Developing and Implementing Mathematics Courses for K-12 Teachers: Merging Professional Development and Course Design

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What is OMLI?

- NSF-funded MSP Institute Project
- Two-pronged (yet integrated) approach to professional development
  - 3 week mathematics leadership summer residential institute
  - On-site academic year support for participating teachers
- An ongoing and self-sustaining collaborative network of mathematics teachers, school administrators, and university and community college disciplinary faculty
Who is OMLI?

• 180 K-12 mathematics teachers in 10 Oregon school districts (at least 2 teachers/participating school)
• 90 administrators (of the teachers in those 10 school districts)
• 35 staff including university mathematicians and mathematics educators, community college mathematics faculty, and experienced K-12 mathematics teachers
• A partnership between Portland State University, Oregon State University, and Teachers Development Group
OMLI Design

OMLI Summer Institute

Teachers

PD Staff

Higher Ed Faculty

School Districts

K-12 Schools

Administrators
Take a moment to think about…

- What is the vision for your program?

- What are your goals?
OMLI Vision

Create sustainable and generative leadership capacity and provide support for systemic mathematics reform.
OMLI Goals

- Increase mathematics achievement of all students in participating schools
- Close achievement gaps for underrepresented groups of students;
- Increase enrollment and success in challenging mathematics coursework that support state and national standards through coherent, evidence-based programs.
OMLI Design Principles

• Building teachers’ mathematics content knowledge (CBMS, 2001)
• Building strong leadership capacity (Lambert, 1998)
• Developing strong professional learning communities (Lieberman, 1994; McLaughlin & Talbert, 2001)
Knowing Your Community

• The 10 school districts involved in OMLI had all adopted or were planning adoptions of Standards-based mathematics curricula K-12.

• The 10 school districts had been working with Teachers Development Group on K-12 mathematics development.

• The 10 school districts had clear expectations of what the mathematics content courses should involve:
District Expectations

• The content courses should model research-based ‘best practices’ for teaching mathematics.
• The content courses should provide teachers with some understanding of the trajectory of mathematical ideas through the grades.
• The content courses need to be sensitive to issues of equity.
Think about...

- What are the expectations of the community for whom you are designing courses?
Building teachers’ content knowledge

- Number & Operation
- Algebra & Function
- Data & Chance
- Measure & Change
- Geometry
- Discrete Math

(Based on recommendations from the Conference Board of Mathematical Sciences, 2001)
Nuts & Bolts of Mathematics Courses

- 3 graduate mathematics credits/course
- 2 hours/day for 5 days/week for 3 weeks Typical Schedule: 8-10am: Math Course I  
  10-12pm: Math Course II  
  1-3pm: Study Groups  
  3-5pm: Collegial Leadership
- K-12 teachers take all 6 summer courses over 3 years of participation. K-12 teachers were in the same classrooms.
- Developed and taught by 4-person team
Example: Discrete Math

- **Graph Theory** (Graphs as Tools for Problem Solving)
  - interesting applications
  - highly visual
  - spans k-12
  - clear, interesting application

- **Combinatorics** (Counting Problems)
  - link with probability and statistics
  - currently in curriculum

- **Cardinality** (Infinity, Infinity, Infinity)
  - wow factor
  - they use it without being aware
  - expands mathematical content knowledge to take advantage of student interest
Challenges of meeting needs of K-12 teachers

- Emphasize depth in a few “big idea” topics rather than breadth across many topics.
- Emphasize discourse and model pedagogical techniques used in K-12 math classrooms.
- Interaction across grade levels gives teachers better sense of the “trajectory” of the K-12 mathematics curriculum.
Strategies for Success

• Look for multiple “entry” points (topics that can be approached at several levels of sophistication)
• Use new or unfamiliar settings
• Heterogeneous grouping and using strategies for effective groupwork (i.e., Cohen, 1994)
• Purposeful use of discourse protocols
What we’re still working on…

• Appropriately challenging secondary teachers
  – Differentiated homework (self-selection of problems)
• Addressing issues of status and equity in the OMLI classrooms
• Working effectively with English Language Learners
Examples

• **Number & operation:**
  Working in different bases

• **Algebra & function:**
  *Investigations in number, data, and space* (reform curriculum) 3rd grade task: the infinite elevator

• **Data & Chance:**
  Tinkerplots (exploratory data analysis)
Examples

• **Geometry:**
  Spherical geometry, taxicab metric

• **Measure & change:**
  Non-standard units (how many frogs will fill a classroom?), matching stories to graphs over time
OMLI Staff Professional Development

• Adapted Teacher’s Development Group’s 40-hour “Best Practices in Teaching Mathematics” workshop (developed for K-12 teachers) for our audience of post-secondary mathematicians, mathematics educators, community college faculty, and experienced K-12 teachers.

