

# A Review of Changes in the Alabama Course of Study Based upon Adoption of the Common Core State Standards

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## Abstract

In November of 2010, the State of Alabama adopted the Common Core State Standards to direct the Alabama Course of Study for Mathematics. In Spring of 2011, the State Department of Education published the new Alabama Course of Study. This article reviews the new document and draws attention to significant changes at the High School level.

## 1 The Common Core

On November 18, 2010, the state of Alabama adopted the Common Core State Standards CCSS-M (2010), which were developed by teachers, administrators, and education experts across the nation in a state led effort to improve and define education expectations nationwide. Despite common misconception, the CCSS do not provide a national curriculum but rather the standards provide guidance of what students are expected to learn. However, it is the states' responsibility to decide how to implement and meet the standards. After comparing effective models from across the country, the Common Core State Standards Initiative now provides consistent standards to prepare students for success in college courses and in the workplace. Standards were also examined through an international scope to increase students' success in the global economy. While the CCSS provide the minimum standards that should be met they also allow for states to include additional content.

Alabamas adoption of the CCSS has led to the development of a new course of study based upon the Principles for School Mathematics developed by the National Council of Teachers of Mathematics (NCTM) 2000. The secondary mathematics standards within the CCSS describe procedural skills but emphasize conceptual understanding through higher-order thinking and application. To ensure college and career readiness, students must use mathematics to analyze and model real-world situations. The mathematics standards provide teachers a clear and specific understanding of what should be taught in the classroom while allowing them flexibility and creativity for implementation.

With Alabama's new course of study, which is based upon the CCSS, teachers need to have an understanding of the major changes in the new course of study in order to modify and improve instruction. After analyzing both the old and new Alabama courses of study, we will highlight the major changes in Algebra I, Geometry, and Algebra II with Trigonometry as well as provide updated examples below.

## 2 Algebra I

### 2.1 Modeling

The first major change in the Algebra I content standards is the overarching influence of modeling. Modeling is the process of choosing and using appropriate mathematics and statistics to analyze empirical situations, to understand them better, and to improve

decisions. In the previous course of study, the content standards heavily focused on procedural skills rather than conceptual applications of these skills. As a result, the Alabama High School Graduation Exam (AHSGE) focuses primarily on skills. However, with the new course of study, we can expect to see a shift toward more conceptual understanding assessed. Modeling allows students to relate the mathematics learned in the classroom to real-world concepts and decision-making. It is important to note that modeling is not one specific content standard, rather it should be incorporated throughout the entirety of Algebra I.

The following is a modeling example that would assess content standard 27 that states, “For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship.” ALDOE (2010)

### Example 1

Read the following situation, draw an example of what the graph would look like and explain your reasoning. Do not forget to label your axes.

Caroline leaves her house and walks to the school bus stop. When she arrives, she sees the bus has already left. She then runs to the next stop. While she is running, she trips, falls, and drops all of her belongings; she must stop running to gather her things and tie her shoelace. After that, she turns around to walk home and ask her mom for a ride to school. Her mom then drives her all the way to school without stopping.

## 2.2 Explaining and Creating Concepts

Another major change in the new course of study is evident when measuring students understanding of equations and functions. In the previous course of study, students simply had to procedurally solve equations and determine properties of functions.

Teachers would teach this standard by giving students a list of algebraic equations to solve, never asking them to conceptually create or analyze equations and inequalities. However, with the new influence of the CCSS, students must create equations and functions and then use their creations to solve problems. When given relationships between two quantities, students must create equations, graphs, and then explain the meaning of the algebraic and graphical representation of the relationship.

In the following example, students must create an inequality when given a verbal description, described in content standard 11, “Create equations and inequalities in one variable, and use them to solve problems.” ALDOE (2010)

### Example 2

Create an inequality for the following situation and then solve the given problem:

John received \$75 from his parents for his birthday. He earns \$5.50 each week for doing his chores around the house. Since his birthday, he has saved more than \$150 to buy a new bicycle. How many weeks ago was his birthday?

## 2.3 Functions

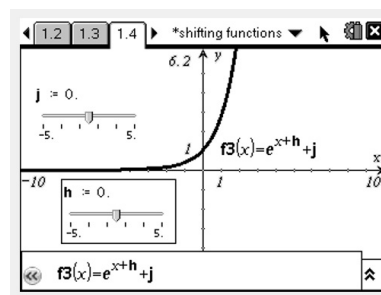
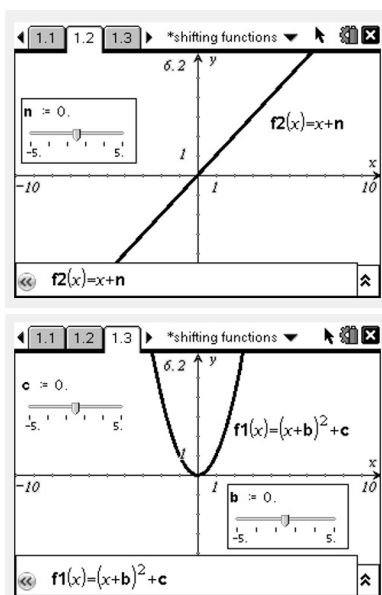
The majority of changes within the new Alabama course of study reflect a deeper and more conceptual understanding of functions. In previous courses of study, students analyzed linear functions through the scope of finding slope and intercepts of a line. In addition, students constructed basic graphs and determined properties of a function in both algebraic and graphical ways. However, the CCSS now incorporates an expanded and more conceptual understanding of functions revolving around modeling and the use of technology to deepen content understanding. Students are now asked to build new functions from existing functions by using translations and understanding of inverse functions. In addition, the new Algebra I course of study pushes students to explore quadratic functions, exponential functions, and other basic functions. Students must distinguish between certain situations modeled by these different

