WHAT IS MATHEMATICS?

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February 28, 2020

1 Introduction

When the question" *What is Mathematics ?*" is asked, the answer that pops to the mind of some is "numbers" or "arithmetic's". Some even recall how stressful and boring it might have been to them in school or probably now. Most people especially students see Mathematics as just crunching numbers, playing with arithmetic operations or probably a game of logic with some specific set of rules. A 2008 study by Menderick et al as cited in Gunter and Andreas stated that:

> *The student's view of maths itself included narrow and inaccurate images that are often limited to numbers and basic arithmetic's*

But the funny thing is, nobody seems to give a precise and rigid answer to the question. They just seem to say what they feel about it being a subject.
Similarly, many education bureaucrats and scholars of mathematics have given or proposed many definition as to what mathematics actually is. Some define it as a science subject, some define it as the curriculum in schools, while some define it as an abstract subject, which is worse since they explain it as having little or no correlation with real life.
All these definitions are unsatisfactory and does not really relate to what the subject actually is, making it look boring, tiring and less interesting when in fact it brings pleasure and a sense of mental satisfaction when you get to solve problems with it.

Now beyond arithmetic and numbers in classes, Mathematics is ambiguous and has a wide range of application in virtually every aspect of life. Mathematics is every where from things very close to us, to things very far as the galaxies. It is needed in our every day life from the basic addition and subtraction to advanced algebra.
Mathematics is universal in the sense that other field of human thoughts are not(project 2061,www), it is needed in business, media, sport, cooking, politics, game(e.g chess,football e.t.c),engineering , agriculture, computing, what ever the field just name it, even music. This is why it is said that to live in a mathematically-driven world and not know math is like walking through an art museum with your eyes closed!(www.piday.org). If so then how would you enjoy the beauty of the exhibition ?
And this is why Roger Bacon $(1214 - 1294)$ as cited in Roohi(), once stated that

> *Neglect of mathematics works causes injury to all knowledge, since he who is ignorant of it cannot know the other science or the things of the world.*

Mathematics is multi-facetted, one definition is not enough, so based on this ambiguity and multi-faceticity, we see that there can be no general definition encompassing this beauty called Mathematics.
Thus, each definition of mathematics actually defines how the person defining mathematics sees it. This is why Gunther and Andreas stated that:

> *Many answers to "What is Mathematics ?" show more as much about the person who give the answers as they manage to characterize the subject.*

To this, here I adopt some(few) definitions of mathematics, which might seem humorous to some and look skeptical to others, but in the real sense shows the ambiguity of Mathematics and a part of it's true itself, rather than a one dimensional definition.

2 DEFINITIONS

2.1 MATHEMATICS IS A SCIENCE

Is Mathematics really a science? or is it a concept based on logic, deductions and assumptions

Some psychologist claim and have debated that Mathematics is not a science.
Then let's look into this.

First of all, before anything can be ascribed as a science, it must have the ability or capacity to satisfy the scientific process or the major component of science, of which is summerised as follows:

Observation & Questioning $\Longrightarrow$ Hypothesis $\Longrightarrow$ Method $\Longrightarrow$ Result & Conclusion.

Therefore, to determine whether Mathematics satisfies the scientific process We illustrate using the problem of further derivatives.
(Note: This is taking one example in about a million, if not billion).

Now, if

$y = ax^n$, $a \in R$, $n \in N$

We observe on successive differentiation that,

$$\frac{dy}{dx} = nax^{n-1}\,,\ \frac{d^2y}{dx^2} = n(n-1)ax^{n-2}\,,\ \frac{d^3y}{dx^3} = n(n-1)(n-2)ax^{n-3}\ldots, \qquad Observation$$

Thus, We can follow the pattern and hypothesise that the rth derivative is given as

$$\frac{d^ry}{dx^r} = n(n-1)(n-2)\ldots(n-r+1)ax^{n-r} \qquad Hypothesis.$$

From here, We can implement the methodology of mathematical induction.
Since

$$\left.\begin{array}{l} {}^{n}P_1 = \frac{n!}{(n-1)!} = n \\ {}^{n}P_2 = \frac{n!}{(n-2)!} = n(n-1) \\ {}^{n}P_3 = \frac{n!}{(n-3)!} = n(n-1)(n-2) \\ so, \\ \quad {}^{n}P_r = \frac{n!}{(n-r)!} = n(n-1)(n-2)\ldots(n-r+1) \end{array}\right\} \quad Method$$

Therefore, by induction we have that

$$\frac{d^r y}{dx^r} = {}^{n}P_r a x^{n-r}, \qquad Result$$

Conclusively, We obtain after rigorous testing that the rth derivative of a function $y = ax^n$, is given as

$$\frac{d^r y}{dx^r} = \frac{n!}{(n-r)!} a x^{n-r}, \qquad Conclusion$$

THIS IS A TYPICAL SCIENTIFIC PROCESS!

