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Information

Professional Services Committee

Update on the Work of the Teaching Mathematics Advisory Panel

Executive Summary: At its December 2008 meeting, the Commission directed that an advisory panel be convened to study the mathematics specialist authorization. This agenda item provides an update on the work to date of the Teaching Mathematics Advisory Panel.

Recommended Action: For information only

Presenters: Rebecca Parker, and Terry Janicki, Consultants, Professional Services Division

Strategic Plan Goal: 1

Promote educational excellence through the preparation and certification of professional educators

- ◆ Sustain high quality standards for the preparation and performance of professional educators and for the accreditation of credential programs

December 2009

Update on the Work of the Teaching Mathematics Advisory Panel

Introduction

At the December 2008 meeting, the Commission directed staff to convene an advisory panel to consider the need for, and, if necessary, to propose revised authorizations and program standards for the Mathematics Specialist Credential (<http://www.ctc.ca.gov/commission/agendas/2008-12/2008-12-3G.pdf>). During the January 2009 meeting, the Commission expanded the charge to the advisory panel to include a review of all authorizations for the teaching of mathematics. This agenda item provides an update on the work of the Teaching Mathematics Advisory Panel (TMAP).

Background

Currently, there are varied authorizations that permit a certificated individual to teach mathematics in California's public schools. An agenda item describing all authorizations that allow an individual to teach mathematics was presented to the Commission in January 2009 (<http://www.ctc.ca.gov/commission/agendas/2009-01/2009-01-3E.pdf>). An individual who will teach mathematics must demonstrate a specified level of content knowledge in the area of mathematics and must complete theoretical and field training related to the teaching of mathematics.

The subject matter program standards and examination content specifications for mathematics were last updated between 2001 and 2003 as part of the SB 2042 revision process. These content specifications describe the mathematics content knowledge a teacher must have to satisfy the subject matter requirement. An individual with a multiple subject teaching credential must meet the content specifications applicable to the mathematics subject matter taught in the self contained classroom at the elementary school and an individual with a single subject teaching credential in mathematics must meet the content specifications applicable to the subject matter taught in departmentalized mathematics classes in K-12.

The teacher preparation standard focusing on pedagogy, including the teaching of mathematics for multiple and single subject credentials, was last revised in 2001. Although the Commission adopted modifications to the SB 2042 standards in January 2009, none of the modifications addressed the pedagogy of teaching mathematics. The program standard that addresses the teaching of mathematics for a multiple subject teacher is program standard 8A (a) while the program standard that addresses the pedagogy of teaching mathematics in a single subject classroom is addressed in program standards 8B (a).

The authorizations that allow an individual to teach mathematics include a Mathematics Specialist credential. However, this authorization does not permit the holder to perform any service above and beyond that of the authorization for a single subject teaching credential in mathematics. The standards for the mathematics specialist preparation program were last reviewed in 1992.

In order to look more closely at the issues raised by the agenda item of January 2009, the Commission directed staff to form a Teaching Mathematics Advisory Panel which would include

representatives from key stakeholder groups. Staff developed an application that was publicized widely through the Commission's website, mathematics professional associations, the California Subject Matter Projects, and the Professional Services Division weekly e-news. The application process closed on February 20, 2009.

The twenty member panel (see Appendix A) was appointed by Executive Director Dale Janssen following a review of a large number of applications for the panel. The members were selected based on their expertise in mathematics and mathematics instruction. The panel membership represents diversity with respect to organizational affiliation, geographic region and credentials held. In addition, a consultant from the California Department of Education (CDE) serves as a liaison to the panel.

Charge to the Advisory Panel

The panel is charged to review the need for and, if necessary, propose authorizations and program standards for a *Mathematics Specialist Credential*. In discharging this task, the Panel must consider:

1. *Mathematics Specialist Credential Program Standards*
2. *The 2005 K-12 Mathematics Framework (2005)*
3. Commission adopted *Multiple and Single Subject Teacher Preparation Program Standards (2009)*
4. Other resources as appropriate such as current credential requirements and standards used by other states or professional organizations for similar credentials
5. Current research about effective instructional strategies in the teaching of mathematics

The Teaching Mathematics Advisory Panel has met four times since the Commission directed the Executive Director to convene an advisory panel to review the Mathematics Specialist Credential requirements and program standards, explore the possibility of a credential and a certificate option, and subsequently propose revisions to the Commission (Dec. 2008), and to review the needs of schools and consider flexibility and options for the field (Jan 2009).

