Session Number: **27**

Abstract Name: **STEM Faculty in the MSP: Evolutions and Revolutions**
MSP Project: Rocky Mountain Middle School Math and Science Partnership
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1. Questions(s) or issue(s) for dialogue at Learning Network Conference session:

- How does participation of STEM faculty in MSP efforts affect their practice in the traditional classroom? What results are sustainable?
- What are the characteristics of effective vs. ineffective co-teaching models? How does one implement effective co-teaching with STEM faculty? How can co-teaching models be sustainable beyond the funding period?
- How do STEM faculty approach interactions with non STEM colleagues within the university? Outside the university?
- Other questions include: How do STEM faculty from multiple universities take this work back to their respective universities and/or departments; Do they talk/share with others about the work; How do STEM faculty reconcile the level of content and issues of breadth versus depth; How do you collect the evidence that shows that faculty are transferring new teaching knowledge into the university classroom; and How are faculty using this work to move towards tenure/promotion and/or post-tenure review?

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

Co-teaching has been a topic of study for a long time and is used to enhance collaboration and shared learning in a number of disciplines. For example, in the area of special education (Murawski & Swanson, 2001), co-teaching between general and special education teachers has been shown to enhance instruction for students with special needs. In teacher preparation, co-teaching models have also been encouraged so that classroom teachers and interns or student teachers are learning from each other in order to improve instruction for students. In health and social care, deliberate use of interactions creates an active learning environment (Crow & Smith, 2003) as well as enabling each member of a co-teaching team to bring particular expertise into a course.

In this MSP context, a co-teaching model was devised that created course development and instructional teams comprising a STEM faculty member, a K-12 participant, and faculty member from the Educational arena. This model was deemed important by the principal writers and implementers of the grant for several reasons. First, that the tripartite group would learn from each other; K-12 faculty would learn more about the culture and expertise of university faculty and would come to understand more fully the theoretical underpinnings of math and science content. Education faculty would have an opportunity to learn more about the issues of K-12 education and develop a different sense of content expertise and research from math and science faculty. And finally, math and science faculty would learn more about pedagogy and student

learning from both K-12 and Education faculty. We were interested to see if this learning would transfer to traditional math and science courses within the university.

STEM faculty were chosen from three local universities (two public; one private) who were partners in the project. Faculty members were selected based either on their initial interest and involvement in the project, their involvement in previous professional learning activities with K-12 stakeholders, or their reputation for being good university teachers. Thus the group of STEM faculty clearly had a bias towards sound instructional practice and an interest in K-12 education. Each STEM faculty member was teamed with two or three other instructors to develop the course. The other instructors were drawn from faculty in Education and teacher leaders, instructional coaches, or curriculum specialists from area school districts. In two courses, two STEM faculty members shared the role of content specialist and were teamed with two other co-teachers. Typically this development team also became the instructional team and taught the course to groups of 25 – 30 teachers. The STEM faculty co-taught the course either one or two times. The teachers were typically middle level (grades 5 – 9) mathematics and science teachers from our partner districts, although there were some teachers from both lower and higher grades, as well as teachers who specialized in other areas (e.g. language arts, social studies, special education.)

In order to effectively facilitate the co-teaching practice, the project management team supported a variety of professional learning workshops for all course developers and instructors. The co-teaching portion of the workshops focused on the demonstration of various co-teaching models. During the workshop, the teams of instructors were asked to develop lessons using their content and curriculum that would include at least three different models of co-teaching. Instructors talked about the models and discussed the purposes of each and when each might be most appropriate. Although the management team felt that one day was likely not enough, it gave the teams a start and discussions about co-teaching have continued in subsequent instructional team workshops and meetings. Other professional learning workshop sessions addressed other instructional strategies, such as scaffolding for English Language Learners, the Science Writing Heuristic and science notebooks, Model Eliciting Problems in mathematics, and teaching using inquiry models. After the first summer sessions, experienced development and instructional team members were matched with new development and instructional teams as new courses were developed to share experiences and provide advice and guidance.

As the co-teaching model developed, we probed the instructional participants as to how they implemented co-teaching. To categorize we used a taxonomy adapted from Sands, Kozleski & French (2000), a copy of which will be distributed at the session. Most of the teams implemented some variation or combination of the following:

A. **One Person Teaches, One Gathers Data or Coaches.** One person has instructional responsibility while the other gathers student assessment information, research data, and/or coaches the instructor. Either person may take either role or switch roles at any time. In our case, the other members of the team often circulated to help answer questions or pose additional questions or experiments as teachers worked through problems or experimental procedures. This is similar to the following category.

B. **One Person Teaches Group, One Person Teaches Individuals**. One person provides individual help and guidance to students while the other provides instruction to the group. (See above (A) for implementation)
C. **Tag Team Teaching.** Presenters take turns, one on, one off. The person who is not presenting at the moment may fill a variety of roles (from data collection to individual assistance). Also similar to the two above. In many instances STEM faculty presented traditional science/math content; Education faculty provided contextual background, and K-12 faculty provided implementation strategies or links to model content standards.
D. **Speak and Add Teaching.** Both presenters are "on stage" at the same time. One leads, the other supports. The lead person is in charge of the content and makes process decisions. The support person adds examples, humor, or other perspectives. In our case, this approach would simply be a less formal version of example C. above.

