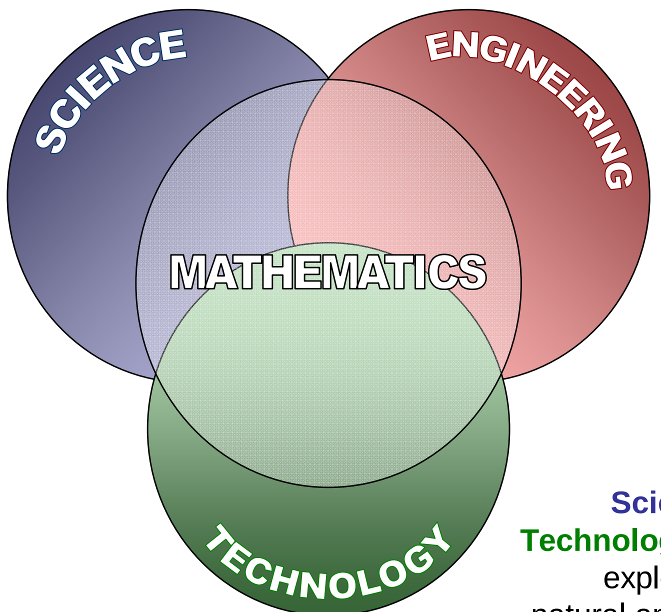
User’s Guide to the Tennessee Mathematics Curriculum Framework

Tennessee Vision for STEM Education

Engineering creatively applies scientific principles to analyze events, design processes, develop materials, and construct objects that benefit society.

Science seeks to explain the complexity of the natural world and uses this under-standing to make valid and useful predictions.



Technology utilizes innovative tools, materials, and processes to solve problems or satisfy the needs of individuals, society, and the environment.

Science, **Engineering** and **Technology** use **Mathematics** to explore questions about the natural and human-made worlds.

Adapted with permission from the Massachusetts Science and Technology / Engineering Curriculum Frameworks.

Revised Standards Approval Dates: K-8 & 9-12 Jan. 25, 2008
Implementation: School Year 2009-2010

NOTE: This document is a “work in progress” and will undergo subsequent revisions as needed.

User's Guide to the Tennessee Mathematics Curriculum Framework Index

Introduction

Welcome to the User's Guide designed to assist in the implementation of the 2007 version of the *Tennessee Mathematics Curriculum Framework.* Approximately every six years the Department of Education is mandated by the Tennessee State Board of Education's *Rules, Regulations, and Minimum Standards* to reassess the state's curriculum standards. The 2008 revised mathematics standards resulted from the efforts of committees comprising mathematics educators from across the state. The new standards are:

- Focused on major mathematics themes and their contextual applications
- Organized and consistent across the grade bands
- Stated clearly and concisely
- Increasingly complex across grade bands K-12
- Aligned with both the National Council of Teachers of Mathematics *Curriculum Focal Points for Prekindergarten though Grade 8 Mathematics* and the *Principals and Standards for School Mathematics*, American Diploma Project Benchmarks, National Association for Educational Progress standards, and ACT Standards.
- Easier to implement than previous versions

Overview of the Mathematics Curriculum

Framework Revision Process

Approved Mathematics Framework K - 12

High School Mathematics Redesign

Changes

1. Effective with the ninth grade class entering high school during school year 2009-2010, all students will pursue a focused program of study that includes four credits in mathematics. The four credits are to include Algebra I and II, Geometry or its equivalent, and another mathematics course beyond Algebra I. Students must be enrolled in a mathematics course each school year. A Bridge Mathematics course is designed for students who have not scored a 19 or higher on the ACT by the beginning of the senior year.
2. Students with qualifying disabilities in math, as documented in the individualized education program, shall be required to complete a minimal sequence of Algebra I and Geometry (or its equivalent). The required number of credits in mathematics may be earned with modifications such as, but not limited to, increased time, appropriate methodologies, and accommodations as determined by the IEP team.

Rationale for High School Mathematics Redesign

Research points out that unlike their counterparts in other countries, a significant number of American children display little or no mastery of mathematics applications. National tests including PISA and NAEP, international assessments (TIMSS, http://nces.ed.gov/timss/), and reports such as the Glenn Commission, urge that the United States carefully redesign high school science and mathematics programs. Reform efforts are necessary to ensure that our educational system prepares adequate numbers of scientists, engineers, and mathematicians to sustain the growth of our economy.

