of student-centered, research-supported instructional

practices. The targets of the FIG projects are courses where pre-service teachers receive their content preparation (either as part of a STEM major or as a content component of a STEM education major). All projects make use of Maine Learning Assistants (MLAs) as part of the instructional modifications.

Objectives

Increase the number of undergraduate courses taught using student-centered, active learning approaches; improve learning opportunities for pre-service students in their undergraduate STEM courses; create teaching-related professional development opportunities for STEM faculty instructors; create a community among STEM faculty that supports research-based instructional change.

Results

Our fourth cohort of FIG recipients carried out their course modification projects, in addition to the continuation of the first, second, and third cohorts. Cohort 4 included five new courses (four new faculty), representing four departments. As in previous years, these faculty were selected based on written proposals they submitted that included descriptions of their proposed course changes, the rationale for those changes, their plans for incorporating undergraduate learning assistants into their courses, and strategies they will use to assess the impact of the changes on the course and students' learning opportunities.

These new courses had a total enrollment of 532 undergraduate students. The faculty gathered data on their students' performance and attitudes and analysis of those data has begun.

With these new courses, the set of departments represented by FIG faculty now includes 11 total departments. We are renewing the funding for all of the fourth cohort recipients and they will be analyzing their data and then teaching a revised version of their course in the coming academic year.

We met with FIG faculty once each semester during the 2015-2016 year. These meetings were an opportunity to discuss topics of relevance to all faculty, such as questions pertaining to MLA implementation.

Examples of project descriptions include:

Enhancing students' opportunities to engage in authentic forms of inquiry-based, scientific writing so they can improve their knowledge and their scientific communication skills.

Using clickers to facilitate peer discussion and to study how knowledge of peers' answers shapes peer-to-peer discussions. Also using MLAs to help with in-class small group activities.

Enhancing students' opportunities to learn during small group discussions in lab by having MLAs as facilitators for those discussions. Also enhancing student engagement with clicker questions in the classroom by having MLAs present to facilitate.

Incorporating clicker discussions, small group tutorials, and metacognitive and system design activities in an electronics laboratory.

In the past academic year, we carried out the data collection plan that we had developed in previous years. Data were collected from the following sources:

(1) Students in transformed courses

- Content survey (administered before and after instruction)
- Perception of the discipline survey (administered before and after instruction)
- Questionnaire about the impact of MLAs on course experience (near the end of instruction)

(2) Maine Learning Assistants

- Content survey (administered before and after instruction)
- Perception of the discipline survey (administered before and after instruction)
- Questionnaire about their experiences as MLAs (near the end of instruction)

(3) Global Measures

- Number of undergraduate MLAs, courses, faculty, and departments impacted
- Selectivity of MLA program

A total of 65 undergraduate Maine Learning Assistants worked during the 2015-2016 school year, with a total of 36 new to the MLA program who also enrolled in a seminar about teaching and learning (as a co-requisite to a student's first year as a MLA).

We continue to adapt the MLA seminar to accommodate a diverse assortment of STEM majors, including those who do not have backgrounds in the physical sciences. This course is based on the University of Colorado's pedagogy course for LAs (undergraduate peer facilitators). At this point, we have assembled a relatively extensive collection of suitable articles; while core articles are unchanged from semester to semester, certain articles are added to or removed from the course readings based on MLA interest. We continue to find that group presentations about articles on discipline-specific ideas ensure that MLAs think deeply about the learning and teaching of content related to their teaching assignments; moreover, the quality of the presentations during the 2015-2016 academic year was highest we have seen since implementing the discipline-specific presentations. In addition, in-depth discussions about videos of teaching and instructor-student interactions in a variety of instructional setting continue to be a key part of the course. We continue to update and revise the course content and activities.

Dissemination of Results

Results of data collection analyses have been shared with FIG faculty and campus administrators during various meetings that occurred over the 2015-2016 academic year.

