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Connections

AMTE
Association of Mathematics Teacher Educators

Revision of the *Professional Standards for Teaching Mathematics*

by Lynn Stallings, lstalling@kennesaw.edu

Fifteen years after the initial publication of the *Professional Standards for Teaching Mathematics* [PTS] (NCTM, 1991) a revised version will be published. The publication date for the document has not yet been announced, but is projected for after the NCTM's 2006 Annual Conference and Exposition in St. Louis. AMTE members will have the opportunity to learn more at AMTE's Annual Conference, which will conclude with a session on the revision of the PTS by 1991 writing team chair Glenda Lappan, Michigan State University, and revision team chair Tami Martin, Illinois State University.

Changes to the now 14-year-old document include updates to reflect the *Principles and Standards of School Mathematics* [PSSM] (2000), updates to reflect what is now known about best practices for development of mathematics teachers, updates to technology mentioned (as appropriate), a proposed change to the title to reflect the broader focus of the document, and inclusion of supporting research by additional references. Revision task force chair Martin commented that the task force's goal was to ensure the revision reflected the "spirit of PSSM," as well as its content.

Figure 1 symbolizes the revision task force's emphasis on the continual improvement of mathematics teaching. The task force emphasized teacher development, collaboration, and ongoing professional development rather than evaluation of teachers. The organization of the document parallels that of the original.

Another interesting change results from alignment of the Teaching Standards with the PSSM grade level bands. The document now requires the same preparation of prekindergarten teachers as it does of fifth grade teachers. Those high expectations parallel those of the National Board Professional Teaching Standards (http://www.nbpts.org/).

Background. In spring 2003, the NCTM Board of Directors decided that, although the content of the original teaching standards (NCTM, 1991) was still sound, the then-12-year-old document should be updated. This decision was informed by several advisory groups' recommendations that a revision was warranted by developments in the field, especially the publication of PSSM (NCTM, 2000).

Then-NCTM President Johnny Lott appointed chair Tami Martin and a group representing a variety of perspectives including teacher educators, professional developers, award-winning teachers, and administrators. The task force membership is balanced between members of the initial writing team: Roberta Koss, Timothy Kanold, and William Speer; as well as members who brought a fresh perspective to the document: Martin (chair), Terese Herrera, and Patrick Ryan. According to Martin, NCTM Board liaison Harry Tunis was invaluable to the

(Continued on page 6)

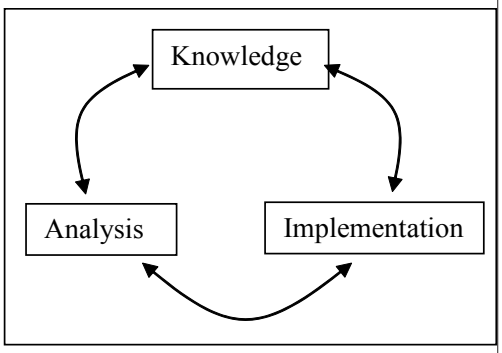

Figure 1: The task force conceptualized the continual improvement of teaching as involving the interaction of these three elements.

The task force's goal was to ensure the revision reflected the "spirit of PSSM," as well as its content.

Inside this issue:

AMTE Tenth Annual Conference Information

The Tenth Annual Conference of the Association of Mathematics Teacher Educators (AMTE) will be held in Tampa, Florida, from Friday, January 27, through Saturday, January 28, 2006. Conference activities will begin with a Pre-conference Symposium on Thursday evening, January 26, 2006. Watch http://www.amte.net for the complete conference program.

REGISTRATION INFORMATION

The conference registration fee includes admission to all sessions and the Browsing Room. In addition, a large portion of the fee includes continental breakfast, lunch, dinner, and afternoon snack on Friday and continental breakfast and lunch on Saturday. With your conference registration, you can renew your membership in AMTE by paying the $45 dues ($22.50 for students). The table found on the Conference Registration Form details the categories of registration.

Please note that

- registration costs vary by postmark date,
- total registration is limited to 400 participants, and
- no on-site registration will be available.

We encourage you to register early.

HOTEL RESERVATION INFORMATION

To reserve your room for the conference, call the phone number listed below or make your reservations online via the AMTE website. Be sure to mention the "Association of Mathematics Teacher Educators" conference when you call. The reservation deadline for the hotel is Friday, January 6, 2006. We have a block of rooms arranged for the conference and when the block is full, which may occur prior to January 6, the hotel will accept reservations at the hotel's prevailing rate and only on a space-available basis.

Renaissance Tampa Hotel International Plaza
4200 Jim Walter Blvd.
Tampa, FL 33607
(813) 877-9200
www.renaissancehotels.com/tpaim
(800) HOTELS 1 (Reservations) or (813) 877-9200
Single or Double Occupancy: **$139 per night**

The deadline for reservations at our group rate is Friday, **January 6, 2006** or until the room block is full. Reservations made after that date will be accepted on a space-available basis at the hotel's prevailing rate.

Procedure for on-line hotel reservations:

1. Go to http://marriott.com/property/propertypage/tpaim?groupCode=amtamta&app=resvlink
2. Complete the information requested, including your desired check-in and check-out dates, and the number of guests attending.

Remember, reservations at our group rate can be made until January 6, 2006 or until the room block is full.

ASSOCIATION OF MATHEMATICS TEACHER EDUCATORS
TENTH ANNUAL CONFERENCE

January 26 – 28, 2006
Tampa, FL

REGISTRATION FORM

Name _____ Nametag _____

Mailing Address _____ [ ] Home [ ] Institution

City _____ State/Province _____ Zip/Postal Code _____

Work Phone ( )_____ Home Phone ( )_____ Fax ( ) _____

E-mail _____ Institution Name _____

Check here if you are a **speaker** _____ (the deadline for speaker registration is Nov. 1, 2005)

CONFERENCE FEES (amounts listed are US funds)**:** NOTE: THERE WILL BE NO ONSITE REGISTRATION AVAILABLE. Also please note that conference registration is limited to 400 people.

