FEATURED PAPER SESSION:

Coherence and Change in Teacher Professional Learning Communities

Targeted MSP: Project Pathways: Opening Routes to Math & Science Success for All Communities

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About This Summary

This documentation of the 2010 Math and Science Partnership Learning Network Conference offers a brief summary of the presentation that took place during one conference breakout session and focuses on questions, answers and discussions during the session.

Readers interested in pursuing information about the project discussed in this breakout session are encouraged to visit MSPnet to access the full PowerPoint presentation.

The abstract for this presentation is posted on MSPnet at the following URL:

http://hub.mspnet.org/media/data/36_Oehrtman.pdf?media_000000006523.pdf

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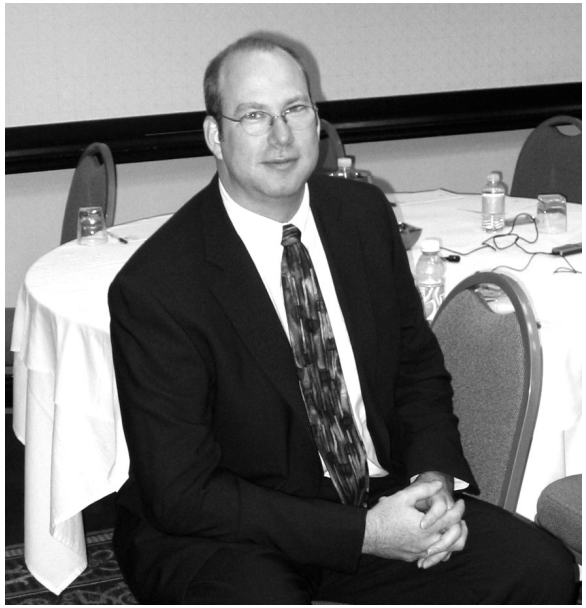
COHERENCE AND CHANGE IN TEACHER PROFESSIONAL LEARNING COMMUNITIES

Project Overview

Michael Oehrtman explains that Project Pathways works with several school districts in the Phoenix valley, and one of the main components of the project is teacher Professional Learning Communities (PLCs). While past papers and talks have detailed the overall results and the change that occurred across large numbers of teachers, the focus of today's presentation is on what that change process looks like for particular individuals. This will involve looking at case studies regarding one teacher Professional Learning Community at one school as well as the facilitator's role in that PLC and that of the STEM faculty to see what change looked like for those individuals.

Michael Oehrtman



First, however, Oehrtman provides a context in terms of the project in general. In talking about Professional Learning Communities, Oehrtman notes that he likes the phrase "meaningful collaboration." Several of the bullets below characterize what is meant by "meaningful."

Project Pathways Professional Learning Communities

- Based on Japanese Lesson Study
- Career-long learning
- Focus on student thinking and classroom practices
- Scientific engagement
- Open teachers' classrooms to the "critical colleagueship" of their peers
- Companion courses

"We view the work as necessarily involving a long-term process so that ideas have time to mature, become useful, be reflected on, be modified," he explains. The focus of the work is on student thinking and classroom practices so that it is relevant and useful for the teachers. The project strives for scientific engagement,

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Authors & Presenters:
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Targeted MSP Project:
Project Pathways: Opening Routes to Math & Science Success for All Students

Project Pathways is an ongoing Math and Science Partnership at Arizona State University to implement and research teacher professional development in six large urban school districts. One component of Project Pathways has been school-based Professional Learning Communities (PLCs) for interdisciplinary groups of secondary mathematics and science teachers. PLC sessions engage teachers in conceptual conversations about knowing and learning central ideas in secondary mathematics and science, discussion and assessment of student thinking, development of inquiry-based conceptually-focused lessons, and reflection on the effectiveness of their Instruction. This presentation focuses on results related to the following research questions:

1. What issues motivate teachers to engage productively in a PLC around reflection on teaching practice and implementing change in their classrooms?
2. What supports are necessary for engaging teachers reform efforts derived from various motivating issues?

Design of the Intervention

Discipline-specific Frameworks

- Carlson & Bloom's Mathematical Problem Solving
  - Polya, 1957
  - Schoenfeld, 1985, 1989, 1992
  - Carlson & Bloom, 2005
- Lawson's Scientific Inquiry
  - Wallas, 1926
  - Koestler, 1989
  - Lawson, 2001
- Atman's Engineering Design
  - Fogler & LeBlanc, 1995
  - Voland, 1999
  - Atman et al., 1989, 1999, 2001, 2003

with teachers looking at their own data to understand what is going on and making appropriate modifications based on the problems they identify.