basic functions and must prove and construct functions given graphs or verbal descriptions.

The following is an example that asks students to recognize types of functions and investigate the effects of translating functions using technology, such as the TI-Nspire CAS. The activity can be modified with other TI graphing tools. This activity satisfies content standard 35, which states, “Identify the effect on the graph of replacing  $f(x)$  by  $f(x) + k$ ,  $kf(x)$ ,  $f(kx)$ , and  $f(x + k)$  for specific values of  $k$  (both positive and negative); find the value of  $k$  given the graphs. Experiment with cases and illustrate an explanation of the effects on the graph using technology. Include recognizing even and odd functions from their graphs and algebraic expressions for them.” ALDOE (2010)

### Example 3

For each graph, record what type of function it represents. Next, translate each function at least eight times by using the slider and record your observations. Finally determine how changes to the graph also change the equation of the function, and explain what you have observed.



## 3 Geometry

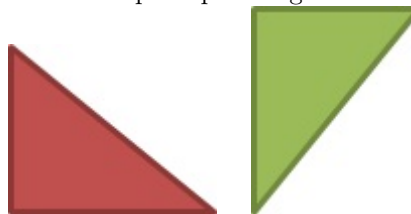
### 3.1 Transformations

The first major change in the Geometry content standards is experimentation with transformations in the plane. Transformations are focused on in the first five content standards of the new course of study based off the CCSS. In the new course of study, students are expected to understand the definitions of transformations, recognize transformations, and perform transformations. In the previous course of study, transformations are not mentioned. Not only are transformations an important concept for students to understand in Geometry, but it is also an important topic to enhance students understanding of congruence through rigid motions. It is important to note that students should perform transformations in a variety of ways including dynamic geometry software such as Geometers Sketchpad.

The following is a transformation example that would assess a portion of content standard five, which states, “Specify a sequence of transformations that will carry a given figure onto another.” ALDOE (2010)

### Example 4

Identify a sequence of transformations that would map the pre-image to the image.



### 3.2 Proofs

The second major change in the Geometry course of study is the emphasis on proofs. While proofs were briefly mentioned in the old Alabama Course of Study, now proofs are a standard for almost every topic in Geometry. The rationale behind the importance of proofs in Geometry is that by writing and solving proofs, students enhance their critical thinking skills as well as have a better understanding of Geometrical concepts (ALDOE, 2010, p. 98). It is important to note that the new course of study recognizes that there are multiple ways to write proofs; furthermore, the new course of study encourages students to write proofs in multiple ways.

The following example assesses the students understanding of rigid motions and congruence in triangles. It also is a good way to introduce the concept of proofs to students. Example 4 assesses the student's ability to prove theorems about triangles as stated in content standard number 10 ALDOE (2010).

#### Example 5

*Given:*  $\overline{AB} \cong \overline{DB}$  and  $C$  is the midpoint of  $\overline{AD}$

*Prove:*  $\triangle ABC \cong \triangle DBC$

Statements:	Reasons:
1. $\overline{AB} \cong \overline{DB}$	Given
2. $C$ is midpoint of $\overline{AD}$	Given
3. $\overline{AC} \cong \overline{CD}$	Definition of Midpoint
4. $\overline{BC} \cong \overline{BC}$	Reflexive Property
5. $\triangle ABC \cong \triangle DBC$	Side-Side-Side Congruence.

### 3.3 Constructions

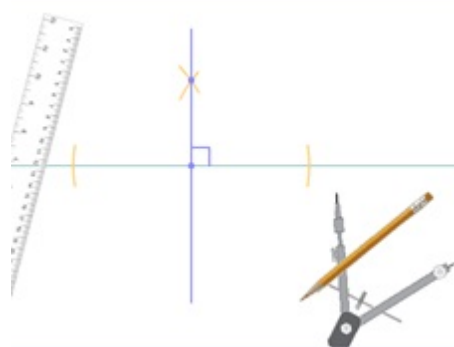
Another major change from the old course of study to the new course of study based on the CCSS is the importance of constructions in Geometry. Previously, the course of study did not mention constructions. In the new course of study, constructions mentioned in content standards numbers 12 and 13. Furthermore, in the new construction content standards, students are required to perform a variety of constructions

with multiple types of tools including dynamic geometry software such as Geometers Sketchpad.

