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CAEP, NCTM, and Secondary Mathematics Program Revisions  
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Abstract

Eight assessments were developed for CAEP (formerly NCATE) and NCTM recognition of our secondary mathematics program. These assessments include internship work samples, field evaluations, and candidate portfolios addressing content knowledge, pedagogical methods, and mathematics technology. Based on data collected from these assessments, alongside ongoing evaluation of the program, several curriculum and program revisions were implemented, including: 1) development of mathematics content-specific courses in classroom management, assessment, and secondary curriculum; 2) restructuring of a senior seminar course in mathematics education; and 3) an increased content focus in probability and statistics. The adoption of new NCTM standards in the CAEP review process then provided an opportunity to significantly revise these assessments. We describe the original assessments, the results of assessment data analysis, subsequent program changes, assessment revisions now in progress, challenges encountered, and additional program enhancements envisioned.

Keywords: CAEP, NCATE, NCTM, secondary mathematics, program recognition, CAEP and program revisions

## CAEP, NCTM, and Secondary Mathematics Program Revisions

## 1. Setting and Context

The undergraduate secondary mathematics certification program discussed in this paper is housed in the Department of Mathematics, as the “mathematics major with secondary certification.” The major, often called “secondary mathematics” and leading to a B.S. degree, overlaps significantly with the “pure” mathematics major, requiring the same number of mathematics courses, with only these distinctions:

- 1) Courses in geometry, discrete mathematics, and history of mathematics are required for secondary mathematics, but are electives available to mathematics majors.
- 2) A course in real analysis is required for mathematics majors, but is one of many electives available to secondary mathematics majors.

The School of Education supplies both framework and support for meeting certification requirements, including field placements, guidelines for supervision of student teachers, and coursework in education. Thus, candidate admission to the School of Education is required, although the degree itself is granted by the Department of Mathematics, which resides in a different school within the university.

As of the previous review under the National Council for Accreditation of Teacher Education (NCATE) and the National Council of Teachers of Mathematics (NCTM), the secondary mathematics program is classified as “nationally recognized”. The department will seek to maintain its recognition from the Council for the Accreditation of Educator Preparation (CAEP, which is the successor to NCATE) in the next accreditation cycle.

## 2. Initial Program and Assessments

When long-range planning began for the previous NCATE accreditation cycle, the secondary mathematics program required a minimum of 39 semester credits in mathematics, 6 in computer science, 6 in mathematics education (Department of Mathematics), and 26 in education

(School of Education).

The required mathematics education courses were 1) Methods and Materials for Secondary Mathematics and 2) Mathematics Education Seminar. Both were typically taught during the semester immediately preceding the candidate's student teaching assignment, also known as the internship. The program's required courses housed in the School of Education included 3 lower-level foundational courses, 12 hours of coursework integrated with the internship, and 3 upper level courses in assessment, classroom management, and curriculum, which were completed prior to internship.

In preparation for NCATE program review at that time, the department identified eight assessments to provide evidence of alignment with the 2003 NCTM Program Standards for the Initial Preparation of Mathematics Teachers, then in use for NCATE/NCTM recognition. Of these eight assessments, one was the GACE state licensure test; one was a subset of the internship evaluation required by the School of Education, known as the Teacher Work Sample (TWS); and the remaining six were developed by faculty in the Department of Mathematics. It is worth noting here that at the time these assessments were defined, using course grades was not perceived as a viable option. Although NCATE/CAEP and NCTM have since given carefully prescribed recommendations for how to use course grades successfully as one of the assessments (see NCATE, 2010; NCTM, 2013), their use was still discouraged when planning for the NCATE evaluation cycle in question began. Therefore, the remaining assessments developed by mathematics faculty included a secondary mathematics student teaching evaluation rubric and five course portfolios, associated with five required courses in the program: Geometry, History of Mathematics, Technology in Mathematics (a computer science course), and the two mathematics education courses noted above.

Of particular note was the portfolio associated with the Mathematics Education Seminar, also called the capstone course for secondary mathematics. This course, a vehicle for review,

synthesis, and assessment of essential mathematics content knowledge and associated pedagogical content knowledge for secondary teachers, was significantly revised to include an assessment aligned with several NCTM content and process standards not easily demonstrated in any of the other assessments. The course was re-organized to follow explicitly the seven content strands of the 2003 NCTM standards. Candidates created one portfolio entry for each of the seven content standards; multiple problems and their solutions were part of an entry, where each problem aligned with one or more indicators within the content standard. Some problems aligned with process standard indicators as well.

