

# Curricular Content Principles

## ❖ Curricular Coherence

- Curricular Structure

## ❖ Curricular Focus

- Exposure Time (OTL)

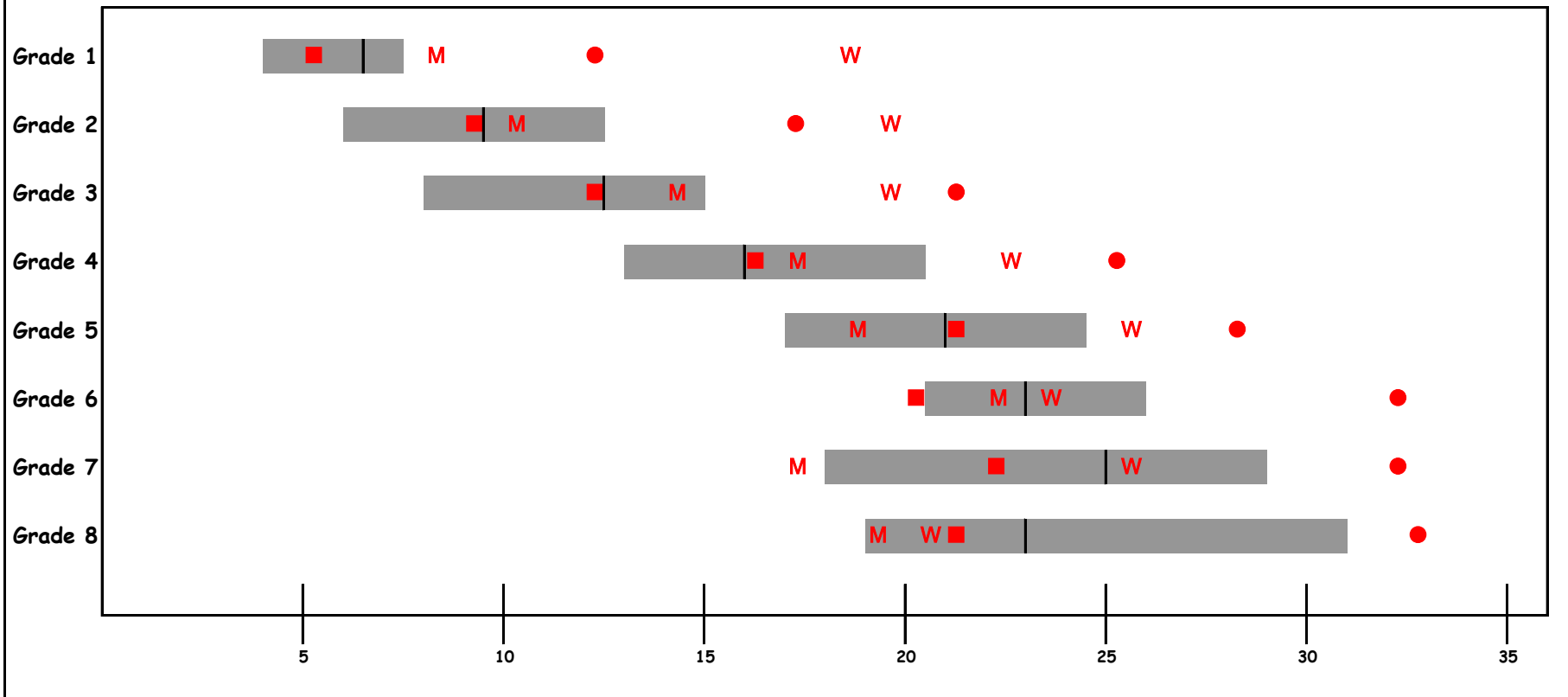
## ❖ Curricular Rigor

- Level of Cognitive Complexity

# Number of Mathematics Topics Intended in Grades 1-8


- Gray bars show how many mathematics topics were intended to be covered at each grade in the 1995 TIMSS countries.
- The bars extend from the 25th percentile to the 75th percentile.
- The black line indicates the median number of topics at each grade.
- Michigan Standards were included since they were developed to reflect international benchmarks.

- = Composite
- M = Michigan
- W = West Virginia, July 2008
- = Top Achieving Countries' Composite



