



Innovative Arrangements and Strategies for Strengthening STEM Teaching and Learning

Introduction

The Maine Physical Sciences Partnership (PSP) is a six-year investment of federal funds that has fostered an important partnership between the University of Maine and local K-12 teachers, curriculum coordinators, and superintendents.

One of the key successes of the Maine PSP is the development of innovative arrangements to strengthen STEM teaching and learning, both at the university and in 6th-9th grade classrooms throughout the region. These arrangements address specific challenges in reforming STEM education at the university and K-12 classroom levels. They build capacity and foster learning communities of practice within university faculty and classrooms, within the community of K-12 teachers and classrooms, and most importantly, in cross-over and collaboration between these two communities.

These innovative arrangements and strategies improve teaching and learning in STEM courses on campus and provide increased opportunities for undergraduate and graduate students to gain teaching experiences on campus and/or in K-12 classrooms. These arrangements have been strategic in the ways in which they have brought teachers, curriculum coordinators, and university faculty and students together to study and document each other's work, to implement and investigate STEM education reforms and the supports needed to sustain those reforms, and to build a true partnership between the university and K-12 systems.

Crucial assets have been built through this partnership, both at the university and in the schools, establishing a platform for future improvement work.

Maine PSP Innovative Arrangements

Faculty Course Modification Incentive Grants – Maine Learning Assistants Program (FIG-MLA)

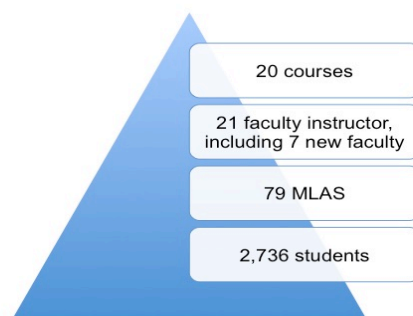
The FIG-MLA program set out to address specific challenges: University STEM courses, often lynchpins for student success or failure in STEM disciplines, can be impersonal, lacking in active learning, and overwhelming in challenging content. The program engages STEM faculty who propose reforms to their courses with undergraduate students who have taken their courses to help them implement innovative reforms.

❖ **The FIG-MLA program has reached a substantial number of courses, faculty, and students.**

Since fall 2012, the FIG-MLA program has supported improvements in 69 course offerings with cumulative enrollment of 9,730 students across nine STEM departments including physics, chemistry, biology, calculus, electrical and computer engineering, and marine biology. This represents 23 individual undergraduate courses taught by 29 instructors over multiple semesters.

Data for 2015-2016 show the number of faculty, MLAs, and students involved on an annual basis:

FIG-MLAs 2015-2016



❖ **There have been multiple important outcomes of the FIG-MLA program to date.**

- The FIG-MLA program may contribute to improved retention rates.**
 Preliminary data indicate that when comparing retention data for FIG-MLA courses before the program and after, retention rates post FIG-MLA were higher.
- The program is a “win-win” arrangement with benefits for all involved: faculty, MLAs, TAs, and students taking the courses.**
 Of the 25 returning MLAs responding to end-of-semester surveys administered by the Maine PSP, 84% agreed or strongly agreed that their MLA experience increased their interest in a teaching career; 88% reported that the experience made them more confident in pursuing a career in math or science. And 98% of 50 new and returning MLAs reported that the experience was valuable to their professional development.

End-of-semester survey responses from 738 students in FIG-MLA courses (representing just under 8% of total enrollment in those courses) show 73% reporting that Maine Learning Assistants were useful to their learning.

Benefits from the FIG-MLA Program	
<p>Faculty</p> <p>Support for students, input, greater student engagement, improvement community</p>	<p>MLAs</p> <p>Greater understanding of course content, teaching experience, relationships with faculty, TAs, students</p>
<p>TAs</p> <p>Gain help facilitating student discussion and problem-solving, learn new ways to explain things and facilitate student learning</p>	<p>Students</p> <p>Value additional avenues for support</p>

FIG-MLA Participant Quotes:

...between exam one and exam two, the students who joined an MLA group and stuck with it and went to all of the sessions, their learning gains were about twice what they were for the students who didn't join up and even compared to the students who weren't invited.

– Faculty

I really like it when you just see someone finally understand it. For example, you realize that there is some flaw to how they are doing it and you get at, "Well, okay this is happening. What would happen in this situation?" When they realize it and then fix what they are thinking, that is really exciting.

