Preparing Future Science and Mathematics Teachers
Faculty Write About CETP Innovations on Campuses Today

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Course Reform at Western Oregon University: A Success Story for K–8 Mathematics Teacher Training

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INTRODUCTION

Western Oregon University (WOU) has an outstanding program for preparing pre-service K-8 teachers to effectively teach mathematics. WOU’s historical position as an education school, coupled with intensive work by the Oregon CEPT (OCEPT) fellows, has resulted in a rich curriculum where future teachers take a program of courses exceeding the set of national recommendations for the mathematical training of K-8 teachers (CBMS, 2001). Each of the WOU mathematics courses for pre-service K-8 teachers is deliberately designed to use active learning, appropriate technology, hands-on exploration and other best practices to help prospective teachers develop a deep understanding of the mathematics they will teach.

Although the number of required credit-hours in the K-8 mathematics program has remained constant since our arrival, the authors were charged with re-thinking, refining and strengthening the curriculum design, content and delivery of all of these courses when they began their work at WOU (Burton in Fall, 2000; Fung in Fall 2001). Trained as mathematicians, our pedagogical training and reform perspectives were honed in a variety of workshops and seminars given to national MAA NExT fellows (see http://archives.math.utk.edu/projnext/). As OCEPT fellows, we also received course release time and further intensive education training in workshops and seminars given by leading Oregon mathematics educators (Burton, 2003, 17). Additionally, we were connected with an OCEPT fellow in the WOU Education Department and given course release time to work together to help ensure a strong connection between the mathematics content courses offered in the mathematics department and the mathematics pedagogy courses offered in the education department.

THE WOU MATHEMATICS PROGRAM

All pre-service K-8 teachers at WOU take a 15 quarter-hour core of coursework. This core starts with a 12 quarter-hour, year-long sequence exploring foundational school mathematics topics such as introduction to set theory, numbers and number operations, basic probability, basic statistics and elementary geometry. This newly revised sequence uses exploration and hands-on activities in student-centered classrooms and includes out of class explorations of teacher resources (Java applets, NCTM resources, etc.) and reflective writings about working with children. In the next core three quarter-hour course, "Problem Solving," students focus on a variety of problem-solving strategies and techniques through working on, selecting, and writing quality word problems. Special emphasis is placed on problem solving assessment and gaining proficiency with the official Oregon Problem Solving Scoring Guide (http://www. ooe.state.or.us/assessment/scoring_guides/2002-03/math/scoringguide.pdf). As their culminating experience in this course, students work with K-8 problem solvers through the "Math Fundamentals and Pre-Algebra Problem of the Week" environment at the Math Forum, which offers non-routine story problems to upper elementary and middle school students (see http://mathforum.org/pows). In their role as online mentors, pre-service teachers are immersed in an early field experience by first assessing young problem solvers' work with a prescribed scoring rubric, and then follow up this assessment with an e-mail reply full of hints and helpful suggestions aimed at improving the problem solving abilities of each youngster (see Fung & Roland, 2004, for further details).

Pre-service middle school teachers working on their Oregon middle-school authorization with a mathematics endorsement continue their mathematics training with six more courses (18 quarter-hours); elementary education majors with a math focus select three of these six courses (9 quarter-hours) to complete their mathematics focus area. Students explore college algebra, advanced probability and statistics, abstract algebra, geometry, teaching methods for mathematics for children and a visual approach to calculus as noted in the following brief course descriptions.

College Algebra for Teachers

Using the rich Visual Math/Math in the Mind’s Eye curriculum from the Math Learning Center, students start by modeling integer operations with black (positive) and red (negative) tiles and then advance through three levels of modeling and abstraction in which they work with sequences, algebraic expressions, and linear and quadratic equations. Throughout the course, models are connected to paper and pencil algorithms and graphical techniques. This is a particularly powerful course that often entirely changes student perspectives and attitudes as they gain genuine understanding of algebra and algebraic techniques through their work with concrete models. This course gives the future teachers a much more meaningful and applicable experience than the “standard” college algebra courses previously available to them.

