Session Number: **8**

Abstract Name: **Year 1 Implementation of A TIME for Freshman Physics**
MSP Project: A TIME for Freshman Physics in Missouri
Author(s): Meera Chandrasekhar, Dorina Kosztin, Sara S. Torres, Keith S. Murray, and Martha A. Henry
Presenter(s): Meera Chandrasekhar, Dorina Kosztin, Sara S. Torres, and Keith S. Murray

1. Questions(s) or issue(s) for dialogue at Learning Network Conference session:

Our project, which is in its first year, has begun curriculum revisions from a previous pilot project, and is in the process of completing recruitment.

In this first year, as we begin implementation and leadership training, we wish to pro-actively address issues that might affect implementation in the first year, thereby laying ground-work for long-term leadership implementation and sustainability. Questions that we wish to dialogue include: What methods help sustain enthusiasm among participants? What methods assist with providing teachers confidence about new subject matter? What methods help buy-in within buildings and districts among administrators whose support is necessary, but who may not be involved in the nitty-gritty of the project? What methods can help with fidelity in the implementation of curriculum and the methodology?

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2. Context of the work within the STEM education literature and within your MSP project:

Physics First has been gaining steam since 1995, spearheaded by Leon Lederman, a Physics Nobel Laureate. A framework was released by Project ARISE[i], which advocates the inversion of the standard biology-chemistry-physics teaching order[ii]. The logic is that the "foundational" science,[iii] physics, underlies all chemistry content, and together they support[iv,v,vi] the biological sciences. Nationwide a small number of schools teach Freshman Physics (FP), but the sequence in later grades varies.

The AAPT[vii] reports that FP promotes growth in enrollment in advanced courses, including 4th year and AP electives[iv]. Minorities and female students, when familiar with physics, are encouraged to take more sciences as they enter higher grades[viii,ix]. The top achieving countries on TIMSS[x], like Scandinavia, teach physics every year starting in the 6th grade[xi]; with FP, 9th and 10th graders' performance compares well with seniors on the New York Regents exam.[xii] Math educators also support FP[xiii]. FP allows immediate opportunities for students to practice their newly acquired algebra skills. In contrast, the traditional sequence produces a 3-year delay between 9th grade algebra and 12th grade physics.

Nonetheless, the benefits of placing physics first in the curriculum cannot be realized without effective teaching. Teachers' effectiveness depends not only on their knowledge of the subject matter, but also their knowledge of teaching and learning, or pedagogical knowledge. There is a

considerable amount of literature within STEM[xiv xv, xvi, xvii] that supports teaching high school physics using inquiry and modeling methods. In our previous Department of Education-funded MSP project (2005-2008) we developed a professional development curriculum for Freshman Physics that was based on modeling and inquiry. This pilot curriculum has been in use in 25 Missouri districts that participated. The previous project's successes include increased motivation in Missouri to offer 9th grade physics, strong retention (80.5%) over the 3-year project, development of a successful PD curriculum for teachers that utilizes inquiry and modeling-based instruction, and excellent gains in content knowledge of teachers (gain = 29%, n = 58) and students (gain = 45%, average n = 911) using project-constructed unit tests.

In the current NSF project we are revising the curriculum to be more student centered, and developing digital resources such as podcasts. The pedagogy will continue to be inquiry and modeling based. Teacher resources and help will also be included, based on the Educative Curriculum Material (ECM)[xviii] model. The curriculum will be keyed to both the National Science Education Standards and the Missouri Course Level Expectations. Our challenge is to integrate these different aspects and still have a curriculum where the additional notations are easily accessible. Furthermore, we hope this curriculum will be used with fidelity as teachers exercise their leadership skills in their buildings, districts and in statewide and national settings. As teachers implement the curriculum in their classrooms, in-person visits by coaches and online support by mentors will provide them support. Coaching and Mentoring occur for two different cohorts, who are separated from one another by a delayed entry design.

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3. Claim(s) or hypothesis(es) examined in the work (anticipating that veteran projects will have claims, newer projects will have hypotheses):

Our project's two research questions are:

Research Question 1: In a teacher professional development project, can enhancement of pedagogical practice, student content acquisition and teacher leadership growth through participation in an online learning community achieve results comparable to sustained classroom coaching support?

The project intends to test whether the inherent challenges in training and maintaining qualified coaches, addressing teacher needs outside a particular coach's range of skills, and managing logistics of travel and the associated burden of costs in the coaching model may be offset by a well-implemented, active and engaging online alternative. The researchers/evaluators are in the process of publishing results from a previous NSF MSP in which content gains for students of participating teachers exceeded those for students of control teachers. These teachers were engaged in a Moodle-based online community without individualized coaching, and the greater student gains apparently occurred as a result of pedagogical rather than content-knowledge changes among their teachers[xix].

Hypothesis: We expect that the online learning community will achieve comparable results to the in-person coaching support cohort

Research Question 2: Does implementation of Freshman Physics through the project curriculum yield positive results aligning to National Science Foundation goals for improved student math and science achievement, compared to more traditional educational sequencing of science?

Hypothesis: The implementation of the Freshman Physics curriculum will exceed in student achievement.

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4. Evaluation and/or research design, data collection and analysis:

Project evaluation and research activities both take advantage of the random-assignment, delayed-entry control group design of two cohorts of teachers that frames the professional development implementation. Evaluation, based on a utilization- and needs-based design, will include formative, process and summative components, with formative and process evaluation focusing on fidelity and decision-making to accommodate issues that arise. Evaluations, aligned to project goals, are:

Evaluation Question 1: Through what processes do teachers become leaders in freshman physics?

Evaluation Question 2: What are critical district support mechanisms that assist the leadership development in teachers?

Evaluation Question 3: What characteristics are present in the learning environments (specifically schools) of students who attain higher levels of content?

Evaluation Question 4: What are the constraints to institutional change in core partners?

Evaluation Question 5: How is successful institutional change evidenced in core partners?

Evaluation Question 6: What are the critical factors in students' continuation of science course-taking in high school?

Teacher leadership goals will be evaluated through analysis of leadership plans, teacher surveys, online discussions, leadership plans and implementation reports, and teacher and administrator surveys. Teacher and student content gains will be assessed annually using pre/post content tests (MOSART 9-12 Physics). Pedagogy and teacher confidence goals will be evaluated through analysis of annual confidence tests, coach reports, online discussions and curriculum coverage reports. Institutional change will be considered through surveys, interviews, examination of course syllabi and Praxis data. Student course taking will be evaluated from results concerning the second research question.

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5. Key insights (retrospective for veteran projects, prospective for newer projects) that have value for the Learning Network:

In addition to commitment to achieving the specific goals and objectives of the project, A TIME for Freshman Physics anticipates that, enabled by its evaluation and research design, several insights may be possible. The opportunity to compare outcomes between treatment that incorporates an online learning community versus sustained classroom coaching will contribute to continued discussions in the field on how best to apply teacher support resources and to make appropriate use of emerging technologies. The ability to look more closely at the relative merits of Physics First curriculum versus traditional STEM coursework staging will further ongoing research on the issue. Additional consideration of the arc of leadership growth in teachers and related effects on student achievement also will add to the field's understanding.

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