– MLA

I really enjoy having the MLAs in the recitation section with me. They are sometimes more approachable than I am, and they can sometimes better understand where the students are coming from when they get stuck than I can.

– TA

I had taken this class before and failed it, and now I am doing so much better. It isn't just because I have had it before. This class is structured differently now, and there is so much more I can access when I need help. There are a lot more supports built in. I really like having the MLAs in the math lab—between the lab and the lecture, there are a lot of people who can answer my questions and check my thinking. It is surprising—I have never done so well in a math class before.

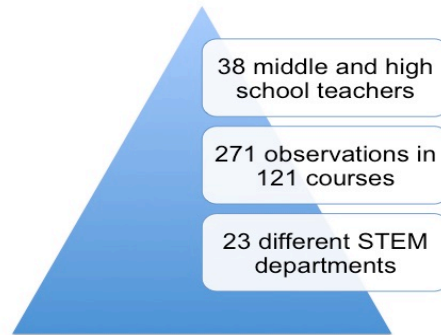
– Calculus student

University Course Observation Program (UCOP)

UCOP is an arrangement aimed at improving the quality of undergraduate STEM education. The program set out to address the need to collect data to inform the reform of higher education STEM courses at the University of Maine. K-12 teachers come to the university to observe STEM courses and fill out rigorous observation protocols, then share the data gleaned from those observations with faculty and the university.

- ❖ **More than 120 STEM courses have been observed by more than 35 teachers, and observation data have been shared with over 60 different STEM instructors.**
- ❖ **The following graphic of summary data from 2014-2015 shows an annual picture of the scope of UCOP:**

UCOP 2014 and 2015



❖ There have been multiple important benefits from the UCOP program to date.

Benefits from the University Course Observation Program	
<p>Faculty</p> <p>Gain feedback on their courses; learn from K-12 teachers' pedagogical expertise; opportunity to become part of an improvement community</p>	<p>University</p> <p>Gain campus-wide data for faculty PD and supports</p>
<p>Teachers</p> <p>Facilitates reflection on their own teaching; feel valued by the University; gain better understanding of what their students going on to college will need</p>	<p>Field</p> <p>Helped inform new observation protocol (COPUS); model that other universities are interested in learning about</p>

Teaching Partners

The Teaching Partners program set out to provide support to teachers as they implement new instructional materials, particularly in the area of science content knowledge, and to provide university students with experience in classrooms, particularly more in-depth understandings of the realities of STEM teaching and learning with inquiry-based instructional materials. The program places graduate students from the Master's of Science Teaching (MST) program, as well as undergraduates, in the classrooms of teachers participating in the Maine PSP to help them implement inquiry-based instructional materials with their students.

❖ From the fall of 2011 through the spring of 2015, 38 Teaching Partners visited 74 classrooms on a regular basis or when requested.

❖ **There have been multiple important outcomes of the Teaching Partners program:**

Benefits from the Teaching Partners Program		
<p>Teaching Partners</p> <p>Increased ability to effectively communicate science content and facilitate students learning; better understanding of realities of classrooms</p>	<p>Teachers</p> <p>Gain additional facilitators for inquiry activities; content knowledge from TPs; another person to debrief lessons with</p>	<p>K-12 Students</p> <p>Gain role models and mentoring from college students</p>

Teacher Partners Program Participant Quotes:

I wanted to learn as well as help. I was interested in what kind of knowledge teachers need to have in order to teach, especially around assessment practice. How does one do that skillfully to support student learning? I really wanted the chance to talk with teachers. I teach physical science and math. Formative assessment is an important part of teaching. I wanted to see how experienced teachers were doing that. Different teachers have different practices.

– Teaching Partner

Having someone [a teaching partner] who understands the materials and can support additional methods of instruction to differentiate the lesson was wonderful.