# Mathematics Topics Intended in Grades 1-8 by Top Achieving Countries

Topic	Grade							
	1	2	3	4	5	6	7	8
Whole Number: Meaning	●	●	●	●	●			
Whole Number: Operations	●	●	●	●	●			
Measurement Units	●	●	●	●	●	●	●	
Common Fractions			●	●	●	●		
Equations & Formulas			●	●	●	●	●	●
Data Representation & Analysis			●	●	●	●	●	●
2-D Geometry: Basics			●	●	●	●	●	●
2-D Geometry: Polygons & Circles			●	●	●	●	●	●
Measurement: Perimeter, Area & Volume			●	●	●	●	●	●
Rounding & Significant Figures			●	●	●	●		
Estimating Computations			●	●	●	●		
Whole Numbers: Properties of Operations			●	●	●	●		
Estimating Quantity & Size			●	●	●	●		
Decimal Fractions			●	●	●	●		
Relation of Common & Decimal Fractions			●	●	●	●		
Properties of Common & Decimal Fractions					●	●		
Percentages					●	●		
Proportionality Concepts					●	●	●	●
Proportionality Problems					●	●	●	●
2-D Geometry: Coordinate Geometry					●	●	●	●
Geometry: Transformations						●	●	●
Negative Numbers, Integers, & Their Properties						●	●	●
Number Theory							●	●
Exponents, Roots & Radicals							●	●
Exponents & Orders of Magnitude							●	●
Measurement: Estimation & Errors							●	●
Constructions Using Straightedge & Compass							●	●
3-D Geometry							●	●
Geometry: Congruence & Similarity								●
Rational Numbers & Their Properties								●
Patterns, Relations & Functions								●
Proportionality: Slope & Trigonometry								●

Intended by more than half of the top-achieving countries 

# Mathematics Topics Intended at Grades 1-8 by West Virginia

Mathematics Topics	Grades							
	G1	G2	G3	G4	G5	G6	G7	G8
Whole Number: Meaning	●	●	●	●	●			
Whole Number: Operations	●	●	●	●	●			
Measurement: Units	●	●	●	●	●	●	●	
Common Fractions	●	●	●	●	●	●	●	
Equations & Formulas	●	●	●	●	●	●	●	●
Data Representation & Analysis	●	●	●	●	●	●	●	●
2-D Geometry: Basics		●	●	●	●	●	●	●
2-D Geometry: Polygons & Circles	●	●	●	●	●	●	●	●
Measurement: Length, Perimeter, Area, & Volume		●	●	●	●	●	●	●
Rounding & Significant Figures	●	●	●	●	●	●	●	●
Estimating Computations		●	●	●	●	●	●	●
Whole Number: Properties of Operations	●	●	●	●	●	●	●	●
Estimating Quantity & Size	●		●	●	●	●	●	●
Decimal Fractions			●	●	●	●	●	●
Relationships of Common & Decimal Fractions			●	●	●	●	●	●
Properties of Common & Decimal Fractions					●	●	●	●
Percentages					●	●	●	●
Proportionality Concepts				●	●	●	●	●
Proportionality Problems					●	●	●	●
1-D & 2-D Geometry: Coordinate Systems	●	●	●	●	●	●	●	●
Geometry: Transformations: includ'g Patterns, Symmetry	●	●	●	●	●	●	●	●
Negative Numbers, Integers & Their Properties					●	●	●	●
Number Theory: Primes & Factorization; Even/Odd	●	●			●	●	●	●
Exponents, Roots, & Radicals					●	●	●	●
Orders of Magnitude & Scientific Notation						●	●	●
Measurement: Estimation & Errors	●	●	●	●	●	●	●	●
Constructions w/Straightedge & Compass							●	●
3-D Geometry	●	●	●	●	●	●	●	●
Congruence & Similarity	●	●		●	●	●	●	●
Rational Numbers & Their Properties							●	●
Patterns, Relations & Functions	●	●	●	●	●	●	●	●
Slope & Right Triangle Trigonometry							●	●

West Virginia Standards Objective ●  
 More than Half of Top Achieving Countries ■