The portfolio for the other mathematics education course (Methods and Materials) included three components: a unit plan, a classroom observation of a lesson taught during a pre-internship field placement, and a formal written summary and analysis of sessions attended at the GCTM Georgia Mathematics Conference (required for all candidates). These components addressed multiple indicators within the 2003 NCTM Standards 6 (Knowledge of Technology), 7 (Dispositions), and 8 (Knowledge of Mathematics Pedagogy). The portfolio for the Technology in Mathematics course also addressed indicators within Standard 6. Likewise, the Geometry and History of Mathematics portfolios addressed content indicators well aligned with their course content.

### 3. Findings and Program Changes

The rationale for collecting assessment data is not only to demonstrate evidence of meeting standards, but also to drive future decisions for improving and strengthening the program. A section of the NCATE/CAEP program report is devoted to explaining how assessment results have been used to improve the program. The sections below detail the findings of the data collected, followed by subsequent program changes that were made.

#### 3.1 Findings from Assessment Data

The assessment data suggested a disconnect between program coursework and candidates'

content knowledge in statistics. This gap was most evident in candidates' capstone portfolio submissions, as well as in the candidates' content knowledge displayed during classroom observations, both for the internship evaluation and the pre-internship observation component of the methods portfolio. The required upper-level course in probability and statistics is not fully aligned with the statistics content needed by secondary mathematics teachers; such content includes basic univariate plots and data summaries, the nature of variability, the reasoning of statistical inference, design of statistical investigations, and the use of statistical simulation. However, redirecting the content of the course to include many of these fundamental concepts of statistics would result in an undesirable dilution of the course, making it less distinguishable from the elementary statistics course offered for non-mathematics majors. Thus, a need was uncovered to address candidates' statistics content knowledge.

The assessment data in both the capstone and geometry portfolios also revealed a need for greater emphasis on axiomatic proof. The required proofs course covers many types of proof, but candidates displayed a particular weakness in leveraging axiomatic systems in their construction of proofs.

Finally, the process itself of collecting data through course portfolios suggested the need for a formal structure and system through which the requirements for these assessments were communicated among faculty and implemented consistently.

### 3.2 Program Changes

Because it was not deemed appropriate to significantly alter the content of the Probability and Statistics course, other avenues were selected to address candidates' statistics content knowledge. One of these avenues took the form of changes in advisement; the other was a modification to the Mathematics Education Seminar course. Although secondary mathematics majors are not required to take the non-calculus Elementary Statistics course offered for non-mathematics majors, departmental advisors began to recommend the course strongly for those

majors. The course addresses the fundamental concepts that best align with the content prescribed in the NCTM standards, and which secondary mathematics teachers clearly need in today's mathematics classroom. Yet for many reasons, it was not feasible to make Elementary Statistics required for the secondary mathematics major, at least in the short term. Therefore, until a more robust change could be implemented in the program coursework, the Mathematics Education Seminar was modified to ensure some measure of competency in statistics. Direct instruction and class time devoted to statistics concepts were increased by approximately 250%. The focus and class time taken from other content areas to facilitate this increase had no discernable negative ramifications, as evidenced by candidates' work submitted in the remainder of the capstone portfolio; this is likely because those areas were more readily perceived as a revisiting of content previously learned.

Additional adjustments were made to both the seminar and the geometry course to promote students' ability to work with axiomatic systems. In the seminar, more emphasis was placed on this skill through a portfolio assignment in which candidates construct proofs based on a given set of definitions and axioms which, although using familiar words, describe constructs that are novel in a context candidates have not previously encountered. Therefore, candidates cannot create proofs by relying on any prior understanding of these constructs, but must instead rely on the axiomatic system provided.

Finally, to address the need for a formal supporting structure for ongoing assessments and program revision, a Secondary Mathematics Program Committee (SMPC) was formed in the Department of Mathematics. The committee consists of mathematics faculty, mathematics education faculty, and field supervisors for the secondary mathematics field placements and internships. The committee reviews not only the NCATE/CAEP NCTM assessment data, but other aspects of the program, including internship placements, supervision, communication and coordination with counterparts in the School of Education, and overall program curriculum issues.

The committee designated a mathematics faculty member as a departmental coordinator for secondary mathematics placements; this coordinating role proved an essential liaison and point of contact for candidates and faculty alike, as the field placements are assigned by the School of Education, but field supervisors are mathematics faculty.

The SMPC has initiated a number of other beneficial changes as well, particularly in mathematics education coursework. Initially, the only course devoted to addressing mathematics pedagogy indicators was the mathematics education course, Methods and Materials for Secondary Mathematics. Addressing all of the desired topics, including mathematics-specific assessment, selection of curricula, etc., was not only challenging, but strained the intended scope of the course. In response, the committee developed three additional mathematics education courses in curriculum, assessment, and classroom management. Taught by faculty in the Department of Mathematics, these courses superseded the three corresponding education courses in the required secondary mathematics curriculum, addressing similar requisite material, but with specific attention paid to these topics in a mathematics classroom. For example, candidates can focus in the assessment course on formative assessment practices by listening to the ways students are communicating about mathematics, and can engage in creating formal assessment items that require reasoning, application, and synthesis of mathematics concepts. Similarly, management of students and their learning using technology, concrete manipulatives, and active investigation can be a focal point of a classroom management course designed expressly for secondary mathematics majors.