Next Steps

The MLA program received bridge funding to allow it to continue in 2015-2016 and recently received additional funding for 2016-2017. However, we will continue to our efforts to make this a permanent program of the University. We plan to continue and expand the data collection and analyses to examine the impact of the FIG-MLA program on the various stakeholders. These data will guide modifications to various elements of the programs (including, for example, the MLA seminar). These data will also inform our discussions with University of Maine administrators as we seek to secure funding to sustain the MLA program beyond the term of this grant

Fall Summit

We hosted our 5th annual summit in the fall at Sugarloaf, bringing together our entire community for a focused celebration and conference on teaching and learning. The theme of our summit this year was Evidence-Based Strategies for Excellence in Teaching: Active Learning and Student Engagement.

Objectives

The specific objectives of the Summit expand on some of the goals of the MainePSP:

- Deepen content knowledge and pedagogical content knowledge in STEM
- Strengthen proficiency with high-impact instructional strategies for active learning and student engagement
- Support connections and networking within our partnership and learning community

Results in the Past Year

A total of 127 participants attended the fall Summit. This was broken down into 43 elementary teachers, 34 middle and high school teachers, 10 pre-service teachers, 8 faculty and 8 project team, and 24 partners, presenters and guests. In the two days, we hosted several strands focus on sharing best practices and research on the topic of active learning and student engagement. Through panels, invited talks, keynote presentations, workshops and working groups, participants deepened their knowledge and exposure to these themes and the work being done in this field.

Dissemination of Results

We made conference proceedings available to participants of the conference as well as others in our partnership who were unable to attend. Our summit planning committee also uses the findings and feedback from this summit to inform and improve the plans for the next summit.

Next Steps

We plan to continue running an annual Summit each fall focusing on a theme within evidence-based strategies for effective teaching.

MainePSP Warehouse

Since the MainePSP Curriculum Selection Task Forces selected materials in 2010-11 for middle school physical sciences and in 2011-12 for high school physical sciences, the RiSE Center has provided a materials warehouse (the MainePSP Warehouse) for our school and district partners. The MainePSP Warehouse is staffed by one or more Resource Coordinators, who work closely with partners to coordinate teachers' needs for materials. Coordination allows the entire community to share materials, to provide high-quality science materials to students in a way that is cost-effective for schools.

Objectives

The purpose of the MainePSP Warehouse is to provide high-quality instructional materials to teachers and students, including teacher and student books, and all materials needed to conduct extensive hands-on inquiry-based activities as recommended in the selected materials (SEPUP, PBIS, and EarthComm) as well as by MainePSP Teachers in Residence.

Results in the Past Year

A total of 146 teachers and 5,386 students in grades K-9 from 57 schools and 26 districts, obtained materials through the MainePSP Warehouse. For the first time, the MainePSP Warehouse was staffed by a single Resource Coordinator where in the past there have always been multiple Resource Coordinators. In addition, the MainePSP Warehouse expanded to provide materials to teachers in K-5, who participated in the RiSE Center's Elementary Sciences Partnership.

In order to improve the potential for sustaining the MainePSP Materials Warehouse beyond the lifetime of the MainePSP and MaineESP grant funding, school districts began to financially support the Warehouse by paying \$12 per student for their books and materials.

Next Steps

For the coming year, school districts have been asked to include support for the MainePSP Warehouse in their budgets.

New Teacher Professional Development

This targeted professional development focused on teachers who were new to our partnership and community. The goal was to provide them with a transformative immersion into inquiry pedagogy, preparation for how to use our common instructional resources, and support for getting the most of participation in a dynamic, data-guided improvement community.

Objectives

The specific objectives of New Teacher Professional development support the goals of the MainePSP:

- Provide new-to-partnership teachers with an immersion into inquiry pedagogy in science teaching
- Prepare new-to-partnership teachers to effectively use our community's instructional resources
- Introduce new-to-partnership teachers to the concept of data-guided improvement community and show them how to be an active participant and get the most out of their participation

Results in the Past Year

A total of 10 teachers participated in new teacher professional development sessions in August. We offered a workshop from the Exploratorium to expose teachers to inquiry pedagogy in science, and we brought in veteran teachers from our community to introduce the new teachers to our community resources and how they work. Finally, we brought in our research and evaluation coordinator to discuss what it means to be part of an improvement community that uses data and research to improve our practice on an ongoing basis.

We continued this work throughout the academic year, providing specific sessions conducted by our experienced teachers to support teachers who were using MainePSP curricula for the first time. These sessions provided continued support for using the new materials and resources as well as community-identified potential issues with teaching and learning using these resources. A safe environment was created and teachers felt comfortable asking questions and sharing experiences.

