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ABSTRACT

This paper presents four different perspectives on the numerous changes associated with the implementation of Core-Plus Mathematics Project (CPMP), that of the university mathematics educator, two experience levels of practicing classroom teacher (both field-test teachers for CPMP), and the "student" teacher. Differences between teaching CPMP compared to more traditional mathematics courses are outlined, areas in which veteran and "student" teachers need additional education and training are suggested, potential shortcomings in current university mathematics and methods courses are highlighted, and teachers' own roles in the curriculum research and development process are discussed. A synopsis of each of these perspectives is presented. A discussion of implementation issues associated with similar projects and dilemmas faced by university educators in organizing content for methods courses and meaningful field experiences for their student teachers is also presented. (ASK)

Teaching a Reformed High School Mathematics Curriculum: Inservice and Preservice Perspectives

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Numerous high school curriculum development projects have emerged across the nation in response to the publication of the NCTM Standards documents. The Core-Plus Mathematics Project (CPMP), centered at Western Michigan University and funded by the National Science Foundation, is one project that is currently undergoing pilot- and field-testing in 36 high schools across the nation. The CPMP curriculum integrates strands of algebra, geometry, discrete mathematics, probability, and statistics into each course (grades 9-11) and emphasizes mathematical modeling, investigating, reasoning, and interpreting data in a variety of application contexts. The CPMP instructional model emphasizes students constructing their knowledge through group work and class discussion, teacher as facilitator, and use of alternative assessments. Now in its third year of field testing (with high school juniors), the project has already experienced a growth in the number of schools wanting to adopt the materials either as an alternative for or supplement to traditional mathematics curricula. For example, eight additional schools in Iowa began using the materials in their schools this year.

The adoption and implementation of reformed curricula, such as CPMP, require changes in the way mathematics educators at all levels think about the teaching and learning of mathematics. Adoption also requires broadened views of pedagogy, classroom structure, and the mathematics that is appropriate for secondary students. Such changes affect practicing teachers, who are asked to implement new curricula, by requiring inservice in new content and pedagogy. These changes also affect the preparation of teachers, both mathematics educators, who must provide appropriate methods courses and field experiences as the foundation for adequate training of prospective teachers, and their students who trust that these courses and experiences will provide sufficient preparation for their first real teaching experience after graduation.

This session presented four different perspectives on the numerous changes associated with implementation of CPMP: that of the university mathematics educator, two experience levels of practicing classroom teacher (both field-test teachers for CPMP), and the "student" teacher. The session presenters outlined differences between teaching CPMP compared to more traditional mathematics courses, suggested areas in which veteran and

"student" teachers need additional education and training, highlighted potential shortcomings in current university mathematics and methods courses, and discussed their own roles in the curriculum research and development process. A synopsis of each of these perspectives is presented below. The session concluded with a discussion of implementation issues associated with similar projects and dilemmas faced by university educators in organizing content for methods courses and meaningful field experiences for their student teachers.

Perspectives

1. Steve Ziebarth (University mathematics educator)

The CORE-Plus Mathematics Project has for the past four years presented me with opportunities to reexamine a number of issues associated with being a researcher and teacher. As the Evaluation Coordinator for CPMP since its start in 1992, my time has been devoted to collecting and analyzing both quantitative and qualitative data from all students and teachers involved in the pilot- and field-test sites. A fair amount of this data has been used formatively in the curriculum development process, while the majority of data continue to be gathered for use in the forthcoming summative evaluation. To date, a number of preliminary reports of student and teacher outcomes have been published and presented at various meetings.

While the data analysis and evaluation components of this kind of project are important for determining the impact of reform curricula like CPMP (i.e. whether or not they are successful), they were not the focus of this symposium. Instead, the focus was on the impact this project has had on mathematics educators with various levels of experience and positions within the research and teacher education process. Granted, this data, in the form of written experiences with teaching CPMP materials, is not systematic or complete, but rather serves as a basis for generating questions about teaching and preparing to teach in a reformed classroom environment consistent with the NCTM Standards documents. If the Standards do indeed represent a grass roots and broad representation of the mathematics education community, the voices of all teachers are important to the reform conversation and may suggest important ways in which we, at the universities, may be better able to help teachers in a reformed classroom environment.

