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Mathematics in Life

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Abstract

In the work different fields of applications of mathematics are examined, namely: Mathematics and music, Mathematics and education, Mathematics and sport, Mathematics and modern technologies. The purpose of this work is to demonstrate on particular examples, the way mathematics has penetrated all spheres of human activities, in one form or another. The use of mathematics in sports is represented by the example of basketball (strategy and tactics of the game, calculation of results). Mathematics in music reveals itself in symmetry, euphony and the construction of scales. The application of mathematics in education is exemplified by the development of the schools of ancient Greece and Rome and schools of a later period. The relation of Mathematics with modern life is shown in the section “Mathematics and modern technologies”. Computing heavily relies on mathematics. Such algebras as elementary, abstract and Boolean are the most commonly used in coding. Mathematics is also applied in scientific software. Mathematics together with computers assists in physics, chemistry, biology, geology and even mathematics themselves. Computers are also used to teach mathematics to children. Thousands of programs are designed to help children with mathematics.

It is difficult to name at least one kind of human activity which is not related to mathematics anyhow. Of course, it is impossible to disclose all the spheres of application of mathematics in one work, but the students used the analytical and research approach to the given task, and the corresponding conclusions were formulated by them.

Keywords: Mathematics; Education; Civilization

Introduction

Mathematics was developed to understand the cycles of nature as well as seasonal cycles. Ancient people understood the need to define time in relation to celestial movements for agricultural, astronomical and navigational reasons. They also understood that math is all around us, in everything we do.

Mathematics in Life

Sometimes we do not even notice how often we use math in our everyday routine. Math is the building block for everything in our daily life.

Where do people use mathematics?

- Currency exchanges (divisions)
- Travelling (budget, fuel needed for the car)
- Architecture (calculations, geometry)
- Weather (probability, numbers)
- Bank transactions (so we would not be deceived)
- Planning family budget (money-spending)
- Money (it is counted in numbers)
- Which professions use maths?
- Shopkeeper (giving change)
- Cooker (proportions)
- Teacher
- Doctor (amounts of medicine)
- Accountant (calculating budget)
- Banker
- Engineer (calculations, geometry).

Future is Math

Today, it doesn’t come as a surprise when you hear that future belongs to robots. Robots help people in routine problems, and math is the keystone of robotics. All commands executed by robots are in fact thousands of numbers and equations transformed by the computers into commands. Banking is something that we use every day. We also know about the FUTURE e-banking system called block chain, where data is gathered and ordered into blocks, which are chained together securely using cryptography. There are also thousands of numbers and proportions that are used in it.

Mathematics and Education

First steps

The first civilization which started learning and discovering mathematics was Ancient Greece. Here are some of the world-known Greek mathematicians: Pythagoras, Euclid, Thales of Miletus, Plato, etc.

Greeks at the beginning used mathematics only to measure, count something or for rituals, but by the 6th century B.C all the free Greeks (not including slaves) were educated and were studied, among others, mathematics. There were two types of schools: Palaestras (where pupils only learned simple counting in mathematics lessons) and second type - Gymnasiums, private schools of higher level (where pupils were taught arithmetic and geometry).

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Pythagoras school was saying: “Numbers rule the world” and “Nature speaks with us using the language of mathematics”.

Euclid (325 B.C) who was regarded as “Father of geometry”, wrote the famous book “Elements” based on thirteen essays and on works of Hippocrates, Leon and Feudius. In Elements there were basic geometrical axioms and theorems. Elements became the main book for learning math for the next two thousand years.

Ancient Rome

Roman math took many things from the Greeks. Roman numerals and Julian calendar are well-known in the world nowadays. The first mechanical calculator called abacus was invented in Ancient Rome. However, there weren’t any famous mathematicians in Rome.

The education in Rome was different, rich families were sending their children to Greece or invited teachers to their houses. Whereat poor people attended ordinary schools that had three levels of education: primary, secondary and higher pupils learned counting only in primary school, then they were only taught theoretical subjects like history and law.

The Medieval Ages

When the barbarians destroyed the Roman Empire, in the fifth century A.C. there came medieval period in Europe when there were terrible diseases and the majority of people weren’t able to afford books and schools. Also many people were thinking about the church and their sins more than education. But then the first universities started to appear, e.g. in the eleventh century in the Italian city of Bologna. In Spain in the twelfth century scientists started to translate books and essays of Greeks and Arabians. Also in the twelfth century Paris University, Cambridge and Oxford were established.