	Registration (Postmarked by Nov. 21)	Late Registration (Postmarked by Dec. 19)	Indicate Amount Paid Below
Member Registration	$230	$270	
Non-Member Registration	$275	$315	
Registration and Membership Dues	$275	$315	
Graduate Student Member Registration*	$160	$185	
Graduate Student Registration and Membership Dues*	$182.50	$207.50	
Pre-conference Symposium (Thursday, 1/26, 5:30 - 7:00 p.m.) Note: dinner is on your own.	Free— preregistration required	N/A	____ Check here to attend
Pre-conference Technology Workshop** (Thursday, 1/26, 1:30 - 4:30 p.m.)	Free— preregistration required	N/A	____ Check here to attend
	TOTAL AMOUNT SUBMITTED		

Meals included in the registration fee:
Friday: continental breakfast, lunch and dinner buffets and afternoon snack
Saturday: continental breakfast and lunch buffet
Special dietary needs: _____
(must be received by Dec. 19, 2005)
*Graduate student advisor's signature _____

**The Pre-conference Technology Workshop is limited to the first 50 registrants.

(Registration form is continued on page 4.)

Mail Registration Form with check made payable to AMTE to:

AMTE Conference Registration
Dr. Mark Klespis– AMTE Treasurer
Department of Mathematics & Statistics
Box 2206
Sam Houston State University
Huntsville, TX 77341-2206
936-294-1577
936-294-1882 (fax)
klespis@shsu.edu

If paying by credit card, please complete the following information:

Type of card (circle one): Visa MasterCard Discover

Name as it appears on the card: _____

Card number: _____Expiration:_____

Amount to be charged: _____

PRE-CONFERENCE SESSIONS AND SYMPOSIUM
Thursday, January 26, 2006

1:30 - 4:30 PM AMTE-Sponsored Technology Workshop
The AMTE Technology Committee will conduct a workshop entitled "Technology PCK (or TPCK) and the Preparation of Mathematics Teachers for Teaching Mathematics With Technology."

5:30 - 7:00 PM AMTE Pre-Conference Symposium
New Directions and Focus for Standards, Curricula, and Assessments
The AMTE Pre-conference Symposium will be held in Salon D of the Renaissance Tampa Hotel International Plaza. Speakers include Randall Charles, Francis (Skip) Fennell, Cathy Seeley, and Rose Mary Zbiek. There is no fee to attend, but we ask that you indicate your plan to attend by checking the box on the registration form so we may plan for seating. This year, Thursday dinner is on your own and several restaurants are within walking distance of the hotel.

Sessions Sponsored by Other Groups

9:00 - 11:30 AM NCTM/NCATE Program Reviewer Training
or 1:30 - 4:00 PM
The National Council of Teachers of Mathematics will offer the same session entitled "NCTM/ NCATE Program Reviewer Training Workshop" at the two times listed.

11:00 AM - 2:30 PM TI-Navigator™ Basics
Texas Instruments will conduct a session entitled "TI-Navigator™ Basics to Get You Started in Your Classroom," which requires a registration fee of $10. Lunch will be provided.

12:00 - 4:00 PM Using Mathematical Knowledge for Teaching
The Center for Proficiency in Teaching Mathematics will conduct a session entitled "Using Mathematical Knowledge for Teaching as a Learning Opportunity for Teacher Developers."

AMTE Technology Statement Draft:

Preparing Teachers To Use Technology To Enhance The Learning Of Mathematics

This draft was developed by members of AMTE's Technology Committee (2005), with assistance of Virgil Fredenberg, Christine Browning, and over 65 participants in the Technology Pre-Conference Session at the AMTE's 2005 Annual Conference. Committee members include Maggie Niess (chair), Oscar Chavez, Marcia Weinhold, Shannon Driskell, David Pugalee, Joe Garofalo and Board Liaison Gary Martin. Please send comments to Chair Maggie Niess at niessm@onid.oregonstate.edu.

The Association of Mathematics Teacher Educators (AMTE) supports the National Council of Teachers of Mathematics' (NCTM) Technology Principle: "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning." Mathematics teacher preparation programs must ensure that all mathematics teachers and teacher candidates have opportunities to acquire the knowledge and experiences needed to incorporate technology in the context of teaching and learning mathematics.

What is meant by the use of technology in the context of teaching and learning mathematics?

Technology in this context includes computers with appropriate mathematical software, Internet and other digital resources, handheld computing tools and their extensions, and future and emerging forms of similar devices and applications. Technology can be used in a variety of ways to improve and enhance the teaching and learning of mathematics. It can be used to facilitate mathematical discovery, understanding, and connections that may be difficult or impossible without its use. The computational and graphical capabilities of current technologies enable users to efficiently generate and manipulate a variety of representations of mathematical ideas and processes. Activities that engage students in connecting multiple representations (e.g., graphical, numerical, algebraic and verbal), and those that invite students to analyze or create images, visualizations, and simulations provide wide-ranging opportunities for mathematical exploration and sense-making. Instruction that takes full advantage of what technology has to offer can encourage, foster, and support students' construction of mathematical knowledge in a variety of ways. Technology can also improve mathematical communication, facilitate more efficient use of mathematical resources, and raise the quality of mathematical products and presentations.

What is AMTE's position on the preparation of mathematics teachers to teach with technology?

AMTE recognizes that technology has become an essential tool for doing mathematics in today's world, and thus that it is essential for the teaching and learning of mathematics. For mathematics teacher candidates to be able to implement appropriate uses of technology in the teaching of K-12 mathematics they should have:

- a deep, flexible, and connected conceptual understanding of K-12 mathematics that acknowledges the impact of technology on what content should be taught;
- a research-based understanding of how students learn mathematics and the impact technology can have on learning;
- a strong pedagogical knowledge base related to the effective use of technology to improve mathematics teaching and learning; and
- appropriate experiences during their teacher preparation program in the use of a variety of technological tools to enhance their own learning of mathematics and the mathematical learning of others.

