



## Research and Philosophy

### Introduction

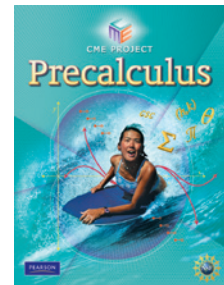
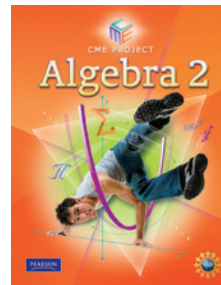
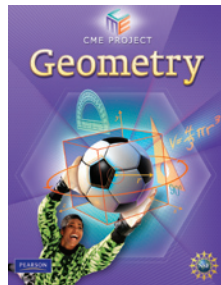
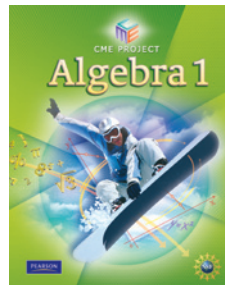
This guide will take a brief look at the research and philosophy behind the CME Project. It will spend some time discussing Habits of Mind and their importance to the CME Project.

### What is the CME Project?

The CME Project is a high school mathematics program funded by National Science Foundation research. It was developed by the Center for Mathematics Education of the Education Development Center.

This program is organized around mathematics courses that are traditionally taught in high school grades. These courses include the following:

- Algebra I
- Geometry
- Algebra II
- Precalculus



The program helps teachers teach mathematical concepts through problem-based, student-centered, and organized mathematical themes.

The CME Project was designed as a math program that offers a progressive, problem-centered curriculum with an organization and structure that is similar to traditional skills-driven texts.

**Example**

**Problem** Invent a story that the graph illustrates.

**Emma's Walk**

**Solution:** In the graph, the horizontal axis represents time. The vertical axis represents distance from home. Time and distance increase as you move to the right from the origin. After 25 minutes, time increases, but distance from home stays the same.

You can use this information to write a story about Emma.

Emma leaves home at the point (0, 0). While she walks at a constant rate to the basketball court, the graph slants upward. After 25 minutes, she arrives at the basketball court, at the point (25, 5000).

When she gets to the court, Emma plays basketball for 15 minutes. During the time she plays, the y-coordinate, or her distance from home, remains the same. So the graph is flat from (25, 5000) to (40, 5000).

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**Research and Philosophy**

The authors of the CME Project had four main research goals in mind that lead to the development of the program. They wanted to develop a program with the following attributes:

- High levels of mathematical proficiency
- A coherent and rigorous curriculum
- Accessibility and success for all students
- Meaningful experiences that give students the opportunity to work and think like mathematicians and scientists

In 2001, the National Research Council released a report titled "Adding It Up: How Children Learn Mathematics." This report describes mathematical proficiency as having five characteristics. The authors of the CME project used these characteristics to guide and define the program's focus on mathematical proficiency.

The first characteristic is that students should develop conceptual understanding to comprehend mathematical concepts, operations, and relationships.

They should also develop procedural fluency to carry out procedures flexibly, accurately, efficiently, and appropriately.

Students can develop strategic competence by gaining the ability to formulate, represent, and solve mathematical problems.

Students should develop the capacity for adaptive reasoning. This enables students to engage in logical thought, reflection, explanation, and justification.

The last characteristic is that students should develop a productive disposition. This allows students to see mathematics as sensible, useful, and worthwhile.

During the development of the program, the authors also examined international math practices and characteristics of math curricula in highly performing countries. These characteristics include the following:

- An emphasis on proficiency and mathematical thinking
- Topics that are developed from the general to more specific
- Topics that are not repeated endlessly throughout the course of study (focus is placed on deep understanding and not repetition)
- The organization of a curriculum that is disciplined and systematic

The authors have implemented these international characteristics in the design of the CME Project.

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**Mathematical Habits of Mind**

Mathematical habits develop over sustained and focused study. The mathematical habits emphasized in the CME Project are known as Habits of Mind. These habits encourage students to look at the world through a mathematical lens.



The program encourages students to become pattern detectives. They learn to build and see patterns, look for relationships, and recognize similar processes. Students also learn to visualize mathematics. They imagine the results, model situations, and think proportionally.

Students will also become comfortable with tinkering around with mathematics. They will learn to reverse directions, and study, analyze, and investigate mathematical behaviors.

Experimentation is another important behavior that students will learn to use. They will learn to simplify problems, find and repeat processes, and identify key characteristics.

By learning to be inventors, students become more systematic with their problem solving and reasoning.

Finally, students will learn to use conjecture. They become more comfortable with making generalizations, extending their generalizations, and finding counter examples.

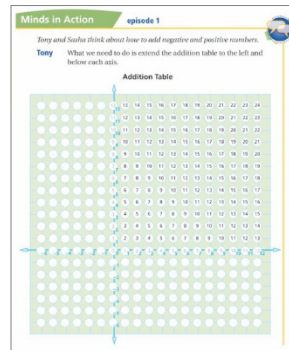
## Mathematical Approaches

Each textbook in the series focuses on mathematical approaches that help students relate to the mathematical concepts that are presented. These approaches allow students to extend their understanding to more challenging concepts.

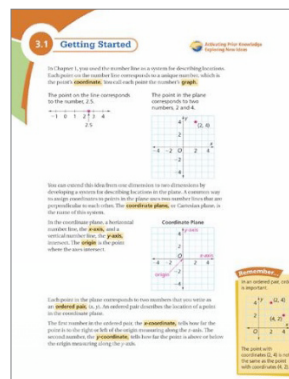
In the Algebra I textbook, teachers will find that emphasis is placed on mathematical tables that are designed to resemble a Cartesian coordinate grid system. Students will use these tables initially for basic addition and multiplication practice.



As students progress, they experience these tables in the context of negative numbers. Patterns in the tables make it clear to students how to extend this approach to the concept of negative numbers.



Eventually, this mathematical table approach is extended to the concept of coordinate planes.



This textbook also uses the mathematical approaches of number lines, expansion boxes, backtracking, and others.

**Developing Habits of Mind**

**Establish a process.** Here is a method for performing good backtracking steps.

**Step 1** Make a list of steps, in order, that show how to get from the input variable to the output. You can build a machine diagram or a flowchart to show your steps.

**Step 2** Make a list that reverses the order of the steps in the first list and shows how to undo each operation.

**Step 3** Start with the output. Perform each step on the list of reverse steps to find the value of the input variable.

For more information about the mathematical approaches emphasized in the CME textbook, consult the CME Project Implementing and Teaching Guide.

## Review

This guide explained that the CME Project is a high school mathematics program funded by National Science Foundation research.

The program includes the following goals:

- Obtain high levels of mathematical proficiency
- Exhibit a coherent and rigorous curriculum
- Present accessibility and success for all students
- Offer meaningful experiences that give students the opportunity to work and think like mathematicians and scientists

This guide explored the general philosophy of the program and introduced the concept of Mathematical Habits of Mind.

Finally, it showed how each textbook features a unique set of mathematical approaches to the discipline. These mathematical approaches are explained in detail in the CME Project Implementing and Teaching Guide.