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Information

Professional Services Committee

Pedagogical Preparation to Teach Mathematics

Executive Summary: This agenda item continues the discussion related to the teaching of mathematics in California. The focus of the item is the pedagogical preparation required for individuals who are authorized to teach mathematics.

Recommended Action: For information only

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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

June 2009

Pedagogical Preparation to Teach Mathematics

Introduction

The Commission began a discussion at its October 2008 meeting related to the preparation of individuals who teach mathematics (<http://www.ctc.ca.gov/commission/agendas/2008-10/2008-10-2D.pdf>). At the November 2008 Commission meeting (<http://www.ctc.ca.gov/commission/agendas/2008-11/2008-11-2G.pdf>) staff presented a plan for addressing the issues related to the authorizations to teach mathematics in California's public schools. Based on the Commission's discussion at the November 2008 meeting, the December 2008 item focused on the Mathematics Specialist Credential (<http://www.ctc.ca.gov/commission/agendas/2008-12/2008-12-3G.pdf>) and proposed a plan for an advisory panel to review the preparation of individuals who teach mathematics and possibly to revise the standards and authorizations for a Mathematics Specialist Credential in the future. The January 2009 item provided a description of all the authorizations that allow an individual to teach mathematics in California's K-12 public schools (<http://www.ctc.ca.gov/commission/agendas/2009-01/2009-01-3E.pdf>). The April 2009 item focused on mathematics subject matter competence and how it is assessed for individuals who earn an authorization to teach mathematics (<http://www.ctc.ca.gov/commission/agendas/2009-04/2009-04-3E.pdf>). This item provides a description of the pedagogical preparation that individuals must complete to earn a teaching credential that authorizes an individual to teach mathematics in California's K-12 public schools.

Background

The Commission's adopted program standards (<http://www.ctc.ca.gov/educator-prep/standards/AdoptedPreparationStandards.doc>) define the scope of teacher preparation programs individuals must complete to earn a credential. Pedagogical preparation is addressed in a number of ways in the adopted program standards. Program Standard 6: *Pedagogy and Reflective Practice* addresses general pedagogy:

Standard 6: Pedagogy and Reflective Practice

To maximize student learning, candidates learn to create and maintain well-managed classrooms that foster students' physical, cognitive, emotional, and social well-being. They learn to develop safe, inclusive, positive learning environments that promote respect, value difference, and mediate conflicts according to state laws and local protocol.

By design, the preliminary teacher preparation program fosters the ability of candidates to evaluate instructional alternatives, articulate the pedagogical reasons for instructional decisions, and reflect on teaching practices. The program fosters each candidate's realization that the analysis and assessment of practices promote a teacher's professional growth.

In the program, candidates read, analyze, discuss, and evaluate professional literature pertaining to important contemporary issues in California schools and

classrooms, and use sources of professional information in making decisions about teaching and learning.

Candidates learn how to use and interpret student assessment data from multiple measures of student academic performance to inform instruction. They learn how to plan and differentiate instruction based on student assessment data and diverse learning needs of the full range of learners (e.g., struggling readers, students with special needs, English learners, speakers of non-standard English, and advanced learners).

Candidates learn to select, assess, make pedagogical decisions, and reflect on instructional practices in relation to (a) state-adopted academic content standards for students and curriculum frameworks, (b) principles of human development and learning, (c) the observed effects of different practices, and (d) consultation with colleagues.

In addition, there are specific pedagogical statements related to teaching mathematics contained in ***Program Standard 8: Pedagogical Preparation***. Standard 8 has two sections. Section A addresses the pedagogy that multiple subject teachers must understand and be able to implement. For multiple subject teachers there are six subsections that address the teaching of different content areas: mathematics, science, history-social science, visual and performing arts, physical education, and health. (The teaching of reading is addressed in Program Standard 7: ***Preparation to Teach Reading-Language Arts***.)

