Professional development for middle school teachers: a growing adult student audience

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In the United States there has been a growing call to strengthen the mathematics knowledge of teachers in the middle school grades, that is, teachers whose students are eleven to fourteen years of age. Several states, New Jersey included, have increased the certification requirements for these teachers and are now requiring that additional university courses be completed. This paper will summarize the national middle school professional development movement and report on a pilot project at Saint Peter's College that addresses the New Jersey licensure requirements.

Introduction

The structure of the compulsory educational system in the United States varies but generally breaks down into two levels, elementary and secondary. Elementary school encompasses grades Kindergarten through eighth grade (Ages 5 through 14) while secondary school consists of grades nine through twelve (Ages 14 through 18). The upper elementary grades are often referred to as *middle school* and over the past twenty years there has been a gradual recognition of the need for specialist certification in several content areas, one of which is mathematics. Ohio has had middle school licensure since the 1980's (L. Wallich, electronic communication 5/28/2009), while other states like New Jersey have implemented the license endorsement recently.

The research described in this paper reports on the national move towards middle school mathematics certification as well as the local effort of the author's institution to provide appropriate course offerings to teachers seeking the license endorsement. The recommendations of the former guided the latter.

Impetus for Change

Calls to improve mathematics education in the United States are now in their third decade, propelled by the now classic reports *A Nation at Risk* and *Everybody Counts*. In 1989 the National Council of Teachers of Mathematics (NCTM) responded to the challenge and published the first volume of a trilogy of standards for school mathematics programs, the mathematics teaching profession, and assessment of student achievement. The second volume in the series, *Professional Standards for Teaching Mathematic*, stressed the need for teachers in the upper elementary school grades to possess deep content knowledge. The authors promoted a minimum standard of fifteen semester hours of college coursework in content mathematics. An American semester hour translates to fifteen instructor/student contact hours so the *Professional Standards* document endorsed a substantial investment of time on the part of the teacher candidate, 225 classroom hours. Suggested areas of concentration

were number systems and algebraic structures, geometry and measurement, statistics and probability, and calculus concepts.

Federal impulses to endorse elementary certification with content area specializations evolved from the landmark *No Child Left Behind Act* that introduced the *Highly Qualified Teacher* (HQT) designation. The legislated description requires that an HQT must hold at least a bachelor's degree, possess full state certification, and demonstrate knowledge in the core academic subjects that he or she teaches. As far as middle school is concerned:

> Middle School Teacher Requirements
> Importantly, states have the authority to define which grades constitute elementary and middle school. States may determine, by reviewing the degree of technicality of the subject matter being taught and the rigor of knowledge needed by the teacher, whether demonstrating competency as an elementary or as a middle school teacher is appropriate. In addition, states may approve rigorous content-area assessments that are developed specifically for middle school teachers aligned with middle school content and academic standards. (United States Department of Education, 2004)

Middle School Certification

A survey of state requirements conducted by the author revealed great variety in the specifications for middle-school certification. Middle school was defined to start as early as 4th grade or as late as 6th grade. Some states issue a separate certificate while others "endorse" an existing elementary certificate. Many states required college course credit. These ranged from twelve to thirty semester hours of mathematics content courses. Most stipulated a standardized test to satisfy the assessment requirement. Many states used the *PRAXIS*™ series administered by Educational Testing Services, but the state decreed the passing score. This could be as low as 135. In New Jersey the passing score is 152. Most of the states that did not use *PRAXIS*™ used a state-tailored version of a test offered by the Pearson Corporation. Passing scores would be unique to the state and not comparable.

Portfolios of teacher work and credentials are another path to the middle school designation. These could be in place of or combined with a *Highly Objective Uniform State Standard Evaluation* (HOUSSE) that considers various measures of teacher criteria: years teaching middle grades, college credit hours, professional development experiences, and/or leadership roles assumed. Each state determines the weight of the various components and well as maximum points allowable. For example, a state might assign two points to a year of teaching in the middle grades but cap the allowable experience points at forty.