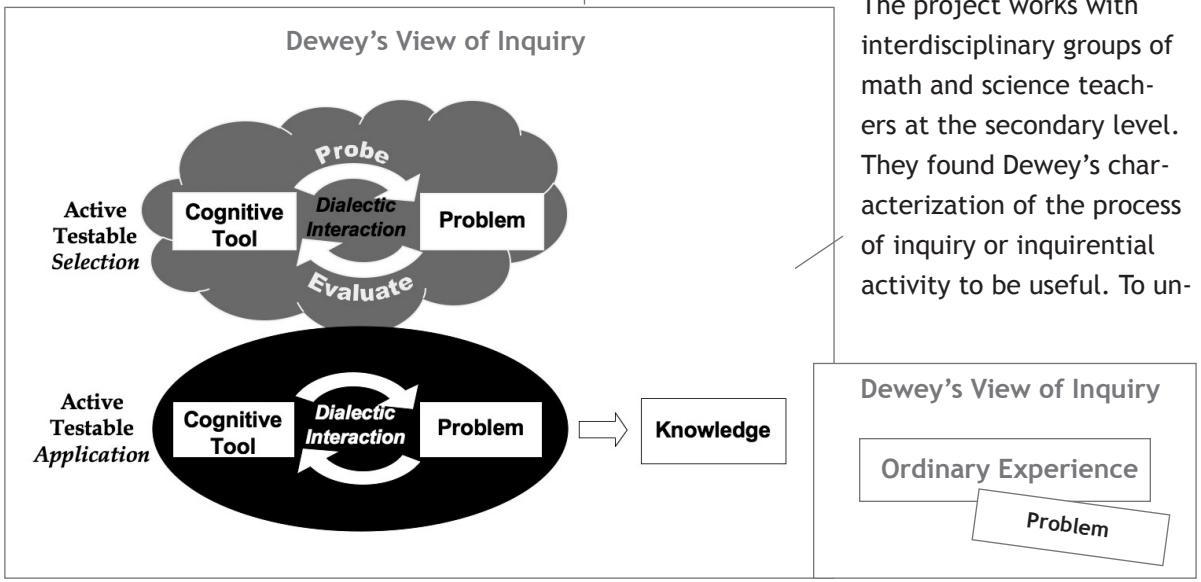
In terms of collaboration, Oehrtman points to the phrase, "Opening the teachers' classrooms to the 'critical colleagueship' of their peers,'" which captures the idea of breaking down the barriers of isolation that teachers typically experience behind the closed doors of their classrooms.

The design of the project utilized several theoretical frameworks. Three in particular focused on the processes of engaging in doing math, science and engineering.

When the project focused on the data analysis they realized they needed something that generalized what was common about those frameworks from the discipline specific work. The project works with interdisciplinary groups of math and science teachers at the secondary level. They found Dewey's characterization of the process of inquiry or inquirential activity to be useful. To understand what Dewey meant by "inquiry," Oehrtman observes, it is interesting to note that he contrasted that with ordinary experience, which characterizes the bulk of our everyday lives and is only interrupted when something problematic occurs. If we choose to focus on that problem and engage in the process of resolving it, that is what engages the process of inquiry that Dewey talked about.

"The detail that I want to pull out of what he meant by that," Oehrtman states, "is the reciprocal influences between the tools that one applies to the problem and the problem itself." When we say "tool," he explains, we mean that in the broadest possible sense. In this work it often involves concepts, teaching strategies and pedagogical content knowledge. When you apply a tool to a problem, hopefully that problem changes—thus the reciprocal influence. It may change towards a resolution but if not, your understanding of the nature of that situation is often changed.

Reciprocally, the tools are given meaning by the problem itself in the way that you select appropriate tools to apply to the problem and in your reflection on the effectiveness of the application of the tools. "It is in this dynamic system, the interplay between those two things, that Dewey characterized the emergence of new knowledge," Oehrtman states, "and as we were analyzing our data, those were the kinds of things we tried to keep in mind." That involved looking at video data and identifying the observable characteristics of the teachers and the



STEM faculty interaction that matched these various aspects of Dewey's characterization of inquiry.

Six categories of findings emerged from this work: three dispositional behaviors and three process behaviors.

General Results: Dispositional Behaviors

Conceptual Orientation: Members clarify ideas, focus on meanings in mathematical and scientific activity, and identify and resolve ambiguity

Intellectual Integrity: Members provide rationale for claims, exhibit honesty about lack of understanding, and show willingness to challenge others and be challenged

Coherence: Members seek connections among ideas and topics, express ideas using multiple representations, and generalize conclusions or find limiting conditions

General Results: Process Behaviors

Productive Engagement: Members engage in exploring a common problematic issue, clarify the nature of the problem, and encourage inquirential engagement of all members

Conceptual Resources: Members are intentional in their selection of conceptual resources to apply to a problem, apply appropriate and powerful ideas, and seek appropriate external assistance when there is a gap in their collective understanding

Persistence and Reflection: Members stay engaged until a problem is resolved, evaluate the quality of their solution, and reflect on the effectiveness of the tools they applied

The dispositional behaviors relate to the characteristics of the individuals involved in a group. The three process behavior categories roughly correspond to actions that occur in the process of inquiry just described.

Case Study: HS Geometry PLC

The teachers that are the focus of this presentation are from a school the project started working with a year-and-a-half ago. The project is now in its sixth year and was in a position to put "a pretty solid intervention on the table," Oehrtman relates. "We wanted to try that out, from scratch, at a new site."