Implications for Mathematics Teaching

The teacher is the most important link in connecting our students to higher levels of accomplishment and learning. If Dr. William Sanders, developer of TVAAS (Tennessee Value Added Assessment System), tells us anything, it is the inexorableness of *teacher-effect*. He lists it as the single-most important factor in student achievement: more than socio-economics, budgets, parents, and facilities. The teacher is the most important asset that any school system has to offer.

The new Tennessee Mathematics Standards will require more coverage and depth than the previous standards, and will therefore require more teacher-knowledge and a change in facilitation and pedagogy to achieve these goals. In order to attain greater student achievement, instructors will need to use more efficient methodologies, which are undergirded by a paradigm shift in *how students learn*.

One such paradigm shift is a move away from the stereotypical textbook-driven plan, which is linear in nature, and thus limited in efficiency, toward a plan which is spiraled and more inline with how human beings actually are wired to learn. Below is a concise compare-contrast of the old and new paradigms.

Contrasting Spiraled vs. Linear Methods

Spiraled Paradigm (*Human-Friendly*)	Linear Paradigm (*Not Ideal for Humans*)
• Time is the variable; performance is constant	• Time is constant; performance is the variable
• Goal: expect performance standards to be obtained by all students	• Goal: Expect normally distributed performance
• Based on spiral learning curve	• Based on linear learning curve
• Less “coverage” yields more “higher order” cognition	• More “coverage” yields less “higher order” cognition
• Domains-driven curriculum	• Textbook-driven curriculum
• Long-term retention	• Short-term memorization
• Concrete-to-abstract	• Abstract; no concrete basis
• Constructivist mathematics	• Traditionalist mathematics
• Gifted students allowed time to linger on various topics	• Gifted students must keep up pace, potential for burnout
• Emphasis placed on raising underachievers’ performance levels	• Emphasis on maintaining timeline, underachievers separated
• Socratic, discovery methods	• Lecture, dissemination
• Begins with end in mind	• Rarely reaches the end
• Time frames collapsed	• High emphasis on time
• Teach inquiry mathematics	• Teach math history
• Integrated curriculum	• Segmented curriculum

It goes beyond the scope of this document to elaborate on each facet of the *new paradigm*, but here are a few points worth mentioning:

- All people do not learn in the way a textbook presents a topic anymore than they learn to speak a language by reading a dictionary. In learning to speak, humans proceed in a *need-to-know* basis, and the formal structures are added later. When a child learns a language, it is more *caught than taught*, and teachers who design lesson plans and activities based on this idiosyncrasy of human behavior are able to train students more effectively with less stress on the part of both instructor and student.

- The introduction of *rich tasks* into the curriculum early in the school year enables the teacher to collapse time frames and cover more topics in a deeper vein than textbook-lecture formats.
- There is a *myth of coverage* among teachers of mathematics that assumes that if a topic is covered then it is mastered. Teaching is more than telling, and just because a topic is *covered* doesn't mean that it is *mastered.*
- When possible, topics should be introduced in a concrete fashion, and abstraction should be added gradually throughout the year until the concrete example is no longer needed. Abstraction is difficult for many students, especially early in their educational tenure, and should be preceded by concrete activities to allow students to attach meaning to the abstraction.
- Most ideas can be introduced early in the school year, even in the first six weeks, and then gradually covered again and again in depth so that all students have an opportunity to master the topics from a concrete, discovery approach to the more abstract, symbolic approach.
- We must assume that *all* students can learn at higher levels
- In the typical *coverage* model, time is constant; i.e. the teacher sets aside a week or two to *cover* a topic. Assessment is done at the end of that time period. Results are generally normally distributed. But if knowledge is the constant, then it is assumed that all students can and will learn the topic, but time and pedagogy will vary greatly for each student to uniformly achieve high standards.
- If learning/achievement, not time, is held constant, then that means students will learn at different rates. This allows students who learn more quickly to serve as tutors, use free-time to explore topics in more depth, and/or allow them more time to work on other subjects and projects that interest them. It is a myth that all students should be working on the same topic at the same pace all of the time for optimal learning.
- With increased emphasis on *high-stakes* testing, often the joy of teaching and learning can wane. Keep teaching and learning fun.
- There are master teachers in every system in the state. It is imperative that teachers utilize these *experts*, along with the many other resources available, to achieve the new, high expectations. Teachers need not feel overwhelmed or as if they have to *re-invent the wheel*.

