# EUROMATH & EUROSCIENCE CONFERENCE 2023
# &
# EUROPEAN STEAME CONFERENCE 2023

# ABSTRACTS BOOKLET

**11 – 15 MARCH 2023**

**KRAKOW, POLAND**

# Abstracts Booklet

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# WELCOME GREETINGS



**Gregory Makrides**

Dear students, teachers, parents and colleagues, I would like to welcome you to the EUROMATH & EUROSCIENCE 2023 and the European STEAME Conference 2023.

It is with pleasure to welcome 370 participants this year, with the conference overcoming the pandemic period.

During this event we have three more activities, the EMS EDU Committee meeting that was organized during 10-11 March, the STEAME-Students meeting for the European STEAME-Student School Network and on 13-14 March we will celebrate the International Day of Mathematics. Part with the "Mathematics and Science by Night" dinner dance on the 13th and special event during the award ceremony of 14 March.

The conference programme has 64 Math Presentations by school students, 39 Science Presentations by school students, 7 workshops delivered by teachers and researchers, and 5 STEAME presentations.

Student participants have the opportunity to develop research and communication skills and at the same time to network and make new friends from many different countries.

There are participants from 17 different countries in series of events during 11-15 March 2023.

I want to thank specially the Pedagogical University of Krakow in Poland for hosting the event and the local colleagues for their volunteering contribution in supporting the event.

I wish to all a fruitful conference and a pleasant stay in Krakow, Poland.

**Gregory Makrides, President of the Cyprus Mathematical Society, President of the THALES Foundation and Chair of the Education Committee of the European Mathematical Society**

# GREETINGS FROM THE PRESIDENT OF THE EUROPEAN MATHEMATICAL SOCIETY



**Jan Philip Solovej, President of the European Mathematical Society**

It is a great pleasure for me as president of the European Mathematical Society to be given the opportunity to address you, the participants at the EUROMATH & EUROSCIENCE 2023 conference for school students. I am very sorry that I cannot be present in person and enjoy the conference with you. It is wonderful to see that almost 400 students are participating from all over the world. Mathematics as a field is unique in how it unites people across cultural and geographic barriers. No other topic is taught worldwide from first grade in all school systems everywhere. Some find the topic difficult. Others love it. I am sure you all are brought together here because you find mathematics interesting and enjoyable. I am immensely impressed with the breadth of the topics presented at the conference. I have never worried about the future of mathematics but it is nevertheless fantastic to see how mathematics keeps engaging new generation. I hope you will all benefit personally from participating in the conference, but I also hope that you will go home from the conference and act as ambassadors for mathematics and spread the word of how much fun it can be. For me personally mathematics has always been a very social activity that I love to do with my collaborators. I hope you will all experience this at the conference and I wish you all some exciting days that will stimulate your interest in mathematics even more.

# KEY NOTE SPEAKER

## HOW THE INVENTION OF THE MICROCHIP CHANGED OUR WORLD
Bernd Deutschmann
Professor of Electronics, Head of Institute of Electronics, Technical University of Graz, Austria



## PROFILE OF KEYNOTE SPEAKER

Bernd Deutschmann received his M.Sc. degree and the Ph.D. degree in telecommunication engineering from the Graz University of Technology/Austria in 1999 and 2002, respectively. After his studies, he worked in the semiconductor industry from 2000 to 2014 on improving the electromagnetic compatibility (EMC) of integrated circuits. In 2014, he returned to academia and moved to the Technical University of Graz/Austria as a full professor for "Electronics" and since then heads the Institute of Electronics. His research area is the design of electronic systems and integrated circuits with a special focus on their electromagnetic compatibility. As part of his research activities, he has filed several patents and authored and co-authored numerous papers and technical articles.

# STUDENT PRESENTATIONS IN MATHEMATICS

## MP1. RATIONAL NUMBERS IN ARCHITECTURE AND CONSTRUCTION

Amadea Filipović
OŠ Braća Radić, Koprivnica, Croatia

I always wanted to be an architect. Everyone told me that I couldn't handle the math. I think that they're wrong. To be honest, I love math and I am always curious where math is in different things around me. So, I am going to talk about rational numbers in architecture and construction. A lot of famous buildings use math and the principals of the Golden Section in their design. For example: Parthenon. A bunch of constructions are calculated by certain calculation methods. Their stability and load-bearing capacity are calculated. Foundations bearing columns, beams and lattice girders are studied. The resistance of the structure to various loads and wind, snow, earthquake and its own weight is studied. All in voices are expressed through formulas or aesthetic calculations.