Deliberations of the Teaching Mathematics Advisory Panel

During the first meeting, panel members were asked to discuss the panel's charge and to identify questions that might guide the panel's work. Their comments fell into two main topic areas: 1) the adequacy of the mathematics teaching preparation for multiple subject teachers in both content knowledge and pedagogical knowledge, and 2) the possible role(s) of and knowledge required for mathematics specialists. None of the panelists identified concerns about the adequacy of single subject teachers for teaching secondary level mathematics. All of the comments reflect concerns about the adequacy of students' preparation for Algebra I (beginning in the primary grades) and experience in Algebra I classes. These concerns continue to drive the panel's work.

Having identified the panel's areas of concern, CTC staff provided information about authorizations for teaching mathematics, subject matter competence of teachers of mathematics, and current required pedagogical preparation to teach mathematics. With regard to authorizations to teach mathematics and subject matter requirements, the information provided

by staff supported the panelists' observations that multiple subject teachers are authorized to teach mathematics beyond the level they are required to know as reflected in the California Subject Examinations for Teachers: Multiple Subject (CSET:MS) Subject Matter Requirements (SMRs).

Research-Based Information about Teaching Mathematics

During the second panel meeting, Deborah Lowenberg Ball, Dean of the School of Education at the University of Michigan and a respected researcher in the preparation of teachers for teaching mathematics presented a powerpoint of her findings via a videolink. Dr. Ball emphasized that teachers' mathematical knowledge is a key factor shaping what they are able to do with regard to teaching mathematics to their students. Her research has focused on identifying the mathematical knowledge teachers need. By studying the mathematical work of teachers who were teaching mathematics, she and her colleagues were able to analyze the mathematical knowledge teachers were using. The researchers developed measures of mathematical knowledge for teaching (MKT), validated teachers' scores on the measures against teachers' practices and student achievement gains. They then developed and evaluated approaches to help teachers learn the MKT.

MKT is comprised of Subject Matter Knowledge and Pedagogical Content Knowledge. Subject Matter Knowledge includes: Common Content Knowledge (CCT), Knowledge at the Mathematical Horizon, and Specialized Content Knowledge (SCK). Pedagogical Content Knowledge includes Knowledge of Content and Students (KCS), Knowledge of Content and Teaching (KCT) and Knowledge of Curriculum.

Mathematical Knowledge for Teaching (MKT)

Subject Matter Knowledge

- Common Content Knowledge (CCT)
- Knowledge at the Mathematical Horizon
- Specialized Content Knowledge (SCK)

Pedagogical Content Knowledge

- Knowledge of Content and Students (KCS)
- Knowledge of Content and Teaching (KCT)
- Knowledge of curriculum

Dr. Ball's research has demonstrated that Knowledge of Content and Students is comprised of information that reflects how K-12 students understand the mathematics they are being taught. Two examples she uses are: 1) common errors students make in dividing fractions and 2) how students' experiences with division of whole numbers supports or confuses their understanding of the division of fractions. Knowledge of Content and Teaching is the set of skills that enables a teacher to effectively present lessons in mathematics and support students' understandings of mathematics including 1) knowing which representation would be best to use when introducing the meaning of division of fractions and 2) knowing what solution methods should be presented, and in what order, during a whole-class discussion. The research team used their findings to develop an approach for helping teachers develop MKT and, in particular, Specialized Content Knowledge (SCK).

Issues Identified in the Preparation of Individuals to Teach Mathematics

In the TMAP discussions it became clear that there are some concerns about the preparation of individuals who earn the multiple subject credential to teach mathematics. Areas that have been discussed by the TMAP include the following:

- The mathematics content knowledge for candidates moving toward a multiple subject teaching authorization.