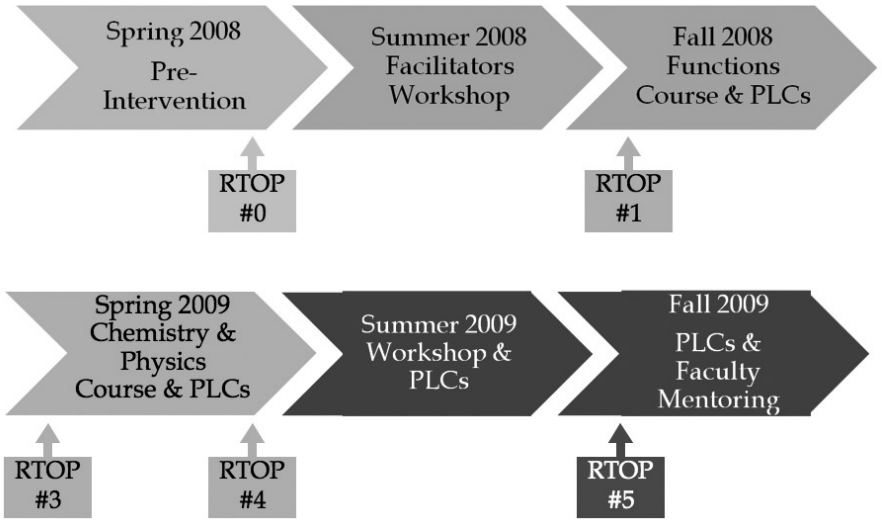
Five data points collection points were used in the teachers' classrooms. The Reformed Teaching Observation Protocol (RTOP) is an observation instrument that uses a 100-point scale with 25 items, each scaled from 0 to 4 to indicate to what degree the teacher is engaging the students in a process of inquiry.

In this school (*see sidebar*), of the teachers

General Results: School M RTOP Trends

- Participating Teachers: **Increase 3.3** points per observation
- Non-Participating Teachers: **Decrease 0.5** points per observation

General Results: School M Participation and RTOP



participating in the project, on average there was a 3.3 point gain per observation over those five observations. In the teachers that didn't participate there was a 0.5 point decrease per observation.

Jason Martin takes over the presentation to explain what that change looked like for particular individuals. The case study involves a PLC at a high school in the summer and fall of 2009. Martin proceeds to explain how the framework fits what was going on in this PLC.

When teachers are looking at the district standards, Martin explains, one of the first things they see is a lack of coherence in the district standards, and they have this idea of anchoring ideas to prior lessons. The quote below from a teacher reflects the general feeling of the PLC.

This lack of coherence provided a problem for the teachers to address, Martin observes, adding that this relates to what Michael Oehrtman was explaining about the dialectic interaction between the problem and the cognitive tools selected to address the problem. Teachers recognize they have a need for the tools and that moves them into the conceptual resources of the processes and behaviors.