From a research perspective, the veteran and preservice teachers have gained a great deal from being involved in a project like CPMP. The veteran teachers who pilot- and field-test the materials have committed themselves to weeks of inservice training, learning the materials, understanding the instructional model, developing facility in using the graphing calculator, and broadening their understanding of mathematics and its application.

As they try the materials with their students, their feedback to the writing team is essential in determining whether or not the materials are actually viable in the classroom. CPMP has also provided a number of opportunities for preservice teachers. They have been an integral part of the scoring and analysis of student work from CPMP classrooms and a few have completed special research projects as part of the university honors program. For both levels of teachers, the opportunities to become a part of the research process have hopefully contributed to their professional growth and helped them develop a deeper understanding of curriculum reform in mathematics education.

While most of these benefits may seem obvious, it is difficult to ignore a number of issues and dilemmas associated with implementing reformed mathematics curricula. Our symposium discussion section suggested that other university teacher educators and other projects are faced with similar concerns. A few of these are introduced here, but are also echoed in the other perspectives presented below. One issue raised in the discussion focused on the content of methods courses. How do we properly balance the treatment of the many topics required to teach reformed curricula: cooperative and investigative learning, alternative assessment, the growing varieties of technology appropriate for the mathematics classroom, and still present interesting and challenging mathematics problems? Can all of these be adequately presented in a single methods course or even a sequence of courses? A number of AMTE sessions outlined exciting and innovative possibilities for dealing with this issue.

In those universities where reformed projects are being developed, a related concern is that of project bias. Certainly, methods students should be exposed to a wide variety of curriculum materials, both reformed and more traditional, because it is important for students to develop a critical approach to the materials that they will eventually choose for their own schools and classrooms. Yet, this approach to a broader understanding of mathematics curricula could easily be compromised by focusing a methods course exclusively on a single "pet" curriculum development project. Can or should we guard against such bias?

Another related concern moved the discussion from methods courses to field experiences. A number of participants expressed concerns about the difficulty of finding good placements for student teachers in school environments that encourage reforms consistent with those advocated in the Standards. Even when students participate in an excellent methods course, with many of the features described above, they often find themselves in a placement where more traditional texts and teaching methods are the norm and there is little support for trying new ideas and materials. Although most participants felt that they had many good mentor teachers, quite often the number of student teachers

exceeds this supply or placements are made through other university channels. Finding good placements seems essential to sustaining the current reforms. And by thinking about each of these concerns and bringing them into the conversation on the impact of reformed curriculum, we can all participate in finding ways to continually improve mathematics education.

2. Judy Slezak (Classroom teacher for 26 years)

As an experienced secondary teacher, I can say that I have never taught mathematics that was so creative, comprehensive, and exciting as the Core-Plus Mathematics materials. The materials strongly support the NCTM Standards. As a supervising teacher, I found that preservice teachers had a challenge that they weren't totally prepared for.

In comparing the CPMP materials to a more traditional high school mathematics curriculum, the following four changes would most affect the preservice teacher:

i. The curriculum is based on strands of **algebra** and **functions**, **geometry** and **trigonometry**, **statistics** and **probability**, and **discrete mathematics**. These units last from 4-6 weeks each instead of the normal year-long course. Preservice teachers are required to know a vast amount of mathematics and related applications. Instead of algorithms, it is important that they understand the 'why' behind the mathematics. They are required to come up with many examples where the mathematics can be used in real situations in addition to those presented in the materials.

ii. Instruction using the CPMP materials is completely different from that in a traditional classroom setting. Preservice teachers need to know when to be a director, moderator, facilitator, or intellectual coach instead of a lecturer. There are four phases to each lesson: **Launch**, **Explore**, **Share and Summarize**, and **On Your Own**.

All lessons are started with a **launch**. This is a full-class discussion of a problem situation and related questions to think about. This discussion sets the context for the student work to follow and helps generate student interest. The preservice teacher needs to assess student knowledge and clarify directions for group activities.

Next, the class breaks up into four-person groups, where students **investigate** problems brought up in the launch by gathering data, looking for patterns, constructing models and meanings, and making and verifying conjectures. The preservice teacher needs to help each group work more cooperatively, circulating from group to group, providing guidance and support, clarifying or asking questions, giving hints as needed, and drawing group members into the discussion.