# Mathematics Topics Intended at Each Grade by West Virginia

Mathematics Topic	Grades								Algebra I Geometry	Trigonometry Pre-Calculus	Algebra II Prob'y & Stat	Conceptual Math
	G1	G2	G3	G4	G5	G6	G7	G8				
Whole Number: Meaning	●	●	●	●	●							
Whole Number: Operations	●	●	●	●	●							
Measurement: Units	●	●	●	●	●	●	●					
Common Fractions	●	●	●	●	●	●	●					
Equations & Formulas	●	●	●	●	●	●	●	●	●	●	●	●
Data Representation & Analysis	●	●	●	●	●	●	●	●	●	●	●	●
2-D Geometry: Basics	●	●	●	●	●	●	●	●	●	●	●	●
2-D Geometry: Polygons & Circles	●	●	●	●	●	●	●	●	●	●	●	●
Measurement: Length, Perim, Area, & Vol	●	●	●	●	●	●	●	●	●	●	●	●
Rounding & Significant Figures	●	●	●	●	●	●	●	●	●	●	●	●
Estimating Computations	●	●	●	●	●	●	●	●	●	●	●	●
Whole Number: Properties of Operations	●	●	●	●	●	●	●	●	●	●	●	●
Estimating Quantity & Size	●	●	●	●	●	●	●	●	●	●	●	●
Decimal Fractions	●	●	●	●	●	●	●	●	●	●	●	●
Relationships of Common & Decimal Fractions	●	●	●	●	●	●	●	●	●	●	●	●
Properties of Common & Decimal Fractions	●	●	●	●	●	●	●	●	●	●	●	●
Percentages	●	●	●	●	●	●	●	●	●	●	●	●
Proportionality Concepts	●	●	●	●	●	●	●	●	●	●	●	●
Proportionality Problems	●	●	●	●	●	●	●	●	●	●	●	●
1-D & 2-D Geometry: Coordinate Systems	●	●	●	●	●	●	●	●	●	●	●	●
Geo: Transform'ns includ'g Patterns, Symmetry	●	●	●	●	●	●	●	●	●	●	●	●
Negative Numbers, Integers & Their Properties	●	●	●	●	●	●	●	●	●	●	●	●
Number Theory: Primes & Factoriz'n; Even/Odd	●	●	●	●	●	●	●	●	●	●	●	●
Exponents, Roots, & Radicals	●	●	●	●	●	●	●	●	●	●	●	●
Orders of Magnitude & Scientific Notation	●	●	●	●	●	●	●	●	●	●	●	●
Measurement: Estimation & Errors	●	●	●	●	●	●	●	●	●	●	●	●
Constructions w/Straightedge & Compass	●	●	●	●	●	●	●	●	●	●	●	●
3-D Geometry	●	●	●	●	●	●	●	●	●	●	●	●
Congruence & Similarity	●	●	●	●	●	●	●	●	●	●	●	●
Rational Numbers & Their Properties	●	●	●	●	●	●	●	●	●	●	●	●
Patterns, Relations & Functions	●	●	●	●	●	●	●	●	●	●	●	●
Slope & Right Triangle Trigonometry	●	●	●	●	●	●	●	●	●	●	●	●
Real Numbers & Their Properties	●	●	●	●	●	●	●	●	●	●	●	●
Validation & Justification	●	●	●	●	●	●	●	●	●	●	●	●
Structuring & Abstracting	●	●	●	●	●	●	●	●	●	●	●	●
Complex Numbers	●	●	●	●	●	●	●	●	●	●	●	●
Uncertainty & Probability	●	●	●	●	●	●	●	●	●	●	●	●
Infinite Processes	●	●	●	●	●	●	●	●	●	●	●	●
Change	●	●	●	●	●	●	●	●	●	●	●	●
Vectors	●	●	●	●	●	●	●	●	●	●	●	●
Systematic Counting	●	●	●	●	●	●	●	●	●	●	●	●
Binary Arithmetic & / or Other Number Bases	●	●	●	●	●	●	●	●	●	●	●	●
Linear Interpolation & Extrapolation	●	●	●	●	●	●	●	●	●	●	●	●
Matrices	●	●	●	●	●	●	●	●	●	●	●	●
Trigonometry & Analytic Geometry	●	●	●	●	●	●	●	●	●	●	●	●
Other Content	●	●	●	●	●	●	●	●	●	●	●	●

West Virginia Standards Objective ●  
More than Half of Top Achieving Countries ■

# Mathematics Topics Linked to Advanced Cognitive Demand Skills in West Virginia Objectives

Mathematics Topic	Grades								Algebra I Geometry	Trigonometry Pre-Calculus	Algebra II Prob & Stat	Conceptual Math
	G1	G2	G3	G4	G5	G6	G7	G8				
Whole Number: Meaning	○	○	○	○	○							
Whole Number: Operations	○	●	●	●	●	●	●					
Measurement: Units	○	●	●	●	●	●	●					
Common Fractions	○	○	○	○	○	○	○					
Equations & Formulas	○	○	○	○	○	○	○	○	○	○	○	○
Data Representation & Analysis	●	●	●	●	●	●	●	●	●	●	●	●
2-D Geometry: Basics	○	○	○	○	○	○	○	○	○	○	○	○
2-D Geometry: Polygons & Circles	●	○	○	○	○	○	○	○	○	○	○	○
Measurement: Length, Perim, Area, & Vol	○	○	○	○	○	○	○	○	○	○	○	○
Rounding & Significant Figures	○	○	○	○	○	○	○	○	○	○	○	○
Estimating Computations	○	○	○	○	○	○	○	○	○	○	○	○
Whole Number: Properties of Operations	○	○	○	○	○	○	○	○	○	○	○	○
Estimating Quantity & Size	○			○	○							
Decimal Fractions			○	○	○	○	○					
Relationships of Common & Decimal Fractions			○	○	○	○	○					
Properties of Common & Decimal Fractions			○	○	○	○	○					
Percentages				○	○	○	○			○		
Proportionality Concepts				○	○	○	○			○		
Proportionality Problems				○	○	○	○			○		
1-D & 2-D Geometry: Coordinate Systems	○	○	○	○	○	○	○	○	○	○	○	○
Geo: Transform'ns includ'g Patterns, Symmetry	○	○	○	○	○	○	○	○	○	○	○	○
Negative Numbers, Integers & Their Properties				○	○	○	○					
Number Theory: Primes & Factoriz'n; Even/Odd	○	○			○	○	○					
Exponents, Roots, & Radicals				○	○	○	○			○		
Orders of Magnitude & Scientific Notation					○	○	○					
Measurement: Estimation & Errors	○	○	○	○	○	○	○					
Constructions w/Straightedge & Compass	○	○	○	○	○	○	○					
3-D Geometry	○	○	○	○	○	○	○					
Congruence & Similarity	○	○		○	○	○	○					
Rational Numbers & Their Properties	○	○		○	○	○	○					
Patterns, Relations & Functions	○	○		○	○	○	○					
Slope & Right Triangle Trigonometry						○	○			○		
Real Numbers & Their Properties						○	○			○		
Validation & Justification						○	○			○		
Structuring & Abstracting	○											
Complex Numbers												
Uncertainty & Probability	○	○	○	○	○	○	○					
Infinite Processes			○	○	○	○	○					
Change												
Vectors												
Systematic Counting												
Binary Arithmetic & / or Other Number Bases												
Linear Interpolation & Extrapolation												
Matrices												
Trigonometry & Analytic Geometry												
Other Content												

