



MATHEMATICS EDUCATION COMPREHENSIVE EXAMS SYLLABI

MTED 511: Mathematics Teaching and Learning

I. Topics

- Individual view on approaches and theories to learning (e.g., discovery learning, Gestalt psychology, problem-solving, hierarchical learning structures, constructivism)
- Differences in learning (e.g., gender, mathematical ability)
- Social/Cultural view—situated cognition, language, ethnomathematics
- Impact of teaching and attitudes on student achievement
- Meaning in the teaching of mathematics—learning mathematics with understanding
- Influence of constructivism in mathematics education
- Role of beliefs in learning and teaching
- Concept development
- Understanding, analyzing, and engaging in mathematics education research

II. References

- Carpenter, Dossey, & Koehler (Eds.). (2004). *Classics in Mathematics Education Research*. Reston, VA: NCTM.
- Orton, A. (2004). *Learning Mathematics: Issues, theory and classroom practice* (3rd Ed.). New York, NY: Continuum International Publishing Group.

MTED 512: Curriculum and Assessment in Mathematics

I. Topics

- What are national standards? What is the role of standards in mathematics education? What are CA expectations for curriculum and assessment? Examining the NCTM Standards (2000), Common Core State Standards for Mathematics (2010/2013), and the CA Mathematics Framework (2023)
- Standardized assessments at all levels (international, national, state, district); What is the purpose of assessment? What role can/should making an assessment high stakes play?
- Classroom assessment—What is it, what should it be, and what does it suggest about a teacher’s view of curriculum and mathematics? What are ethical considerations of assessment?
- Defining and exploring various types of assessment
- Curriculum theory in mathematics education; Why, when and how should curriculum change? What is the role of “M” in STEM?
- Historical and current perspectives on curriculum development
- What is data science and what is the role of math/stat in this field?
- Historical development and current status of school mathematics curricula
- What is coherence and why is it important to the quality of mathematics curriculum and instruction?
- What do national and international studies (NAEP, TIMSS, PISA) reveal about mathematics curriculum and student learning in the U.S.?
- What is alignment and why is it important to good practice? How does one integrate beliefs (e.g., learning theories) and practice?
- Impact of technology on curricular development; historical perspectives on effectiveness of technology in enhancing learning/achievement; What does research suggest about how technology should be integrated into curriculum and assessment (e.g., online and computer assisted instruction)?
- What is the role of assessment versus grading? How does one negotiate competing factors? What is the teacher’s role in establishing equitable practices?

II. References (Primary listed below; secondary should also be revisited)

- Brahier. (2020). *Teaching Secondary and Middle School Mathematics* (6th Edition). Routledge.
- [California Mathematics Framework \(2013, 2023\)](https://www.cde.ca.gov/ci/ma/cf/): <https://www.cde.ca.gov/ci/ma/cf/>
- [California Common Core State Standards for Mathematics \(2013, 2014\)](https://www.cde.ca.gov/be/st/ss/documents/ccsmathstandardaug2013.pdf): <https://www.cde.ca.gov/be/st/ss/documents/ccsmathstandardaug2013.pdf>
- [Common Core State Standards for Mathematics \(2010\)](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf): http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

- Groth. (2013). *Teaching Mathematics in Grades 9-12: Developing Research-Based Instructional Practices*. Sage.
- Lester, F. (2010). *Teaching and Learning Mathematics: Translating Research for Secondary School Teachers*. Reston, VA: NCTM.
- Mathematical Sciences Education Board & National Research Council. (1990). *Reshaping School Mathematics: A Philosophy and Framework for Curriculum*. Washington DC: National Academies Press.
- [National Assessment of Educational Progress \(NAEP\)](https://nces.ed.gov/nationsreportcard/).
<https://nces.ed.gov/nationsreportcard/>
- NCTM. (2014). *Annual Perspectives in Mathematics Education: Using Research to Improve Instruction*. Reston, VA: Author.
- NCTM. (2014). *Principles to Actions: Ensuring Mathematical Success for All*. Reston, VA: Author.
- NCTM. (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.
- NCTM. (1995). *Assessment Standards for School Mathematics*. Reston, VA: NCTM.
- [Programme for International Student Assessment \(PISA\)](https://www.oecd.org/pisa/): <https://www.oecd.org/pisa/>
- [Trends in International Mathematics and Science Study \(TIMSS\)](http://nces.ed.gov/timss/):
<http://nces.ed.gov/timss/>