By the completion of their preparation, new mathematics teacher candidates should be able to:

- demonstrate flexibility with high-quality and creative instructional techniques, both with and without technology, to help students explore and learn mathematics, develop mathematical thinking and communication abilities, and solve complex real-world problems;
- understand, by reflecting on how technology affords and constrains student actions and thoughts, when and how use of technology can advance learning and critical thinking, and when it can hinder the mathematical development;
- efficiently troubleshoot technology difficulties in both student and teacher use; and
- incorporate a variety of assessment techniques, including the use of technology to evaluate students' understanding of important mathematical concepts.

With the needs of future teachers of mathematics in mind, mathematics teacher educators should provide opportunities for teacher candidates to strengthen their knowledge of how to incorporate technology to facilitate student learning of mathematics through experiences that:

- allow teacher candidates to explore and learn mathematics using technology in ways that build confidence and understanding of the technology and mathematics;

(Continued on page 7)

Technology can also improve mathematical communication, facilitate more efficient use of mathematical resources, and raise the quality of mathematical products and presentations.

Revision of *Principles of Teaching Mathematics* *(Continued from page 1)*

work of the group. The task force met initially in Bloomington, Illinois in summer 2003. Task force members are profiled on page 7.

The initial charge by the NCTM Board of Directors included the following responsibilities: revise the existing document to reflect the PSSM's content standards, process standards, principles, and grade-band structure as appropriate; update the Professional Standards for Teaching Mathematics; and write appropriate executive summary documents for the updated Professional Teaching Standards to support NCTM's advocacy in this area. After re-examining the document and considering the charge, the task force adopted several additional goals for the revision: to incorporate updated references throughout the text to show that the document, like PSSM, reflects current literature and is supported by relevant research; to update Standards, elaborations, and vignettes to reflect current perspectives on best practices in teaching, supervision, teacher education, and professional development; to update technology references as needed; to add transitions and summaries throughout the document to help the reader make connections between the vignettes and the Standards they are illustrating; and to add "Questions for the Reflective Practitioner" at the end of each Standard section to promote reflection and connections between the document's recommendations and professional practice.

Task force chair Martin said that the challenge was in writing generally enough for all these audiences, yet maintaining appropriate depth for a document of this nature.

A draft of the document was circulated for review during summer 2005. NCTM President-Elect Francis (Skip) Fennell coordinated the review process, which is now complete. Approximately twenty reviewers were involved, including mathematicians, mathematics educators, and AMTE members. Reviewers included those who were very familiar with the original document and those selected for expertise in specific areas. During fall 2005, the task force is considering that feedback and incorporating it as appropriate.

When asked to comment on the task of revising the document, chair Martin said that one of the biggest challenges was that the Teaching Standards document addresses so many different audiences. The audience of the first section is teachers. The audience of the second is teachers, supervisors, and principals. The audience of the third is teacher educators and professional developers. The final section broadens to address all constituencies and all those who have influence over teaching. Martin said that the challenge was in writing generally enough for all these audiences, yet maintaining appropriate depth for a document of this nature.

The brief final chapter "Working Together to Achieve the Vision" addresses members of the larger community interested in mathematics education: parents, business people, universities, and politicians. This chapter is designed to encourage those important groups to reflect on their role in pursuing the common goal of ensuring all students learn to make sense of the world using mathematics. Martin emphasized that all of those audiences were considered in the writing process and will benefit from the final document. She suggests that one of the challenges of dissemination and use of the document might be to ensure all audiences are exposed to the document, from teachers and teacher educators to school-level administrators, to system and state-level administrators, to policy makers and everyone else interested in or influential in mathematics education.

References

National Council of Teachers of Mathematics. (1991). *Professional standards for teaching mathematics*. Reston, VA: Author.

National Council of Teachers of Mathematics. (2000). *Principles and standards of school mathematics*. Reston, VA: Author.

Chapter Titles in the 1991 and 2006 Documents

Professional Standards for Teaching Mathematics (1991)

- Introduction
- Standards for Teaching Mathematics
- Standards for the Evaluation of the Teaching of Mathematics
- Standards for the Professional Development of Teachers of Mathematics
- Standards for the Support and Development of Mathematics Teachers and Teaching

Standards for the Mathematics Teaching Profession (2006)

- Introduction
- Standards for Teaching and Learning of Mathematics
- Standards for the Observation, Supervision, and Improvement of Mathematics Teaching
- Standards for the Education and Professional Development of Teachers of Mathematics
- Working Together to Achieve the Vision

Teaching Standards Revision Task Force

The following six mathematics educators were named by then-NCTM President Johnny Lott to the task force charged with revising the 1991 *Professional Standards for Teaching Mathematics*. Martin, Herrera, and Speer are currently AMTE members.

Tami S. Martin, Chair of the Professional Teaching Standards Revision Task Force, is an associate professor at Illinois State University specializing in mathematics education. Her research has focused on the teaching and learning of proof. She has also served on the NCTM Professional Development and Status Advisory Committee. She has authored or contributed to two *Navigations* books as well as a *Curriculum and Evaluations Standards Addenda* book. She has authored or co-authored several research publications and book chapters and has presented at national and international professional conferences.

Terese (Terry) A. Herrera has been a mathematics resource specialist for the Eisenhower National Clearinghouse, a position that has involved her in the selection and evaluation of instructional and professional development materials. Her dissertation research focused on teacher change through professional development programs. Her earlier professional experience includes 15 years teaching math in middle and high school classrooms, as well as teaching mathematics methods courses at the Ohio State University. In recent years, her publications and presentations at national conferences have focused on the use of the Internet in teaching K-12 mathematics.

Timothy D. Kanold is Superintendent of nationally-recognized and award-winning Adlai E. Stevenson High School District 125 in Lincolnshire, Illinois. Dr. Kanold served as a teacher and Director of Mathematics for 17 years prior to becoming Superintendent. He is the recipient of the Presidential Award for Excellence in Mathematics and Science Teaching, and a past President of the Council for Presidential Awardees in Mathematics. He has served NCTM and NCSM as co-author and presenter of the leadership academies and served on the committee for the development of Teaching Performance Standards in Mathematics. Co-author of 27 mathematics textbooks grades 6-12, Dr. Kanold is a frequent speaker at national and international mathematics meetings.

