THE STATE OF MATHEMATICS EDUCATION IN INDIANA

“Here, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run at least twice as fast as that.”

*The Red Queen, “Through the Looking Glass”*
"The beauty of this is that it is only of theoretical importance, and there is no way it can be of any practical use whatsoever."
“Algebra class will be important to you later in life because there’s going to be a test six weeks from now.”
J. Q. Public’s View of Math...

I wish this sled had a speedometer so we could know how fast we’re going.

I suppose we could measure the hill, time our descent, calculate our rate in feet per minute, and convert that into miles per hour.

That sounds like math.

Um, yes.

Suddenly I stopped caring.
Mathematics Access and Achievement in Indiana

Data and Graphics contributed CEEP and IU-SMAP
This takes into account students’ race/ethnicity, gender, socioeconomic status, eighth grade achievement levels, high school behavior, parenting variables, and psychological variables.

# Math Requirements for Diplomas

<table>
<thead>
<tr>
<th>Regular</th>
<th>Core 40</th>
<th>Academic Honors</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 credits (2 years)</td>
<td>6 credits (3 years)</td>
<td>8 credits (4 years)</td>
</tr>
<tr>
<td>Algebra I and any other course</td>
<td>Algebra I, Geometry, and Algebra II</td>
<td>Algebra I, Geometry, Algebra II, and any other course</td>
</tr>
</tbody>
</table>

- The Class of 2011 and beyond must complete, at the minimum, the Core 40 diploma.
The percentage of regular diplomas granted has decreased 31.2 points from the 1997-98 to 2008-09 school years.

In this same time frame, the percentages of Honors and Core 40 diplomas granted have increased 11.8 and 19.3 percentage points, respectively.
End-of-Course Assessments

- Prior to the Class of 2012, students had to pass the GQE (Grade 10 ISTEP+) in order to graduate high school.

- With the Class of 2012 and beyond, students must pass End-of-Course Assessments (ECAs) in both Algebra I and English 10.
In 2003, the average scale score for Indiana was 3% higher than the US average and 8% higher than the international average for Grade 4.

For Grade 8, Indiana was 1% higher than the US average scale score and 9% higher than the international average scale score.
Indiana did not participate separately in the 2007 TIMSS.

The average scale score for the United States was 12% and 10% higher than the international average for Grade 4 and Grade 8, respectively.
The National Assessment of Educational Progress (NAEP)

- Also known as The Nation’s Report Card, NAEP collects data from representative samples of students from grades 4, 8 and 12 and in all 50 states in a variety of subjects.

- NAEP is the only uniform and continuous assessment of America’s students.

- In addition to standard scale scores, NAEP identifies the percentages of students in four proficiency categories: Below Basic, Basic, Proficient, and Advanced.
Student Performance on NAEP: Grade 4 Mathematics

- Indiana has performed above the national average, between 2000 and 2007, Indiana’s average scale score increased 5.2% while the nation’s improved 6.7%.

- The next round should be watched closely to see if the 07 – 09 decrease becomes a trend or was an aberration.
4th-grade NAEP Mathematics Race/Ethnicity Gaps
The nation has seen a 4.0% increase in its average scale score from 2000 to 2009, compared to Indiana's 2.1% increase in the same period.
8th-grade NAEP Mathematics Race/Ethnicity Gaps

- **White**
- **Hispanic**
- **Black**
Student Performance on ISTEP+

- The percentage of students passing the mathematics portion of ISTEP+ has increased across Grades 3, 6, 8, and 10 since the 1997-98 school year.
• Grade 3 mathematics achievement gaps all widened between 2006 and 2008, but decreased in 2009
• Grade 8 achievement gaps decreased between 2006 and 2008, but widened in 2009
• Grade 10 achievement gaps decreased from 2005 to 2007, but widened in 2008
## Indiana State Averages
### Algebra I End-of-Course Assessment