- The pedagogical preparation focusing on mathematics for individuals working toward a multiple subject teaching authorization.
- Professional development opportunities for individuals in the area of teaching elementary and middle school mathematics.

Teaching Mathematics Advisory Panel Preliminary Thinking

Based on study and discussion of the research articles, national panel recommendation, Commission agenda reports, and the California mathematics curriculum framework, the TMAP provides the following preliminary thoughts for Commission discussion:

- At each step of the Learning-to-Teach System enumerated below, specific steps could be taken to emphasize mathematics content and pedagogy for the individuals who teach mathematics. These *may* include:
 1. *Prior to entering a Multiple Subject Credential program*, potential candidates could be required to meet additional mathematics content requirements. When the majority of multiple subject credential candidates completed an approved liberal studies or elementary subject matter program, it was known that each candidate completed some courses in mathematics at the college level. In the approved programs, this was usually a minimum of three courses. It is unclear how the Commission would require potential candidates to complete college level mathematics now that the subject matter requirement is that all candidates for a multiple subject credential must pass the California Subject Examination for Teachers (CSET-MS).
 2. *During the Multiple Subject Credential program*, program sponsors could be required to provide a program that meets a program standard exclusively focused on teaching mathematics.

Within the preparation for an individual for a multiple subject credential, there is a program standard devoted specifically to the teaching of reading – Program Standard 7A. For all other content areas, there is a program standard related to pedagogy (8A – Pedagogical Preparation for Subject-Specific Content Instruction for Multiple Subject Candidates) that includes content area for the remaining curriculum areas. Currently, each approved multiple subject preparation program must meet the mathematics part of program standard 8(A)a.

Program Standard 8(A)a Mathematics. During interrelated activities in program coursework and fieldwork, MS candidates learn specific teaching strategies that are effective in supporting them to teach the state-adopted academic content standards for students in mathematics (K-8). They enable students to understand basic mathematical computations, concepts, and symbols; to use these tools and processes to solve common problems; and to apply them to novel problems. They help students understand different mathematical topics and make connections among them. Candidates help students solve real-world problems using mathematical reasoning and concrete, verbal, symbolic, and graphic representations. They provide a secure environment for taking intellectual risks and approaching problems in multiple ways. Candidates model and encourage students to use multiple ways of approaching mathematical problems, and encourage discussion of different solution strategies. They foster positive attitudes toward mathematics, and encourage student

curiosity, flexibility, and persistence in solving mathematical problems.

The result of this difference in standards between reading and mathematics is that all multiple subject teacher preparation programs have a minimum of one and usually two courses devoted to the teaching of reading. In the area of mathematics, some preparation programs have a single mathematics pedagogy course while other programs offer a general pedagogy course where mathematics is the focus for three or four weeks. Therefore, the TMAP has discussed if a more specific program standard related to the pedagogy of teaching mathematics is necessary. (See Appendix B for possible language for a Teaching Mathematics program standard.)

In addition, some panelists are recommending the development of a Mathematics Instruction Competence Assessment (MICA), similar to the Reading Instruction Competence Assessment (RICA), which would be designed to measure the components in the new mathematics pedagogy standard.

3. *During completion of Induction*, teachers and their support providers could measure and support the beginning teacher's practice utilizing a formative assessment tool that identifies multiple levels of math teaching performance across the California Standards for the Teaching Profession (CSTP).
4. *Following completion of the clear credential*, teachers would have the option of expanding their mathematics content knowledge, pedagogical skills, and professional opportunities through the completion of a Mathematics Specialist Program. The Commission could develop program standards for two types of mathematics specialists. Specifically, the panel discussed two possible levels of Mathematics Specialists:
 - Level one could be a mathematics instructional specialist credential that would allow individuals with deep content and pedagogical knowledge to teach mathematics from Kindergarten through Algebra 1 (see discussion on pages 6-7 for more information on a possible mathematics specialist authorization).
 - Level two could be a mathematics instructional leader credential that would prepare the holder to provide professional development and guide decisions about curriculum and the use of assessment data in addition to teaching mathematics in Kindergarten through High School.