WV Standards Objective w/Low Cognitive Demand ○  
 WV Standards Objective w/Advanced Cognitive Demand ●  
 More than Half of Top Achieving Countries

# Ratio of Grade 1-8 Mathematics Topics Associated with Advanced Cognitive Demand Skills to Total Topics Intended for Coverage in West Virginia Objectives

	Grades							
	G1	G2	G3	G4	G5	G6	G7	G8
<b>Advanced CD Links</b>	5	7	4	8	15	16	20	17
<b>Topics Intended</b>	19	20	20	23	26	24	26	21
<b>Advanced CD Ratio</b>	0.26	0.35	0.20	0.35	0.58	0.67	0.77	0.81

## Ratio of High School Course Mathematics Topics Associated with Advanced Cognitive Demand Skills to Total Topics Intended for Coverage in West Virginia Objectives

	Algebra I	Geometry	Trigonometry	Pre-Calculus	Algebra II	Prob'y & Stat	Conceptual Math
<b>Advanced CD Links</b>	<b>10</b>	<b>14</b>	<b>7</b>	<b>11</b>	<b>10</b>	<b>5</b>	<b>8</b>
<b>Topics Intended</b>	<b>13</b>	<b>14</b>	<b>14</b>	<b>13</b>	<b>13</b>	<b>5</b>	<b>10</b>
<b>Advanced CD Ratio</b>	<b>0.77</b>	<b>1.00</b>	<b>0.50</b>	<b>0.85</b>	<b>0.77</b>	<b>1.00</b>	<b>0.80</b>



# Intended Topic Coverage in West Virginia High School Courses (Slide 2)

Code Description	Algebra I	Geometry	Trigonometry	Pre-Calculus	Algebra II	Prob'y & Statistics	Conceptual Math
One & Two Dimension geometry: Coordinate geometry Line and coordinate graphs Equation of a line in the plane Conic sections and their equations	● ● ●	●	●	●	● ●		
Points, lines, segments, rays, angles, and planes Angles Parallelism and perpendicularity Two dimension geometry: Polygons and circles		● ● ●			●		●
Triangles, quadrilaterals: classification and properties Pythagorean Theorem and applications Other polygons and their properties Circles and their properties		● ● ● ●	●				●
Three dimensional geometry 3-Dimensional shapes and surfaces and their properties Spatial perception and visualization Vectors		● ●	●	●			●
Patterns, tessellations, friezes, stencils, etc. Symmetry Transformations Isometries and congruence		● ● ● ●		●	●		●
Similarities, similar triangles, and their properties Constructions using ruler and compasses		● ●					
Validation and Justification Conditional statements and equivalence of statements Direct deductive proofs	●	● ●					
Indirect proofs and proof by contradiction Proof by induction Sets, set notation, and set combinations		● ● ●		●			
							Geometry
							Proofs, Axioms, Set Theory

# Intended Topic Coverage in West Virginia High School Courses (Slide 3)

Code_Description	Algebra I	Geometry	Trigonometry	Pre-Calculus	Algebra II	Prob'y & Statistics	Conceptual Math
Slope and gradient in straight line graphs	●	●					
Trigonometry of right-angled triangles		●	●				●
Linear interpolation and extrapolation	●						
Number Patterns	●				●		●
Recursion					●		
Linear functions					●		●
Quadratic functions					●		●
Logarithmic and exponential functions				●	●		●
Trigonometric functions			●				
Functions and their properties			●	●	●		
Representation of relations and functions	●			●	●		
Families of functions: graphs and properties					●		
Operations on functions					●		
Related functions (inverse, derivatives, etc.)			●	●	●		
Interpretation of function graphs							●
Representation of numerical situations	●		●	●	●	●	
Solution of equations reducing to quadratics	●			●	●		
Inequalities and their graphical representation	●				●		
Systems of equations	●				●		
Systems of inequalities					●		
Substituting into or rearranging formulas	●	●	●				●
The general equation of the second degree: conics				●	●		
Operations with expressions	●			●			
Equivalent expressions (factorization and simplification)	●				●		
Linear equations and their formal (closed) solutions	●				●		
Quadratic equations and their formal (closed) solutions	●				●		
Polynomial equations and their solutions	●			●	●		
Trigonometrical equations and identities			●				
Logarithmic and exponential equations and their solutions				●			