<table>
<thead>
<tr>
<th>Year</th>
<th># of students tested</th>
<th>Average scale score</th>
<th>% passing Middle School</th>
<th>% passing High School</th>
<th>% passing Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005-2006</td>
<td>73,587</td>
<td>510</td>
<td>NA</td>
<td>NA</td>
<td>24%</td>
</tr>
<tr>
<td>2006-2007</td>
<td>78,429</td>
<td>517</td>
<td>59%</td>
<td>18%</td>
<td>29%</td>
</tr>
<tr>
<td>2007-2008</td>
<td>87,219</td>
<td>527</td>
<td>69%</td>
<td>21%</td>
<td>34%</td>
</tr>
<tr>
<td>2008-2009</td>
<td>97,388</td>
<td>524</td>
<td>70%</td>
<td>31%</td>
<td>41%</td>
</tr>
</tbody>
</table>
## Table 1. First-Year Students in Indiana Public Higher Education Institutions Taking Remedial Coursework

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of first-year students</th>
<th>% taking remedial Mathematics</th>
<th>% taking remedial Language Arts</th>
<th>% taking remedial Mathematics and Language Arts</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>105,863</td>
<td>27.5</td>
<td>11.9</td>
<td>8.9</td>
</tr>
<tr>
<td>2005-06</td>
<td>110,711</td>
<td>26.5</td>
<td>11.5</td>
<td>8.0</td>
</tr>
<tr>
<td>2006-07</td>
<td>111,126</td>
<td>27.9</td>
<td>11.0</td>
<td>8.5</td>
</tr>
</tbody>
</table>

College Math Remediation in **Indiana**
Reaching Higher: Strategic Initiatives for Higher Education in Indiana (2008)

Recommendations in six key areas:
- College Completion
- Affordability
- Preparation
- Community College
- Major Research Universities
- Accountability

Source: http://www.in.gov/che/2349.htm
Define a common college readiness assessment and passing score range that will be used consistently to determine if a student is ready to start credit-bearing, college-level coursework. This common metric should be determined collaboratively between higher education and K-12 and also should be used to identify student remedial needs.

Work with the Indiana State Board of Education to implement an aligned system of voluntary college readiness tools that students may take advantage of at key points during their K-12 years. These assessments should provide students and teachers with understandable and dependable signals of whether or not a student is on track to meet the common metric for college readiness (i.e., ACT tools — EXPLORE, PLAN, ACT; College Board tools — new 8th grade assessment, PSAT, SAT; CSU Early Assessment Program; etc.).

Communicate information from these college readiness assessments in ways that provide schools, teachers, students and families with a clear understanding of where the students are in terms of their academic progression. Information should be timely to allow students to use the junior and/or senior year to correct any academic deficiencies while in high school rather than taking remedial coursework in college.
Conclusions

- Indiana has traditionally been a stronger math education state than language education state regarding student outcomes.
- Although there are many positives to point to, several historic and recent trends are cause for serious concern.
  - HS students not taking four years of math
  - Large achievement gaps
  - Tremendous remediation rates at the college-level
- Although outcome data are similar to those for students in states such as Florida, the increases in these other states point to much greater rates of positive change.
March 2009 – Indiana Adopts new Academic Standards for Mathematics

2009-10 – Year for Instructional Materials Adoption for Math

Indiana -- Dana Center provides a process for adoption

In March of 2010, school corporations were advised to delay their math textbook adoption.

Teachers will NOT teach Math 2009 standards
The Common Core State Standards Initiative is a state-led effort coordinated by the National Governors Association Center for Best Practices (NGA Center) and the Council of Chief State School Officers (CCSSO). The standards were developed in collaboration with teachers, school administrators, and experts, to provide a clear and consistent framework to prepare our children for college and the workforce.

These standards define the knowledge and skills students should have within their K-12 education careers so that they will graduate high school able to succeed in entry-level, credit-bearing academic college courses and in workforce training programs.
The Common Core State Standards

Math

- Initially 48 states and three territories signed on to adopt (Which states didn’t?)