## MP2. MATHEMATICS AND FOOTBALL

Leona Salajpal
Osnovna skola„Braca Radic, Koprivnica,Croatia

Apart from sports, I also like mathematics. Mathematics is everywhere around us, including in sports. I'm sure many people don't really know how much mathematics is involved in sports, from measuring results, keeping records and creating statistics.

Some people play sports professionally, some recreationally, but the competitive part is always present. What all athletes and teams have in common is that they want to win. Can mathematics help us to be more successful, to win more often?

Each sport has its own specifics. In some sports we perform alone, in others as a team. Some sports are played outside and some are played indoors. Does the mathematical approach also depend on the type of sport we are observing?

Today, playing sports professionally can be very profitable. Athletes earn a lot of money. In order to be more successful, they put together their own coaching teams who follow them and try to contribute to their players being as good as possible. What do they use, what kind of math is involved?

Mathematics is present in every sport. How much it actually affects certain sports disciplines, their development and the change of rules throughout history, I will show with interesting examples from sports that we all know.

## MP3. INFLATION

Marija Švegović
Udruga mladih koprivničkih matematičara, Croatia

In today´s world, price increases are becoming more common. Of course, in the last few months we havw felt them drastically. What until the other day cost 0.46 euros, today costs 1.18 euros, and tomorrow it can reach a price of 1.33 euros. Certainly we found ourselves in this because of the war in Ukraine, but also of the consequences of COVID – 19 which affected the economy.

In this presentation, I will initially talk about the inflation that is happening in the world, specifically what is happening in Croatia. I will also touch on the topic of Croatia´s transition to the eurozone. And also I will compare the prices of the same products in the Croatia with prices in Hungary. By doing so, I will compare the currencies of the two countries.

# MP4. MATH IN ASTRONOMY

Antea Jelović

OŠ Braća Radić, Koprivnica, Croatia

Since I was a little girl, planets of Solar system always been point of interest to me and I had a lot of questions about space and planets.

Today, using math, I can get answers and calculate how far away planets and stars are, or how fast planets are moving in space. Some of themes that I will explain in this assignment are:

1. How we can calculate distance of each planet from Sun
2. How planets are moving around the Sun
3. How to calculate size of planets
4. How spacecraft leave the Earth atmosphere

Thanks to astrologist Keppler we know that planets are going around Sun in elliptical orbit, all due to gravity and planet weight.

When planets are closer to Sun they are moving faster and opposite, slower when they are far away from Sun.

Period (time it took planet to go around the Sun) of each planet is in correlation with its distance from Sun. How spacecraft leave Earth? What is speed that satellite need to gain to circle around the Earth? Understanding of cosmic velocity will give us answers on those questions.

Math plays important role for understanding solar system. Without mathematics, people would not be able to build spacecrafts or calculate route for it, build telescopes and satellites. Math is essential in astronomy.

# MP5. MATHEMATICS IN HISTORY

Juraj Ašić

Osnovna skola „Braca Radic", Koprivnica, Croatia

When, how and in which order where the numbers created? How did people in the past count? When did they start to write down numbers? How did they call them at their time of occurence? These are the questions which you cannot easily answer. One thing is sure: people didn't always know how to count in the way that we do today.

The development of mathematics is inseperably linked to the general development of human society. Millenias have passed in the pre – civilization era, until the concept of numbers began to form in human consciousness. A lot of time passed before a man who was gathering fruits didn't begin to hunt, raise cattle and coltivate the land. By doing this tasks he was able to tell the difference between the number of fruit picked and animals hunted. A person from the pre – civilization era was able to identify the elements of a set. This enabled him to asses the size of his herd and to see if he is missing any sheep.

In my presentation I am going to show you how numbers and people with them evolved in the past, and how maths has helped them in that.

# MP6. MATHEMATICS IN MUSIC

Eva Papić Bogadi

OS Antun Nemcic Gostovinski, Koprivnica, Croatia

Music is a very important part of our everyday lives. When we are listening to music, we often don't realize that it involves math.

Both music and math have their roots in ancient Greece. Music was a branch of mathematics because it dealt with relationships between numbers, proportions, and ratios. We can find math in both rhythm and melody, such as different note durations, intervals and chords, scales and time signatures, etc. Music is divided into sections called measures and each measure has equal amounts of beats. These are the same as mathematical divisions of time. Therefore, each piece of music has a time signature that gives rhythmic information about the piece, such as how many beats are in each measure. In addition, different intervals make chords, for example, a major third, which is made up of four half steps, and a minor third which is made up of three half steps, make up a major triad. If we want to write it like a mathematical equation, it will look like this (for a chord with a root of C): M3 (major third) + m3 (minor third) = C (the C major triad)

To sum up, in this presentation I will show you how math plays an important role in music.