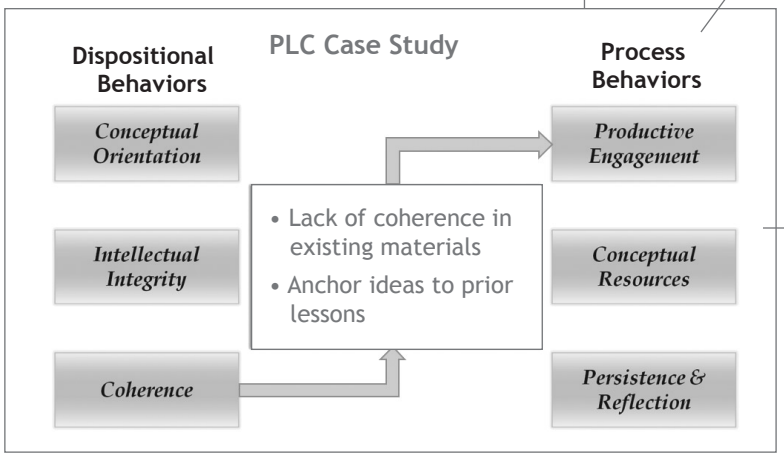
PLC Case Study Overview Summer 2009

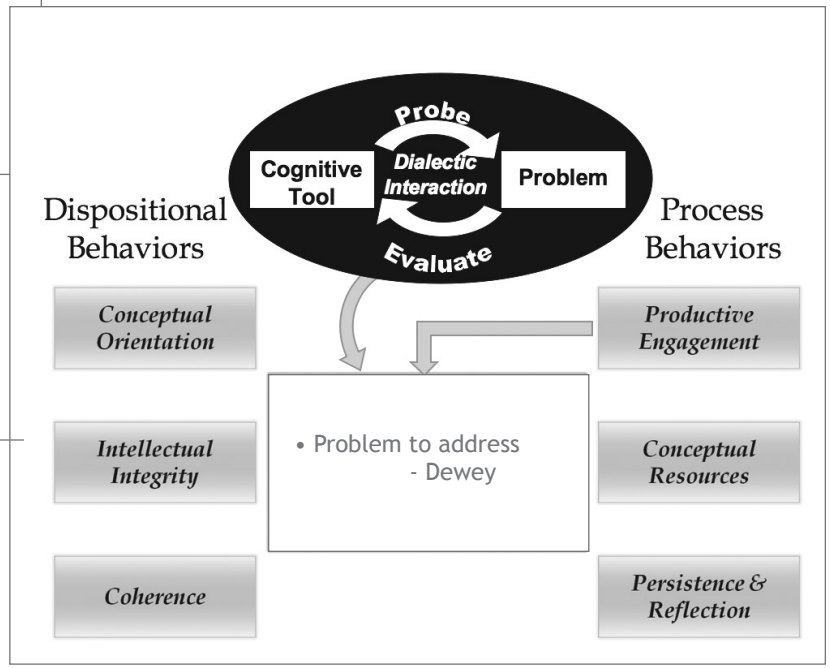
- Week-long summer workshop run by STEM faculty (40 hours)
  - Teachers took an in depth look at district standards.
  - STEM faculty helped outline overarching ideas.
- Following the workshop (60 hours total):
  - Working meeting once or twice a week.
  - Left with action items to accomplish before the next meeting.

PLC Case Study Overview Fall 2009

- Full teaching load.
- Weekly three-hour session after school with STEM faculty.
- An additional one-hour session with themselves during a common planning period

"Once we knew what students would know based on our lessons then it would, you know, you're doing what makes sense, what flows from one thing to the next. And if it didn't flow, where would it make the most sense to put it and start talking about it and how could we make a bridge or connection to that topic?"





Feeding into this, Martin points out, the teachers have all sorts of resources available to them. Project Pathways personnel provide not only content knowledge but reorientation to student thinking and keeping students' minds focused. They also have the textbook and Internet resources.

The teachers have conceptual resources available and then make a very intentional selection of four strands. For example, "quantitative reasoning" emphasizes the identification of mathematical objects as measurable qualities and units. What is going on here, Martin explains, is these dispositional behaviors are influencing these four strands around which teachers are designing their curriculum.

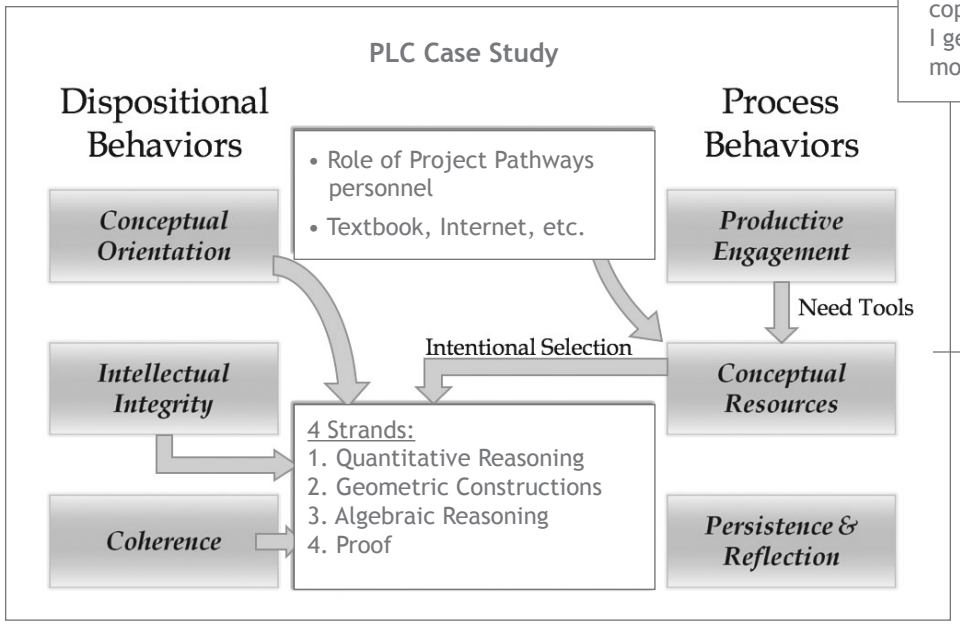
The project observed the facilitator probing PLC members for a deep and rich understanding of the topic and probing them to speak with meaning. On the student side they are designing lessons and assessments that do the same thing, Martin explains.