A Possible New Structure for the Mathematics Specialist Credential

Although the Commission has program standards for a Mathematics Specialist credential preparation program, only three programs were ever developed in the state and fewer than 10 individuals have earned a Mathematics Specialist credential. The TMAP discussed how an individual with a Mathematics Specialist authorization could work with both K-12 students and teachers to support increased understanding of mathematics in California's public schools.

The TMAP has discussed the need for an individual with a Mathematics Specialist authorization to have completed advanced preparation and fieldwork in a) mathematics content and the b) pedagogy of mathematics—above and beyond what is required for the multiple subject teaching credential. Provided below is a description of a possible two level system for the Mathematics Instructional Specialist and the Mathematics Instructional Leader. The panel has discussed the

structure, authorizations, content knowledge and program standards for these two levels of a mathematics specialist and would be prepared to present these at a future Commission meeting.

Level One: Mathematics Instructional Specialist

What a Mathematics Instructional Specialist Could Do: May provide mathematics instruction in Kindergarten through Algebra I. Examples might include but are not limited to the following:

- Teaching mathematics in a single-subject setting in Kindergarten through Algebra I classrooms;
- Multiple Subject teaching with expertise in mathematics instruction; and
- Teaching mathematics in a small-group setting to targeted populations, such as struggling or advanced learners.

What a Mathematics Instructional Specialist Would Need to Know to Do the Job

The emphasis would be on improvement in knowledge and practice beyond that required for basic teaching certification. A mathematics instructional specialist would have enhanced capacities and knowledge in the areas of mathematical knowledge for teaching, mathematical pedagogy, and use of assessments and curriculum.

Level Two: Mathematics Instructional Leader

What a Mathematics Instructional Leader Could Do: Provide leadership and vision for K-12 mathematics programs to support student learning. Mathematics instructional leaders may:

1. Support teachers' use of successful, research-based mathematics instructional strategies through
 - Collaborating with individual teachers (preservice, novice, and experienced) through co-planning, co-teaching, and coaching;
 - Facilitate learning groups of teachers and administrators;
2. Facilitate the alignment of mathematics curriculum with standards, including
 - Evaluating and facilitating the adoption of mathematics curriculum materials;
 - Developing instructional guides, such as pacing guides and scope and sequence;
 - Articulating between grade levels/spans and schools;
 - Monitoring alignment with mathematics Content Standards;
3. Assessment leadership
 - Helping faculty develop, use, and interpret common assessments;
 - Work with teachers and schools to use formative, summative, and standardized assessments;
 - Assist administrators and instructional staff in interpreting data and designing instructional approaches;
4. Design and provide standards-aligned, research-based professional development in mathematics teaching and learning;
5. Work with parent/guardians and community partners to foster continuing home/school/community partnerships focused on students' learning of mathematics.

Next Steps

Based upon Commission discussion, staff will continue to work with the Teaching Mathematics Advisory Panel to develop its recommendations for Commission consideration. Another agenda item will be brought to the Commission early in 2010.

Appendix A
CTC Teaching Mathematics
Advisory Panel (2009)

Name	Employer	Representing
CK Green	Newport-Mesa Unified School District	California Federation of Teachers (CFT)
Crystal Gips	California State University, Office of the Chancellor	California State University, Office of the Chancellor
Jody Priselac	University of California, Los Angeles	University of California, Office of the President
Katharine Clemmer	Loyola Marymount University	The Association of Independent California Colleges and Universities (AICCU)
Pam Tyson	Contra Costa County Office of Education	California County Superintendents Educational Services Association (CCSESA)
Phil Quon	Cupertino Unified School District	Association of California School Administrators (ACSA)
Jan Bridge	Chino Valley Unified School District	California Teachers Association (CTA)
	None appointed at this time	California School Boards Association
Brenda Hensley	Vacaville Unified School District	
Carole Vargas	Folsom Cordova Unified School District	
Katherine Morris	Sonoma State University	
Kyndall Brown	University of California, Los Angeles	
Lisa Hoegerman	Apple Valley Unified School District	
Dennis Parker	University of the Pacific	
Nadine Bezuk	San Diego State University	
Sunny Chin-Look	Alhambra Unified School District	
Vriana Kempster	San Francisco Unified School District	
Zeev Wurman	Independent Consultant	
Megan Holstrom	Hillbrook School, Los Gatos	
David Simmons	Ventura County Office of Education	
Michael Fickel	California State University, San Marcos	
Jim Greco	Liaison with the California Department of Education	
Staff Working with the Math Advisory Panel		
Terry Janicki	Commission on Teacher Credentialing	
Rebecca Parker	Commission on Teacher Credentialing	
Teri Clark	Commission on Teacher Credentialing	