Algebra

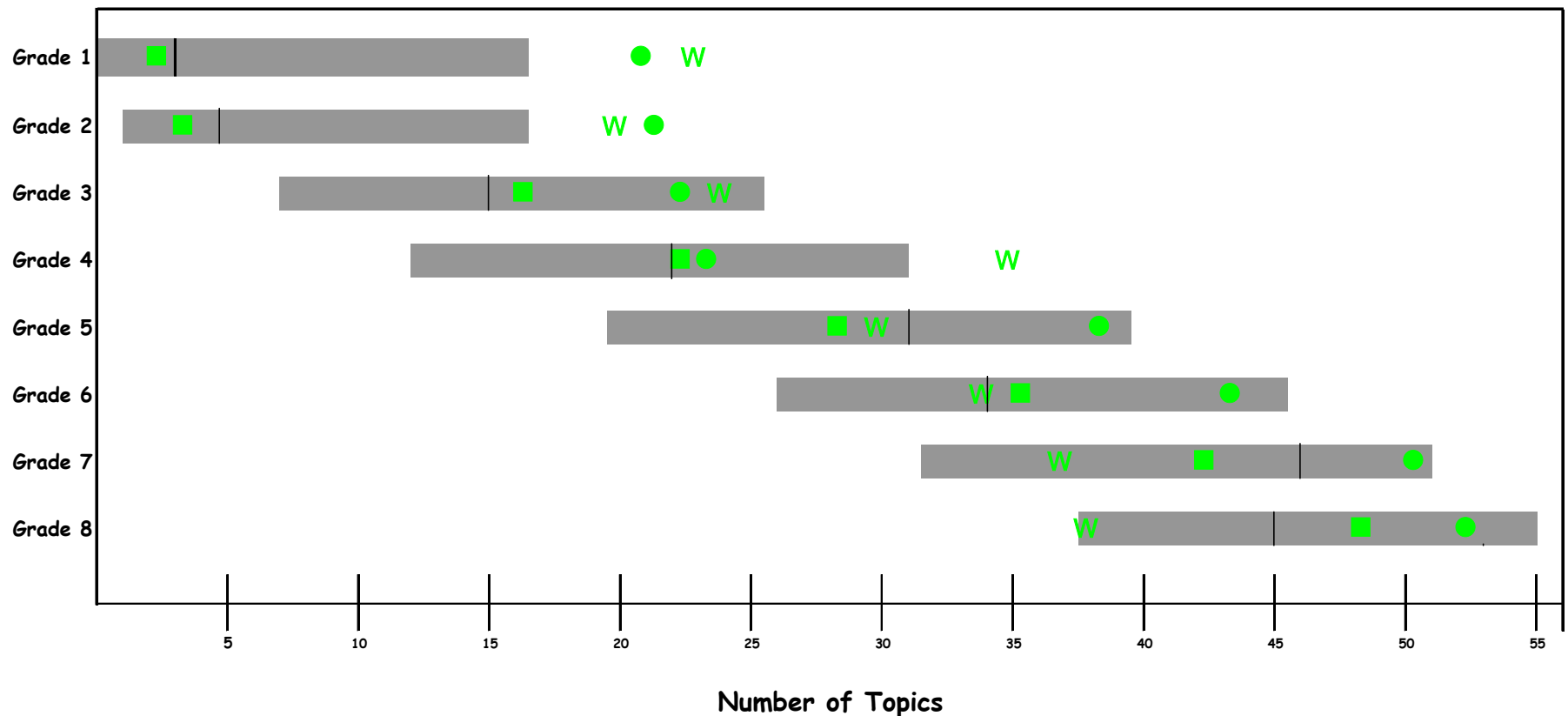
# Intended Topic Coverage in West Virginia High School Courses (Slide 4)

Code_Description	Algebra I	Geometry	Trigonometry	Pre-Calculus	Algebra II	Prob'y & Statistics	Conceptual Math	
Trigonometry & Analytic Geometry			●					Trigonometry
Angle measures: radians & degrees			●					
Law of sines and cosines			●					
Unit circle and trigonometric functions			●					Trigonometry
Parametric equations				●				
Polar coordinates			●					
Polar equations & their graphs			●					Elementary Analysis
Arithmetic and geometric sequences				●	●			
Arithmetic and geometric series				●				
Binomial Theorem				●				Elementary Analysis
Limits and convergence of series				●				
Limits and convergence of functions				●				
Growth and Decay	●							Elementary Analysis
Data Representation and Analysis							●	
Collecting data from experiments and simple surveys	●		●				●	
Correlations and other measures of relations						●		Probability & Statistics
Use and misuse of statistics								
Representing data	●		●			●	●	
Interpret tables, charts, plots and graphs	●		●			●	●	Probability & Statistics
Measures of central tendency			●			●	●	
Measures of dispersion			●			●	●	
Sampling, randomness and bias						●		Probability & Statistics
Prediction and inferences from data	●		●			●	●	
Fitting lines and curves to data	●			●	●	●	●	
Informal likelihoods and the vocabulary of likelihoods						●		Probability & Statistics
Sampling	●					●		
Hypothesis testing			●			●		
Bivariate distributions						●		Probability & Statistics
Numerical probability and probability models	●					●	●	
Counting principles						●	●	
Probability distributions for discrete random variables						●		Probability & Statistics
Probability distributions for continuous random variables	●					●	●	

# Number of Science Topics Intended in Grades 1-8

- Gray bars show how many science topics were intended to be covered at each grade in the 1995 TIMSS countries.
- The bars represent the middle 50 percent of 1995 TIMSS countries.
- The black line indicates the median number of topics at each grade.