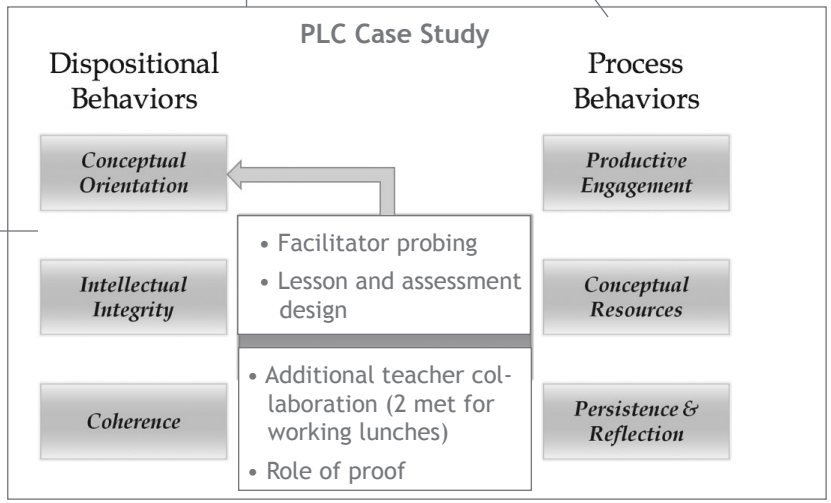
At right below is another exemplary quote from a teacher regarding what was learned during this process.

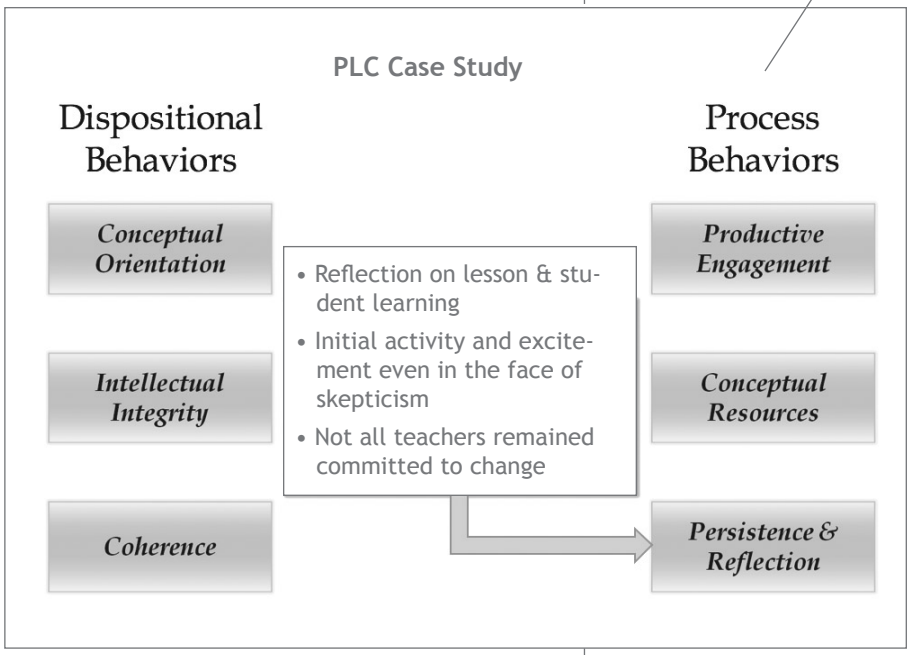
Teachers were also observed meeting together on their own initiative. For example, two geometry teachers got together on a daily basis at lunch to review their lessons and make adjustments based on their progress. On the student side, there is the role of proof, and teachers' use of rigorous reasoning and proof.

Jason Martin

"I found myself prepping for 'How I'm gonna draw this out of this kids?' Instead of 'How am I gonna say these things and deliver these things?'... Say copy this, copy this, copy this, these are the steps. That doesn't take long to do. How do I get you to understand and how do I know if you understand the steps is a lot more time consuming."







PLC Case Study Teacher Difficulties

- Time / Energy
- District assessments
- Parent expectations
  - Providing answers to students
  - Homework quantity & advanced availability
  - Familiarity with approach and resources for helping their child
  - Overly divorced themselves from their previous lessons

Persistent behaviors included ongoing reflection on the part of teachers regarding their lessons and student learning, and making adjustments as needed. While there was initial activity and excitement, even in the face of skepticism by those who were not part of the PLC, not all teachers remained committed to change.

The difficulties teachers involved in the PLC encountered are outlined in the sidebar at left. District assessments were not necessarily structured in parallel with the PLC and as a result, some teachers found themselves engaged in assessment related to material they had not yet covered. Parental expectations and concerns can pose another difficulty. Assuring that parents were familiar with the new approach and resources proved a challenge. Some teachers abandoned their former lessons and exercises altogether, when in fact some of those may have been useful and may have helped reduce the burden and stress on teachers.

Facilitator Case Study

Judy Sutor turns the focus of the presentation to one specific teacher in the PLC group and describes that teacher's engagement and process of change. This teacher was the facilitator of the group, which means she had a little extra training and involvement with the staff, Sutor explains

This teacher first came into contact with the project during the a week-long facilitator training workshop in the summer of 2008. This teacher appeared to have a very strong conceptual orientation for her own mathematical understanding and was always trying to make meaning as she worked through activities, but that didn't seem translate to her teaching, Sutor relates.