The following is a construction example that would assess a portion of content standard 12, which states, "Make formal geometric constructions with a variety of tools and methods such as compass and straight-edge, string, reflective devices, paper folding, and dynamic geometric software" ALDOE (2010). Students could have the opportunity to make this construction in a variety of ways; two ways are shown below.

#### Example 6

Construct a pair of lines that are perpendicular.



Construction with pencil, ruler, and compass (From [www.mathisfun.com](http://www.mathisfun.com))

GeoGebra Applet showing construction

## 4 Algebra II with Trigonometry

### 4.1 Complex Numbers

After analyzing the new common core standards, it is obvious that Algebra II with Trigonometry is designed to enhance and deepen the conceptual understanding and skills that are assessed in Algebra I. The first major change in the new course of study compared to previous works is the application of complex numbers. Previously, students created Venn diagrams to sketch a surface-level understanding of the set of complex numbers and then simplify algebraic expressions involving complex numbers. Students were not asked to apply complex numbers to

the algebraic skills that they learned in previous Algebra courses. However, with the adoption of the common core, students now use complex numbers to solve quadratic equations, extend polynomial identities, and use the Fundamental Theorem of Algebra (ALDOE, 2010, p. 112).

The following are three examples involving complex numbers, which would assess a student's ability to apply complex numbers to algebraic situations, following content standard number 3, which states, "Solve quadratic equations with real coefficients that have complex solutions." (ALDOE, 2010, p. 112)

#### Example 7

1. Solve the equation. Use substitution to check your solutions. Label each solution as real, imaginary, and/or complex.

$$x^2 + x = -1$$

2. For an equation  $ax^2 + bx + c = 0$ , what is the relationship between  $a$ ,  $b$ , and  $c$  for the equation to have
  - (a) one real solution
  - (b) two real solutions
  - (c) two complex solutions
3. Can  $1 + i$  and  $1 - i$  be solutions to an equation  $ax^2 + bx + c = 0$  with real coefficients. Explain your reasoning.

## 4.2 Specific Trigonometry

Another major change in the new course of study revolves around specific skills and concepts associated with Trigonometry. Previously, trigonometric concepts were spread across the entire course of study, providing teachers with non-specific standards that were assessed in a variety of ways. However, the new course of study outlines the trigonometric concepts in five specific standards. Students now must prove and apply trigonometric identities and conceptually understand and explain trigonometry according to the unit circle. In addition, modeling trigonometric functions has been implemented into the new course of study, pushing students to apply conceptual and procedural knowledge to solve real-world problems.

The following is an example of modeling with trigonometric functions, following content standard number 35, which states, "Choose trigonometric functions to model" (ALDOE, 2010, p. 116).

#### Example 8

Two swimmers are competing in a swim competition. Spectators argue over whether Swimmer 1 or Swimmer 2 gets a better start off the blocks. Swimmer 1 makes a  $25^\circ$  angle of elevation with the water and Swimmer 2 makes a  $29^\circ$  angle of elevation with the water. The starting blocks are 3 feet high. Does Swimmer 1 or Swimmer 2 get the better start? Explain your reasoning.

## 4.3 Creating Equations and Functions

Similar to the changes made for Algebra I, the new course of study deepens students' conceptual understanding of solving equations and analyzing functions by asking students to create equations and functions given certain descriptions or characteristics. Students must now explain their reasoning for solving an equation and then use these methods of reasoning to flexibly create functions and/or equations, working backwards. Previously, students were assessed by their ability to determine characteristics of functions and perform operations on already given equations. However, now students must use their knowledge to create equations and functions and then solve problems using these functions. Because of these application-based problems, students must analyze functions from a variety of representations, including graphically, numerically, and algebraically.

In the following example, students are given an expression and asked to write a function in different terms that is still equivalent to the expression. This example follows content standard 26, which states, "Write a function defined by an expression in different but equivalent forms to reveal and explain different properties of the function." (ALDOE, 2010, p. 115).

**Example 9** (Modified from Key Curriculum Press-Adv. Algebra)

The following rectangle diagram represents an algebraic expression. What equation does the diagram demonstrate? What properties do you know are true of the following equation?

	$x$	5
$2x$	$2x^2$	$10x$
1	$x$	5

## 5 Conclusion

With the adoption of the new Alabama course of study, teachers must have the knowledge of how the Common Core State Standards should and will affect their instruction in the classroom. Because the new course of study emphasizes conceptual understanding and modeling of real world situations, teachers must alter their lesson plans to focus on the application of mathematical concepts. Rather than simply focus on the mathematical content standards, teachers must also connect the standards for mathematical practice as stated by the CCSS. The standards for practice involve the application of content standards by pushing students to make sense of problems and persevere in solving them, reason abstractly and quantitatively, construct viable arguments and critique the reasoning of others, model with mathematics, use appropriate tools strategically, attend to precision, look for and make use of structure, and look for and express regularity in repeated reasoning. As shown in the previous examples, teachers can be flexible and creative when planning lessons while still meeting the content standards and standards for mathematical practice that are reflected in the new Alabama course of study.

## References

ALDOE (2010). Alabama course of study: Mathematics. Retrieved August 1, 2011 from

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