– Classroom teacher

Other Innovative Arrangements

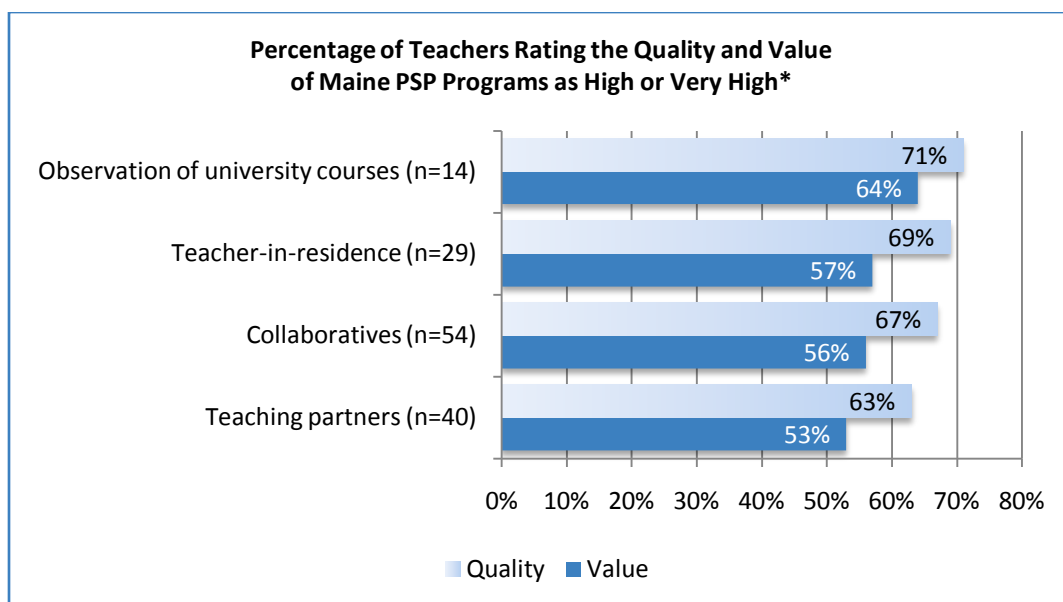
- ❖ The **Teachers-in-Residence** program brings participating Maine PSP teachers to the University of Maine for several weeks each summer to work with university faculty, MST students, and Summer Undergraduate Research Assistants to develop supports and assessments for the implementation of the new instructional materials, address vertical alignment issues, and address specific challenges and issues related to national and state STEM teaching and learning priorities (such as the Next Generation Science Standards and new teacher evaluation mandates). This program has successfully allowed teachers, university faculty, and students to work closely together, and it has provided the flexibility and means for teachers to get the additional supports they need to implement the materials and new and emerging contextual influences.
- ❖ The **Collaboratives** bring the university and K-12 communities together very early on in the life of the project, and include teachers (those participating in the PSP as well as non-participating teachers), curriculum coordinators, university faculty, and graduate students. The Collaboratives have been an important avenue of community building for the Maine PSP. For teachers, the

opportunity to engage with university faculty, to try new activities, learn new content, and talk with their fellow colleagues were all important benefits of participating. University faculty benefitted from having a mechanism by which they could work with K-12 personnel and explore research questions with knowledgeable practitioners. The spirit of these collaborative meetings, where teachers and university faculty jointly inquire into specific activities, instructional materials, and approaches, has been very positive. In a project with goals to create authentic partnerships between university and K-12 systems, the Collaboratives are one of several reinforcing mechanisms to do this.

- ❖ The **Curriculum Task Forces** allow the Maine PSP community to rigorously identify and select new research-based instructional materials to be implemented in all of the participating districts. University faculty, post-docs, curriculum coordinators, and teachers used a modified but still rigorous version of the American Association for the Advancement of Science (AAAS) protocol for selecting materials. In the first year of the project, the process was used to identify and select materials for 6th- 8th grade, and the second year focused on 9th-grade materials. This innovative arrangement was one borne of necessity, as the project needed to move quickly to identify and select new instructional materials. More importantly, the project needed a process that would provide sufficient rigor for the selection of inquiry curricula with research to support its effectiveness, and that would build buy-in among, and be amenable to, the multiple school districts participating in the project, all of which have their own processes in place for curriculum selection.

Teacher Perceptions of the Innovative Arrangements

On the 2015 survey, the majority of teachers rated the overall quality and value of specific components of the Maine PSP that involved significant partnership with the University of Maine as high or very high quality and value:



*Rated a 4 or 5 on a scale of 1-5, where 1 = very low, 2 = low, 3 = mixed, 4 = high, and 5 = very high.

Summary

This brief has highlighted some of the ways in which the grant from the National Science Foundation provided resources and opportunities to develop and explore innovative arrangements. These arrangements and strategies built on the partnership between the University of Maine and K-12 schools and districts throughout Maine, and sought ways to provide feedback loops for the improvement of undergraduate education and the teacher preparation pathway. Through the partnership, crucial assets have been developed both at the university and in the schools, providing a platform for future improvement work.

Inverness Research, a national education evaluation and consulting group headquartered in Northern California, has over 25 years of experience studying local, state, and national investments in the improvement of education.

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