● = U.S. Composite  
 W = West Virginia, July 2008  
 ■ = Top Achieving Countries' Composite



# Science Topics Intended at Each Grade by Top Achieving Countries

Topics	Grade							
	1	2	3	4	5	6	7	8
Organs, Tissues			•	•	•	•	•	•
Physical Properties of Matter			•	•	•	•	•	•
Plants, Fungi			•	•	•	•	•	•
Animals			•	•	•	•	•	•
Classification of Matter			•	•	•	•	•	•
Rocks, Soil			•	•	•	•	•	•
Light			•			•	•	•
Electricity				•		•	•	•
Life Cycles				•	•	•	•	•
Physical Changes of Matter				•	•	•	•	•
Heat & Temperature				•	•	•	•	•
Bodies of Water				•	•	•	•	•
Interdependence of Life					•	•	•	•
Habitats & Niches					•	•	•	•
Biomes & Ecosystems					•	•	•	•
Reproduction					•			•
Time, Space, Motion					•	•	•	•
Types of Forces					•	•	•	•
Weather & Climate					•	•	•	•
Planets in the Solar System					•	•	•	•
Magnetism						•	•	•
Earth's Composition						•	•	•
Organism Energy Handling						•	•	•
Land, Water, Sea Resource Conservation						•	•	•
Earth in the Solar System						•	•	•
Atoms, Ions, Molecules							•	•
Chemical Properties of Matter							•	•
Chemical Changes of Matter							•	•
Physical Cycles							•	•
Land Forms							•	•
Material & Energy Resource Conservation							•	•
Explanations of Physical Changes							•	•
Pollution							•	•
Atmosphere							•	•
Sound & Vibration							•	•
Cells							•	•
Human Nutrition							•	•
Building & Breaking								•
Energy Types, Sources, Conversions								•
Dynamics of Motion								•
Organism Sensing & Responding								•

Intended by more than half of the top achieving countries 

# Science Topics Intended at Grades 1-8 by West Virginia

Topic	Grades							
	1	2	3	4	5	6	7	8
Organs, tissues	●	●	●	●	●	●	●	●
Physical properties of matter	●	●	●	●	●	●	●	●
Plants, fungi	●		●	●	●	●	●	●
Animal types	●				●	●	●	●
Classification of matter	●				●	●	●	●
Rocks, soil	●		●	●	●	●	●	●
Light		●	●	●	●	●	●	●
Electricity			●	●	●	●	●	●
Life cycles	●	●	●	●	●	●	●	●
Physical changes of matter	●	●	●	●	●	●	●	●
Heat & temperature		●	●	●	●	●	●	●
Bodies of water	●		●	●	●	●	●	●
Interdependence of life	●		●	●	●	●	●	●
Habitats & niches		●		●	●	●	●	●
Biomes & ecosystems					●	●	●	●
Reproduction					●	●	●	●
Time, space, motion	●		●	●	●	●	●	●
Types of forces					●	●	●	●
Weather & climate	●	●		●	●	●	●	●
Planets in the solar system	●		●	●	●	●	●	●
Magnetism	●	●		●	●	●	●	●
Earth's Composition			●		●	●	●	●
Organism energy handling					●	●	●	●
Land, water, sea resource conservation					●	●	●	●
Earth in the solar system	●	●	●	●	●	●	●	●
Atoms, ions, molecules				●	●	●	●	●
Chemical properties of matter			●	●	●	●	●	●
Chemical changes of matter				●	●	●	●	●
Physical cycles				●	●	●	●	●
Land forms	●		●		●	●	●	●
Material & energy resource conservation	●				●	●	●	●
Explanations of physical changes				●	●	●	●	●
Pollution							●	●
Atmosphere	●				●	●	●	●
Sound & vibration	●	●		●	●	●	●	●
Cells					●	●	●	●
Human nutrition							●	●
Building & breaking		●	●	●	●	●	●	●
Energy types, sources, conversions			●	●	●	●	●	●
Dynamics of motion	●	●	●	●	●	●	●	●
Organism sensing & responding							●	●

West Virginia Standards Objective ●  
More than Half of Top Achieving Countries ■