We found that this professional development not only provides the teachers with the skills they need as they begin working with our partnership, but also with a small community of others in the partnership who are at the same place as they are. The bonds formed here help carry new teachers through years of teaching within our partnership.

Dissemination of Results

We have shared the results of this professional development with our leadership team and design teams, and will use the lessons learned from offering this program this year to improve our offering for next year.

Next Steps

We have found this professional development to be an effective way to orient new teachers to our community and we will be offering this program again next year with a fee to districts.

Summer Academy

We have shifted the timing and structure of our Summer Academy to work more like summer content courses that are open to in-service and pre-service teachers. This upcoming summer (July) we will offer modules in earth science, life science and chemistry and energy.

As in past years, the Summer Academy engaged teachers in rigorous science activities to improve both their science content knowledge and their pedagogical content knowledge.

Teachers had the options to join one of three strands for professional development. One was an opportunity to both learn from and interact with faculty from the School of Earth and Climate Science in a four-day session held at the Bryand Global Science Center, where teachers had the opportunity to use various resources and pieces of equipment in their activities. Eighteen teachers attended the Earth Science Content Strand.

Objectives of the Earth Science Content Strand

- To engage teachers in activities and discussion about plate tectonics, earthquakes in the lithosphere, post glacial rebound.
- To increase teachers' understanding of plate tectonics, earthquakes in the lithosphere, post glacial rebound.

A Force and Motion content strand engaged teachers in a set of rigorous inquiry activities on force and motion to strengthening teacher content and pedagogical content knowledge. The teachers experienced this inquiry unit working in small groups of three or four with check out session held by faculty and a postdoctoral science educator. Twelve teachers attended the force and motion strand of summer academy. Postdoc Carolina Alvarado gathered data about how teachers engage with the force and motion inquiry activities, and how they learn about the concepts. This data will be analyzed, presented to the K-12 Research and Implementation Group (K12-RIG), and used in future publications.

Objectives of the Force and Motion Content Strand

- To engage teachers in activities and discussion about force and motion.
- To engage teachers in an inquiry learning experience.
- To increase teachers' understanding of force and motion concepts.
- To conduct research about how teachers learn about chemistry and energy

The place-based learning strand engaged teachers in discussions of place-based learning opportunities related to the SEPUP middle-level weather unit. Time was also spent exploring the research around the use of place-based learning activities. Thirteen teachers attended the place-based learning strand of summer academy.

Teaching Partner Program

The MainePSP offers a Teaching Partner Program for MainePSP teachers. The program matches teachers with a Teaching Partner (an undergraduate or graduate student) who spends time in the teacher's classroom each week helping the teacher with instructional materials and small group work. The aim of this program is to provide a mutually positive and beneficial experience, wherein the teacher receives additional support from a University student who is familiar with the instructional materials and science content, and the University student experiences the science teaching and learning process in a K-12 classroom.

Our experienced teachers identified lessons in our curricula when having another adult in the classroom would be a benefit for students and teacher. The program attempted to utilize an online scheduling program to set up times for Teaching Partners to go to classrooms on an as needed basis. This did not work as well as intended and Teaching Partners made contact with teachers to schedule visits to classrooms.

Objectives:

- Provide assistance to the teacher in the classroom.
- Provide pre-service teachers with classroom experiences in a science classroom.

Results

Fifty teachers had a Teaching Partner visit their classroom at least once this year. Self reporting by teachers and Teaching Partners shows us that the experience is positive for both groups.

Next Steps

The Teaching Partner program will continue another year and will combine scheduling a teaching partner for a regular time to visit and have flexibility for scheduling a Teaching Partner on an as needed basis.

University Classroom Observation Program (UCOP)

Because of the national call-to-action to reform undergraduate STEM instruction, there is increasing interest in collecting information on the range and frequency of teaching practices at department-wide and institution-wide scales. To help facilitate this process, we helped to develop a classroom observation protocol known as the Classroom Observation Protocol for Undergraduate STEM or COPUS (Smith et al., 2013). This protocol allows observers, after a short 1.5-hour training period, to reliably characterize how faculty and students are spending their time in the classroom.