- Final Standards released June 2, 2010, and as of September 15, 2010, all but 13 states officially adopted the Common Core in Math and ELA as the state standards

Design and Organization

Standards for Mathematical Practice

- Carry across all grade levels
- Describe habits of mind of a mathematically expert student

Standards for Mathematical Content

- K-8 standards presented by grade level
- Organized into domains that progress over several grades
- Grade introductions give 2–4 focal points at each grade level
- High school standards presented by conceptual theme (Number & Quantity, Algebra, Functions, Modeling, Geometry, Statistics & Probability)
Design and Organization

- **Content standards** define what students should understand and be able to do.
- **Clusters** are groups of related standards.
- **Domains** are larger groups that progress across grades.

**Number and Operations in Base Ten**

3.NBT

*Use place value understanding and properties of operations to perform multi-digit arithmetic.*

1. Use place value understanding to round whole numbers to the nearest 10 or 100.
2. Fluently add and subtract within 1000 using strategies and algorithms based on place value, properties of operations, and/or the relationship between addition and subtraction.
3. Multiply one-digit whole numbers by multiples of 10 in the range 10-90 (e.g., 9 × 80, 5 × 60) using strategies based on place value and properties of operations.
Design and Organization

Grade Level Overviews

Grade K Overview

Counting and Cardinality

- Know number names and the count sequence.
- Count to tell the number of objects.
- Compare numbers.

Operations and Algebraic Thinking

- Understand addition as putting together and adding to, and understand subtraction as taking apart and taking from.

Number and Operations in Base Ten

- Work with numbers 11-19 to gain foundations for place value.

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Design and Organization

Focal points at each grade level

Mathematics | Grade 6

In Grade 6, instructional time should focus on four critical areas: (1) connecting ratio and rate to whole number multiplication and division and using concepts of ratio and rate to solve problems; (2) completing understanding of division of fractions and extending the notion of number to the system of rational numbers, which includes negative numbers; (3) writing, interpreting, and using expressions and equations; and (4) developing understanding of statistical thinking.

(1) Students use reasoning about multiplication and division to solve ratio and rate problems about quantities. By viewing equivalent ratios and rates as deriving from, and extending, pairs of rows (or columns) in the multiplication table, and by analyzing simple drawings that indicate the relative size of quantities, students connect their understanding of
Algebra, Grade 8

Graded ramp up to Algebra in Grade 8

- Properties of operations, similarity, ratio and proportional relationships, rational number system.

Focus on linear equations and functions in Grade 8

- Expressions and Equations
  - Work with radicals and integer exponents.
  - Understand the connections between proportional relationships, lines, and linear equations.
  - Analyze and solve linear equations and pairs of simultaneous linear equations.

- Functions
  - Define, evaluate, and compare functions.
  - Use functions to model relationships between quantities.
High School

Conceptual themes in high school

- Number and Quantity
- Algebra
- Functions
- Modeling
- Geometry
- Statistics and Probability

College and career readiness threshold

(+ standards indicate material beyond the threshold; can be in courses required for all students.)
Geometry, High School

Middle school foundations
- Hands-on experience with transformations.
- Low tech (transparencies) or high tech (dynamic geometry software).

High school rigor and applications
- Properties of rotations, reflections, translations, and dilations are assumed, proofs start from there.
- Connections with algebra and modeling
Key Advances

Focus and coherence
• Focus on key topics at each grade level.
• Coherent progressions across grade levels.

Balance of concepts and skills
• Content standards require both conceptual understanding and procedural fluency.

Mathematical practices
• Foster reasoning and sense-making in mathematics.

College and career readiness
• Level is ambitious but achievable.
Conclusion

The promise of standards

These Standards are not intended to be new names for old ways of doing business. They are a call to take the next step. It is time for states to work together to build on lessons learned from two decades of standards based reforms. It is time to recognize that standards are not just promises to our children, but promises we intend to keep.
CCSS Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.
Common Core Format

K-8

Grade
Domain
Cluster
Standards

(No pre-K Common Core Standards)

High School

Conceptual Category
Domain
Cluster
Standards

Traditional v Integrated HS Pathways
## Indiana’s Teaching and Testing of Standards Timeline 2010-11