Eastern Countries

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Renaissance Time

After the medieval ages, at the end of the fifteenth century people started thinking about science and Byzantium became a knowledge centre of Europe. The sixteenth century was a turning point in mathematics, where a big breakthrough was made based on previous knowledge. Del Ferro Tartaglia and Ferrari came up with a method for solving cubic and quartic equations, something that was considered impossible until then. In 1585 Simon Stevin published a book “Decimal” in which he explains actions with decimal fractions.

In the seventeenth century mathematics kept developing fast, but by the end of the century math has changed a lot. Rene Descartes in his book “Geometry” corrected the mistake of ancient scientists and restored algebraic understanding of numbers. Pierre Fermat, Jacob Bernoulli, Huygens created the theory of relativity.

At that time many schools and universities were built and more subjects related to mathematics were introduced at schools. The majority of people concentrated on learning math.

Quadratic Equations: From Ancient to Our Time

The need to solve the equations of not only the first but also the second degree in the antiquity was caused by the need to solve problems related to finding areas of land and with earthwork of a military nature, as well as the development of astronomy and mathematics itself. People were able to solve quadratic equations in 2000BC by Babylonians. Applying the modern algebraic notation, we can say that the rule for solving these equations, as stated in the Babylonian texts, coincides with the modern one, but it is not known how the Babylonians reached this rule.

Almost all cuneiform texts found so far lead only to problems with solutions set out in the form of recipes, without instructions as to how they were found. Despite the high level of development of algebra in Babylon, cuneiform texts lack the notion of a negative number and general methods for solving quadratic equations.

In Diophantus's "Arithmetic," there is no systematic exposition of algebra, but it contains a systematized series of problems, accompanied by explanations and solved by compiling equations of different degrees.

The problems of square equations are already encountered in the astronomical treatise "Aryabhattiam", compiled in 499. Indian mathematician and astronomer Aryabhatta. Another Indian mathematician Brahmagupta (VII century), expounded the general rule for solving quadratic equations, reduced to a single canonical form. In India, public competitions were held in solving difficult problems. In one of the ancient Indian books, the following is said about such competitions: "As the sun shines its stars with a brilliance, so a learned man will eclipse fame in public assemblies, offering and solving algebraic problems”.

Al-Khwarizmi algebraic treatise gives a classification of linear and quadratic equations. The author has 6 types of equations For Al-Khwarizmi, who avoided the use of negative numbers, the terms of each of these equations are terms, not subtractions. In this case, equations that do not have positive solutions are certainly not taken into account. The Al-Khwarizmi treatise is the first book that has come down to us, in which the classification of quadratic equations is systematically presented and the formulas for their solution are given. The forms of solving quadratic equations modeled on Al-Khwarizmi in Europe were first set forth in the "Book of the Abacus", written in 1202 by the Italian mathematician Leonardo Fibonacci. The author has developed independently some new algebraic examples of solving problems and the first in Europe has approached the introduction of negative numbers. His book contributed to the dissemination of algebraic knowledge not only in Italy, but also in Germany, France and other European countries.

Nowadays

Nowadays modern math keeps developing, every day scientists find something new or improving mistakes of the past. Mathematical subjects like geometry and algebra are now in every school they are necessary to learn. In every exam we will see math and in order to get a place in a university we need to take a mother language exam and math exam [1].

Mathematics and Music

Math and music have a lot in common – especially in frequencies. Let’s talk about them.

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How a string vibrates

When a string on a violin is vibrating, its ends are fixed to the instrument. This means the string can vibrate only on certain waves - sine waves (like a jump ropes), with different number of bumps between the ends. The more the bumps – the higher the pitch of a string is, and the faster the string is vibrating (we will get to that later.):

String (ends fixed to the instrument),

Sine waves with: 1 bump, 2 bumps,

Frequency of a strings' vibration

The frequency of a string's vibration is the number of bumps multiplied by its fundamental frequency (frequency of a string vibrating with only 1 bump - when you play it without touching it).

"A" string's fundamental frequency is 440 Hz (cycles per second). We will use that information later.

Number of Bumps

Frequency

1	F
2	2*F
3	3*F
4	4*F

"F" stands for string's fundamental frequency.

Intervals

Ratios between different frequencies have their own names. These are the intervals [2].

Octave – 2:1

Fifth – 3:2

Fourth – 4:3

Major Third – 5:4

Minor Third – 6:5

7:6 and 8:7 don't have names

Whole step – 9:8

Major Sixth – 5:3

Major Seventh – 15:8

Diatonic scale

Diatonic scale is built using the base frequency and intervals.