Roberta Koss is a returning member of the Professional Standards for Teaching Mathematics Committee. She is a retired secondary educator who is currently serving as a contract teacher for Texas Instruments. Roberta is a former member of the NCTM Board of Directors and a Presidential Awardee for Secondary Mathematics. She is a co-author of two geometry textbooks and a frequent speaker at state and national conferences.

Patrick Ryan is an education specialist for the Ministry of Education in the province of Quebec. He is currently working to assist teachers in First Nations schools throughout Quebec. He has taught mathematics courses to pre-service teachers at McGill University. He has served as a member of the planning teams for NCTM Regional Conferences in Montreal and is a member of the Program Committee of the NCTM Annual Meeting and Exhibition in St. Louis in April 2006.

William R. Speer is Interim Associate Dean and Director of the Center for Mathematics and Science Education at the University of Nevada, Las Vegas. Dr. Speer is a past president of several professional organizations including the Ohio Council of Teachers of Mathematics, the Nevada Mathematics Council, the Nevada Association of Teacher Educators, the Research Council on Mathematics Learning, and the School Science and Mathematics Association. Dr. Speer is the primary author of *Today's Mathematics*. He has authored numerous articles in various professional journals and has served as editor of two monthly sections of *Teaching Children Mathematics*.

The task force membership is balanced with three members of the initial writing team (Koss, Kanold, and Speer) and three members who brought a fresh perspective to the document (Martin, Herrera, and Ryan).

Technology Statement Draft

(Continued from p. 5)

- model appropriate uses of a variety of established and new applications of technology as tools to develop a deep understanding of mathematics in varied contexts;
- help teacher candidates make informed decisions about appropriate and effective uses of technology in the teaching and learning of mathematics; and
- provide opportunities for teacher candidates to develop and practice teaching lessons that take advantage of the ability of technology to enrich and enhance the learning of mathematics.

If technology is used to improve the learning of mathematics at all levels, students will be better prepared to use technology appropriately, fluently, and efficiently to do mathematics in the techno-rich environments in which they will study and work in the future.

Theory & Practice Question:

Bridging the Potential Divide between Theory and Practice

A common complaint about university courses or professional development is that they are too theoretical and do not provide immediately applicable activities for the classroom. In what ways do you attempt to get teachers (preservice or inservice) to bridge the potential divide between theory and practice?

Response by James Brickwedde, Hamline University,

jbrickwedde@gw.hamline.edu

Over the years of providing professional development in Cognitively Guided Instruction here in Minnesota we have grappled with designing learning communities that reflect the research on how children learn mathematics and how teachers interpret that knowledge into instructional practice. We have built into our work two specific elements that reflect research-based findings.

A teacher's growth and change in practice occurs over time. This clearly matches many other research findings that have demonstrated that teachers learn best when provided professional development that is sustained and supported over time. Building upon this, we designed our summer institutes to automatically include fifteen hours of follow-up support during the succeeding school year. It's an all-in-one package. The follow-up sessions focus intensely on analyzing student work samples drawn from the teacher's own classroom. The analysis helps to clarify what they know about the research, how children learn the mathematics, and how to use that information to shape instructional decision-making. The teachers plan common mathematical tasks as well as for individual goals for the next reflection session. The five three-hour sessions spread typically from September to February to capture the growth of students over time. Case studies are built on three students from the teacher's classroom to focus on the growth of the individual and the changes in teacher decision-making over that portion of the school year.

This structure of one-week summer institute with follow-up support during the school year is replicated for the series of professional development offerings over a three to four year period. Each class focuses on children's development of the mathematics and the teacher interface of instructional decision-making. Through that process the teacher's mathematical content knowledge is specifically developed and expanded.

Another element we have expanded upon during the fulltime, weeklong summer institute is bringing students directly into the week's schedule for teachers to begin working with. While videotapes of students and teachers interacting and physical artifacts of student work are powerful learning tools, there is no replacement for teaching a child. Initially, we only brought students in for two short one-hour sessions during the week. For teachers returning for a third year we built a lab school format of working with students all morning in summer school, then analyzing their work and planning for the next day throughout the afternoon. The extensive teacher growth in this lab class format led us to expand this concept earlier in our work with teachers. Currently, depending on access issues to children, we bring students into the teacher institutes three to four mornings for an hour to an hour and a half each day.

The lab sessions are a combination of "fish bowl" instruction by the course instructor followed by two teachers working with one student, followed by whole group sharing. The session with the students is followed by partner and whole-group debriefing. They discuss what was learned about the students' knowledge of the mathematics and where to go next instructionally. As the teachers grow in their experiences within the institute and from one year to the next, the teachers take on more and more planning for these interviews. They begin to consider carefully how to construct mathematical tasks that will move the students further along the mathematical learning trajectory.

Recently I assisted a school district in writing a grant supported by NCLB dollars through the state. The grant requires that a mathematics department (we are in the Graduate School of Education) be a direct participant. When we asked the mathematicians if they, too, wished to have students for the teachers to work with as part of their work, the response was, "I guess we could, but I don't see the purpose." The purpose, we have found, is that it is the students who motivate the teachers to reflect on their own knowledge of the mathematics as they themselves delve deeper into how the children are constructing their knowledge. It is working with children that the theory becomes practice, where teachers grapple with what makes sense on paper to what works instructionally with

It is the students who motivate the teachers to reflect on their own knowledge of the mathematics as they themselves delve deeper into how the children are constructing their knowledge.

the students. The theory makes sense. The more teachers grapple with the problems of practice and the insights offered by theory, the more their own practice is impacted.

Response by Cynthia Hernon, Boise State University,
cynthiahernon@boisestate.edu and
Janet McShane, Northern Arizona University, *janet.mcsshane@nau.edu*

Secondary mathematics teachers often argue that many of the required university mathematics content courses have no relevance to the classes that they will teach at the middle school or high school. Abstract algebra is frequently mentioned as one of those classes. An online graduate course entitled Connections: Algebra and Number Theory was developed with the goal of improving teacher content knowledge in abstract algebra and providing opportunities for these teachers to create classroom learning activities that used this mathematical content. The instruction for the course was a collaborative effort between a mathematics professor and a mathematics educator. Course activities and assessments were divided so that the abstract algebra content was 80% of the class and the mathematics education connections were 20% of the class.