<table>
<thead>
<tr>
<th>Math</th>
<th>English/Language Arts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers will teach Math 2000 standards</td>
<td>Teachers will teach English/language arts 2006 standards</td>
</tr>
<tr>
<td>Teachers will <strong>NOT</strong> teach Math 2009 standards</td>
<td>For ISTEP+ English/language arts 2006 standards will be tested</td>
</tr>
<tr>
<td>For ISTEP+ Math 2000 standards will be tested</td>
<td></td>
</tr>
</tbody>
</table>
### Indiana’s Teaching and Testing of Standards Timeline 2011-12

<table>
<thead>
<tr>
<th>Math</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers will teach Math 2000 standards</td>
<td>Teachers will teach English/language arts 2006 standards</td>
</tr>
<tr>
<td>Teachers will also teach Common Core standards</td>
<td>Teachers will also teach Common Core standards</td>
</tr>
<tr>
<td>For ISTEP+ Math 2000 standards will be tested</td>
<td>For ISTEP+ English/language arts 2006 standards will be tested</td>
</tr>
<tr>
<td>For selected schools, Common Core test items will be piloted</td>
<td>For selected schools, Common Core test items will be piloted</td>
</tr>
</tbody>
</table>
Indiana’s **Anticipated Teaching and Testing of Standards Timeline 2012-14**

- Teachers will teach Math 2000 and Common Core standards
- For ISTEP+ Math 2000 and Common Core standards will be tested

- Teachers will teach English/language arts 2006 and Common Core standards
- For ISTEP+ English/language arts IN 2006 and Common Core standards will be tested
We anticipate a multi-state test on the Common Core State Standards.

We expect this test will be given over the course of the year, so results can be acted upon, with the final section at the end of the year.

We expect this assessment will be given online, with paper and pencil testing only used as an accommodation.
Welcome to the Learning Connection... a message from Dr. Tony Bennett, Superintendent of Public Instruction for the State of Indiana.

About the Learning Connection
Learn how the Learning Connection developed, who is contributing to its development, and how it connects to IDOE’s strategic initiatives. And most importantly, find out how to register for an account.

Features
Discover a full list of the current Learning Connection features as well as details about how different users can access those features.

Curriculum Maps
Access state-level curriculum maps for English/Language Arts and Mathematics content areas.

Growth Model
Explore the progress of students, schools, and corporations by examining the results of ISTEP+ tests in the new Indiana Growth Model. Achievement combined with growth gives a better picture of how schools are helping students progress each year.

Learning Resources
Search the database of learning resources available for educators, and students. Find standards-aligned resources for classroom instruction and professional development resources for instructional improvement.

Support
Ask a question or give suggestions about improving the Learning Connection. Access FAQ’s and the schedule of informational webinars.
The I-STEM Resource Network is a partnership of Indiana’s higher education institutions, K-12 schools, business, and government.

- Eighteen Institutions of Higher Education from 10 geographic areas form the framework for the network.

I-STEM works to support K–12 teachers and leaders working to implement high academic standards towards STEM literacy for all students.
Mathematics Initiatives

- **Algebra Readiness Initiative**
  - For teachers and administrators to prepare students for success in algebra
  - Conference and workshops on cognitive demand, algebraic habits of mind, and formative assessment

- **Middle Level Mathematics Courses**
  - Provide teachers with content and instructional skills to prepare students for rigorous mathematics courses
    - Algebra and Functions
    - Geometry and Measurement
    - Data Analysis and Probability
    - Number Sense and Operations

- **Mathematics Curricular Materials Adoption**

- **Strategic Plan for Mathematics Education in Indiana**
Adding to the challenge of preparing our workforce, businesses have higher expectations of their employees.

