Some describe mathematics as the language of science, others argue that it is an art, and cannot be defined as a science at all. Taking this one step further, MIT Professor Max Tegmark popularised the idea that the Universe is not only modelled well through mathematics, but that physical reality is actually mathematics.
Q: In your opinion, what is mathematics?

PROFESSOR GREG FOREST
[Chair Department of Mathematics, University of North Carolina, USA]:

I don’t want to get into a debate about such a proposition. Is mathematics a manmade creation, or are we simply discovering absolute truth? To me, mathematics has analogies to language if you realise that language fuels the imagination. It not only expresses thoughts, language operates as a feedback mechanism to our brain, triggering new thoughts that, without language, would not have occurred. This is absolutely true of mathematics – many use it to describe the world around them, such as expressing the laws of nature across the spatial and temporal scales from subatomic particles to the galaxies.

The laws of nature, it turns out, do not hand predictive power to us. We must ‘solve’ these laws – the equations for aerodynamics, fluid dynamics, combustion, solid mechanics, atomic fluctuations, molecular structure, the atmosphere, the Solar System, etc., have to be solved to understand how things work and behave, to make predictions, to design, to optimise. But this enterprise involves a whole new realm of mathematics, to either solve existing laws of nature or to construct new ‘laws’ [we call them models] that are approximately true.

In these quests to ‘solve equations’, over time, new mathematics has emerged that is interesting and inspiring in its own right. The so-called ‘pure mathematicians’ pursue long journeys of beautiful abstractions, totally divorced from any relevance or memory of an application. Other mathematicians, the family I belong to, take shorter journeys of abstractions, jockeying back and forth between an application we are inspired by and the mathematics necessary to achieve the requisite understanding of the application.

PROFESSOR SHANDELLE HENSON
[Chair Department of Mathematics, Andrews University, USA]:

The deep structures, theorems and proofs of pure mathematics are highly aesthetically pleasing to mathematicians. The exploration of mathematical patterns requires symbolic reasoning, intuition and creativity. For these reasons, pure mathematicians often consider their discipline to be closer to the humanities than to science.

Applied mathematicians also enjoy the beauty of mathematics, and in addition they have a scientific interest in how mathematical structures can be used to describe, explain and predict the observed Universe.

Mathematical models do not perfectly describe the real world; they are simplifications that capture the main mechanisms driving observed patterns. A major goal of modelling, often called the ‘art of modelling’, is to construct a simple, mechanistic, low-dimensional model that describes enough of the observed variability so that the left-over, ‘higher order’ variability is relatively small and can be described statistically as ‘noise’.

I think that mathematics is, at its root, the abstraction of the main patterns we observe in the natural world. For example, the abstract idea of a circle probably came from observing nearly round things in nature, and the deductive study of ideal circles helps us deduce the implications of almost-roundness in nature. The scientific method contains both inductive and deductive phases; mathematical analyses are the tools of the deductive phase. Abstract representations of physical and biological phenomena and the codification of testable scientific hypotheses into mathematical models are powerful because they provide superb ways to probe the sometimes complex and surprising deductive ramifications of such hypotheses.
Mathematics is a tool to simply physical phenomena. The truth of a physical phenomenon is built under simplicity deduced from mathematics.

Professor Szu-Cheng Cheng
(Department of Physics, Chinese Culture University, Taiwan):

For me, mathematics is the language I work in. It’s a beautiful, powerful tool to describe, create and explain patterns and natural phenomena – and it’s constantly surprising.

Dr Helen Wilson
(Institute of Mathematics & its Applications):

Mathematics is the understanding of structure in all things. Some of the structure applies to the physical and observable world, but much applies to more abstract concepts/ frameworks. Key in mathematics are three things: the use of models, meaning systems of rules to represent the system we wish to study; the use of logic, deduction, analysis and intuition to make statements that are rigorously true, i.e. the concept and use of proof; and the desire to qualify, quantify, estimate and approximate, deterministically or probabilistically.

Professor Ian Frigaard
(Canadian Applied and Industrial Mathematics Society):

I think that mathematics is the mother of everything. The Universe has been generated in a way by the theory of mathematics over billions of years. We can describe everything in the Universe by mathematical formulas. Mathematics is the world in which we live and mathematics will create the world where we are going to live in the future.

Masaki Isozu
(Sony Global Education, Japan):

Why do complicated mathematical tensor relationships used by Einstein in his formulation of general relativity actually explain the bending of light by the gravitational field of galaxies? Another example of the mysterious relationship between mathematics and physical observations was the prediction by Paul Dirac of the existence of positrons (the antithesis of electrons), based on an equation that wanted to take the square root of an energy.

The rigorous logic of mathematics defines what scientists mean by understanding. By contrast non-scientists tend not to include quantitative descriptions in what they believe is ‘understanding’. The misunderstanding of climate change is an example, unfortunately.

Emeritus Professor George Rawitscher
(University of Connecticut, USA):

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