Facilitator Case Study: Background

Coming into the program, this facilitator showed:

- a strong ***conceptual orientation*** in her own mathematical thinking, although in her teaching practice, her goals seem to revolve more around developing skills than around making meaning.
- ***Intellectual integrity***: admitted in group discussions when she had struggled with an idea, and pushed the group to think in less conventional ways.
- Engaged in the inquiry process: ***reflectively engaged, strong conceptual resources, and very persistent***.

Sutor turns to the RTOP scores (*see page five for explanation of RTOP*) to look at how this

individual teacher's classes might be changing. The graph at right below shows the teacher's scores over the five RTOP observations. What you notice immediately, Sutor points out, is that these seem to be grouped. The teacher is at a certain level in the first two observations, then there appears to be a shift in her scores over the next two observations, and then another shift in the last observation. As noted earlier, the RTOP is a 25-question assessment and each question is rated from 0 to 4. Those 25 questions are broken up into five categories and Sutor discusses the teacher's change in each category.

The bottom segment of each bar is Lesson Development and Implementation, and the teacher appears to shift in that category at observation number two. This makes perfect sense, Sutor states, because at this point in the project the teacher was involved with the first lesson study in her group and the project was providing tools for templates and guidance in the lesson design.

The second segment from the bottom represents Propositional Knowledge, and it appears that the teacher continues to improve her scores in this area. What that indicates is that her classroom materials are becoming more conceptually oriented, more connected, more coherent, Sutor observes.

The third segment from the bottom is Procedural Knowledge, a term from science education literature which refers to the process of doing science. It is about looking to see whether students are making conjectures and are then reflective about their thinking, Sutor explains. The shift appears to occur at observation number two, when the teacher is actively involved in the project doing lesson development.

The fourth segment up from the bottom is Classroom Communication, a category where there is a shift in the teacher's scores in the final observation. This tell us that her classroom is now shifting from a lecture-oriented environment to one where there is communication and discussion back and forth, Sutor states.

The top segment is Student-Teacher Relationships, and again we see shifts at observation

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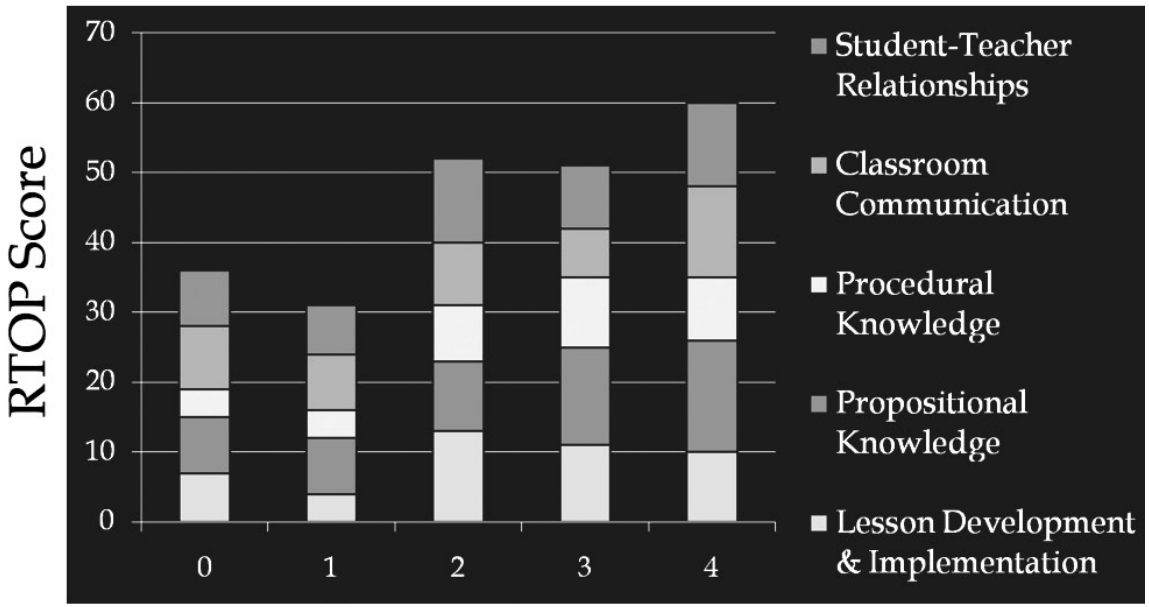
Facilitator Case Study: RTOP Scores



Judy Sutor

number two, which is when the teacher is involved in a lot of lesson development activities.

Sutor herself participated in a number of these observations, and noticed during the first phase that the teacher was very strong in her content understanding and very clear in her presentation, but her classroom was a traditional lecture environment. In observations two and three you could start to see her actively trying to bring activities into the classroom to get students more involved, but it was still a little awkward for her and for her students, Sutor relates. Finally, in the last observation, the classroom culture is changing. Students expect to be more involved and are comfortable with this dialog in the classroom.