In a similar manner, some people feel that science requires evidence that comes directly from nature, and from there conclude errornously that Mathematics is not a science. But looking at it, Mathematics also takes evidence from nature (i.e real life problem), and we see that the modelling process of Mathematics is a typical scientific process.
This modelling process can be summarized as;
(i) Identify the problem
(ii) Formulate a mathematical model
(iii) Obtain the mathematical solution
(iv) Compare with reality
(v) Write a report and/or represent your result

Now, The first modelling step is the process of observation and questioning, the second is the process of hypothesis, the third step is method, fourth is result and then last is conclusion.
Also, this modelling process is an iterative process which can fail at some point or a step, and then requires a modeller to repeat the modelling activity which is either by repeating step one, step two, or checking the variables created.
Similarly, the scientific process is an iterative process, where at some point the scientist has to repeat his observations, questioning, hypothesis or even method, when some things fail.

Hence, this shows that mathematics is indubitably a science. It is in fact a natural science(the science of nature). It is a science of patterns and relations (project 2061), a science of logic and deductions, the science of numbers!

2.2 Mathematics is a part of human culture

When we say culture, it is the way of life of a particular group of people, a pattern some group of people follow, the norms accepted by some people, their do's

and dont's.
But the saying `"Mathematics is a part of human culture"` implies that it is a component of the way of life of people, not just any tribe or race but the entire human race. How?
You see, humans since the beginning of time use mathematics in their every day life, from waking up to calculating time, distance, selling, adding, cooking, taking measurements, writing, anything just think of it, the idea of mathematics is used in one way or the other. It is an habit or custom that characterize humans, irrespective of the society or nation.
Obviously we even see that humans tend to follow a certain pattern through their lifetime, which can be modelled, thus giving a mathematical law.
Hence mathematics is a significant part or component of the human culture.

2.3 Mathematics is nature's language and the language of science

> *To those who do not know mathematics, it is difficult to get across a real feeling as to the beauty, the deepest beauty of nature ...*
> *If you want to learn about nature, to appreciate nature, it is necessary to understand the language that she speaks.*
>
> *Richard .P. feynmann*

Science as whole, acknowledges nature , science tend to describe nature, to search for patterns in it, to understand it, to speak to it, to listen to it, and probably to work with it.
But humorously,nature speaks, she has a language. Nature speaks in Mathematics and Mathematics is the language to which we communicate to it.
Many great scientist have affirmed this, *"Mathematics is a language"* is what the American Physicist Josiah Willard Gibbs once said. And also the Italian Astronomer, Physicist and Engineer, Galileo Galilei after years of much encounter with nature, attested by saying that:

> *Mathematics is the language in which God has written the universe.*

However, HOW IS MATHEMATICS NATURES LANGUAGE?

It has been observed from the history of science that nature presents itself in mathematics, and equations tend to reflect nature in direct proportion in their beauty and simplicity (P.lutus).

You see, everything in this world we live seems to be based on mathematical laws (what.if). Everything in this world follows a certain or distinguishing pattern, *even our genetic codes has a mathematical model. (what.if).*

Take for example, a very common pattern (or should I say shape) exist virtually in the