#### 4. Revision of Standards and Assessments

To prepare for the next accreditation cycle under CAEP, a program report team must now revise the program assessments to align with the NCTM CAEP 2012 Standards. One question raised early in the process was whether the course portfolios could be eliminated and replaced with course grades; since a straightforward and well-documented process now exists for using course



grades as an assessment, this avenue was tempting. However, the team ultimately decided that a set of assessments comprised of both course grades and portfolios would be more robust.

Therefore, the team has identified these eight assessments: the state licensure test, course grades, a comprehensive student teaching internship evaluation, and the same five course portfolios that were used previously.

The course portfolios all need some revision to reflect the new NCTM standards; however, these revisions apply more heavily to structure than to content. At the time of this writing, portfolio rubrics and alignments were fully revised for History of Mathematics, Methods & Materials, and Mathematics Education Seminar courses. The most significant changes have been to the Mathematics Education Seminar and History of Mathematics portfolios, which now each consist of six content entries instead of seven; the change reflects the reorganization of content in the new standards into six domains within a single “content knowledge” standard, replacing the seven individual content standards previously defined. This reorganization removes measurement as an independent content domain, and instead places elements related to measurement within the domain of geometry. The geometry domain has also been extended to include trigonometry more explicitly. These are among the most significant changes accommodated in the revised course portfolios.

## 5. Challenges

During revision of the assessments, a number of challenges have presented themselves. Among the most significant is the manner in which the 2012 standards are articulated. For instance, the 2003 standards addressed each of the following in a separate and distinct indicator: use of appropriate concrete materials; use of technological tools to explore algebraic concepts; creation of appropriate mathematical representations; translation among different mathematical representations; and analysis of patterns, relations, and functions (NCTM, 2003). The 2012 standards address all of these components and some others as well, but all together in one element

of the Algebra domain, which is described stipulating that “secondary mathematics teachers should know the following topics... with their content understanding and mathematical practices supported by appropriate technology and varied representational tools, including concrete models” (NCTM, 2012a). A single element within that domain is described as:

Functional representations (tables, graphs, ...recursive definitions, and finite differences), characteristics (e.g., zeroes, intervals of increase or decrease, extrema, average rates of change, domain and range, and end behavior), and notations as a means to describe, reason, interpret, and analyze relationships and to build new functions (NCTM, 2012a)

Thus, whereas previous portfolio entries, assignments, and evaluation rubrics could be crafted in such a way that each indicator could be reasonably assessed independently, the revised portfolios must contain many components to ensure a single element is fully addressed. This issue could also easily render the task of evaluating the assessments and rubrics in the program report more challenging for the CAEP program reviewers, potentially resulting in less predictable program review outcomes.

A second challenge is the development of the comprehensive internship evaluation. The School of Education has eliminated all of its previous internship evaluation tools and replaced them with edTPA, recently developed on the basis of the former TPA, or Teacher Performance Assessment (AACTE, 2013). Among the evaluations eliminated is the Teacher Work Sample, which provided part of the assessment data for the previous program review. As yet, it is unclear whether the edTPA will have comparable data to contribute to the internship being developed. On one hand, if the necessary components are being assessed in this primary major assessment, it is redundant and unproductive to duplicate their assessment in a separate instrument. However, relying on an external evaluation has already proved precarious: Like the Teacher Work Sample,

any external assessment could be altered or even discontinued, leaving the CAEP program report team short of their required assessment data.

The remaining challenge reflects a broader issue: How can secondary math programs ensure that their curriculum and their assessments address the relevant and necessary content knowledge, mathematical practices, and pedagogical and technological skills needed to be a successful mathematics educator? As in-field practitioners scramble to play catch-up with changing curriculum standards and insufficient professional development, mathematics education programs are at significant risk of falling equally far behind. The continued growth in emphasis on statistical literacy, as evidenced in the Common Core Georgia Performance Standards (CCGPS), is perhaps the clearest example of this phenomenon. The changes implemented to address gaps in the program described here are not sufficient: Whether through new courses or substantially revised existing courses, secondary mathematics candidates need more exposure to both statistics content and statistics pedagogy. This need to adapt mathematics education quickly is not unique. Producing a generation of mathematics teachers capable of meeting the evolving requirements will require diligence at every turn.

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