# Science Topics Linked to Advanced Cognitive Demand Skills in West Virginia Objectives

Topic	Grades							
	1	2	3	4	5	6	7	8
Organs, tissues	○	○	○	○	○	○	●	●
Physical properties of matter	○	○	○	○	○	○	○	○
Plants, fungi	○	○	○	○	○	●	○	●
Animal types	○	○	○	○	○	●	○	○
Classification of matter	○	○	○	○	○	●	○	○
Rocks, soil	○	○	○	○	○	○	●	●
Light	○	○	○	○	○	○	○	○
Electricity	○	○	○	○	○	○	○	○
Life cycles	○	○	○	○	○	○	○	○
Physical changes of matter	○	○	○	○	○	○	○	○
Heat & temperature	○	○	○	○	○	○	○	○
Bodies of water	●	○	○	○	○	○	○	○
Interdependence of life	○	○	○	○	○	○	○	○
Habitats & niches	○	○	○	○	○	○	○	○
Biomes & ecosystems	○	○	○	○	○	○	○	○
Reproduction	○	○	○	○	○	○	○	○
Time, space, motion	○	○	○	○	○	○	○	○
Types of forces	○	○	○	○	○	○	○	○
Weather & climate	○	○	○	○	○	○	○	○
Planets in the solar system	○	○	○	○	○	○	○	○
Magnetism	○	○	○	○	○	○	○	○
Earth's Composition	○	○	○	○	○	○	○	○
Organism energy handling	○	○	○	○	○	○	○	○
Land, water, sea resource conservation	○	○	○	○	○	○	○	○
Earth in the solar system	○	○	○	○	○	○	○	○
Atoms, ions, molecules	○	○	○	○	○	○	○	○
Chemical properties of matter	○	○	○	○	○	○	○	○
Chemical changes of matter	○	○	○	○	○	○	○	○
Physical cycles	○	○	○	○	○	○	○	○
Land forms	○	○	○	○	○	○	○	○
Material & energy resource conservation	○	○	○	○	○	○	○	○
Explanations of physical changes	○	○	○	○	○	○	○	○
Pollution	○	○	○	○	○	○	○	○
Atmosphere	○	○	○	○	○	○	○	○
Sound & vibration	○	○	○	○	○	○	○	○
Cells	○	○	○	○	○	○	○	○
Human nutrition	○	○	○	○	○	○	○	○
Building & breaking	○	○	○	○	○	○	○	○
Energy types, sources, conversions	○	○	○	○	○	○	○	○
Dynamics of motion	○	○	○	○	○	○	○	○
Organism sensing & responding	○	○	○	○	○	○	○	○

WV Standards Objective w/ Low Cognitive Demand ○  
 WV Standards Objective w/ Advanced Cognitive Demand ●  
 More than Half of Top Achieving Countries

## Ratio of Grade 1-8 Science Topics Associated with Advanced Cognitive Demand Skills to Total Topics Intended for Coverage in West Virginia Objectives

	Grades							
	1	2	3	4	5	6	7	8
<b>Advanced CD Links</b>	2	1	4	7	4	9	6	18
<b>Total Topics Covered</b>	23	20	24	35	30	34	37	38
<b>Advanced CD Ratio</b>	0.09	0.05	0.17	0.20	0.13	0.26	0.16	0.47

**West Virginia Mathematics Objectives – Effective July 2008:  
Highlights of Content and Performance Expectation Analysis**

- At first glance, West Virginia’s intended curriculum appears cluttered, with an abundance of topics introduced in the early grades, before their time, and continued into middle school and at least a portion of the high school courses. The mathematics curriculum appears to lack coherence and a reasoned, well developed structure that reflects the hierarchical nature of mathematics.
- Several topics are intended to be introduced in the early grades (grades one through three) that internationally at least four of the six top achieving countries first introduce in upper elementary or middle school grades (grades five through eight). These include: Coordinate Systems; Transformations including Patterns and Symmetry; Measurement: Estimation and Errors; 3-D Geometry; Congruence and Similarity; Patterns, Relations and Functions. Another topic – Uncertainty and Probability – is first introduced in the tenth grade by a majority of the top achieving countries, but at grade one in West Virginia.
- The intended coverage of content related to Number Theory in the early grades – grades one, two, five and six – but not again after grade six, is an indication that what is covered is not at a level sophisticated enough to promote a deeper understanding of number theory that is required for middle school and high school course work.
- It is noteworthy that similarly to what the top achieving countries intend West Virginia discontinues coverage of several topics beginning in the early middle school years (grade six) and throughout the middle school grades. These topics are related to whole numbers, fractions and decimals.
- A majority of the top achieving countries intend to cover Constructions with Straightedge and Compass in grades seven and eight but West Virginia covers this topic only in high school Geometry.
- The language in the objectives leads one to believe that West Virginia students are expected to work with mathematics content at cognitive demand levels beyond what is seen in most curricular documents.
  - Overall, 60% of topics intended across all grades are linked to advanced cognitive demand skills – which require problem solving and reasoning.
  - The proportion of topics linked to advanced cognitive demand skills at each grade level tends to increase across the grades, from about 25% in grade one to over 80% in grade eight.
  - Objectives that require reasoning skills as part of cognitive demand are first introduced in grade two. Reasoning, particularly justifying, also becomes a more

predominant part of the required advanced cognitive skills as a student advances from grade two to grade eight.

- Given that the ability to think abstractly does not begin to develop until the middle grades, and develops later in many students, the predominance of content linked to reasoning is surprising. A few examples of this from the West Virginia document are provided on the next page.
- Intended topic coverage in high school courses offers no surprises. All courses carry a high concentration of content areas in their discipline. And Algebra II has more coverage of complex numbers, rational numbers and functions than Algebra I, which is also expected.