MTED 540: Algebra in the Secondary School Curriculum

I. Topics

- Issues concerning algebra and algebraic thinking in state and national curricular standards
- Learning and teaching algebraic thinking
- Assessment and remediation of common errors in algebra
- Exploring the Fundamental Theorem of Algebra and problem solving
- Exploration of content and method relative to all types of functions (e.g., radical, rational, exponential, linear)
- Applications of all types of representations (e.g., algebraic expressions, graphing)
- Understanding transformations

II. References

- [California Mathematics Framework \(2013, 2023\)](https://www.cde.ca.gov/ci/ma/cf/): <https://www.cde.ca.gov/ci/ma/cf/>
- [California Common Core State Standards for Mathematics \(2010, 2013, 2014\)](https://www.cde.ca.gov/be/st/ss/documents/ccsmathstandarداug2013.pdf): <https://www.cde.ca.gov/be/st/ss/documents/ccsmathstandarداug2013.pdf>
- [Common Core State Standards for Mathematics \(2010\)](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf): http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf
- Driscoll, M. (1999). *Developing Algebraic Habits of Mind: A framework for Classroom Questions Aimed at Understanding Student Thinking*. Newton, MA: Education Development Center.
- Kieran, C. (2007). Learning and teaching algebra at the middle school through college level. In *Second Handbook of Research on Mathematics Teaching and Learning*, NCTM, pp.707-762.
- Kieran, C. (1992). The learning and teaching of school algebra. In *Handbook of Research on Mathematics Teaching and Learning*. NCTM, pp.390-419.
- Moses, R. (1993, December). Algebra: The new civil right. In *The algebra initiative colloquium* (Vol. 2, pp. 53-67). Washington, DC: US Department of Education, Office of Educational Research and Improvement.
- National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics*.
- Wasserman, N. H. (2016). Abstract algebra for algebra teaching: Influencing school mathematics instruction. *Canadian Journal of Science, Mathematics and Technology Education*, 16, 28-47.
- Select NCTM Publications/Journal articles (e.g., *Algebraic Thinking, Grades K–12, 1999; Curriculum Focal Points, PreK–Grade 8, 2006; Algebra and Algebraic Thinking in School Mathematics*. (70th Yearbook, 2008))
- Current high school and college algebra texts (e.g., *College Algebra with Trigonometry, graphs and Models*, 2005, by Barnett Ziegler and Byleen)

MTED 550: Geometry in the Secondary School Curriculum

I. Topics

- Exploration into geometric proof, utilizing multiple approaches
- Learning and teaching geometric proof
- Assessment and remediation of common errors in geometry
- Exploration of content and method relative to key concepts in geometry (e.g., lateral area, surface area, volume, Pythagorean Theorem, trigonometric functions)
- Applications of all types of representations (e.g., algebraic expressions, graphing)
- Understanding content and applications of congruency, similarity, coordinate geometry

II. References

- [California Mathematics Framework \(2013, 2023\)](https://www.cde.ca.gov/ci/ma/cf/): <https://www.cde.ca.gov/ci/ma/cf/>
- [California Common Core State Standards for Mathematics \(2010, 2013, 2014\)](https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf): <https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandardaug2013.pdf>
- [Common Core State Standards for Mathematics \(2010\)](http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf): http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf
- Tomas, D. A. (2002). *Modern Geometry*. Brooks/Cole.
- Select NCTM Publications/Journal articles (e.g., *Navigating through Geometry, Grades 6-8*, 2002; *Navigating through Geometry, Grades 9-12*, 2002)
- Current high school and college geometry texts (e.g., *College Geometry: A Discovery Approach*, 2nd ed., 2001, by D. C. Kay)

MTED 560: Analysis in the Secondary School Curriculum

I. Topics

- Foundations: types of numbers, arithmetic properties and operations, completeness axiom, boundedness, suprema/infima, Principle of Mathematical Induction
- Polynomial functions
- Limits & continuity (Intermediate Value Theorem)
- Derivative (rules for numerous types of functions, Rolle's Theorem, Mean Value Theorem, L'Hopital's Rule)
- Trigonometric functions (definitions, identities derivations/proofs, inverse, polar representations)
- Integrals (definition, multiple ways to conceptualize, Fundamental Theorem. of Calculus)
- Sequences & Series (definitions, arithmetic and geometric, infinite and finite, derivations and applications of basic formulas)

II. References

- Bryant, Victor. (2002). *Yet another introduction to analysis*. Cambridge: Cambridge University Press.
- California Department of Education. (2005). Mathematics Framework for California Public Schools, Chapter 2 on Mathematical Analysis.
- Harcharras, A. & Mitrea, D. (2007). *Calculus Connections: Mathematics for Middle School Teachers*, Person Education.
- Kosmala, W. (2004). *A friendly introduction to analysis, single and multivariable* (2nd ed.). New Jersey: Pearson Prentice Hall.
- Rudin, W. (1976). *Principles of mathematical analysis* (3rd ed.). New York, NY: McGraw-Hill.
- Sawyer, W. (1962). *What is calculus about?* Washington, D.C.: Mathematical Association of America.
- Usiskin, Z., Peressini, A., et al. (2003). *Mathematics for high school teachers: An advanced perspective*. New Jersey: Prentice Hall, Pearson Education, Inc.
- Current high school and college calculus texts