The groups gather again as a full class for the next phase which is to **share and summarize**. Students share their understandings of the investigation with a

Checkpoint, which includes questions summarizing concepts learned in the investigation. Varying points of view are shared and the preservice teacher needs to moderate this discussion.

The last phase is **On Your Own**. This reinforces individual understanding of a concept or method and is assessed as homework. Preservice teachers are required to check homework, which is collected in group folders, and make comments on papers if needed. Homework is only discussed in class if many students have trouble on a particular problem. On Your Own problems are supplemented with a set of problems called **MORE**s. These out-of-class (**MORE**) activities are grouped into various types of tasks:

Modeling tasks present new contexts to which students can apply the ideas and methods they developed in the lesson;

Organizing tasks offer opportunities for integrating the formal mathematics underlying the mathematical models developed in the lesson and for making connections with other strands;

Reflecting tasks encourage students to reflect about mathematical thinking, meanings, and processes, and promote self-monitoring and evaluation of understanding; and

Extending tasks permit further, deeper, or more formal study of the topics under investigation.

These two types of homework problems, **On Your Own** and **MORE**s, often require considerable thinking and effort for students to complete and for teachers to grade. Thus, students are generally assigned only a few problems at a time. Students no longer do 25 problems exactly like those demonstrated by the teacher.

iii. **Cooperative groups** are imperative to the success of the exploring phase. Preservice teachers need to gain experience with assessing the roles of group members. The four roles used for my groups are **reader, recorder, quality controller**, and **coordinator**. The **reader** needs to read out loud and explain the questions or problems on which the group will be working. The **recorder** writes a summary, using complete sentences, of the group's decisions and ideas, and reads them back to the group to ensure agreement and accuracy. The **quality controller** monitors the group's results and makes sure that the group produces high quality work. After each response, s/he checks to see that each group member has recorded the correct response. **Coordinators** keep the group on task, make sure everyone participates, gather necessary resources, and communicate with the teacher for the group.

iv. It is very important that preservice teachers learn to use technology. I find student teachers are coming out of college with no experience with the graphing calculator,

so it becomes another learning experience in order for them to be effective with the classes they will teach. CPMP classes use the TI-82 graphing calculator regularly during the year. The last preservice teacher I supervised had never used a graphing calculator in her college career. It was another obstacle she had to face when she started student teaching. I might add that it was a learning experience that she enjoyed.

One other change my student teacher encountered was getting prepared for her traditional classes and CPMP. In her CPMP classes, she needed to be mentally prepared to answer any questions the groups came up with as they went through the investigations. She never knew what the students would have to say during the launch and what questions she had to be prepared to answer. However, in my precalculus class, the student teacher had reams of paper filled out with lecture notes and examples of problems. She gave students all the information they needed and did not get any surprise questions. In both cases, she had to know the information well, but had to be more prepared (on paper) for the precalculus class.

Homework was also a contrast in the two classes. In precalculus, because we went over the homework daily, the student teacher had to be prepared to answer any question that arose, but she didn't have to grade any papers. The day of the test was the only time she looked at students' work in their notebooks. In CPMP, no time is spent in class on homework, but the student teacher had to grade all the papers outside of class. She felt that she got to know the students better and how much each could do.

This brief outline of how CPMP is used in my classroom illustrates that, not only has the curriculum changed, but the whole process of how we teach mathematics has changed drastically. I might add that this is definitely for the better. I have also tried to illustrate ways in which student teachers have had to balance two quite different approaches to teaching and the difficulties that it presents in their preparation and as they actually begin teaching in the classroom. Preparing preservice teachers for these changes is the job of both the college and the supervising teacher.

3. Dave Lagrange (Classroom teacher for 5 years)

CPMP is an NCTM standards-based curriculum written from an investigative perspective. As such, I see at least three areas of change that need to be addressed by mathematics educators as they prepare teachers to use this kind of curriculum. The first change deals with preparing teachers to be able to manage a variety of classroom situations. Since small groups are used quite often as an essential part of the CPMP instructional model, the ability to manage cooperative groups is vital. The more training teachers have in

using these kinds of methods, the easier it will be to step into a classroom that uses reformed materials like CPMP.