Abstract Algebra for Teachers

Through hands-on explorations and concrete applications for the elementary and middle school classroom (Burton, 2004), stu-
Students study both commutative and non-commutative groups and master the idea of a binary operation. By gaining an understanding of the larger picture, students create their own deep understanding of the number systems and number properties studied in K-8 mathematics.

Statistics for Teachers

Students explore the meaning, representations and basic statistics of data through hands-on activities, games, simulations, and applications using the software package Fathom (http://www.keypress.com/fathom/) and explore some of the key curriculum "Workshop Statistics" materials (http://www.keycollege.com/ws/fathom/index.html). The interplay between theoretical analysis and experimental simulation is emphasized throughout the course.

Integrated Methods for Teachers

Students revisit some of the fundamental topics of school mathematics from the perspective of writing reflective essays, activities and lessons integrating appropriate content with best-practice pedagogical ideals. Students focus on the development and interconnectedness of foundational ideas of the K-8 mathematics curriculum (for appropriate selections of topics see Van de Walle, 2004).

Geometry for Elementary Teachers and Geometry for Middle School Teachers

Students explore topics in two-dimensional Euclidean transformational geometry through hands-on group activities and exploratory labs, problem-solving sessions and Geometer’s Sketchpad labs (http://www.keypress.com/sketchpad). The van Hiele Model (Mason, 2000) of geometric thought is used in both courses to help students gain meaningful insights into teaching and learning geometry.

Calculus for Middle School Teachers

Students build upon their understanding of algebra and how algebraic ideas can be expanded and developed into higher mathematical analysis. Pre-service teachers develop a deep understanding of the fundamentals of calculus (derivatives and integrals of polynomial functions in an applied context, and optimization and constant acceleration motion), as well as teaching and learning strategies for pre-algebra and algebra, through weekly explorations using hands-on and graphical methods from the "Math in the Mind’s Eye" curriculum and through connecting these methods to standard algebraic and calculus algorithms and techniques.

The curriculum requirements in the WOU mathematics education program for elementary and middle school teachers exceed the national recommendations for 13.5 quarter-hours contract hours for K-8 teachers and 31.5 quarter-hours for middle school mathematics teachers (CBMIS, 2001, chap. 2). It is the authors’ strong belief that this carefully designed program at least matches the national recommendations for content focus and pedagogical approaches for these K-8 teachers (CBMIS, 2001, chap. 3 & 4).

KEY LESSONS

We found the established three days a week, 50-minute course time periods to be less than ideally effective for developing an interactive, reflective and sharing atmosphere focused on gaining depth of mathematical understanding. As a result, each course was reformed to meet twice a week for two hours per meeting.

To aid in refining and refocusing program’s mathematics content, Burton took the Praxis Middle School Mathematics endorsement exam and as a result, Burton and Fung adjusted content in several courses to best serve their students. In recent years, all future middle school mathematics teachers completing the 15-hour core and 18-hour middle school mathematics endorsement sequence have also successfully passed this exam.

Overall, we both found connections and collaborations with each other and with colleagues from other Oregon colleges and universities to be essential to our ability to develop and integrate successful curricula. Furthermore, we found the use of effective learning materials and resources to be critical to our success in the program development endeavors.

SUSTAINING THE PROGRAM

Mathematics has become one of the most popular focus areas for WOU’s K-8 pre-service teachers and attracts high numbers of students. Intellectually strong students in particular are attracted to the breadth and rigor of the effective middle school mathematics training program.

Sprawling from the success of the undergraduate curriculum work, the authors have also established a program of graduate courses for in-service middle school mathematics teachers. We are in the process of designing a set of eight hands-on courses focusing on visual methods and active exploration for the local teaching community. These eight classes may serve as a content core in a Masters in Education program offered by the Education Department at WOU.

References


