# MISSING PIECES IN MATH EDUCATION

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The impression most people have of mathematics, if it is a good one, is that it is practical regarding paying bills, figuring a mortgage, paying taxes, balancing a checkbook, planning for retirement (although computer tools already do most of this math for you). A goodly number of people (too many, in my opinion) have bad feelings about math. They say:

"I hate math" or
"I've never understood math" or
"Math was (or is) my worst subject in school."

The reason for these negative responses is what I call the missing pieces in math education. For example, let's consider a basic algebraic equation:

$$x^2 - 2x - 6 = 0$$

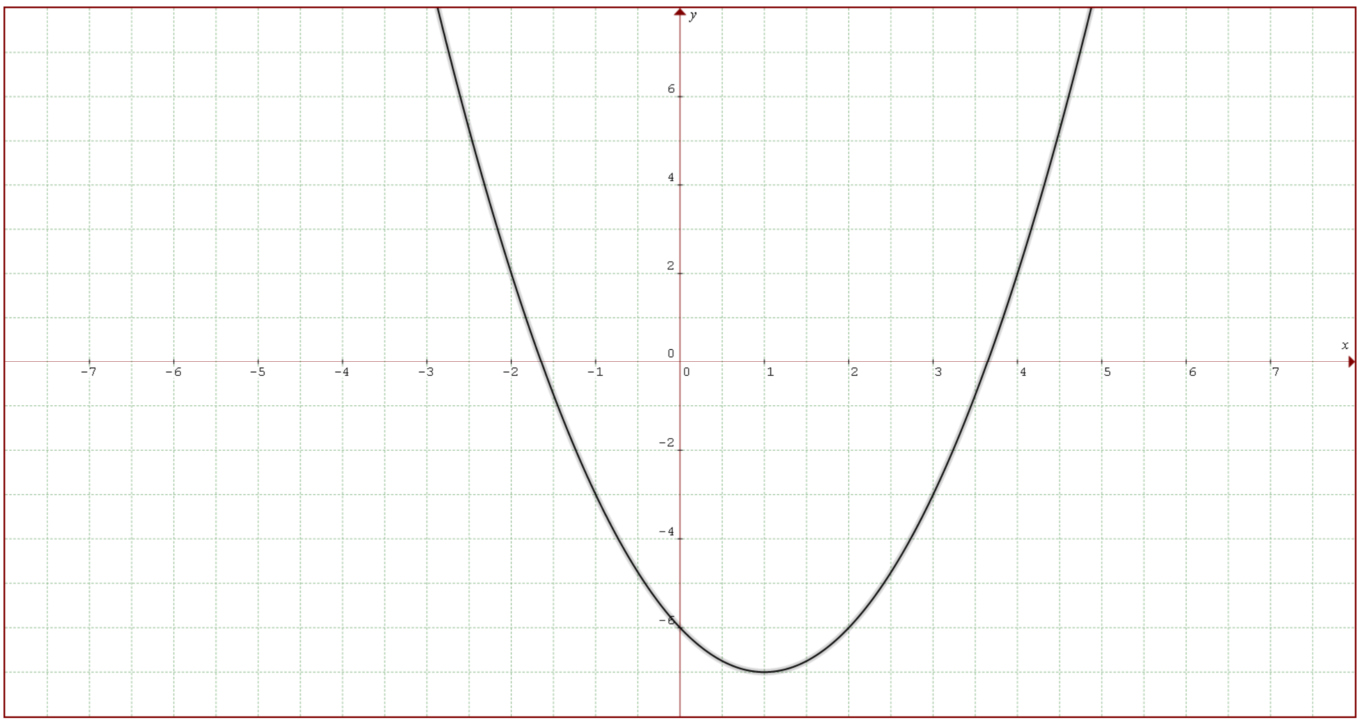


Figure 1: Graph of $y = x^2 - 2x - 6$

This equation (called a quadratic – from a Latin word, *quadrate*, meaning "to make square") is the typical fodder for Algebra I and Algebra II high school classes. Teachers instruct students in how to factor and solve such equations. Some students may even be required to memorize the quadratic formula for solving a general second-degree equation in the form $ax^2 + bx + c = 0$:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If, as an adult, these symbols and numbers bring back bad memories, you are not alone We have these recollections because we learned this material, or any other mathematical concept, in a vacuum; i.e., without a context or rationale for its study. Most modern mathematics educators now realize that they need to give students a rationale for learning this stuff. Some teachers and some textbooks try to provide this justification using a broad range of motivational gimmicks. Very few look at history to explain why quadratic equations popped up in the first place.