MTED 570: Modeling in the Secondary School Curriculum

I. Topics

- The nature and process of mathematical modeling
- The role of modeling as a scientific endeavor
- The role of modeling in secondary school education
- Modeling curriculum, instructional practices, and student learning
- Linear models and linear regression, line fitting and approximation criteria
- Empirical modeling. Linearizable models
- Polynomial models, multiple regression
- Discrete dynamic systems, recursive sequences
- Finite differences
- Optimizations via algebraic and calculus tools, simple differential equations
- Probabilistic modeling through simulations

II. References

- [California Mathematics Framework \(2013, 2023\)](https://www.cde.ca.gov/ci/ma/cf/): <https://www.cde.ca.gov/ci/ma/cf/>
- [California Common Core State Standards for Mathematics \(2010, 2013, 2014\)](https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandarداug2013.pdf): <https://www.cde.ca.gov/be/st/ss/documents/ccssmathstandarداug2013.pdf>
- Brian Albright (2010). *Mathematical Modeling With Excel*. Jones & Bartlett Publishers.
- Brown, J. and Edwards, I. (2010). Modelling Tasks: Insight into Mathematical Understanding. In R. Lesh et al. (eds.), *Modeling Students' Mathematical Modeling Competencies*. Springer Science+Business Media, LLC.
- COMAP & SIAM (2016). *Guidelines for Assessment and Instruction in Mathematical Modeling Education*.
- Galbraith, P. L., Stillman, G., and Brown, J. (2010). Turning Ideas into Modeling Problems. In R. Lesh et al. (eds.), *Modeling Students' Mathematical Modeling Competencies*. Springer Science+Business Media, LLC.
- Lesh, R. & Zawojewski, J. (2007). Problem solving and modeling. In F. K. Lester, Jr. (Ed), *Second Handbook of Research on Mathematics Teaching and Learning*, (pp. 763-804). Information Age Publishing.
- Pollak, H. O. (2003). A history of the teaching of modelling. In G. Stanic & J. Kilpatrick (Eds.), *A History of School Mathematics*, (pp. 647-671). Reston, VA: NCTM.
- Schoenfeld, A. (2014). Mathematical modeling, sense making, and the Common Core State Standards. In Dickman, B. and Sanfratello, A. (Eds.), *Proceedings of the Conference on Mathematical Modeling*. Teachers College, Columbia University.

MTED 580: Probability and Statistics in the School Curriculum

I. Topics

- Issues concerning probability and statistics in state and national curricular standards
- Learning and teaching probability and statistics
- Exploration of the following content:
 - Organizing and Displaying Data
 - Describing Data with Numbers
 - Data with Two Variables
 - Probability
 - Counting Techniques
 - Random Variables and Probability Distributions
 - Distributions from Random Samples
 - Estimating With Confidence
 - Testing Hypotheses

II. References

- Franklin, C. A., Kader, G., Mewborn, D., Moreno, J., Peck, R., Perry, M., & Scheaffer, R. (2005). *Guidelines for assessment and instruction in statistics education (GAISE) report: A pre-K--12 curriculum framework*, American Statistical Association.
- Konold, C. (1995). Issues in assessing conceptual understanding in probability and statistics. *Journal of Statistics Education*, 3(1), 1-9.
- NCTM. Research on students' thinking and reasoning about averages and measures of center. *NCTM Research Brief*, Retrieved from: www.nctm.org/news/content.aspx?id=12710.
- Perkowski, D. A., & Perkowski, M. (2006). *Data and probability connections*. New Jersey: Prentice Hall.
- Shaughnessy, J. M. (2003). Research on students' understandings of probability. *A research companion to principles and standards for school mathematics* (pp. 216-226). Reston, VA: NCTM.
- Shaughnessy, J. M. (2006). Research on students' understanding of some big concepts in statistics. In G. Burrill, & P. Elliott (Eds.), *Thinking and reasoning with data and chance*, 68th yearbook (pp. 77-95). Reston, VA: NCTM.
- Shaughnessy, J. M. (2008). What do we know about students' thinking and reasoning about variability in data? *NCTM Research Brief*, Retrieved from www.nctm.org/news/content.aspx?id=15521