Major Features of the Mathematics Curriculum Framework

The new Mathematics Standards for Tennessee exhibit more rigor. In constructing the new standards, teams of math teachers and professors from across the state synthesized national standards from several resources: the American Diploma Project Standards, National Council of Teachers of Mathematics *Focal Points (NCTM)*, National Assessment of Educational Progress (NAEP), ACT Standards, and Mid-Continent Research for Education and Learning Standards (MCREL). The development of these new Standards involved three stages: teams of teachers composed necessary content, the standards were reviewed and held up to the national standards by a different team of reviewers, and finally, they were proofed and organized into the form found on the Tennessee Department of Education website.

Governor Bredesen commissioned the Standards Committees to develop a curriculum that will "ramp up" the mathematical education of all Tennessee students. There were several guiding premises. Among these are the following.

1. There is no redundancy in the content standards. If a concept is addressed at a grade level subsequent to its introduction, it must include deeper understanding, more complexity, wider application, or more rigor.
2. Every Tennessee student can learn more than he/she is currently learning and expectations are higher.
3. The Mathematical Processes must be addressed at every grade level and in every one of the Content Strands.

4. Appropriate use of technology (not to replace understanding and individual performance) will be addressed at each grade level.
5. All concepts in the standards of every grade level will be addressed in the classroom. The standards are streamlined to allow for greater depth of understanding and more facilitation with problem-solving and application.

When the P-16 Council developed recommendations for future graduates, it was with the understanding that existing teachers would receive the professional development necessary to allow them to be qualified to teach the mathematics of the new standards. We must be proactive in preparing our teachers for this eventuality while exposing them to the changes in the new standards. In the tables in this document, it can be seen how the WCS Curriculum Department and the FSSD Curriculum Department are informing teachers of the changes that will be meet in the transition year 2008-2009. It is hoped that teachers will be fully prepared to address the new standards while being cognizant that the TCAP of 2009 will address the former standards.

Organization of the New Standards

There are still five strands; two former ones have been combined and one new one has been added:

- *Mathematical Processes – New Strand**
- Number and Operation – *Content Strand*
- Algebra– *Content Strand*
- Geometry and Measurement– *Content Strand*
- Data Analysis, Probability, Statistics– *Content Strand*

Each Strand is composed of three major parts:

- Grade Level Expectations or Course Level Expectations
- Checks for Understanding
- State Performance Indicators

New Strand:* The Grade Level Expectations for the Mathematical Processes Strand are the same for grade bands K-8 and for 9-12. The Checks for Understanding and the SPIs differ at each grade/course level.

Elementary/Middle Grades K-8 Mathematical Processes Grade Level Expectations

GLE 00-08 06.1.1 Use mathematical language, symbols, and definitions while developing mathematical reasoning.
GLE 00-08 06.1.2 Apply and adapt a variety of appropriate strategies to problem solving, including estimation, and reasonableness of the solution.
GLE 00-08 06.1.3 Develop independent reasoning to communicate mathematical ideas and derive algorithms and/or formulas.
GLE 00-08 06.1.4 Move flexibly between concrete and abstract representations of mathematical ideas in order to solve problems, model mathematical ideas, and communicate solution strategies.
GLE 00-08 06.1.5 Use mathematical ideas and processes in different settings to formulate patterns, analyze graphs, set up and solve problems and interpret solutions.
GLE 00-08 06.1.6 Read and interpret the language of mathematics and use written/oral communication to express mathematical ideas precisely.
GLE 00-08 06.1.7 Recognize the historical development of mathematics, mathematics in context, and the connections between mathematics and the real world.
GLE 00-08 06.1.8 Use technologies/manipulatives appropriately to develop understanding of mathematical algorithms, to facilitate problem solving, and to create accurate and reliable models of mathematical concepts.