Teaching mathematics devoid of its history is the first missing piece in math education. Quadratic equations came into the forefront of scientific thinking as a result of the study of motion, e.g., free fall, projectile motion, the motion of planets. If you consider an object's motion in terms of time and distance, then these second-degree equations describe the situation perfectly. Not only do they describe the situation, they enable the scientist to make predictions (e.g., the maximum height of a projectile, the time a projectile hits the ground, the distance a projectile will travel before it hits the ground). Needless to say, 16th to 17th-century army generals were interested in this type of analysis.

Astronomers like Johannes Kepler (1571-1630) used these second-degree equations to mark the regulatory patterns of the motions of the heavenly bodies. He was able to take an ancient Greek geometrical idea (the conic sections: the circle, the ellipse, the parabola, and the hyperbola) and use a combination of algebra and geometry (called coordinate geometry) to trace out the paths of the planets using quadratic equations that describe ellipses. Galileo Galilei (1564-1642) and Isaac Newton (1642-1727) were able to determine the paths of projectiles or objects in free fall using quadratic equations that describe parabolas. In our jet age, the shock wave of a sonic boom is a quadratic equation that is descriptive of a hyperbola.

The German mathematician Karl Weierstrass (1815-1897) believed that it was the glory of mathematics to be indispensable to physics. In 1857, he also warned that one should think of:

> …the relation between mathematics and physics in a deeper manner than is the case when a physicist sees in mathematics only an indispensable auxiliary discipline, or when a mathematician is willing to see only a rich source of illustrations for his method in the questions posed to him by the physicist.[1]

According to theologian Thomas F. Torrance (1913-2007):

> Geometry cannot be pursued simply as an axiomatic-deductive science [entirely *a priori* – JN] detached from actual knowledge of physical processes or be developed as an independent science antecedent to physic, but must be pursued in indissoluble unity with physics [*a posteriori* – JN], as the science of its inner rational structure and as an essential part of empirical and theoretical interpretation of the physical world.[2]

Today there is hardly a branch of modern mathematics, even its various esoteric sections, that has not yet found some indispensable use in modern physics.[3]

It is clear that we must understand abstract mathematics, like the study of quadratic equations, in the context of the missing pieces of history and science, particularly, the physics of motion. As I have already noted, very few math teachers do this and the reason why is because of the way these teachers are being prepared to teach the subject.

Now, even if we required all math educators to teach these equations in the context of history and science, there would still be a missing piece, the most important piece in the puzzle. That critical piece, a piece missing for *every* public or government school, is the Scriptural revelation of the Triune God. We have given an equation that is replete with a wide variety of symbols. This abstract mathematical construct interpenetrates a concrete physical situation; e.g., the physics of motion. A law-word, a person, governs the physics of motion. Known as the creation covenant, all things are created and sustained by the Word of the Triune God of Scripture (Genesis 1; John 1; Jeremiah 31:35-37). Since all of God's covenants are Christo-centric, then the motion of objects, whether terrestrial or celestial, are part of the "all things visible and invisible" that "cohere or hold together" in Christ (Colossians 1:15-17). You see, therefore, that when a student learns quadratic equations in this context, that student is two steps away from a glorious and transforming revelation of the person of Jesus Christ:

Step 1. Abstract equation.
Step 2. History and the physics of motion.

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[1] Karl Weierstrass, "Akademische Antrittsrede," in *Mathematische Werke* (Berlin, 1894), 1:225. Albert Einstein (1879-1955) stated, in a speech before the Prussian Academy in 1921, that "geometry constitutes the epistemological foundation that lies at the depths of physics." For the entire speech, see Albert Einstein, *Ideas and Opinions* (New York: Wings Books, 1954), pp. 232-246.

[2] Thomas F. Torrance, *Space, Time, and Incarnation* (New York: Oxford University Press, 1969), p. 69.

[3] Stanley L. Jaki, *The Relevance of Physics* (Edinburgh: Scottish Academic Press, [1966, 1970] 1992), p. 117.

Step 3. Christ, in whom all things are sustained, and all things include both the thinking of the mathematician and the rational order of the universe.

Exposing the student to the realities of a Christ-created and Christ-sustained creation is what Biblical Christian education is all about. Since Christ is the source and sustenance of creation and since Christ is the foundation and the treasure of all wisdom and understanding (John 1:1-3; Colossians 2:3), then we dare not teach any subject, even quadratic equations, without a reverential submission to Him. If we remove the Christ of Scripture from the acquisition of any knowledge, then all we will know is surface or pseudo-knowledge. It is the revelation of Christ that brings meaning, significance, perspective, and purpose to the study of every aspect of human endeavor, even mathematics!