**STATE OF SOUTH CAROLINA**
**DEPARTMENT OF EDUCATION**

# Geometry with Statistics Before Algebra 1

## The Research Behind the Switch

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## The Research

Traditionally the mathematics pathway for South Carolina began with Algebra 1 as the gateway course. Upon successful completion students would then transition to Geometry then Algebra 2 and on to Probability and Statistics or another high-level mathematics course. The 2025 South Carolina College and Career-Ready Mathematics progression has Geometry with Statistics as the introductory course prior to Algebra 1. Why the shift?

The Geometry with Statistics course is intended to be taught at a conceptual level of learning. Daniel Pink (2005) author of "A Whole New Mind" states that we all live in a conceptual age. This conceptual age requires learners no longer to rely on the knowledge of one particular content specialist. Rather, it requires learners to think critically, be problem-solvers, and adapt to new environments by transferring ideas. Hart Research Associates (2013) reported the top skills that employers seek are critical thinking and problem-solving skills, collaboration, communication (written and oral), and the ability to adapt to a changing environment. It is predicted that by 2033, 47% of jobs in the United States will no longer exist.

The developmental appropriateness of geometry before algebra is supported by research. Research has found that younger students often learn better through concrete experiences with shapes and objects, which aligns with the nature of basic geometry concepts. Research has shown that the early introduction of proofs helps students to better understand the concept of logical reasoning and deduction, which is essential in higher mathematics. In preparation for Algebra 1, Geometry with Statistics offers concepts like graphing on a coordinate plane and manipulating shapes using transformations which when introduced in algebra, are easier to grasp when students have a strong foundation in geometric shapes and their properties. Geometry allows students to develop spatial reasoning and visualize concepts before dealing with complex algebraic manipulations.

Geometry with Statistics introduces foundational geometric ideas without diving into the complex algebraic manipulations taught in Algebra 1. Beginning with geometry encourages students to practice the rigor in mathematics by way of some basic concrete concepts and prior knowledge learned in middle school and elementary school. Students will learn logic using methods of proof, which is the same as the justification of steps. In utilizing this type of learning, it helps students adjust to moving towards a higher depth of knowledge, thinking and reasoning. Accordingly, this is the foundational practice of our process standards. Geometry with Statistics standards, if taught with fidelity, will build on the 8$^{th}$ grade concepts students have learned. All prior knowledge students need to know to be successful in Geometry with Statistics has been learned in kindergarten through eighth grade. Students will simply be applying this learning to concrete math to build understanding of algebraic concepts.

Our Geometry with Statistics course concepts will leverage prior middle school coursework. This course includes geometry and measurement ideas that will build on students' prior work with congruence, similarity, and proportionality concepts learned in middle school. The abstract algebraic concepts utilized in Algebra 1 are postponed, which will offer students a better opportunity to hone their reasoning and sense-making skills and experience the wider applicability of mathematics (relnw@wested.org, 27). Currently, the more abstract algebraic

skills and concepts are spread out and separated by an entire other course. Now, there will be no lapse in content learning moving from Geometry with Statistics to Algebra 1 to Algebra 2 for those students on the straight to four-year college pathway and will allow students to build a solid foundation for more advanced mathematics studies. According to data from the National Center for Education Statistics, in 2019, high school graduates who completed higher levels of mathematics courses also had higher average scale scores on the National Assessment of Educational Progress (NAEP) 12th grade mathematics assessment.

Research by the Regional Educational Laboratory Northwest found that fluency around transformations-based geometry concepts like similarity, congruence, scaling, invariance, and proportionality are essential preparation for higher-level mathematical topics, particularly algebra (e.g., Makgakga & Sepeng, 2013; Teuscher et al., 2015; Wiles et al., 2019; Wu, 2017). For example, understanding properties of similar triangles supports understanding of the slope of a straight line and of linear functions (National Mathematics Advisory Panel, 2008; Wu, 2011). This same research acknowledges that beginning with geometry promotes spatial awareness, dynamic visualization skills, and an overall deeper conceptualization of mathematical structure critical to accessing more advanced mathematics, particularly the more abstract concepts students encounter in algebra-focused courses (Cox, 2013; Seago et al., 2013). Another advantage of geometry preceding algebra is students learn to identify and use mathematical structure in a proportional situation. This concept is central to problem solving in both geometry and algebra (Lamon, 2007; Tanton et al., 2020). Transformations-based geometry offers opportunities to connect the mathematical structure behind multiplicative reasoning with visual representations (Cox, 2013) and supports the transition from additive to multiplicative thinking.

Catalyzing Change in High School Mathematics (2018) notes that geometry before algebra provides students with a common mathematics experience at the beginning of high school. The theme across the research agrees that the implementation of Geometry before Algebra 1 allows all students to start at the same point, giving everyone access to the same mathematics. In most traditional math curriculums, Euclidean geometry is typically taught before Algebra 1, meaning students would usually learn basic geometric concepts and proofs before delving into the more abstract world of algebraic equations and manipulations. Our surrounding states offer a heavy concentration of geometry concepts in their 9th grade classes. The concentration is usually found in Integrated Math 1 and 2.

Boaler & Dweck (2016) address the idea that students' feelings of membership and acceptance predicted future math pursuits. Mathematics ability is also not a fixed trait. Historically, it was believed that males were better at mathematics, but research has proven this is not the case. Females are just as capable. Dweck, Good, and Rattan conducted research in 2012 to find out if students feeling a sense of belonging in mathematics affected them going into a related career. They found that female students' sense of belonging caused them to pursue fewer mathematics courses, and in those courses, females tended to have lower grades. Visual representations within geometry may enable more equitable access and opportunities for students (Driscoll et al., 2007; Goldenberg and Cuoco, 1998), particularly for multilingual learners and those with special needs around working memory or language processing (Hord et al., 2018; Wiles et al., 2019). Geometry preceding algebra offers to promote new and creative instructional approaches (Jones, 2002) that when used within geometry may be more engaging for students (Leonard &

Bannister, 2018; Shaghaghian et al., 2021) and help them to identify geometric properties and relationships (DePiper et al., 2018; Noble et al., 2004; Steketee & Scher, 2016). In doing so, it removes the barrier where students feel as if they cannot be successful in mathematics.

Catalyzing Change in High School Mathematics (NCTM,2018) notes that in teaching geometry before Algebra 1 it increases students' retention of algebraic concepts and decreases the need for reteaching. It offers students the opportunity to build their reasoning and sense-making skills by allowing them to see the applicability of mathematics and prepare them more effectively for further studies in algebra. This shift in the progression will stress approaches that seek to engage all students by emphasizing problem-solving, creating context, and revealing the relevance of math to students' daily lives. The goal is to build a conceptual understanding of what students will learn before delving into math procedures and algorithms that traditionally have come first. While it is essential that students are prepared for post-secondary college and career opportunities, Catalyzing Change (2018) asserts that this is not the sole goal of high school mathematics. By learning basic geometric concepts early, students have an opportunity to build their spatial reasoning skills, which are crucial for higher-level math and other subjects like science and engineering. The visual and intuitive nature of basic geometry can provide a more solid foundation for understanding algebraic concepts later, as geometric figures can be represented with equations.

Geometry with Statistics before Algebra 1 will offer students concrete learning before moving to the abstract learning in Algebra 1. Students will have an opportunity to use those skills learned from elementary and middle school to concretely build a more solid foundation of mathematical concepts before moving on to Algebra 1. Therefore, in conjunction with most educational standards it can be agreed upon that "concrete geometry" (meaning basic geometric concepts with tangible applications) should generally be taught before Algebra 1.

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