Appendix B
Possible Draft Standard 8-A: Pedagogical Preparation for
Mathematics Content Instruction by Multiple Subject (MS) Candidates

In the program, MS candidates apply the *Teaching Performance Expectations* (TPEs) to the teaching of math. In the program, candidates begin to interrelate ideas and information within and across the major subject areas. During interrelated activities in program coursework and fieldwork, MS candidates learn specific teaching strategies that are effective in supporting them to teach the state-adopted academic content standards for students in mathematics (K-8) and curriculum frameworks. They enable students to understand basic mathematical computations, concepts, and symbols; to use these tools and processes to solve common problems; and to apply them to novel problems. They help students understand different mathematical topics and make connections among them. Candidates help students solve real-world problems using mathematical reasoning and concrete, verbal, symbolic, and graphic representations. They provide a secure environment for taking intellectual risks and approaching problems in multiple ways. Candidates model and encourage students to use multiple ways of approaching mathematical problems, and encourage discussion of different solution strategies. They foster positive attitudes toward mathematics, and encourage student curiosity, flexibility, and persistence in solving mathematical problems.

The table below indicates the necessary components for candidate's instruction and field experiences must include.

	Number Sense (Domain 1)	Algebra and Functions (Domain 2)	Measurement and Geometry (Domain 3)	Statistics, Data Analysis, and Probability (Domain 4)
Instructional Domain (Reprint from Math SMRs for Multiple Subject Teachers)	1.1 Numbers, Relationships Among Numbers, and Number Systems 1.2 Computational Tools, Procedures, and Strategies	2.1 Patterns and Functional Relationships 2.2 Linear and Quadratic Equations and Inequalities	3.1 Two- and Three-dimensional Geometric Objects 3.2 Representational Systems, Including Concrete Models, Drawings, and Coordinate Geometry	4.1 Collection, Organization, and Representation of Data 4.2 Inferences, Predictions, and Arguments Based on Data 4.3 Basic Notions of Chance and Probability
Instructional Delivery (To foster competencies in procedural fluency, conceptual understanding and problem solving)	<ol style="list-style-type: none"> 1. Able to do error analysis: errors should not simply be considered mistakes to be corrected but an opportunity to understand how the students understand the problems. (Framework page 215 chapter 4 Instructional Strategies) 2. Know the common misconceptions; task analysis 3. Know a variety of models to represent math concepts 4. Know the grade level standards and framework 5. Use assessment data to adjust instruction 6. Know alternative strategies to address the needs of the students 7. Understand the interrelatedness of math concepts and the interdisciplinary of math with the other subjects 			