The algebra content was separated into four sections. These included a foundations section (a review of terminology and proof techniques), number theory, ring theory, and group theory. A deliberate decision was made to use a textbook that introduced ring theory before the study of groups because the examination of polynomials, i.e. polynomial rings, is an integral part of the secondary school algebra curriculum. Five specific activities were assigned to guide the teachers into making connections between this abstract mathematical content and their teaching practice. The five assignments included participating in an online discussion of the NCTM Algebra Standards, analyzing an existing online number theory activity (http://www.shodor.org/interactivate/lessons/clock.html), writing a critique of an article that focused on the teaching and learning of algebra, creating a lesson plan for a topic from ring theory or group theory, and producing a final reflection paper.

The candid and intelligent online discussion of the how the algebra content strands and process standards appeared in each teacher's school established a quality benchmark for subsequent assignments. The online modular arithmetic/cryptography lesson was viewed as being applicable for both middle school and high school students. A high school teacher modified this lesson for his algebra students and a seventh grade teacher stated that she had never taught clock arithmetic or cryptography to her students, but feels that these topics can easily be included in a seventh grade mathematics class. The teachers overwhelmingly liked the variety of articles provided for the critique assignment and planned to read more of the articles after the course was completed. The lesson plans demonstrated a commitment to promoting student examination of congruence, the factor theorem, the remainder theorem, and symmetry of groups from a theoretical and practical perspective.

In the reflection paper, the teachers were asked to discuss how participation in this course influenced their attitudes toward the study of more abstract mathematics and which aspects of the mathematics content and/or mathematics education connections could be integrated into their teaching practice. With this last assignment the teachers produced papers that were insightful, honest, and rich with detailed descriptions of how they had struggled with learning the abstract algebra content and the place this content has in their teaching practice.

General comments included statements of appreciation for the order in which the concepts were presented, interest in using the online clock arithmetic lesson with their own students, how

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Mathematics teachers often argue that many of the required university mathematics content courses have no relevance to the classes that they will teach at the middle school or high school.

Spring Issue Theory & Practice Question:

Challenging Preservice Teacher Expectations for their Students

Are we making progress in ensuring preservice teachers see all students as capable learners and doers of mathematics? Especially students who historically have not been expected to succeed? How are we preparing preservice teachers to change these patterns of failure? What successes can we document? What issues persist despite our efforts? What specific strategies have you found to be useful for addressing them?

AMTE members are encouraged to respond to this question with an essay of 800-1000 words. Submit your response to *Connections* Editor Lynn Stallings (lstalling@kennesaw.edu) by February 1 to ensure consideration for the spring issue.

Response by Hernon and McShane

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valuable the articles will be as a source for improving the teaching of algebra, and an understanding of "how often these topics creep into the basic levels of algebra that we teach." In particular, the teachers thought examining ring theory before the study of groups allowed them to study concepts that paralleled those in secondary algebra courses. One individual summarized the connections as "providing a richer concept of the different number sets" and demonstrating "how humbling it is to see what a small part of the picture is taught in high school regarding polynomial rings."

For us, as instructors, the most significant comments related to the perceived connections between the content of this university mathematics class and the teaching of secondary mathematics. Teachers remarked that seeing and using these connections when teaching will hopefully lead to a deeper understanding by students. They felt that their own mathematical awareness became more acute, the algebra content connections among the different 7-12 mathematics courses became more obvious, and the value of knowing the theory behind the algebra became more apparent. Summer 2005 was the first time that this course was taught, but we believe that the mathematics education component of this content course successfully connected the abstract algebra concepts to the teaching and learning of algebra in the secondary schools. One teacher remarked that even when the work in this abstract algebra class did not directly correspond to the topics he was teaching the increased confidence in his knowledge of algebra made him a better teacher.

One way to bridge the divide is having course design be responsive to developments in the school system.

Response by Larry Lesser, University of Texas at El Paso, *lesser@utep.edu*

One way to bridge the divide is having course design be responsive to developments in the school system. I taught at the University of Northern Colorado while Colorado's K-12 schools were in the process of moving towards a legislated development of content standards and performance-based assessments. So I articulated standards for our secondary math methods course, we explored and thoroughly analyzed a Colorado Grade 11 performance assessment task and its scoring rubric, and had critical discussion of the various levels (local, state, national) of mathematics standards (Lesser 1999). Such critical discussion was also part of a technology course I've taught at the University of Texas at El Paso for present and future secondary math teachers. In that course, we were not merely cheerleaders for the power of technology, but also explored and discussed each form's limitations, tradeoffs and real-life pitfalls (Lesser, in press).

The "conceptual mathematics" course for preservice elementary teachers I've taught at UTEP was also designed with numerous strategies to bridge theory and practice. First, the course was one of three courses taught in an integrated block, making it easier for all three faculty to sit in on and contribute to parts of each other's courses, connecting domains of content and pedagogy. Also, the block was field-based and held each meeting in an actual elementary school with student demographics fairly representative of schools where preservice teachers might likely be placed. On the weekdays our block did not meet, those students spent half-days in assigned internship schools, a great source of real discussion the next day! The semester's built-in microteaching, lesson plans, Parent Power Night, and opportunity for teacher observations and collaborations, gave further authenticity to course objectives.

Also, as part of a goal for UTEP's Carnegie Foundation TNE (Teachers for a New Era) grant, we are working to identify strategies to support new teachers in those crucial first 3 years (where turnover is so high). We have offered conferences and workshops on topics most requested by teachers (e.g., classroom management, technology). Resources identified include Salas, Tenorio, Walters, and Weiss (2004) as well as the elementary, middle and high school versions of NCTM (2004).