The sections of Standard 8 that apply to multiple subject teacher preparation programs and the teaching of mathematics are provided below:

Standard 8-A: Pedagogical Preparation for Subject-Specific Content Instruction by Multiple Subject (MS) Candidates

In subjects other than Reading-Language Arts, the preliminary teacher preparation program provides introductory coursework and supervised practice that begin to prepare each candidate for a Multiple Subject (MS) teaching credential to plan and deliver content-specific instruction consistent with state-adopted academic content standards for students and curriculum frameworks in the following major subject areas: mathematics, science, history-social science, visual and performing arts, physical education, and health. In the program, MS candidates apply the appropriate *Teaching Performance Expectations* (TPEs) to the teaching of each major subject area. They learn and use specific pedagogical knowledge and skills that comprise the subject-specific TPEs for multiple subject candidates. In each major subject area, MS candidates demonstrate basic ability to plan and implement instruction that fosters student achievement of state-adopted academic content standards for students, using appropriate instructional strategies and materials. In the program, candidates begin to interrelate ideas and information within and across the major subject areas.

8A(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.

Section B of Program Standard 8 addresses the pedagogy that single subject teachers must understand and be able to implement. The sections of Standard 8 that apply to single subject teacher preparation in the mathematics content area are provided below:

Standard 8-B: Pedagogical Preparation for Subject-Specific Content Instruction by Single Subject (SS) Candidates

In the subject to be authorized by the single subject teaching credential, the preliminary teacher preparation program provides substantive instruction and supervised practice that effectively prepare each candidate for an SS Credential to plan and deliver content-specific instruction that is consistent with (a) the state-adopted academic content standards for students and/or curriculum framework in the content area, and (b) the basic principles and primary values of the underlying discipline. The program provides multiple opportunities for each SS candidate (a) to learn, practice and reflect on the specific pedagogical knowledge and skills that comprise the Commission adopted subject-specific *Teaching Performance Expectations* (TPE 1B), and (b) to apply the TPEs to instruction in the subject to be authorized by the credential. In the program, each SS candidate demonstrates basic ability to: plan and organize instruction to foster student achievement of state-adopted K-12 academic content standards for students in the subject area; use instructional strategies, materials, technologies and other resources to make content accessible to students; and interrelate ideas and information within and across major subdivisions of the subject.

8B(a) **Mathematics.** During interrelated activities in program coursework and fieldwork, candidates learn specific teaching strategies that are effective in supporting them to teach the state-adopted academic content standards for students in mathematics (7-12). They enable students to understand basic mathematical computations, concepts, and symbols, use them to solve common problems, and 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 they encourage discussion of different solution strategies. They foster positive attitudes toward mathematics, and encourage student curiosity, flexibility, and persistence in solving mathematical problems.

Additionally, single subject candidates help students in Grades 7-12 to understand mathematics as a logical system that includes definitions, axioms, and theorems, and to understand and use mathematical notation and advanced symbols. They assign and assess work through progress monitoring and summative assessments that include illustrations of student thinking such as open-ended questions, investigations, and projects.

The language in adopted Program Standards 6 and 8 define the pedagogical knowledge and skills that the teacher preparation programs must address in the preparation of individuals who will be authorized to teach mathematics.

Teaching Performance Expectations

The introductory section of each part of Standard 8 also requires the preparation program to ensure that the candidates apply, learn, practice and reflect on the Teaching Performance Expectations (TPEs) in the preliminary preparation program. The relevant language from the introductory sections of Standards 8A and 8B are presented in the table below.

Multiple Subjects Preparation	Single Subject Preparation
...apply the appropriate <i>Teaching Performance Expectations</i> (TPEs) to the teaching of each major subject area. They learn and use specific pedagogical knowledge and skills that comprise the subject-specific TPEs for multiple subject candidates.	...to learn, practice and reflect on the specific pedagogical knowledge and skills that comprise the Commission adopted subject-specific <i>Teaching Performance Expectations</i> (TPE 1B), and (b) to apply the TPEs to instruction in the subject to be authorized by the credential.

The TPEs are statements that define what a beginning teacher must know and be able to do the first day he or she walks into the classroom as a preliminary credential holder. The TPEs were validated as accurate statements of the knowledge, skills and abilities required of a beginning teacher in order to do the job of a public school classroom teacher.