**Figure 1**

**TOP 5 NEW-HIRE SKILLS**

(5-point scale: 1=not important, 5=very important)

- Communication skills: 4.69
- Honesty/integrity: 4.59
- Teamwork skills: 4.54
- Interpersonal skills: 4.5
- Strong work ethic: 4.46

Source: Job Outlook 2002, National Association of Colleges and Employers
New Tech High Schools -- PBL

Today’s youth—connected to iPods, game systems and cell phones—often wear more technology than some adults will use in a day. They have global connections through MySpace and Facebook, know computer programs to mix music and make movies, and are fluent in the language of text messaging. However, despite their advanced abilities, these children often spend their days disengaged and disinterested in today’s traditional high school classrooms.
PBL vs. DOING PROJECTS

**Traditional Instruction:** Large activities completed after the students have been pushed through homework assignments, lectures, and readings. Usually a culminating event for a unit or semester.
**PBL vs. DOING PROJECTS**

**PBL:** Students are **pulled** through the curriculum by a driving question or realistic problem that provides a “need to know”. Lectures, readings, and skill building are integrated into the problem as the students need the information.
An initiative to introduce project-based learning (PBL) techniques to mathematics teachers by partnering with local businesses to develop and to deliver projects that instruct students in core math standards.

*Math Matters* provides PBL instruction, structure, and on-going support for math teachers in southeastern Indiana.

Program goal:

*To help teachers improve student achievement in math through rigorous, authentic projects that prepare students for the demands of the twenty-first century.*
The ‘Math Matters’ Model — basic tenets

• A regional community of PBL-experienced math educators can be built one teacher at a time
• PBL can be introduced and prosper in a traditional math classroom
• Math teachers can utilize PBL at the pace that works for them
• Administration understanding and support of PBL is required for it to succeed
• Local community partnerships strengthen PBL by providing a real and immediate context for projects and building the mutually beneficial bond between the classroom and community
• Developing a dynamic and readily available electronic library of standards-based math projects is key to growing PBL regionally and beyond
• On-going local support from experienced PBL educators is necessary for our ‘grass roots’ PBL model to succeed and prosper
<table>
<thead>
<tr>
<th>Programs</th>
<th>Description</th>
<th>Sponsors</th>
<th>Eligible Counties</th>
<th>Grades</th>
<th>Regional Participation Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Math Matters</strong></td>
<td>PBL training and support in developing and delivering a math project based upon an actual process in a business partner’s operations</td>
<td>EcO\textsubscript{15} and IU School of Education</td>
<td>EGR9 counties; participants from outside this region will pay a participation fee of $800</td>
<td>1 to 12</td>
<td>~70 teachers</td>
</tr>
<tr>
<td><strong>Molecules Matter</strong></td>
<td>PBL training and support in developing and delivering a science project in nanoscience</td>
<td>IU Dept of Chemistry, IU School of Education and EcO\textsubscript{15}</td>
<td>Bartholomew, Jefferson, Switzerland, and Monroe</td>
<td>7 to 12</td>
<td>12 teachers</td>
</tr>
<tr>
<td><strong>Inquiry-Based Science</strong></td>
<td>Training in the utilization of hands-on science kits to teach specific science education standards</td>
<td>DOE I-STEM, BioCrossroads, Eli Lilly Corp</td>
<td>state-wide</td>
<td>K to 8</td>
<td>9 schools</td>
</tr>
<tr>
<td><strong>Project Lead the Way (HS)</strong></td>
<td><strong>Gateway to Technology (MS)</strong> Pre-engineering hands-on curriculum of applied math and science offering dual credit</td>
<td>EcO\textsubscript{15} and school districts</td>
<td>nation-wide 11-12 (PLTW) 7-8 (GTT)</td>
<td>~100% of high schools</td>
<td></td>
</tr>
</tbody>
</table>
Math Matters — *by the numbers*

**2009**
Number of projects developed . . . . . . . . 54

**2010**
Participants (K through post-secondary) . . . . 71

% of elementary teachers . . . . . . . . . 54%

Number of returnees from 2009 . . . . . . .12

Number of teacher partnerships . . . . . . 20

Number teachers earning grad credit . . . . 10

Number of projects developed . . . . . . . 44
When someone tells you that ‘Oh, math is not really my thing,’ respond back, ‘and working at McDonald’s isn’t mine.’”

- Danny Crichton, Stanford University Student