The second area of change for teachers is learning more and better ways to assess students. Rather than simply checking for correct answers, teachers and student teachers need to learn methods for assessing students' reasoning abilities. As student teachers and experienced teachers have found, assessment in a standards-based curriculum requires more of a time commitment than the more traditional mathematics courses, which often tend to focus more on a student's obtaining a single correct answer. This requires teachers to become more familiar with and make use of alternative assessment techniques such as rubrics, criteria checklists, etc. Of course, teachers still need to balance this with an understanding of the uses and limitations of more traditional paper-pencil skills because of concerns about doing well on college entrance exams such as the ACT and SAT. CPMP has addressed these concerns by including units on algebraic and geometric reasoning in the thirdyear curriculum.

A third area of change is for new and experienced teachers to develop a much broader knowledge of mathematics. During a typical year, CPMP students study many real-life situations that draw from strands of data analysis, algebra, geometry, probability, statistics, trigonometry, and discrete mathematics. Teachers must also know applications for each of these topics, connections between them, and how specific concepts and models are revisited, in greater depth, from unit to unit. An example of how the various topics are woven together is taken from the first unit where freshmen study the four ways to graphically organize and analyze data (stem and leaf plots, histograms, box and whisker plots, and scatter plots). In the next unit, students try to draw a line that *best fits* the data on a scatter plot. This leads to a study of slope and then to a more general study of linear models in Unit Three. In this unit, students learn a general form for linear models, $y = a + bx$, which differs from the more traditional form $y = mx + b$. Later in the first-year course (Unit Six), students study exponential models of the form ab^x which connects back to linear models. In both the linear and exponential models, CPMP uses a to represents the initial value or y-intercept for the function and b to represent the rate of change.

Since I have now completed a semester with my first student teacher (and my own training was not too long ago), my experiences with teaching both traditional mathematics courses and CPMP have raised some concerns about the preparation of student teachers. Since not every school uses standards-based curriculum, the student teacher must become comfortable teaching from two very different perspectives. From observing student teachers, I find that they have an easier time teaching in the traditional curriculum. This may be because they were taught high school mathematics using a traditional curriculum

and traditional methods—methods which tend to put the teacher in total control (less risk to the student teacher because they control the lesson). This is probably the method that they also see in most college mathematics courses. The main ingredient for the success of the student teacher teaching reformed curriculum and using non-traditional methods is that they need to continue to try new ideas in the classroom, even when difficulties are encountered and things don't go well the first time.

4. Natalie Kleinfelter (Student teacher for Dave Lagrange)

This part of the symposium provided a student teacher's perspective on preservice preparation and presentation of a reformed mathematics curriculum. My preparation prior to student teaching involved several methods courses as well as an independent research project. My research was on student beliefs in the Core-Plus Mathematics Project and required that I become familiar with the curriculum and its development. My involvement in various aspects of the project heightened my interest and made student teaching with the Core Plus curriculum the culmination of my preservice education.

During the 16-week student teaching experience, I had the opportunity to observe and teach Courses II and III of CPMP, three traditional Algebra classes, and Advanced Placement Calculus. With this as my basis for comparison, I will begin by discussing the benefits and drawbacks of being a student teacher in a curriculum such as CPMP, then discuss how I could have been better prepared. I am writing this purely from my experiences prior to and during student teaching.

One of the major benefits of CPMP is the group work and what it allowed me to do as a teacher. I found that in the group setting I was able to interact more with the students on an informal basis to get more feedback from them. This information helped me understand what is important to them in their lives, how they felt about mathematics and learning, and what they did and did not understand. There is a lot of potential for learning through observing groups, and I gained a much greater understanding of the students than I did from the larger, more traditional classroom setting.

Second, I had the opportunity to allow students to discover mathematics with the aid of their minds, calculators, and peers rather than being the sole provider of information in the classroom. The exploratory lesson is very difficult to develop, especially for a beginning teacher, and initial attempts often end in failure. Although this is a good learning process for the teacher, this curriculum provided me with the reward that this type of learning is very effective and I should continue to try to implement it in all my classes despite meeting with some failure.