It will be easier to show the diatonic scale of C than the diatonic scale of A, so we are going to find the frequency of C.

C D E F G A B

There are 6 steps (including C) between C and A, so we are going to use the ratio of Major sixth, 5:3. If C: A is 5:3, then A:C is 3:5. So, to get the frequency of C, we need to multiply A by 3 and divide by 5.

440 * 5: 3=264

(Previously we said that the frequency of A is 440 Hz)

This is the diatonic scale of C Major. Everything seems to be all right until we change the key of the scale...

A lot of frequencies don't match. This is why musicians need to tune their instruments right if they want to change the key of the scale.

Equitemped (equal temped) scale was invited for a great reason

It's impossible to tune a piano using diatonic methods! Each note has its own string, and there are 12 notes in each 7 octaves on an average piano. If we try to multiply perfect ratios from the diatonic scale, we'll never get 2 – we will never go an octave up perfectly.

So, equitempered scale is built on perfectly equal steps between these 12 semitones in an octave.

Let's try to find a formula to get the frequency of any note between A4 (440 Hz) and A5 (880 Hz, because we go an octave up).

A	A#	B	C	C#	D	D#	E	F	F#	G	G#	A
440	?	?	?	?	?	?	?	?	?	?	?	880
	*x	*x	*x	*x	*x	*x	*x	*x	*x	*x	*x	*x

440 * x^12=880

x^12=2

$x = 12\sqrt{2} = \sim 1.0595$

Now we found our multiplier, so we can find all the missing frequencies.

A	A#	B	C	C#	D	D#	E	F	F#	G	G#	A
440	466.1	493.8	523.3	554.4	587.3	622.3	659.3	698.5	740.0	784.0	830.6	880
	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)	(*x)

$x = 12\sqrt{2}$.

Any instrument tuned using equitempered scale can be used to play any key with tiny differences in tune. As I said earlier, most of modern pianos are tuned to this scale.

Mathematics and Sports

At first glance, sports and math seemingly have little in common. However, a closer look at the sport reveals that there is a considerable amount of math in sports. Let's take basketball as an example.

The angle at which the ball is thrown is defined as the angle made by the extension of the player's arms and a perpendicular line starting from the player's hips.

Geometry in basketball

Whether they realize it or not, basketball players make use of many geometric concepts while playing a game. The most basic of these ideas is in the dimensions of the basketball court. The diameter of the hoop (18 in), the diameter of the ball (9.4 in), the width of the court (50 ft) and the length from the three point line to the hoop (19 ft) are all standard measures that must be adhered to in any basketball court [3].

The path the basketball will take once its shot depends on the angle at which it is shot, the force applied and the height of the player's arms. When shooting from behind the free throw line, a small angle is necessary to get the ball through the hoop. However, when making a field throw, a larger angle is called for. When a defender is trying to block the shot, a higher shot is necessary. In this case, the elbows should be as close to the face as possible.

Understanding arcs will help determine how to best shoot the ball. Basketball players understand that throwing the ball right at the basket will not help it go into the hoop. On the other hand, shooting the ball in an arc will increase its chances of falling through the hoop. Getting the arc right is important to ensure that the ball does not fall in the wrong place.

The best height to dribble can also be determined mathematically. When standing in one place, dribble from a lower height to maintain better control of the ball. When running, dribbling from the height of your hips will allow you to move faster. To pass the ball while dribbling, use obtuse angles to pass the ball along a greater distance.

Understanding geometry is also important for good defiance. This will help predict the player's moves, and also determine how to face the player. Facing the player directly will give the player greater space to move on either side. However, facing the player at an angle will curb his freedom. Mathematics can also be used to decide how to stand while going on defiance. The more you bend your knees, the quicker you can move. Utilizing geometry, math in basketball plays a crucial role in the actual playing of the sport.

Statistics in basketball

Statistics essential for analyzing a game of basketball, for players, statistics can be used to determine individual strengths and weaknesses. For spectators, statistics is used to determine the value of players and analyze the performance of an individual or the entire team. Percentages are a common way of comparing players' performances. They are used to get values like the rebound rate, which is the percentage of missed shots a player rebounds while on the court. Statistics is also used to rank a player based on the number of shots, steals and assists made during a game. Averages are used to get values like the average points per game, and ratios are used to get values like the turnover to assist ratio.