I have renewed appreciation for the difference between theory and practice after getting recent full-time precollege teaching experience myself. After 8 years of full-time teaching at Assistant and Associate Professor levels, I spent two years teaching a wide range of students and classes (Algebra I, Geometry, Algebra II, Precalculus, Calculus) at a high school in Houston and this has hugely informed and grounded my subsequent work with teachers.

When I teach teachers, we read and talk explicitly about the tension between theory and practice. Dooley (1998) describes how theory and practice can be bridged via conversations that include students' metaphors and images of teaching. And while we have built into our courses many valuable

Response by Lesser

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ways for students to get various types of experience, it is also important to remind ourselves that field experiences do not always yield perfect or complete knowledge. In particular, Feiman-Nemser and Buchmann (1985, p. 63) articulate three pitfalls of experience: "The familiarity pitfall arises from the fact that prospective teachers are no strangers to classrooms. The two-worlds pitfall arises from the fact that teacher education goes on in two distinct settings and from the fallacious assumption that making connections between these two worlds is straightforward and can be left to the novice. The [cross-purposes] pitfall arises from the fact that classrooms are not set up for teaching teachers."

References

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Response by P. Mark Taylor, University of Tennessee, *pmark@utk.edu*

Between the assessment scheme of the methods course and the ongoing lesson study, the merging of theory and practice has become the theme of our secondary mathematics education program. At the University of Tennessee, we have the advantage of teaching mathematics methods while they are beginning their full year of internship (or student teaching). I have made a real push this year to have most of the grade for the course dependent on what they do in the internship. The rubric for the work, however, is based on the "theoretical stuff" from the methods course. In other words, I force them into seeing the need to work out how the theoretical methods that I am teaching can be applied in their classroom.

One of the assignments that I added for this past year was the teaching methods notebook. It is basically a journal to keep track of what new methods they are trying, how they implemented them, how the students responded, and what they will try differently next time. This is presented as a tool for reflection, which it is, but it is really an accountability tool. On any given week, I can ask them to turn in their notebook and check to see that they are using what we are covering in the methods course.

Another tool is the problem solving notebook. During the methods course I first have them do problems of the week as mathematics learners. I have them write out very thorough solutions using multiple representations, complete sentences, and logical arguments. After a few weeks, they are asked to try out a particular problem with their students and to report the results in our methods course the following week. Eventually, they are asked to implement a problem of the week for their students for the rest of the semester. Special attention is given to whether the problems are used for introduction, as the central learning activity, or for practicing a technique or algorithm. All of this work gets documented in the problem solving notebook.

A third notebook is dedicated to documenting their implementation of different assessment tools and reflections on their effectiveness. This establishes the expectation that they will go beyond, tests, quizzes, and homework. It also reinforces the use of informal assessment schemes beyond "walking around the room to make sure they get it."

Beyond "trying out" techniques, they have to truly dig in and investigate how to make it work as a result of the lesson study assignments that they must complete. The lesson study process that I have them work through is a two-semester process. In the methods course, I have teams of three or more develop research-based lessons. Interns, and sometimes mentoring teachers, take turns teaching the lesson in their internship and the others on the team observe. They go through a debriefing time and revise the lesson based on assessment data. Every part of the original lesson must be justified by research and any change must be justified by assessment data collected and analyzed. The second stage is then done in the spring as their

(Continued on page 15)

Between the assessment scheme of the methods course and the ongoing lesson study, the merging of theory and practice has become the theme of our secondary mathematics education program.

Evaluation of the NSF Local Systemic Change Program: Implications for Preparing New Teachers of Mathematics

by Iris R. Weiss, Horizon Research, hri@horizon-research.com

In 1995, the National Science Foundation (NSF) launched the Local Systemic Change (LSC) through Teacher Enhancement program. The program was based on the understanding that both teachers and instructional materials play a crucial role in the classroom. Providing extensive, high quality professional development to deepen teachers' knowledge and enhance their skills would have little impact if those teachers were given ineffective materials to use in the classroom. At the same time, incorporating findings from research on teaching and learning into new instructional materials would have little impact if the teachers lacked the knowledge and skills to implement them well.

The primary emphasis of the LSC was professional development for teachers of mathematics/science around the research-based instructional materials that would be used in their classrooms. The idea was that that rather than serving "volunteer" teachers, all teachers in a district (or set of districts) would participate in intensive professional development so that all students would benefit. Projects were free to design whatever approaches they believed would be effective in their contexts. Whatever the individual design, however, LSCs were guided by a common set of principles to achieve their overarching goal of improved instruction. These principles included the following:

- Using well-prepared professional development providers whose backgrounds include in-depth content understanding and expertise in K–12 mathematics/science education;
- Establishing a supportive and collegial professional development culture that facilitates teacher learning;
- Providing experiences that deepen teachers' knowledge of the mathematics/science content in the curriculum and the pedagogy needed to teach this content;
- Providing opportunities for teachers to explore and become conversant with research-based instructional materials and the appropriate pedagogy for using these materials in their classrooms; and
- Providing support for teachers in content, pedagogy, and materials over the course of implementation.

By 2002, a total of 88 projects had received funding through the LSC program, roughly half of which involved mathematics teachers at the elementary and/or secondary levels. As part of the LSC program, NSF also funded a "core" evaluation, where project evaluators collected data using common instruments and procedures so the results could be aggregated across projects. Core evaluation data collection activities included observations of professional development sessions, interviews with teachers and project staff, questionnaires administered to teachers and principals, and classroom observations. (See http://www.horizon-research.com/LSC/news/ for reports on the LSC core evaluation findings.)

The purpose of this article is to share results from the LSC that have implications for the preparation of future teachers of mathematics. It is important to note that the teachers targeted by the LSC tended to be somewhat better prepared than is typical nationally. For example, 29 percent of observed "baseline" lessons in LSC districts were judged to be of high quality compared to only 15 percent of lessons of a nationally representative sample. These data are not surprising—districts participating in the LSC had access to leaders who were conversant with principles of mathematics instructional improvement, and were able to secure major federal funding for their work, in many cases because they could point to work that was already underway. Areas that proved challenging in the LSC are likely to be even more challenging for mathematics teachers generally, increasing the importance of addressing these concerns in initial teacher preparation as well as in on-going professional development.