The overlap between the NCTM *Professional Standards for Teaching Mathematics* and the HQT designation was apparent, as many of the states surveyed referred to the *Standards* as guidelines for their certification process. A final escape clause, however, must be noted. Most states waived the middle school certificate requirement for "self-contained" classrooms. Self-containment occurs when one teacher is responsible for instruction in all subjects. While less prevalent in urban areas, the self-containment is commonplace in elementary instruction across the country. As a result, students may still be taught by teachers who have weak mathematical content knowledge. Appendix A contains a table of requirements, by state, as of June, 2009.

Saint Peter's College Middle-School Mathematics Certificate

The author's home institution, Saint Peter's College, is situated in New Jersey. Effective in 2009, individuals teaching mathematics in middle school need to already possess an HQT designation or obtain a middle-school endorsement in Mathematics. Our faculty had anticipated this event and we have been researching content standards at the 6th, 7th, and 8th grade level for the past two years. We are a small institution where communication between departments occurs in both informal and formal settings. During the 2008-2009 academic year these meetings became increasingly formal resulting in an agreement to offer a trilogy of courses to prepare teachers to meet the heightened criteria. Summaries of the pertinent documents and reports follows.

New Jersey Middle School Endorsement Criteria

The New Jersey Department of Education defined several middle school specialty endorsements to the elementary certificate including one in Mathematics. The college course requirement is fifteen college semester hours in mathematics content not to include pedagogy. Teacher candidates at our institution already study six hours of mathematics so the new standard adds an additional nine credits. The Educational Testing Services *Middle School Mathematics PRAXIS™ Test* (0069) is required of endorsement candidates and at the time of writing the required passing score is 152.

PRAXIS™ Middle School Mathematics Test

Educational Testing Services is a leading company in standardized assessment in the United States. Test candidates can access information about the test, the content areas, and sample questions from their website before sitting the examination. For the middle school mathematics test, the website indicates the content areas included and an estimate of the percentage of questions in each area.

ETS Middle School Mathematics PRAXIS™ (0069)	
Arithmetic and Basic Algebra	20%
Geometry and Measurement	17%
Functions and Their Graphs	13%
Data, Probability, and Statistical Concepts,Discrete Mathematics	17%
Problem-Solving Exercises	33%

(Educational Testing Services, 2008)

National Council of Teachers of Mathematics *Curriculum Focal Points*

The 1989 NCTM *Curriculum and Evaluation Standards for School Mathematics* provided broad guidelines for the teaching of school mathematics. In response to requests for more specificity and direction, NCTM released *Curriculum Focal Points* in 2006. The new publication defined content goals and expected topic mastery by grade for elementary school mathematics. The Saint Peter's College certificate project team used this document to delineate the subject matter that middle school teachers must understand if they are to teach students well. While the content is similar, the emphasis differs from that of the PRAXIS™ test.

NCTM *Curriculum Focal Points* Goals by Grade Level
Grade Six (Ages 11-12)
Multiplication and division of fractions and decimals
Connection of ratio and rate to multiplication and division of fractions
Write, interpret and use mathematical expressions
Grade Seven (Ages 12-13)
Proportionality and similarity
Use formulas for area and volume of three-dimensional figures
Operations on all rational numbers and solve linear equations
Grade Eight (Ages 13-14)
Analyze, represent, and solve linear equations and systems of linear equations
Analyze two- and three-dimensional space and figures using distance and angles
Analyze and summarize data sets

(National Council of Teachers of Mathematics, 2006)

National Mathematics Advisory Panel

In April, 2006, President Bush established a panel to examine the "best available scientific evidence" and to recommend ways " … to foster greater knowledge of and improved performance in mathematics among American students." (National Mathematics Advisory Panel, 2008, p. xiii) The panel selected algebra as the focus of school mathematics programs and couched their findings in those terms. In their final report, *Foundations for Success*, the panel suggested benchmarks by grade for states authoring mathematics curriculum frameworks. The introduction of a course in algebra as early as seventh grade was suggested (National Mathematics Advisory Panel, 2008, p. 3-47). The report directed all mathematics instruction on the elementary school level towards algebra and recommended that teacher education programs for should "fully address …the Critical Foundations of Algebra and all of the Major Topics of School Algebra." (National Mathematics Advisory Panel, 2008, p. 3-48)

Eisenhower Program for Effective Professional Development

The Eisenhower Program for Effective Professional Development is a United States government funding stream directed at professional development for elementary and secondary teachers. The American Institutes for Research (AIR) conducted an evaluation of the program over a seven year period culminating in a report issued in 2004. Based on their findings, the AIR research team recommended the characteristics of programs that were effective. Programs that followed a *reform format* incorporating study groups, networks of teachers, mentoring or research projects were deemed to be more effective that those that followed a traditional format. Longer programs, measured by both hours spent on the professional development as well as the span of time from beginning to end were better. Participation with colleagues from the same school, department, or grade level contributed to heightened success. Programs that focused on deepening teachers' content knowledge with an emphasis on active engagement in analysis of teaching and learning were more successful. Finally, the team found that professional development that was closely tied to teacher goals and state standards for content and assessment were more effective.