Mathematics in Computing

In elementary mathematics, a variable is an alphabetic character representing a number, called the value of the variable, which is arbitrary, not fully specified, or unknown. In computer programming, a variable or scalar is a storage location paired with an associated symbolic name (an identifier), which contains some known or unknown quantity of information referred to as a value [4].

In mathematics, equality is a relationship between two quantities or, more generally two mathematical expressions, asserting that the quantities have the same value, or that the expressions represent the same mathematical object.

In mathematics, an inequality is a relation that holds between two values when they are different.

In computer science, a relational operator is a programming language construct or operator that tests or defines some kind of relation between two entities. These include numerical equality (e.g., 5=5) and inequalities (e.g., $4 \geq 3$).

In mathematics, a function is a relation between a set of inputs and a set of permissible outputs with the property that each input is related to exactly one output.

In computer programming, a subroutine (also called a function) is a sequence of program instructions that perform a specific task, packaged as a unit.

Abstract algebra (occasionally called modern algebra) is the study of algebraic structures, such as groups, rings, fields, modules, vector spaces, lattices, and algebras.

Group theory is very important in cryptography, for instance, especially finite groups in asymmetric encryption schemes such as RSA and El Gamal. Another application of group theory, or, to be more specific, finite fields, is checksums. The widely-used checksum mechanism CRC is based on modular arithmetic in the polynomial ring of the finite field GF.

Boolean algebra is a form of mathematics that deals with statements and their Boolean values. It is named after its inventor George Boole, who is thought to be one of the founders of computer science. In computer science, the Boolean data type is a data type, having two values (usually denoted true and false), intended to represent the truth values of logic and Boolean algebra. Allows different actions and changes control flow depending on whether a programmer-specified Boolean condition evaluates to true or false. Languages with no explicit Boolean data type, like C90 and Lisp, may still represent truth values by some other data type [5].

Software that aids in research, testing or design. The software allows keeping complicated workflows based upon previous equations and chaining those together to mock out a fully functioning system, where interconnected sensors would deliver various pieces of data to the overall equation.

Computers are used in education in a number of ways, such as interactive tutorials, hypermedia, simulations and educational games. Tutorials are types of software that present information, check learning by question/answer method, judge responses, and provide feedback. Educational games are more like simulations and are used from the elementary to college level. The Incredible Machines is a good example of this type. E learning systems can deliver math lessons and exercises and manage homework assignments.

Mathematics and Technologies

More than 35 years of active discussions involving academic representatives and practitioners: is math the Foundation of programming? Their opinions often vary greatly: some believe that information technology is derived from math; others argue that information technology is a separate science and math is just its equal partner. Here I will try to consider all points of view.

In the modern school, computers are increasingly used not only in science lessons but also in the lessons of mathematics, chemistry, biology, literature and fine arts. Information technologies not only facilitate access to information and the use of various educational activities, individualization and differentiation, but also allow new ways of interaction of all subjects of study and build an educational system in which student is an active and equal participant in educational activities [6].

The use of new information technologies allows you to replace many of the traditional means of learning. In many cases this substitution is effective, as it allows to maintain the students ' interest to the subject, creates an environment that stimulates the interest and curiosity of the student. At school computers allow the teacher to quickly combine a variety of tools that promote deeper and more conscious assimilation of the studied material saves class time [7].

In mathematics lessons teachers use presentations that that they had created or found in the Internet, for the following reasons [8]:

- To demonstrate to the students neat, clear samples of solutions
- To demonstrate concepts and objects;
- To achieve the optimal pace of students;
- To improve clarity in the course of training;
- To study more material;
- To show students the beauty of geometric drawings;
- To increase cognitive interest;
- To introduce elements of entertainment to enliven the educational process;
- To achieve the effect of rapid feedback.

The intensity of mental activity during math class allows teachers to maintain students' interest to the subject throughout the lesson.

The use of information computer technologies for classes has led to an increase in interest in the subject of mathematics and experiment on their own thus becoming young researchers.

Mathematical methods are quite often used for data processing of information. They can act either as a constituent element of other methods, or independently. Such mathematical methods are used in Financial analysis, Decoding, Handwriting analysis. The role of mathematical methods in data processing increases significantly with the development of computers and information technology [9].

Conclusion

Despite the fact that mathematics appears grey and boring science, it is very diverse. It is difficult to find areas of human activities not related to mathematics. Our project touched only some areas, but there are many more, among them there are medicine, astronomy, theatre and other. Since the Ancient times, mathematics has not only lost its former knowledge, it has been developing and improving human society.

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