Other co-teaching formats were implemented at times as well as will be discussed in the session.

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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):

- Of the numerous co-teaching models, some are more effective than others where there is a disparate level and type of knowledge among instructors.
- There exists a tension between STEM faculty and Education faculty that can be addressed through effective co-teaching.
- Teaching experienced teachers can promote changes in practice among STEM faculty.
- Most STEM faculty require professional development to effectively implement co-teaching.
- MSP participation can affect traditional classroom practice among STEM faculty.

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

STEM faculty participation, attitudes, changes in philosophy and practice, and other effects of participation were determined through a general survey of instructors, observation of courses, and in depth interviews. Interviews and open ended survey questions were analyzed using a coding system that grouped responses into several broad categories. Observations utilized the Reform Teacher Observation Protocol. Later results were less useful as the large number of courses precluded multiple observations. In addition, interviews with and surveys of teachers participating in the courses were utilized in some cases to provide information about the effectiveness of the co-teaching approach. Interviews addressed: (1) implementation of co-teaching, (2) perceptions of their colleagues, (3) what they learned about instruction from their colleagues, and (4) whether there has been fundamental change in their traditional courses because of the co-teaching experience. Results revealed the various formats in which co-teaching was implemented (see Section 2 above). Faculty reported that they had a high comfort level with being interrupted regularly by their colleagues and that, while their primary role was

in the area of science or mathematics content, often another team member would have the expertise to present particular concepts or answer questions.

Interview analysis also revealed that all of the STEM faculty had absolute confidence in the knowledge and capacity of their team members by the onset of the course. This was clearly tied to their collaboration in the course development as well as (in at least six cases) previously established relationships with co-instructors. Results show that course development and planning phases were crucial in the development of well-functioning team that had confidence in all its members.

Carryover into traditional college classrooms was a high area of interest in this project. All of the STEM faculty members reported significant gains in pedagogical content knowledge. These gains can be grouped into 10 distinct areas: new applications of content, modeling of instructional practice, utilization of student-centered or learner-centered approaches, knowledge of culture and expectations in the K-12 arena (middle and high school curriculum, the Math and Science Content Standards, and student and teacher accountability around those standards), teaching science or math within the context of a learning cycle, strategies to support English language learners, recognition and addressing misconceptions among learners, and different instructional strategies modeled by co-instructors (such as cooperative learning, activity-based learning, group problem solving, and use of technology). These gains have resulted in the various changes in the lecture-hall practices by STEM faculty:

1. Assumption of less understanding: reinforcement of conceptual understanding and including assessment to ensure comprehension before covering subsequent material.
2. Incorporation of new activities: additional demonstrations and simulations embedded into the lecture material.
3. Provision of more materials to students: additional handouts, notes, etc.
4. Incorporation of English Language Learning strategies: STEM faculty increasingly recognized that their classes were linguistically diverse and are more inclined to write new words, use less slang, and provide more handouts.

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

The practical implications of this work are many. In the RM-MSMSP, the STEM faculty have been given a clear expectation for collaboration and co-teaching with the intention of developing new methods that will transfer to traditional courses. The initial attitudes about education co-teachers diminished. In this model, we also see STEM faculty that are “pushed” by teachers to teach well and practice the “best practices” of K-12 education. There is evidence that STEM faculty are changing instructional practice in their university courses, but change comes slowly; it has taken some of these faculty multiple years of participating in the RM-MSMSP to recognize how to implement these new practices in traditional courses, and there are still barriers to implementing change in large lecture settings. STEM faculty are learning a lot about schools, teachers, standards, and education policy. There is also evidence that STEM faculty are comfortable attempting a number of different instructional approaches and strategies and that these courses seem to be a safe place to try things out.

As MSPs continue, it is important to continue to examine the impact of co-teaching on STEM instructors' traditional courses using observational and other evidence gathering techniques. The impact of co-teaching on School of Education and K-12 faculty will also be of interest. Of course, there are still all the obstacles noted in the introduction to the paper, and more work needs to be done to develop projects that intentionally marry STEM and education faculty together to learn from each other and narrow the gap. Each has a stake in the realm of education and could be learning much from each other if only they would find ways to come to some common understandings. The RM-MSMSP illustrates that one way is to put them in the same classroom together.

References

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Additional Literature informing this work:

Howey and Zimpher (2006) argue that transformational partnerships occur when there is a nested or layered organizational structure, attention to context, shared responsibility, ambitious goals, shared accountability, and systemic redesign. Howey, Kenneth, and Nancy Zimpher. *Boundary Spanners*. New York, New York: American Association of State Colleges and Universities, 2006.

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