

Columbia Independent School

Mathematics at CIS!

A school mathematics curriculum is a strong determinant of what students have an opportunity to learn and what they do learn. In a coherent curriculum, mathematical ideas are linked to and build on one another so that students' understanding and knowledge deepens and their ability to apply mathematics expands. An effective mathematics curriculum focuses on important mathematics – mathematics that will prepare students for continued study and for solving problems in a variety of school, home, and work settings. A well-articulated curriculum challenges students to learn increasingly more sophisticated mathematical ideas as they continue their studies...The curriculum also should emphasize the mathematics processes and skills that support the quantitative literacy of students.¹

Introduction

Columbia Independent School (CIS) offers a college-preparatory mathematics program for kindergarten through twelfth grade. The main goals of the mathematics program are to help students master basic computation skills and to reason using mathematical theory as applied during problem solving. Throughout our program, students will develop mental math and estimation skills; understand the principles and methods of mathematics; explore, conjecture, and reason logically; communicate mathematical ideas; think with a critical and independent mind; and learn to use resources, including technology. In the end, we strive to provide students with the background and appropriate skills necessary to enable them to expand their mathematical knowledge in the future.

Lower School Sequence

At the CIS Lower School, mathematics is taught as a language that must be understood and spoken fluently. Teachers begin laying groundwork for mathematical literacy at an early age and our curriculum is structured to provide multiple exposures to topics, and frequent opportunities to review and practice skills. *Everyday Mathematics* and the *Singapore Primary Math Program* are both used to develop mathematical reasoning in Lower School students.

Everyday Mathematics supports our spiraling curriculum by rooting mathematics in real life context and situation, allowing children the opportunity to become actively involved in learning. *Singapore Primary Math* focuses on teaching mathematical thinking as opposed to rote problem-solving, introducing mental math puzzles at the very earliest grade levels. In addition, students practice basic addition, subtraction, multiplication and division facts five to ten minutes each day until mastery occurs. Knowing basic facts gives students solid background knowledge for learning fractions, decimals and algebra. Children are capable of acquiring more mathematical knowledge through their environment than previously believed. Our curriculum builds on this intuitive and concrete foundation, gradually helping children gain an understanding of the abstract and symbolic.

¹ Carpenter, Jean and Sheila Gorg, editors, *Principles and Standards for School Mathematics*. Reston, VA: The National Council of Teachers of Mathematics, Inc., 2000, pp. 14-16.

CIS teachers emphasize the application of mathematics to real world situations. Numbers, skills and mathematical concepts are not presented in isolation, but are linked to situations and contexts related to everyday lives. For example, in second grade, students study different kinds of angles and use their bodies to make each one, developing a kinesthetic as well as intellectual knowledge of the concept. The K-5 curriculum includes the following mathematical strands: Algebra and Uses of Variables, Data and Chance, Geometry and Spatial Sense, Measures and Measurement, Numeration and Order, Patterns, Functions, Sequences and Operations.

A concept or skill that is informally introduced in one grade will be revisited, developed and extended numerous times, and in a variety of contexts, throughout the year and in later grades. For example, in Kindergarten students are asked to identify a penny, nickel and quarter and learn their value. By third grade, students are applying their knowledge by making change at student-created restaurants. Mathematical literacy at CIS means that students at the Lower School will have a range of sophisticated mathematical knowledge, multiple exposures to topics and frequent opportunities to solve problems that utilize, but extend far beyond, basic calculation skills.

Upper School Sequence

The CIS Upper School mathematics program incorporates a traditional college preparatory sequence. While it is common that students who attended the CIS Lower School have a stronger mathematics foundation than those who enter CIS at the sixth grade level, our goal is to ensure that all students have the abilities required for future success. Therefore, in the early middle school level, students expand on basic mathematics principles that are necessary for Algebra and beyond. By the time that a student begins Algebra I, they have mastered the arithmetic computation skills, including integers and fractions, necessary for future success. Following Algebra I, the sequence continues with Geometry, Algebra II, Pre-Calculus (including Trigonometry), and Advanced Placement Calculus AB. Although the course titles alone may indicate a compartmentalized program, our faculty members recognize the overlapping nature of mathematics topics. In each class, students are required to draw on a variety of background knowledge and to integrate the new information with previously mastered material.

In each class, important algorithms are taught and discussed, and, when students have the necessary background, are self-discovered through activities. Students must learn the basic rules of mathematics, and we recognize that there will be a deeper understanding when they can understand the mathematical foundations that lead to those rules. The student discovery process, however, can be inefficient and confusing if the required background information is at a level beyond high school mathematics. Therefore, CIS teachers aim for a proper balance between student discovery and teacher-directed activities. When deciding which methodology to use for new material, our goal is to ensure that the students have the ability to master the new topics with confidence.

Technology

Within our mathematics curriculum, our goal is to teach students the use of a variety of technology that will enhance their mathematics learning. By the time that a student completes the CIS mathematics curriculum, we expect them to have mastered the use of a graphing calculator, currently the TI-84 or TI-83. The calculators are first introduced in Algebra I as a tool for exploration and for lengthy arithmetic processes. For example, by using the calculator to quickly view a series of graphs, students can then make conjectures to help them discover important mathematical rules, which can then be utilized without the further assistance of a calculator. It is common practice in our department for students to be frequently assessed both with and without the use of the calculator. As students continue in our sequence, we expect them to be able to evaluate whether a calculator is a necessary tool for efficiently solving a problem.

Upper School geometry classes also use the computer software *The Geometer's Sketchpad*. With this software, students can create electronic constructions through proper geometric reasoning and then deduce geometry properties and theorems on their own. When using *The Geometer's Sketchpad*, the teacher will supply each student with a set of directions designed to assist the student in the exploration and discovery process.

Finally, students and teacher occasionally use internet resources to enhance mathematics learning. For example, there are a variety of Calculus illustrations and animations available on websites that can be used to supplement classroom work.

Summary

United States mathematics education has undergone a variety of paradigm shifts in the past several decades. The latest of these shifts involves integrated mathematics, in which students are asked to comprehend and communicate what can often be complicated mathematics processes in the hopes that they will gain a deeper understanding. Unfortunately, students in integrated mathematics programs are not always prepared with the basics of arithmetic computation. Therefore, trying to learn the deeper meaning of processes which one has not yet mastered can lead to a lack of understanding in later years (and, for some students and families, to more immediate frustration). While it is important for all schools to consider and evaluate ideas associated with the changing face of mathematics education, it is equally important that schools should not subscribe to a single theory.

CIS recognizes that the most effective mathematics education models are not discrete ideas, but are instead a synthesis of best practices. Learning the basics through repetition and memorization, recalling past mathematical knowledge to build new concepts, and explaining the mathematics behind processes – these ideas are mixed throughout the CIS mathematics experience, from Kindergarten through senior year, each introduced when it is appropriate to the age and knowledge base of the students.