• Yearly staff planning retreats in which we:
• Examined research-based teaching methods for promoting mathematical problem solving, invention, discourse, inquiry, challenge, and achievement by all K-12 students and relate these to K-12 mathematics teacher learning.

• Gained tools to support intensive reflection about OMLI students’ and teachers’ learning as a basis for instructional planning and decision-making.
• Sharpen our “critical eye” for teaching and materials that foster:
  – Student understanding
  – A mathematically productive classroom culture
  – Worthwhile mathematical tasks/lessons
  – Deepened teacher content knowledge
• Learn to implement and enhance lessons/tasks to maximize high-cognitive learning by all.

• Develop/enhance our OMLI course plans to assure content and instructional practices that align with research-based characteristics of high-quality mathematics learning and teaching.
• Grow as a community of learners
Impact beyond OMLI

- vanCleave’s current investigation of how OMLI staff use ideas and methods from the institute in their classrooms at the university
- Frechtling & Zhang (Westat) investigating the impact of involvement in MSPs on higher education faculty (http://hub.mspnet.org)
Impact on K-12 Teachers and Students: Evaluation

• Impact on Teaching Practices
  – Teacher self-report surveys
  – Classroom observations

• Student Discourse
  – Teacher self-report surveys
  – Classroom discourse observations
Evaluation Strategies

• Content and Pedagogical Preparedness
  – Teacher self-report survey
  – Content Knowledge for Teaching Mathematics Measures (Univ. of Mich.)
  – Knowledge of Algebra for Teaching (MSU)

• Modeling of Effective Practices
  – OMLI Summer Institute Classroom Discourse Observations
Content and Pedagogical Preparedness of Teacher Leaders

To what extent has the professional development prepared the teacher leaders for their leadership role in terms of both content knowledge preparedness and pedagogical knowledge?
Content Preparedness

• Teachers who participated in the 2005 summer institute demonstrated positive growth on all scales from the Content Knowledge for Teaching Mathematics Measures (U Mich.) and Knowledge of Algebra for Teaching (MSU) presurvey to the postsurvey.

• Elementary teachers demonstrated slightly greater growth than middle and high school teachers, particularly in the areas of geometry and patterns, functions, and algebra.
Pedagogical Preparedness

Secondary OMLI teachers reported a significant increase in pedagogical preparedness after participating in the 2005 summer institute. This means that they indicated an increased preparedness to:

- Use formative and summative assessments
- Teach problem solving
- Teach using manipulatives and other tools
- Encourage students to think mathematically
- Motivate students to search for multiple solutions
- Engage students in discussions and debates about mathematical reasoning
- Encourage students to take conjectures and generalizations
- Hold students accountable for determining the correctness of their approach
- Encourage students to reflect on their own reasoning
Student Discourse

To what extent has the project increased the quantity and quality of meaningful mathematical discourse between teachers and students and among students in the classrooms of the participating schools?
Discourse Observation Protocol

- **TYPES**
  - **A** Answering
  - **S** Stating or Sharing
  - **E** Explaining
  - **Q** Questioning
  - **C** Challenging
  - **R** Relating
  - **P** Predicting or Conjecturing
  - **J** Justifying
  - **G** Generalizing
Discourse Protocol

• MODES
  – T Student to Teacher
  – S Student to Student
  – G Student to Group or Class
  – I Individual Reflection
Modeling of Effective Practices

To what extent have the summer institute courses modeled the pedagogical practices that are encouraged at the K–12 level?
Modeling of Effective Practice

The observations conducted during the 2005 summer institute indicate that participants were involved in a more balanced variety of discourse types at all cognitive levels than typically observed in K–12 classrooms.
For more information and slides

http://www.mth.pdx.edu/~marrongelle

http://omli.org