Based both on teacher self-report data and evaluator observations, the LSCs had a positive impact on mathematics classroom practice. Longitudinal analyses indicated a link between participation in LSC professional development and a classroom culture that was conducive to investigation (e.g., arranging seating to facilitate student discussion; using open ended questions; requiring students to supply evidence to support their claims; and encouraging students to consider alternative explanations.) LSC professional development was also related to an increased use of investigative practices, including having students work on models/simulations; and write reflections in a notebook or journal, as well as enhanced quality

of the content presented to students, and more attention to sense-making.

It is important to note, however, that even teachers with intensive LSC professional development continued to struggle with key elements of teaching for understanding. The glass is either half full or half empty, depending on one's perspective. On the one hand, participation in the LSC had a positive impact on a large number of important indicators of high quality instruction. At the same time, there was considerable room for improvement even among the teachers who had participated in substantial amounts of professional development. For example, in one of the cross-site analyses, 59 percent of mathematics lessons of treated teachers were rated highly on questioning strategies compared to only 27 percent of untreated teachers. Many teachers also had difficulty in engaging students intellectually with important ideas relevant to the focus of the lesson; portraying mathematics as a dynamic body of knowledge continually enriched by conjecture, investigation, analysis, and proof/justification; providing adequate time and structure for "sense-making;" and creating a classroom culture that included intellectual rigor, constructive criticism, and challenging of ideas.

Both the extent of teacher participation in LSC professional development and the use of the research-based instructional materials were associated with higher evaluator ratings of lesson quality. As can be seen in Figure 1, lessons that were taught by teachers receiving treatment *and* based on the LSC-designated instructional materials were twice as likely to receive high ratings as were lessons of untreated teachers who were not using those materials.

Findings from the core evaluation also support the LSC program's emphasis on having teachers implement the research-based instructional materials as designed by their developers. Teachers who participated in LSC professional development were also considerably more likely to use their project's designated, research-based instructional materials in the classroom. The more closely a lesson adhered to the instructions provided in the teacher's manual, the more likely it was to be rated effective. Lessons

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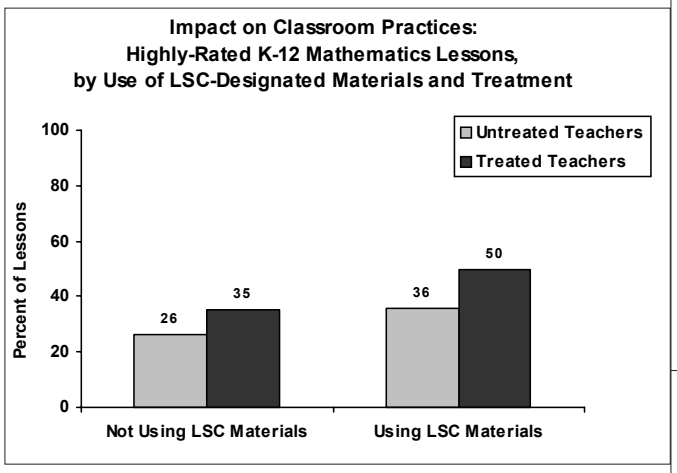

Figure 1: Lessons varied in their rating on important indicators of high quality instruction.

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CITE is an online, peer-reviewed journal, available at http://www.citejournal.org. This journal is jointly sponsored by five professional associations, including AMTE. The other associations are AETS, NCSS-CUFA, CEE, and SITE. The journal's online medium also allows authors to demonstrate the technologies about which they are writing, including video and audio segments, animation, virtual reality, Web links, and simulations. The mathematics education editors of the *CITE* are Iris Johnson (johnsoid@muohio.edu) and Ginny Keen (ginny.keen@wright.edu).

The mathematics education article in the current issue is "A Taxonomy of Software for Mathematics Instruction" by Terri L. Kurz of California State University, Bakersfield and James A. Middleton and H. Bahadir Yanik of Arizona State University. Following is the abstract of their paper:

> The potential to use mathematics software to enhance student thinking and development is discussed and a taxonomy of software categories is outlined in this paper. Briefly, there are five categories of tool-based mathematics software that can be used fruitfully in a mathematics curriculum: a) review and practice, b) general, c) specific, d) environment, and e) communication. A description of the affordances and constraints of the five types of software and how each facilitates different aspects of student learning clarifies the ways in which diverse off-the-shelf offerings can be used to address the goals of mathematics instruction, from building basic skills to exploring mathematical applications in the real world.

Evaluation of the Local Systemic Change Program *(Continued from previous page.)*

that were implemented essentially as designed were much more likely to be judged as high quality, providing students a substantial opportunity to learn important mathematics. (See Figure 2.)

As a complement to the core evaluation, where project evaluators observed a random sample of lessons in each LSC, a number of PIs were asked to visit mathematics classrooms to get their own sense of how teachers were translating the LSC professional development to their practice. Although the PIs used different criteria to select the teachers – in some cases deliberately looking at both "pioneers" and "resistors" – the results were strikingly similar, as the following two excerpts from PI write-ups illustrate. Modeling effective practices for teachers was not sufficient; there is an apparent need to address issues of mathematics conceptual development more explicitly.

Also we could not see any evidence that [the teacher] understood how the content in the lesson fit into the big picture of the unit… She asked questions and her behavior indicated that she was cognizant of student thinking. However we did not see any evidence of a focus on student conceptual development. (PI, K–8 mathematics project)

In all three lessons observed, teachers did not demonstrate that they understood the content or how the concepts in the lessons they were teaching fit into the concepts in the unit. They tended to zero in on the minutiae of a particular lesson and apparently did not recognize how the lessons fit into the bigger picture of the unit. (PI, 6–12 mathematics project)

We would do better to help teachers understand the learning goals and design principles of the instructional materials designated for their use, and encourage them to implement high quality materials as their developers intended.