These trends were shared with the teacher, who was asked what she thought might have caused the shift in scores. The teacher responded that the first jump was probably due to the fact that the PLC had talked so much about questioning and how to listen for speaking with meaning. Obviously, the teacher added, the second jump was from writing a curriculum that was completely conceptual. Sutor points to another comment the teacher made that helps us to understand the shift in her personal conceptual orientation and starting to apply that to her classroom: "I guess I always felt that students should understand things conceptually. I think that's why I always seem to talk more than other teachers, because I'm trying to explain why. I think that I've always been that kind of teacher, but I think that Project Pathways helped me get better at knowing how to do that."

STEM Faculty Case Study

Sutor concludes the presentation with a review of what happened to Project Pathways STEM faculty during their engagement with this process and how their roles changed over the course of that engagement. Once the teachers recognized that the materials they had were not coherent, it was important that they had a resource that could help them put together a coherent story for their geometry curriculum, Sutor explains. They were able to draw on the content knowledge of the STEM faculty which helped with that coherence because they had the appropriate tools to apply to the problem. The faculty were also able to continually refocus the group back to what students were thinking and understanding.

There was some adaptation of Project Pathways personnel, Sutor relates. While in the past they had been in the role of a graduate course class

STEM Faculty Case Study

- Role and Impact of Project Pathways personnel
  - Content knowledge (Coherence, Appropriate tools)
  - Focus on student thinking
- Adaptation of Project Pathways Personnel
  - Class instructor — Resource/Mentor
  - Understanding of the teachers' context (pressures, time, needs)
  - Create scaffolds of classroom activities (different from precalc)
  - Need for a coherent & conceptual curriculum

instructor, they were now an integral part of the group on a weekly basis, acting as a resource and a mentor.

The STEM faculty also learned during this process. They were able to get a real sense of the pressures and time constraints the high school teachers are under and it caused them to adapt their role in the group, Sutor notes. They began to create scaffolds or outlines of classroom activities so the teachers could then fill in the meat of those activities and make them high school student-friendly.

The biggest lesson as a result of this work, Sutor emphasizes, and the lesson that Project Pathways would like to impart, is that the project now understands how important coherent and conceptual curriculum materials are. Attempting to develop those materials while trying to work with teachers during the course of the semester was a fairly high-stress way to go about it, Sutor notes. However, another group used the materials that were generated and they spent their weekly sessions talking about the implementation of the materials and evaluating their effectiveness, and that seemed to work as well. The big message, Sutor stresses, is that if we want teachers to teach in a more coherent and conceptual way, they need to have coherent and conceptual materials.

Group Discussion

Curriculum Based on Student Needs

- We've found some materials that we feel do a good job of conceptual curriculum in math K through 8. Have you found anything at the high school level that gives that type of instruction? • **Participant**

- There are definitely good materials out there. In engaging our teachers, we wanted to focus on particular issues that were coming out of our research with their students and some of our students. For example, we're teaching geometry and precalculus at the high school and college levels. We're doing research trying to identify what some of the barriers are that students are encountering and what sorts of things are working for them. We found the need for a curriculum that addressed those particular issues from that research. We weren't able to find curriculum that addressed learning in those particular ways. That's why we ended up creating some of our own materials in precalculus and working with teachers from scratch with the geometry. I'd love to hear about your experience and what you use. • **Michael Oehrtman**

- We're using Math Expressions and Connected Mathematics and doing a lot of PD. Are any of your lessons available through the network? • **Participant**

- Not yet. We haven't figured out our dissemination model. • **Michael Oehrtman**

Lesson Study

- You mentioned Lesson Study early on. I didn't get a sense of that from the rest of what you said. • **Participant**

- For example, some of the shifts with the individual teacher that Judy was talking about involved Lesson Study with the geometry PLC. They were creating common lessons, implementing them, and video taping them. When they could, they would try to visit each other's classes, though that didn't happen this semester. They would come back and share what happened across their various classes and then revise from there. We didn't do it to the extent that it's done in the traditional Japanese Lesson Study, where you may spend the entire semester or a year on a particular lesson. Partly because, as Judy said, teachers were rejecting their old curriculum completely and wanting all new stuff. We kept trying to push back on that and encourage them to use things they had used before while changing what they can. That became pressing enough that they wanted to develop more than one lesson at a time. We still try to stretch that out and make it a much of a scientific process as possible. • **Michael Oehrtman**

Demographic Setting

- Did you work with any rural schools where the teacher was the lone teacher of that subject area, and if so, how did you develop a PLC in those conditions? • Participant

- No. We're in Phoenix. A huge percentage of the state population is in the valley and that is the context of our partnership. • Michael Oehrtman

Real versus Virtual

- Was any part of the learning community electronic or online? • Participant

- I don't think so. I think everything was pretty much face-to-face. • Michael Oehrtman

Group Discussion

- In terms of the courses with the teachers, we need to get our lessons up. With regard to the algebra/precalculus strand relative to the reform curriculum, there is some research that is showing that they are not laying the strong conceptual foundation for success in calculus, so Mike and I and other colleagues have been working for decades on student understanding of key ideas of algebra through precalculus that are foundational for success in calculus. Mike and I then decided to take it upon ourselves for the past five years to develop a precalculus curriculum that we're using at the university. That was a major undertaking, but for us it was satisfying that we were driving the way that teachers engaged and probed students. We have some data that really supports that critical issue that Judy and Mike and Jason have pointed to, that coherent, conceptually focused curriculum with worksheets and tools is critical for the teachers ability to deliver this coherent curriculum to their students. • Marilyn Carlson