TPE 1 addresses Specific Pedagogical Skills for Subject Matter Instruction. Much like Program Standard 8, TPE 1 is divided into two sections—Part A addresses the teaching of mathematics in the multiple subjects classroom while part B addresses teaching mathematics in the single subject classroom. In the recent reformatting of the multiple and single subject preliminary credential program standards, the TPE statements were used as the basis for the pedagogical requirements for programs. The language of TPE 1A and 1B for the teaching of mathematics follows.

TPE 1A-Teaching Mathematics in a Multiple Subject Assignment

Candidates for a Multiple Subject Teaching Credential demonstrate the ability 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 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 they encourage discussion of different solution strategies. They foster positive attitudes toward mathematics, and encourage student curiosity, flexibility, and persistence in solving mathematical problems.

TPE 1B-Teaching Mathematics in a Single Subject Assignment

Candidates for a Single Subject Teaching Credential in Mathematics demonstrate the ability to teach the state-adopted academic content standards for students in mathematics (7-12). They enable students to understand basic mathematical computations, concepts, and symbols, to use them 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 they encourage discussion of different solution strategies. They foster positive attitudes toward mathematics, and encourage student curiosity, flexibility, and persistence in solving mathematical problems.

Additionally, Single Subject Candidates help students in Grades 7-12 to understand mathematics as a logical system that includes definitions, axioms, and theorems, and to understand and use mathematical notation and advanced symbols. They assign and assess work through progress-monitoring and summative assessments that include illustrations of student thinking such as open-ended questions, investigations, and projects.

The approved teacher preparation programs are required to demonstrate how the coursework and field experiences address the adopted TPEs. In addition the TPEs are assessed by the Teaching Performance Assessment.

Teaching Performance Assessment (TPA)

For all multiple and single subject candidates beginning a preliminary preparation program on or after July 1, 2008 the candidate must pass a TPA prior to being recommended for the teaching

credential. The assessment is a performance assessment—that is, there is a series of tasks and/or activities that candidates must complete with K-12 students to demonstrate that they have mastered the set of knowledge, skills, and abilities exemplified in the TPEs. In two of the three TPA models approved by the Commission, a segment of the candidate’s classroom instruction with K-12 students is videotaped; in the third model there is an in-class observation of the candidate’s performance by the trained assessor. All of the TPA tasks/activities are scored on rubrics that are based on the TPEs.

This concludes the section of this agenda item that provides information on what institutions which offer multiple and/or single subject teacher preparation programs are responsible to 1) provide in the approved preliminary teacher preparation program and 2) ensure that each candidate knows and is able to do. The next section of this agenda item will briefly address the teaching of mathematics in the K-12 schools from a state, national and international perspective.

Mathematics Instruction the K-12 Schools

Institutions provide preparation to individuals who are then credentialed as teachers. Teachers work in the K-12 schools and provide instruction to students. Therefore, it is important to consider the types of instruction, instructional strategies, and pedagogical expectations that employing schools and districts have for their teachers. The State Board of Education (SBE) adopts curriculum frameworks (<http://www.cde.ca.gov/ci/cr/cf/index.asp>) which guide the development of curricular materials, contextualize the adopted content standards for the content area, and provide additional information related to instructional strategies. The SBE has a published cycle of review and adoption for California’s curriculum frameworks (<http://www.cde.ca.gov/ci/cr/cf/documents/frwkdevsch.doc>). The current mathematics framework was adopted in 2005.

California’s Mathematics Framework

In Chapter 4 of the current Mathematics Framework (2005) (<http://www.cde.ca.gov/ci/ma/cf/index.asp>) three components of competency in mathematics are defined: conceptual, procedural, and mathematical reasoning. These components of competency are defined for the K-12 students. Therefore teachers of mathematics must understand and be able to address each of these components of competency with their students.