## West Virginia Mathematics Objectives: A Bit More on Cognitive Demand

As part of document analyses, what students are expected to do with content is thought about in terms of two levels of cognitive demand skills. The low level includes skills that require students to recall facts or definitions, recognize or identify, perform routine calculations, estimate, classify and compare. The advanced level requires students to problem solve and reason. Problem solving includes using a variety of strategies to problem solve, developing strategies and predicting. Reasoning includes developing algorithms, describing solution procedures, generalizing, conjecturing, justifying, proving, and axiomatizing.

Several examples of the rigor of the cognitive demand, directly from the West Virginia objectives follow.

### Grade 1

M.O.1.5.2: conduct simple experiments, record data on a tally chart or table and use the data to **predict** which of the events is more likely or less likely to occur if the experiment is repeated.

M.O.1.2.4: create and **analyze** number patterns based on real-life situations using words, AB form and T-charts and present results.

### Grade 2

M.O.2.1.8: model and **justify** the relationship between addition and subtraction (e.g., identity element of addition, associative property, commutative property, inverse operations, fact families).

M.O.2.1.13: create story problems that require one or two-step procedures, **using a variety of strategies** explain the reasoning used, **justify** the procedures selected and present the results.

### Grade 3

M.O.3.4.3: **determine the formula** of the area of a rectangle and explain reasoning through modeling.

M.O.3.2.1: **analyze** and **extend** geometric and numeric patterns.

### Grade 4

M.O.4.1.3: estimate solutions to problems including rounding, benchmarks, compatible numbers and evaluate the reasonableness of the solution, **justify** results.

M.O.4.1.8: solve multi-digit whole number multiplication problems **using a variety of strategies**, including the standard algorithm, **justify** methods used.

M.O.4.3.7: select, analyze and **justify** appropriate use of transformations (translations, rotations, flips) to solve geometric problems including congruency and tiling (tessellations).

### **Grade 5**

M.O.5.1.4: **use inductive reasoning** to identify the divisibility rules of 2, 3, 5, 9, and 10 and apply the rules to solve application problems.

M.O.5.1.7: analyze and solve application problems and **justify** reasonableness of solution in problems involving addition and subtraction of:

- fractions and mixed numbers
- decimals.

M.O.5.2.1: **use inductive reasoning** to find missing elements in a variety of patterns (e.g., square numbers, arithmetic sequences).

### **Grade 6**

M.O.6.1.9: **develop and test hypotheses to derive the rules** for addition, subtraction, multiplication and division of integers, **justify** by using real-world examples and use them to solve problems.

M.O.6.2.2: **use inductive reasoning** to extend patterns to predict the nth term (e.g., powers and triangular numbers).

M.O.6.3.2: **use inductive reasoning** with the measures of interior angles in polygons and **derive the formula** to determine the sum of the measures of the interior angles.

M.O.6.4.4: **develop strategies** to determine volume of cylinders; solve real-world problems involving volume of cylinders, **justify** results.

## **West Virginia Science Objectives – Effective July 2008: Highlights of Content and Performance Expectation Analysis**

- Intended topic coverage appears to be scattered and not coherent compared to the composite of the majority of top achieving countries. The curriculum lacks the structure that is required to allow for the development of concepts as they relate to science themes.
- Too many topics are intended to be covered in the early grades. Too few are intended for coverage in the middle school grades. With the abundance of topics intended for coverage in grades one through four, there is little opportunity to develop any deep understanding of science content.
- Some topics are intended for coverage too early, before their time, and then dropped from coverage, and therefore never developed. Two examples of this are: Magnetism; and Explanations of physical changes. Magnetism is intended in grades one, two, four and five. Explanations of physical changes is covered in grade four only. Content related to these topics should be included in the curriculum during the middle grades so that students can establish a foundation of knowledge that will enable them to grasp more complex ideas related to chemistry and physics when they reach high school.
- Though intended on and off throughout the first eight grades, other topics are just introduced too early in the curriculum. Examples of topics that are introduced in grade one: Dynamics of motion (buoyancy and the effects of force on motion); Time, space and motion (changes in motion); and Classification of matter.
- Some topics are intended for coverage in seven or eight of the eight grades analyzed: Organs, tissues; Life cycles; Interdependence of life; Sound and vibration; Weather and climate; Earth in the solar system.
- Others are not specifically mentioned as intended for coverage in any of the eight grades: Biomes and ecosystems; Human nutrition.
- Over 20% of the topics that are intended for coverage are linked to performance expectations requiring advanced cognitive demand skills.

### **Cognitive Demand in the Science Curriculum**

Similarly to the mathematics analysis, what students are expected to do with content is thought about in terms of two levels of cognitive demand skills. The low level includes skills that require students to: recall facts or definitions; recognize or identify; understand simple and more complex information about science; use tools; conduct routine experiments; gather, organize, represent data; access and process information; and communicate results. The advanced level requires students to: theorize, analyze, and solve problems; construct, interpret, and apply models; make decisions using scientific skills and knowledge; interpret data; and formulate conclusions based on data.