I did face other difficulties as well, sometimes when trying to use cooperative groups. Group work needs to be a very structured, well-designed program. Getting the opportunity to see productive, and sometimes nonproductive, group work allowed me to experiment with my methods of discipline in this structure. It was quite a different experience from dealing with students in the more traditional classroom setting.

The chance to use and grade alternative assessment was also part of my CPMP teaching experience. This provided an excellent opportunity for me to be introduced into the various benefits and problems associated with different assessment methods. This area was one that I found easiest to implement into the more traditional classes.

After the whole experience was done, I felt that I left student teaching with a more open mind than my fellow student teachers and with an increased knowledge of what mathematics is and how it can be taught.

Although I feel that I was well prepared to student teach, I still met with many difficulties. Most of the major benefits of CPMP also caused the most difficulties. It was more difficult to determine the student's mathematical background having not worked through all of the previous units in detail. In the traditional classroom, we have been through the algebra and geometry topics and feel more comfortable with prior material. Also, in order to jump into this curriculum, a very solid base with the graphing calculator is needed. Even though I could use a calculator for the basics, I had to learn many new functions and tricks to troubleshoot as well as teach.

One of the most enlightening experiences during the semester was reviewing the matrices unit with the Course II students. In reviewing, we used samples from the book but the students were still not understanding the ideas. They asked me to make up a problem - usually a very simple task in a traditional class. Until then it did not occur to me the level at which these students were functioning. I tried to make up a problem on the spur of the moment and the application was not very realistic. Much to my dismay, the students were unwilling to work with the problem. From then on I came prepared with a sample problem of my own and often these applications were difficult for me to generate due to my unfamiliarity with matrices. It seemed as if nontrivial applications of high school mathematics had never been taught to me.

This idea leads me to the needs for reform of preservice education. In the preparation of teachers, more emphasis needs to be placed on the various applications of mathematics. Through this, teachers really begin to see this part of mathematics as important in itself rather than just a stepping stone to more mathematics. Some important areas where applications need to be taught to preservice teachers are statistics, discrete mathematics, matrices, and linear equations. Also, the graphing calculator needs to be

incorporated into more of the classes as a teaching tool rather than just for computation. Computer programming should be closely aligned with the language used by the graphing calculators so that programming can be used to emphasize logical sequencing and understanding of multi-step operations. In addition to better knowledge of the material, preservice teachers need to be continually exposed to various teaching methods such as group work and discovery lessons. Beyond just knowing these as valuable tools, we need to see these methods in action in the classroom and understand how to modify and improve them.

In order for reform in mathematics education to take place, it needs to begin with the preparation of student teachers. This not only includes how it is taught, but what is taught. We almost need to go back and relearn mathematics in an application-based curriculum in order to fully implement these goals. Since this is not possible, we will have to settle for bits and pieces brainstormed in methods classes and have sources available for reference. Overall, having the opportunity to teach this curriculum has expanded my knowledge of mathematics and teaching. It has even changed how I will teach a more traditional course. If I had not experienced teaching with CPMP materials, I may have been frustrated with trying to implement reforms. Seeing success with a curriculum like this is necessary to motivate teachers, especially those of us who are just beginning our teaching careers.

Summary -- These four perspectives on teaching a reformed mathematics curriculum highlight a variety of new teaching and learning experiences in the high school classroom. Teachers (and future teachers) are enthusiastic about the new topics and applications of mathematics that provide the basis for this particular new curriculum. They also appear to like the investigative model of instruction and the way in which graphing calculators are integrated into the materials and how they are used as an essential tool in the learning process. Yet, such enthusiasm is tempered by the realization that veteran teachers may need to reassess the adequacy of their pedagogical and content knowledge, which is often rooted in years of teaching in more traditional ways. Prospective teachers perhaps face an even bigger challenge. With very little experience and only an emerging sense of the teaching and learning process, they need to increase their understanding of content, pedagogy, learning styles, and technology much more so than has been required of new teachers in the past. The challenge for mathematics educators at the university is to find ways to address and meet the needs of both veteran and prospective teachers through improved methods courses, field experiences, and inservice opportunities.

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