At the University of Maine, local middle and high school teachers have been using the COPUS observation protocol to collect snapshots of the types of instructional techniques used in STEM classes. During the past year, teachers completed 152 classroom observations in 74 courses from 75 different instructors, and attended by over 6000 students. This includes 25 different STEM departments. In 2013,

Drs. Michelle Smith, MacKenzie Stetzer, Susan McKay, and Jeff St. John, who were awarded an NSF WIDER grant (DUE 1347577) to explore how to use the observation data to develop meaningful campus-wide professional development opportunities at the University of Maine, have been implementing additional new professional development programs under the WIDER program.

Project Dates

The project began in 2011, but has been modified over the five-year period. The project is currently ongoing. Observations take place during both the spring semester. Observation results were shared and discussed with the observed UMaine instructors in one-on-one meetings with the program coordinator.

Data collected

1. COPUS observation data of faculty - 152 observations during the Spring 2016 semester.
2. UMaine faculty filled out a survey about their teaching practices. This survey is called the Teaching Practices Inventory (Wieman and Gilbert, 2014 CBE-Life Sciences Education).
3. UCOP teachers completed post-observation surveys for each class observed. One survey was completed as an observation pair and another was completed by each teacher individually. Both surveys were developed by MST student, Justin Lewin.
4. Middle and high school teachers filled out feedback surveys about their observation experience and a revised Teaching Practices Inventory for middle- and high-school teachers.
5. All 20 participating middle and high school teachers were individually observed using the COPUS protocol.

Findings

As described in a recent publication: Lewin JD, Vinson EL, Stetzer MR, Smith MK. A campus-wide investigation of clicker implementation: The status of peer discussion in STEM classes. CBE-Life Sciences Education. 2016, 15:1-12. <http://www.lifescied.org/content/15/1/ar6.full>

We have found:

- 1) Investigation of various modes of clicker use in the classroom revealed differences in the range of behaviors, the amount of time instructors lecture, and how challenging the clicker questions were to answer.
- 2) Because instructors can vary their instructional style from one clicker question to the next, we also explored differences in how individual instructors incorporated peer discussion during clicker questions.
- 3) These findings provide new insights into the range of clicker implementation at a campus-wide level and how such findings can be used to inform targeted professional development for faculty.

For data collected during Spring 2016, we are interested in exploring the following question: How do teaching practices vary from middle school, high school, and undergraduate courses (both introductory and advanced)? Are there differences in how active-learning tools are used?

Next Steps

We will be analyzing the data to answer the research questions above, and plan to submit a manuscript in the fall.

List of publications or presentations directly related to this project

Lewin JD, Vinson EL, Stetzer MR, Smith MK. A campus-wide investigation of clicker implementation: The status of peer discussion in STEM classes. *CBE-Life Sciences Education*. 2016, 15:1-12.
<http://www.lifescied.org/content/15/1/ar6.full>

Smith MK, Vinson EL, Smith JA, Lewin JD, Stetzer M. A Campus-Wide Study of STEM Courses: New Perspectives on Teaching Practices and Perceptions. *CBE-Life Sci Educ*. 2014, 13:624-635.

Michelle Smith Interviewed as part of a video on the Festival of Learning in Teaching in Adelaide, Australia:
<http://www.adelaide.edu.au/festival-1/>

Michelle Smith Guest on RRR FM Australian science radio show Einstein A Go Go:
<http://rrrfm.libsyn.com/einstein-a-go-go-16-november-2014>

UCOP teacher blog post:
<http://www.hurricaneisland.net/science-for-everyone/2015/4/24/improving-stem-teaching-through-course-evaluation>

Invited talk by MacKenzie Stetzer:
“Two projects focused on undergraduate STEM education: The University Course Observation Program and an investigation of the role of metacognition in student reasoning in physics,” Center for Teaching and Learning Seminar, Technischen Universität Hamburg–Harburg, Hamburg, Germany, July 2, 2014.

Invited talks by Michelle Smith:
NSF, March 2015, “Strategies that Promote Institutional Transformations in STEM Education”

Dartmouth, March 2015, “Using Student Learning and Observation Data to Guide Changes in STEM Classrooms”

Festival of Learning and Teaching, Adelaide, Australia, November 2014
Documenting the Importance of Active-Learning and Using Data to Guide Institutional Change