	Number Sense (Domain 1)	Algebra and Functions (Domain 2)	Measurement and Geometry (Domain 3)	Statistics, Data Analysis, and Probability (Domain 4)
	8. 3-phase instructional model (Framework page 205 chapter 4 Instructional Strategies) 9. Understand what a balanced math program means: Procedural, Conceptual and Problem Solving (Framework page 211 chapter 4 Instructional Strategies) 10. Focus on the challenging math topics in elementary math 11. Utilize technology to enhance the teaching and learning of mathematics 12. homework			
Math Reasoning (Reprint from Subject Matter Skills and Abilities Applicable to the Content Domains)	1. Identify and prioritize relevant and missing information in mathematical problems. 2. Analyze complex problems to identify similar simple problems that might suggest solution strategies. 3. Represent a problem in alternate ways, such as words, symbols, concrete models, and diagrams, to gain greater insight. 4. Consider examples and patterns as means to formulating a conjecture. 5. Apply logical reasoning and techniques from arithmetic, algebra, geometry, and probability/statistics to solve mathematical problems. 6. Analyze problems to identify alternative solution strategies. They 7. Evaluate the truth of mathematical statements (i.e., whether a given statement is always, sometimes, or never true). 8. Apply different solution strategies (e.g., estimation) to check the reasonableness of a solution. 9. Demonstrate that a solution is correct. 10. Explain the mathematical reasoning through a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and concrete models. 11. Use appropriate mathematical notation with clear and accurate language. 12. Explain how to derive a result based on previously developed ideas, and explain how a result is related to other ideas.			
Math Tasks for Teaching (Content Knowledge for Teaching What Makes It Special? <i>Deborah Loewenberg Ball Mark Hoover Thames Geoffrey Phelps University of Michigan</i>)	1. Presenting mathematical ideas 2. Responding to students' "why" questions 3. Finding an example to make a specific mathematical point 4. Recognizing what is involved in using a particular representation 5. Linking representations to underlying ideas and to other 6. representations 7. Connecting a topic being taught to topics from prior or future years 8. Explaining mathematical goals and purposes to parents 9. Appraising and adapting the mathematical content of textbooks 10. Modifying tasks to be either easier or harder 11. Evaluating the plausibility of students' claims (often quickly) 12. Giving or evaluating mathematical explanations 13. Choosing and developing useable definitions 14. Using mathematical notation and language and critiquing its use 15. Asking productive mathematical questions 16. Selecting representations for particular purposes			

	Number Sense (Domain 1)	Algebra and Functions (Domain 2)	Measurement and Geometry (Domain 3)	Statistics, Data Analysis, and Probability (Domain 4)
	17. Inspecting equivalencies			
Universal Access/ Differentiated Instruction	<ol style="list-style-type: none"> 1. Assess each student’s understanding at the start of instruction and continue to do so frequently as instruction progresses, and use the results of <i>assessment</i> for student placement and program planning. 2. <i>Diagnose</i> the nature and severity of a student’s difficulty and intervene quickly when students have trouble with mathematics. 3. Engage in careful organization of resources and instruction and <i>planning</i> for adapting to individual needs. Be prepared to employ a variety of good teaching strategies, depending on the situation. 4. <i>Differentiate</i> curriculum or instruction or both, focusing on the mathematics content standards and the key concepts within the standards that students must understand to move on to the next grade level. 5. Use <i>flexible grouping</i> strategies according to the students’ needs and achievement and the instructional tasks presented. (Examples of these strategies are homogeneous, semi-homogeneous, heterogeneous, large group, and small group. Individual learning is also an option.) 6. <i>Enlist help</i> from others, such as mathematics specialists, mathematicians, special education specialists, parents, aides, other teachers, community members, administrators, counselors, and diagnosticians, when necessary, and explore the use of technology or other instructional devices as a way to respond to students’ individual needs. 			

In addition to the content pedagogy described above, all candidates for a multiple subject credential would receive instruction and complete fieldwork with the Three-Phase Instructional Model as is presented in the *2005 K-12 Mathematics Framework* (2005).

Three-Phase Instructional Model

(Page 205 chapter 4 Instructional Strategies)

Phase 1	Phase 2	Phase 3
Teachers demonstrate, explain, question, and/or conduct discussions with substantial help that is gradually reduced.	Teachers, individual peers, and/or groups of peers provide students knowledge to new problems. Assessments can vary from informal to formal, depending on the immediate situation and goal of the particular lesson or lessons.	Teachers assess knowledge to new problems. Assessments can vary from informal to formal, depending on the immediate situation and goal of the particular lesson or lessons. The teacher should also review the goals of the lesson with students and tie goals back to the standard or standards.

Phase 1	Phase 2	Phase 3
<p>Students are actively involved through answering questions, discussing topics, and/or attending to and thinking about the teacher's presentation.</p>	<p>Students receive feedback on their performance, correction, additional explanations, and other forms of assistance. Once the concept or procedure is understood, it is important for students to practice the materials, otherwise, they are not likely to retain the just-learned information for long.</p>	<p>Students demonstrate their ability to work independently, generalize, and transfer their knowledge.</p>