New Jersey *Core Curriculum Content Standards*

The New Jersey *Core Curriculum Content Standards* were in a state of flux at the time when we were planning the middle school certificate program. In the version available to us, there was a strong emphasis on algebra by grade six including the concepts of functions, modeling and algebraic notation. The geometric content standards included "spatial sense, geometric modeling, and measurement … to describe and interpret our physical environment and to solve problems.(New Jersey Department of Education, 2008, p. 17)" The *Core Curriculum Content Standards* group data analysis, probability and discrete mathematics together and expect students when exiting eighth grade to be able to estimate lines of best fit as well as use statistical data to make inferences and form arguments based on data (New Jersey Department of Education, 2008). Student learning expectations in the three areas require a depth of mathematics content knowledge that substantially exceeds previous elementary teacher credentialing requirements.

The Saint Peter's College Middle School Mathematics Certificate Program

The members of the Mathematics department met several times to discuss the mathematics content implicit and explicit in the recommendations of the cited organizations and panel. Students at our institution are required to complete six credit hours of mathematics to obtain their undergraduate degree. These can be taken in elementary school content, finite mathematics, or the calculus. It was determined that a trilogy of courses centered on functions, geometry, and probability and statistics would best serve to round out the content knowledge of teacher candidates seeking the middle school endorsement. Table 1 lists the specific content targets of each of the three courses.

The School of Education agreed to offer the three courses as part of the master's degree in education program. Originally the series was to be launched during the summer of 2009 but delays in announcing their availability caused low enrollment resulting in cancellation of the offerings. The academic year 2009-2010 proved a better setting as the graduate school operates on a trimester system and the series could be completed by a teacher candidate in one academic year. Elementary Mathematical Functions for Middle School Teachers was offered in the fall trimester, Geometry for Middle School Teachers in the winter trimester and Statistics, Probability, and Discrete Mathematics for Middle School Teachers will be offered in spring, 2010.

Table 1. Saint Peter's College Middle School Certificate Program for Mathematics

Elementary Mathematical Functions for Middle School Teachers
Functions
Sequences and Difference Equations
Arithmetic Growth
Linear Functions: Graphs and Equations
Quadratic Growth
Quadratic Functions: Graphs and Equations
Polynomial and Rational Equations
Geometric Growth and Exponential Functions

Geometry for Middle School Teachers
Metric and US Standard Measurement
Inductive and Deductive Reasoning
Properties of Polygons
Area, Perimeter, Circumference, Volume, and Surface Area of Geometric Figures
Coordinate Geometry, Rotations, and Transformations
Iterations and Fractals

Statistics, Probability, and Discrete Mathematics for Middle School Teachers
Statistics
Probability Concepts
Set Theory
Counting, Permutations, Combinations
Game Theory and Networks
Mathematical Processes

Once the first cycle of the trilogy has been completed, the Mathematics department will review the plan and fine-tune it to best meet the needs of the middle school teacher candidates.

Future Research

Recognizing the need for professional development for teachers of middle school mathematics, the National Science Foundation (NSF) has sponsored many projects across the country. Unfortunately there is no central repository for materials developed to support the research or to summarize the findings across projects. The next phase of this research project will tackle this void. NSF maintains a database of completed projects. That database will be searched to identify projects which may have produced artifacts that have potential for other researchers and teacher educators. The principal investigators will be invited to share their research tools with the mathematics education research community. Any publications resulting from the grant work will be cataloged. The ultimate goal is to compose an anthology of research in professional development for middle school teacher educators which is as complete as possible. This information is critical if we are to maximize the resources available to advance the national agenda to improve the mathematics education of

students during the important middle school years, during which we lose the interest and enthusiasm of so many students.