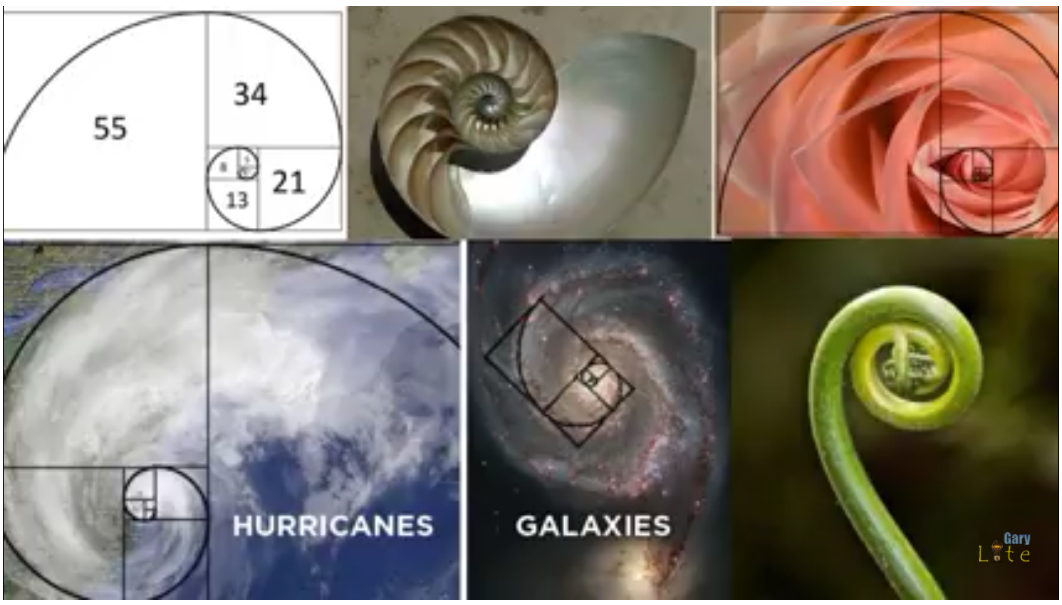

Figure 1: some occurences of fibonacci sequence in nature

Source: Gary Lite

universe, in shells, plants, clouds, galaxies e.t.c just to mention but few.
But surprisingly, this pattern is the popular ***Fibonacci sequence***.

The question now is, *how did Leonardo Fibonacci get this?, did he invent it?*
Definitely no, but he *discovered* it. From where? *From nature!*

Looking at it, when every scientist is encountered with a problem of nature, they end up having their solution in mathematical terms, *as an equation (to be precise).* When Isaac Newton discovered that force is a function of mass and acceleration, he found it to be $F = mg$, Albert Einstein discovered the relation between mass, energy and speed to be $E = mc^2$ and many others.
So, all these problems are directly from nature and are written or even spoken in mathematical terms. This made the famous italian Astronomer and Physicist, Galileo Galilei to conclude that

> *Nature is written in Mathematical language*

Thus, this undoubtedly shows that nature speaks in mathematics and she listens to us in mathematics.
This is why Johannes Kepler also concluded that

> *God created the world in mathematical terms*

and also Paul Dirac, who said:

> *The laws of nature should be expressed in beautiful equations.*

And I say

> *Equation are found in nature, from nature, nature gives, nature speaks to us in mathematics, we just need to listen carefully*

Therefore, when encountered with problems of nature, you can solve them by communicating with the language of nature, Mathematics, if only you understand.

Now since science describes nature, in other to understand and seek patterns in it, we must definitely speak its language, *MATHEMATICS*.

Thus, ***Mathematics is called the language of science.***

2.4 Mathematics is a substantial component of Economy and technology

Science and technology have contributed greatly to mans living in his economy. It has propelled man from the use of stones to computers, from spears and arrows to guns and bombs, from leaves to cloths. It has contributed both positively and negatively to mans achievement on earth.
Of all these great contributions and revolutions to mans economy, just imagine a world without mathematics where you cant count, you cant add, subtract, divide, and multiply, you cant minimize and maximize, no binary numbers (numbers) , no calculus, no analysis, no algebra. Then verily, there will be no computers, no phones, no internet, no money, no banks and so on, since there are no basis for their operations.

Thinking will definitely be very low and thus we will be living in the stone age, if not worse. We can therefore argue that, what makes us higher animals is the ability of our brains to perform calculations, basic arithmetic's i.e thinking, and our ability to improve on this thoughts. Thus, this implies that mathematics itself is a thinking process (and by the way, what are we without our brains ability to think).

Since without mathematics, we therefore can't be where we are today, and where we will be tomorrow.
Hence, mathematics is a substantial factor of science and technology (the accelerator to where we are today), and thus a substantial component of the economy.

3 CONCLUSION

These are very few definitions of mathematics I have adopted, out of its myriad of definitions due to its ambiguity (you can add more, maths is beautiful).
In conclusion, mathematics is more than what we see it as, it is a way of life. We undermine its power based on our lack of understanding of it and what we see on the surface.
So, mathematics is not just a subject or course to be studied and then dumped. It is a way of life itself, a propeller in the scientific revolution and there's definitely more to mathematics than just in schools.

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