Sustainability of the PLCs

- I have a question about the process involved in the PLC. I'm assuming the grant paid and provided the infrastructure for these folks? • Participant

- Yes. We had a huge buy-in from the administration of the school to arrange for the teachers to have a common planning period, for example, but they also met after school and we had the resources to support that work. • Michael Oehrtman

- So I wonder, as people change their practice and see the benefit of that kind of interaction, whether you've seen evidence of sustainability beyond that grant-supported infrastructure. • Participant

- That's a great question. Of everything that we've done in our project, the PLCs have been wildly popular, both with the teachers involved and with the school and district administrators. In the district where this school is located, as well as in a number of other districts we're working with, they're saying that across the district every teacher will participate in a PLC, whether they're involved with us or not. They have found these kinds of experiences to be so useful that they are taking it over. I don't know the details of what kind of resources will continue to support that, but it is something they value and plan to continue. • Michael Oehrtman

- What about the partnership with the IHE? • Participant

- Both Jason and Judy have mentioned the role of the STEM faculty that were crucial in that work. There, I think we're going to have to continue to work with our departments on campus and figure out ways to make sure that the incentives and support are there for faculty to continue to be involved in supporting roles. I can't say that has been hammered out, and if anybody has solutions to that

please let us know. • Michael Oehrtman

- Were there stipends involved for IHE participants? • Participant
- It was a combination of release time and course teaching credit. • Michael Oehrtman

Relation of Content Courses to PLCs

- What was the relationship between content courses and the work the PLCs did? • Participant
- The first semester the teachers were engaged in a course that focused on core mathematics about functions, proportionality, rate of change and exponential functions and tied all of that together. The second course was physics and chemistry integrated with math. Most of the PLCs on the math side were working on precalculus content, so the functions course was a key content area there.

  On the physics-chemistry side, we still did that with a heavy math focus. The idea there was that the math teachers, for example, would be getting meaningful context in which these same mathematical principles were relevant and useful. On the science side, even with the functions course, everything that we do is in context in some science or engineering application, so they're seeing their content organized in a way that uses mathematical tools in relevant ways as well. If there's a chemistry PLC, then they have an opportunity to evaluate through this whole process how to bring in more mathematics and treat it in more rigorous ways. For those two semesters there weren't specific timely links made, but the idea was that the general principles would be there.

  For the geometry PLC for example, one of the things we focus on in the content courses is the identification of quantities that are involved in some kind of a modeling situation and the mathematization of those quantities. That showed up in the geometry PLCs a year later. As they were trying to figure out how to make coherent sense out of this geometry course, they decided to take the issue of measurement and geometry and quantification as a serious organizing principle for their course. So some of these things that we covered earlier did show up in their work. • Michael Oehrtman

Interdisciplinary PLCs

- Were there opportunities for STEM PLCs, so it wasn't just geometry or chemistry but interdisciplinary? • Participant
- Over the past we've shifted back and forth with having interdisciplinary PLCs. The courses were all interdisciplinary. We tried to work with the schools to identify what their needs and interests are. When we started working with this school in the spring of 2008, they wanted the PLC work to focus on particular classes that they found problematic, and we organized them according to that request. So in this school the PLCs were content-specific, but in the summer workshops and the courses

Size of the PLCs

- How large were these groups? • Participant
- This PLC had five members and the first at this school had seven. • Michael Oehrtman

Product Outcome Expectation

- Was there an expectation of a product that they were to create? It's not clear to me whether they were creating activities, creating curriculum....? • Participant
- There was no project expectation or expectation on the part of the administration other than meaningful participation. The PLC decided they wanted to create lessons and activities. • Michael Oehrtman

we had them working across disciplines.

• Michael Oehrtman

- In the first year of our project we had interdisciplinary PLCs and it was hard to get any traction on developing curricular activities. I think, as Mike said, because there was all of that opportunity to engage with how to connect math and physics and math and chemistry in the courses, the role our PLCs played was more about operationalizing it and ways of taking it into the classrooms.

  • Marilyn Carlson

- It depends on the goal. If the goal is to broaden their perspectives on content and bring in science applications or bring math into the science courses, then the interdisciplinary sorts of settings really work. If you want teachers to work on curriculum, which was the goal here, we have not found a way in which the interdisciplinary team can work really well for that. It gets back to this issue that Judy was emphasizing. There is a need for really strong conceptual and coherent curriculum for the teachers as the focus of their work, whether the activity is making that curriculum their own by taking it apart and reassembling it, or less ideally, having to generate it on their own. That process was crucial, and that is a really difficult thing to do out of your content area and across disciplines.

  • Michael Oehrtman