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Appendix

Middle School Licensure Requirements by State

STATE	GRADES	EXAM	MATHEMATICS CREDENTIALS
AK	6-8	PRAXIS™ 069	OR 30 semester hours in subject
AL	4-8	PRAXIS™ 069	30 semester hours in subject
AR	4-8	PRAXIS™ 069	15 semester hours in subject
AZ	K-8 Math Specialist	Arizona Educator Proficiency Assessments (AEPA)	15 semester hours in math ed/3 semester hours in methods
CA	None indicated	California Subject Examinations for Teachers (CSET)	
CO	None indicated		
CT	4-8	PRAXIS™ 069	15 semester hours in subject
DE	6-8	PRAXIS™ 069	No minimum course requirement
FL	5-9	Florida Teacher Certification Examinations (FTCE)	18 semester hours in subject
GA	4-8	Georgia Assessments for the Certification of Educators	12 semester hours in subject
HI	None indicated	PRAXIS™ 069 for HQT	
IA	5-8	No test indicated	12 semester hours in subject
ID	BSC MATH 6-12	PRAXIS™ 069 PRAXIS™ 061	20 semester hours in subject/6 may be Computer Science
IL	5-8	Illinois Certification Testing System (ICTS)	18 semester hours in subject (15) and pedagogy (3)
IN	5-9	PRAXIS™ 069	No minimum course requirement
KS	5-8	PRAXIS™ 069	No minimum course requirement
KY	5-9	PRAXIS™ 069	Have a declared major in the subject OR score 90 points on the KY TC-HQ Index as applicable to the subject, with content coursework verified by the clearinghouse.
LA	4-8	PRAXIS™ 069	12 + 7 semester hours in subject/pedagogy
MA	5-8	Massachusetts Tests for Educator Licensure (MTEL)	No minimum course requirement indicated
MD	4-9	PRAXIS™ 069	OR 30 semester hours in subject
ME	5-8	PRAXIS™ 069	24 semester hours in subject
MN	5-8	PRAXIS™ 069	No minimum course requirements
MI	No Math-specific endorsement	Michigan Test for Teacher Certification (MTTC)	No minimum course requirements
MO	5-9	PRAXIS™ 069	21 semester hours in subject

MS	7-8	PRAXIS™ 069	No minimum course requirements
MT	None indicated		
NC	6-9	PRAXIS™ 069	OR academic major OR graduate degree in subject OR National Board Certification
ND	5-8	PRAXIS™ 069	24 semester hours in subject/methods
NE	4-9	No test is required	18 semester hours in subject
NV	7-9	PRAXIS™ 069	24 semester hours in subject
NH	5-8	PRAXIS™ 069	No minimum course requirement indicated
NJ	5-8	PRAXIS™ 069	15 semester hours in subject
NM	5-9	No test is required	24-30 semester hours in subject
NY	5-9	New York State Teacher Certification Exam	30 semester hours in subject
OH	4-9	PRAXIS™ 069	No minimum but typically 20-24 semester hours
OK	5-8	Oklahoma Professional Teacher Examination (OPTE)	No minimum course requirement
OR	5-9	PRAXIS™ 069	No minimum course requirement
PA	7-9	PRAXIS™ 069	No minimum course requirement
RI	5-8	PRAXIS™ 069	21 semester credit hours
SC	7-8	PRAXIS™ 069	No minimum course requirement
SD	5-8	PRAXIS™ 069	OR 12 semester hours in subject/3 in methods
TN	4-8 General Middle School – No Math	PRAXIS™ 0146 Middle School Content Knowledge	No minimum course requirement
TX	4-8	Texas Examinations for Master Teachers (TExMaT)	No minimum course requirement
UT	Math Specialist Levels 1 and 2	Praxis™ 069	20 semester hours (6 may be in Computer Science)
VT	5-9	PRAXIS™ 069	OR a major in mathematics
VA	6-8	PRAXIS™ 069	21 semester credit hours
WA	4-8 (or 9)	PRAXIS™ 069	No minimum course requirement
WV	5-9	PRAXIS™ 069	15 semester credit hours
WI	No Middle Math endorsement at present		
WY	5-8	PRAXIS™ 069	24 semester hours in subject/3 in pedagogy