Why Mathematics Is a Language

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Mathematics is called the language of science. Italian astronomer and physicist Galileo Galilei is attributed with the quote, "*Mathematics is the language in which God has written the universe*." Most likely this quote is a summary of his statement in *Opere Il Saggiatore:* [The universe] cannot be read until we have learnt the language and become familiar with the characters in which it is written. It is written in mathematical language, and the letters are triangles, circles and other geometrical figures, without which means it is humanly impossible to comprehend a single word.

Yet, is mathematics truly a language, like English or Chinese? To answer the question, it helps to know what language is and how the vocabulary and grammar of mathematics are used to construct sentences.

Key Takeaways: Why Math is a Language

- In order to be considered a language, a system of communication must have vocabulary, grammar, syntax, and people who use and understand it.
- Mathematics meets this definition of a language. Linguists who don't consider math a language cite its use as a written rather than spoken form of communication.
- Math is a universal language. The symbols and organization to form equations are the same in every country of the world.

What Is a Language?

There are multiple definitions of "language." A language may be a system of words or codes used within a discipline. Language may refer to a system of communication using symbols or sounds. Linguist Noam Chomsky defined language as a set of sentences constructed using a finite set of elements. Some linguists believe language should be able to represent events and abstract concepts.

Whichever definition is used, a language contains the following components:

- There must be a **vocabulary** of words or symbols.
- **Meaning** must be attached to the words or symbols.
- A language employs **grammar**, which is a set of rules that outline how vocabulary is used.
- A **syntax** organizes symbols into linear structures or propositions.
- A **narrative** or discourse consists of strings of syntactic propositions.

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- There must be (or have been) a group of people who use and understand the symbols.

Mathematics meets all of these requirements. The symbols, their meanings, syntax, and grammar are the same throughout the world. Mathematicians, scientists, and others use math to communicate concepts. Mathematics describes itself (a field called meta-mathematics), real-world phenomena, and abstract concepts.

Vocabulary, Grammar, and Syntax in Mathematics

The vocabulary of math draws from many different alphabets and includes symbols unique to math. A mathematical equation may be stated in words to form a sentence that has a noun and a verb, just like a sentence in a spoken language. For example:
could be stated as "Three added to five equals eight."
Breaking this down, nouns in math include:

- Arabic numerals (0, 5, 123.7)
- Fractions (1/4, 5/9, 2 1/3)
- Variables (a, b, c, x, y, z)
- Expressions (3x, x^2, 4 + x)
- Diagrams or visual elements (circle, angle, triangle, tensor, matrix)
- Infinity (∞)
- Pi (π)
- Imaginary numbers (i, -i)
- The speed of light (c)

Verbs include symbols including:

- Equalities or inequalities (=, <, >)
- Actions such as addition, subtraction, multiplication, and division (+, -, x or *, ÷ or /)
- Other operations (sin, cos, tan, sec)

If you try to perform a sentence diagram on a mathematical sentence, you'll find infinitives, conjunctions, adjectives, etc. As in other languages, the role played by a symbol depends on its context.

International Rules

Mathematics grammar and syntax, like vocabulary, are international. No matter what country you're from or what language you speak, the structure of the mathematical language is the same.

- Formulas are read from left to right.

- The Latin alphabet is used for parameters and variables. To some extent, the Greek alphabet is also used. Integers are usually drawn from *i*, *j*, *k*, *l*, *m*, *n*. Real numbers are represented by *a*, *b*, *c*, α, *β*, γ. Complex numbers are indicated by *w* and *z*. Unknowns are *x*, *y*, *z*. Names of functions are usually *f*, *g*, *h*.
- The Greek alphabet is used to represent specific concepts. For example, λ is used to indicate wavelength and ρ means density.
- Parentheses and brackets indicate the order in which the symbols interact.
- The way functions, integrals, and derivatives are phrased is uniform.

The Argument Against Math as a Language

Not everyone agrees that mathematics is a language. Some definitions of "language" describe it as a spoken form of communication. Mathematics is a written form of communication. While it may be easy to read a simple addition statement aloud (e.g., 1 + 1 = 2), it's much harder to read other equations aloud (e.g., Maxwell's equations). Also, the spoken statements would be rendered in the speaker's native language, not a universal tongue.

However, sign language would also be disqualified based on this criterion. Most linguists accept sign language as a true language. There are a handful of dead languages that no one alive knows how to pronounce or even read anymore.

A strong case for mathematics as a language is that modern elementary-high school curricula uses techniques from language education for teaching mathematics. Educational psychologist Paul Riccomini and colleagues wrote that students learning mathematics require "a robust vocabulary knowledge base; flexibility; fluency and proficiency with numbers, symbols, words, and diagrams; and comprehension skills."