Conceptual Competence	Procedural Competence	Mathematical Reasoning Competence
Knowing what to do	Knowing how to do it	Knowing where and when to do it
An implicit understanding of how to achieve the goal	Behaviors that act on the environment to actually achieve the goal	An implicit understanding of the contexts within which procedural competencies can be expressed

These three components of competency are not explicitly addressed in the Commission’s adopted program standards although an argument could be made that they are implicitly addressed. California’s Education Code requires that the Commission’s adopted subject matter program standards and examination specifications must be aligned to the “...state content and performance standards for pupils adopted pursuant to subdivision (a) of Section 60605.” (Ed

Code §44259 (b)(5)). As was described in the April 2009 agenda item (<http://www.ctc.ca.gov/commission/agendas/2009-04/2009-04-3E.pdf>) the Commission's subject matter standards, examination specifications, and subject matter requirements are aligned to California's adopted K-12 student academic content standards. There is no requirement that the teacher preparation program standards be aligned to the curriculum frameworks. In addition, the Mathematics Framework provides a "General Framework for Teaching a Mathematics Topic." The information contained in the adopted framework forms the basis for publishers as they develop curriculum materials. It seems important that individuals completing their preparation to be authorized to teach mathematics be prepared to use the instructional materials that the districts will be providing.

California is not the only entity that is currently discussing and examining the teaching of mathematics. A national panel released a report on the teaching of mathematics in March 2009 and the Commission had a presentation from its expert researcher at the April 2009 meeting.

National Activities Focused on the Teaching of Mathematics

The three components of competency identified in California's Mathematics Framework have been underscored by recent federal efforts focusing on the teaching of mathematics. In 2006, President Bush convened a National Mathematics Advisory Panel (Panel) to consider a set of questions about America's competitiveness in preparing enough mathematics-competent workers to maintain the country's technical, scientific, and economic status in the world. During its tenure, the Panel reviewed a very large number of research publications and policy reports, and received public testimony from over 100 individuals. Following two and a half years of work, the Final Report of the Panel was released in March 2008.

The Report contains 45 key findings including the statement that, to prepare students for Algebra, the mathematics curriculum

...must simultaneously develop conceptual understanding, computational fluency, and problem-solving skills. Debates regarding the relative importance of these aspects of mathematical knowledge are misguided. These capabilities are mutually supportive, each facilitating learning of the others. Teachers should emphasize these interrelations; taken together, conceptual understanding of mathematical operations, fluent execution of procedures, and fast access to number combinations jointly support effective and efficient problem solving.
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This recommendation is consistent with the three components of competency identified in the Mathematics Framework. The Panel felt, however, that there was inadequate research of sufficient rigor or quality to allow them to identify the features of teacher preparation programs that have effects on teachers' knowledge, instructional practice, or students' achievement.

International Research on the Teaching of Mathematics

Dr. James Stigler (University of California, Los Angeles) presented information from the Third International Mathematics and Science Study (TIMSS) Video Studies at the April 2009 Commission meeting. Dr. Stigler's presentation, *Reflections on Mathematics Teaching and How to Improve It*, presented three things that have been learned from the TIMSS Video study:

1. Teaching is a cultural activity; varies more across than within cultures.

2. Teaching is contextual; no one “best” way.
3. Teaching quality is defined not by what teachers do, but by the learning opportunities the teachers create for students.

In addition, Dr. Stigler presented information about three types of mathematics problems that students can be asked to address: *stating concepts*, *using procedures*, and *making connections*. He continued with data on the percentage of these types of mathematics problems in six countries, one being the United States. The other five countries all score higher than the United States on the TIMSS study. An obvious difference that Dr. Stigler pointed out is when the students in the United States are asked to address a *making connections* problem, the teachers almost immediately provide information to the students which converts the problem to a *using procedures* problem. In all the countries that score higher than the United States, the teachers allowed their students to grapple with the *making connections* problem without immediately providing a formula and converting the problem into a *using procedures problem*.

Next Steps

The information in this agenda item will be presented to the Commission’s Teaching Mathematics Advisory Panel as they review current credential authorizations to teach mathematics and develop recommendations for the Commission’s discussion and consideration.