Implications for Pre-Service Education

Traditionally, as a part of their pre-service preparation, prospective teachers are asked to create units/lesson plans from scratch. This practice appears to carry over into their in-service experience. In fact, teachers who modify the activities in their instructional materials, bring in activities to supplement the district's instructional materials, or develop their own, are often viewed as the most talented and creative. But most teachers have neither the time nor the expertise to develop high quality instructional materials on their own. The LSC results suggest that we would do better to help teachers understand the learning goals and design principles of the instructional materials designated for their use, and encourage them to implement high quality materials as their developers intended.

The dilemma, of course, is how to prepare prospective teachers to deal with situations where the materials they are expected to use have serious flaws, cases where implementing instructional materials as intended seems unlikely to lead to student understanding. Some pre-service educators advocate focusing on "principles" that teachers will be able to use to decide if their instructional materials need to be modified and how. It will be important to track such efforts to see if the modifications that teachers make in these instances are in fact improvements, or if it would be better to have teachers follow even weak instructional materials essentially as designed.

Moving from instructional materials to instructional strategies, the LSC findings suggest that pre-service educators need to walk a fine line in developing the vision of quality instruction. On the one hand, it is important to introduce prospective teachers to current thinking in mathematics education. At the same time, it is important that pre-service educators do not imply that every "reform-oriented" element is to be embraced, and everything

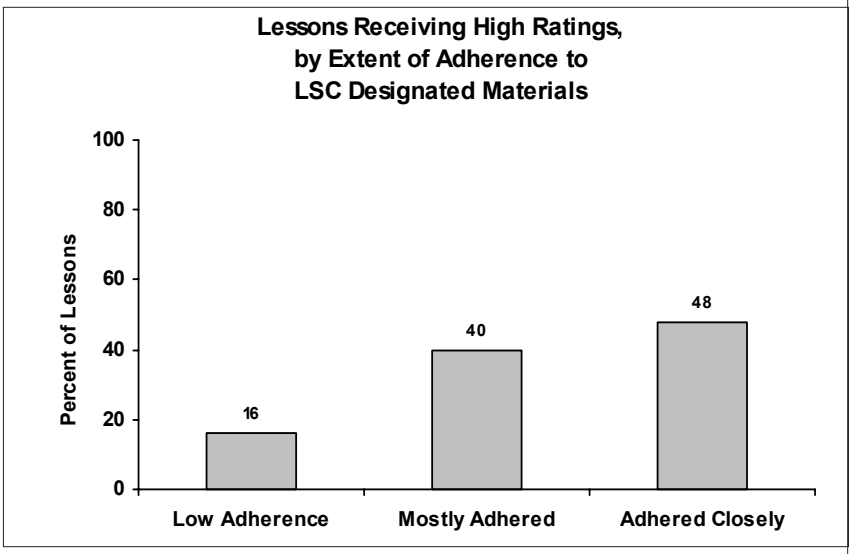

Figure 2: Lessons varied in their implementation of instructional materials as designed.

Evaluation of the Local Systemic Change Program *(Continued from previous page.)*

that is "traditional" is to be abandoned. The point is not to create advocates for "features" of reform, such as use of manipulatives, but rather to help teachers-in-training focus on the substance of reform: teaching for understanding.

As part of developing this vision, prospective teachers could be given opportunities to analyze a variety of lessons in relation to these key elements of high quality instruction, particularly identifying the key mathematics ideas, and how teacher questioning and periodic summarizing, ideally bringing in student ideas, can be used to enhance student conceptual understanding. The challenge is increased, of course, by the fact that pre-service educators typically do not know where their graduates will teach nor what instructional materials they will use. The only plausible approach may be to give prospective teachers practice in ferreting out the key mathematics ideas in various materials if the authors are not explicit, and considering how to keep the mathematics in the foreground while engaging students with various activities.

Based on the LSC experience, pre-service educators will need to not only model teaching for understanding in both mathematics and education courses, but also to focus explicitly on key aspects of teaching for understanding. In particular, prospective teachers need to recognize that the purpose of using activities is not simply to engage the students, but to help them learn powerful mathematics; they need to be able to see how instructional activities are tied to learning goals, and understand how a sequence of activities is intended to introduce, develop, and solidify attainment of the learning goals. In other words, rather than emphasizing particular reform-oriented pedagogies, the vision of high quality instruction should emphasize the need for important and developmentally-appropriate mathematics learning goals; the need to understand how particular instructional activities within and across grades relate to those learning goals; the importance of creating a learning environment that is simultaneously supportive of, and challenging to, students; and, vitally, attention to appropriate questioning and helping students make sense of the mathematics concepts they are studying.

In particular, prospective teachers need to recognize that the purpose of using activities is not simply to engage the students, but to help them learn powerful mathematics.

Theory & Practice Question:

Bridging the Potential Divide between Theory and Practice

Response by Taylor

(Continued from page 11)

official action research project. They can do a new lesson or further revisions of the same lesson. The products include a paper and a presentation at our capstone research conference. Hence, this lesson study process is the overarching theme of the entire program. It connects all of the classes and the internship itself and carries over into how they should approach professional development as they begin their teaching careers – one lesson at a time.

The best example of this approach was the preservice member of a professional development team (PDT) as a part of the Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics (ACCLAIM) project. Each professional development team consists of a group of local teachers within a school or district along with a preservice teacher and a professor from their program. In this case, the preservice teacher was an intern and the lesson study fit into the PDT goal of improving the algebra curriculum. She completed her final lesson study along with inservice teachers at the school.

She summarized the impact of this experience in this reflection: "By using the lesson study process, we have discovered some effective teaching methods that have had a positive impact on our team. Lesson study has helped us to grow not only as individual teachers but has also assisted us in uniting as a team and aligning our algebra curriculum across our middle and high school courses. Because of the extent of research and collaboration required in a lesson study, this project has been an incredible instrument for pulling together my coursework and aligning it with my role as a preservice member of the professional development team. The lesson study has also provided a resource for future teachers to use when teaching the function concept and it has given me a true team experience to duplicate as I join other professional teams in the future. I would encourage all other teaching professionals to participate in lesson study, for as educators we should constantly strive to improve our teaching strategies, and lesson study is an invaluable tool for doing so."

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