High School Grades 9-12 Mathematical Processes Course Level Expectations

CLE 1.1 Use mathematical language, symbols, definitions, proofs and counterexamples correctly and precisely in mathematical reasoning.
CLE 1.2 Apply and adapt a variety of appropriate strategies to problem solving, including testing cases, estimation, and then checking induced errors and the reasonableness of the solution.
CLE 1.3 Develop inductive and deductive reasoning to independently make and evaluate mathematical arguments and construct appropriate proofs; include various types of reasoning, logic, and intuition.
CLE 1.4 Move flexibly between multiple representations (contextual, physical, written, verbal, iconic/pictorial, graphical, tabular, and symbolic), to solve problems, to model mathematical ideas, and to communicate solution strategies.
CLE 1.5 Recognize and use mathematical ideas and processes that arise in different settings, with an emphasis on formulating a problem in mathematical terms, interpreting the solutions, mathematical ideas, and communication of solution strategies.
CLE 1.6 Employ reading and writing to recognize the major themes of mathematical processes, the historical development of mathematics, and the connections between mathematics and the real world.
CLE 1.7 Use technologies appropriately to develop understanding of abstract mathematical ideas, to facilitate problem solving, and to produce accurate and reliable models.

Notes on the Features of the New Tennessee Mathematics Standards

The Mathematical Process Standards should be embedded in the content standards to reap the learning benefits gained from attention to them. These standards exemplify best teaching practices in mathematical instruction and mirror the NCTM Process Standards:

Representation: Students learn in different manners. Addressing content in multiple representations can incorporate differentiation as well as encourage engagement.

Communication: Students' ability to elucidate their thinking both verbally and in writing informs instruction. Classroom discussions and writing activities focus attention to development of meaning for and appropriate use of mathematical language and mathematical notation.

Connections: Making connections within the discipline, to other disciplines (especially, history of development of mathematics), to careers, and to the real world highlight relevance.

Problem-Solving with Reasoning and Justification: These two almost inextricably intertwined. Students should have opportunity to practice both of these standards in theory as well as in application through rich tasks. Students' lack of ability in these areas (as bemoaned by employers and higher education) is the primary catalyst for the rewriting of the standards.

Implementation of Technology and Modeling: Students need opportunities to make appropriate use of tools that foster discovery and facilitate the construction of mathematical concepts. Appropriate use of technology occurring at all grade levels involves more than using technology as computing tool.

State Performance Indicators (SPI) are broader than those associated with the former framework; therefore there are many ways to assess the learning expectations. Tasks that require a skill or an algorithm are important in the classroom but are not sufficient for developing mathematical thinking. Student success on assessments depends on their meeting challenging problems daily. Higher expectations will be actualized in the new assessments. Pay attention to the **Checks for learning** as they could indicate a format for an SPI question.

"**No Redundancy"** in the new TN DOE Math Standards has implications for curriculum planning:

1. Familiarity with concepts learned in previous grades is imperative so that students have the opportunity to
   (a) hone arithmetic skills, undergird algorithms with conceptual understanding, and apply those skills more inclusively in the system of real numbers;
   (b) revisit processes at a more sophisticated level and/or with more complexity;
   (c) apply previously learned concepts in grade level appropriate settings; and
   (d) revisit concepts while developing a greater depth of understanding.
2. Identification of concepts that will be addressed for mastery in the following grade/course in order to take the opportunity to introduce any of those concepts that naturally succeed concepts for the current grade level.

Responsibility for content knowledge: In order to prepare to ramp up the mathematical standards in the mathematics classroom, school instructional leaders will want to be proactive:

1. Request assistance from district math personnel to provide content background at site-based professional development;
2. Work with the professional development coordinator to address teacher content needs prior to the school year 2009-2010 in all aspects of content: vocabulary, notation, processes, concepts, and applications.
3. Encourage math teachers to initiate vertical discussions among teachers of both lower and higher grades.
4. Streamline the curriculum to offer time for students to develop depth of understanding so that students finish a grade/course with conceptual foundations that lead to success in future math courses.
5. Act as a facilitator to provide effective instruction for standards-based curricula to provide discovery learning and student-generated construction of knowledge.
6. Allow time to plan differentiated instruction for content that is not readily addressed in the currently adopted textbooks.