## MP7. 3ANGLES

Marina Loizou, Myrianthi Savva, Daniella Biparva, Nancy Akar, Panagiota Antoniou
American Academy Larnaca, Cyprus

We use Mathematics in our everyday life without us even realising. Mathematics exists in different aspects of our lives and helps us in different ways. Also, we all learned since kindergarten that mathematics includes shapes and numbers and that the triangle is one of the most important shapes. None of the things in our everyday life would be the same without triangles. For example, people use trusses in buildings which are needed to keep them sturdy and balanced. Another example is the pyramids which have a monumental structure and other types of historical buildings found even today in many different countries. What is more, triangles are pretty much in everything we do, and we use a lot of methods to measure them, but the main one that we are going to focus and talk about is Pythagoras' Theorem. Pythagoras' Theorem is named after Pythagoras of Samos who was a Greek Philosopher and it states that the square of the length of the hypotenuse of a right-angle triangle equals the sum of the squares of the lengths of the other two sides. This helps in measuring and designing buildings or even structures. To summarize up we are going to present mathematics in relation to Pythagoras' Theorem and triangles and explain the use of triangles in our daily life.

## MP8. THE RULES OF LOGIC ARE TO MATHEMATICS WHAT THOSE OF STRUCTURE ARE TO ARCHITECTURE"-BERTRAND RUSSELL

Elisavet Papachristoforou, Panayiota Kyriacou, Andriana Nikola, Polina Louka,
Ellie Afxentiou, Mariam Kotzia, Fotia Miltiadous
American Academy Larnaca, Cyprus

If someone asked you in an early age what mathematics is, you would probably say that is a difficult and boring lesson with numbers and that it has no use in real life. In our presentation we are going to show you how this 'boring' lesson has helped with the development of the whole world using shapes and structures. Without mathematics, we would not have been able to build impressive buildings, statues, and monuments all over the world. The Eiffel Tower, the Big Ben, the Colosseum, the Parthenon, The Great Pyramid of Giza and many more amazing statues and buildings have been structured and completed, all using mathematics. Triangles, rectangles, geometry, heights, lengths, meters, diameters, and ratios are all present in those structures. Mathematics can be thought as the 'right-hand' of architects that use mathematics when designing fascinating buildings and other structures. And as the philosopher Bertrand Russell once said: "The rules of logic are to mathematics what those of structure are to architecture".

## MP9. HEXAGONS ARE THE BESTAGONS

Maximos Vardas, Savio Nahas, Haoxiang Ma
American Academy Larnaca, Cyprus

In our presentation we will talk about hexagons and why they are used everywhere in our daily lives. Hexagons offer the greatest area for the least perimeter with no wasted space; therefore, we find them, from planes in the air to a honeybee's hive, down to one of the fundamental building blocks of life, carbon. That's why we are here to present why hexagons are important to the development of our society and its future, with new technologies such as carbon nanotubes and graphene.

## MP10. DESTINATION ; OUTER SPACE

Elina Chili, Demetra Loukia Foulia, Christos Michael, Maria Papaloizou,
Avgilina Kyriakidou, Konstantinos Rossos, Alexandra Christoforou Alexandrou
American Academy Larnaca, Cyprus

What is the main tool that makes it possible to comprehend space? MATHS! Mathematics is the key to space exploration, calculating distances between planets and predicting potential hazards. Moreover, trigonometry helps astronauts to calculate distances between other planets from the earth or even from the sun. In addition, in this presentation we are going to explain how the speed of light creates a delayed image from the earth to what really happens in space. Mathematical functions such as standard forms, π and formulas for volume and areas also make it easier to understand the space. Maths is presented in all aspects of astronomy. Calculations are a critical part of every mission to space. Humans haven't reached outward space and have never been close to the surface of the sun. However, they managed to predict how the sun and other planets are, using maths. Using technology and specifically the field of mathematics enables us to explore regions of space that we have never seen before or even imagined. Without calculations and maths no astronauts or satellites would have been able to reach the space and even to give us the limited data which we have. While mathematics improves and technology continues to advance, the space will one day no longer be a mystery to us.

## MP11. MATHEMATICS FIELD

Christoforos Kekkou, Margarita Paraskevopoulou, Dimitris Georgiou, Giorgos Tsardellis,
Stefanos Stylianou, Martin Stanev, Konstantinos Skordis
American Academy Larnaca, Cyprus

Some people say mathematics is the most useful subject, while others say mathematics is completely useless. We will not try to resolve this but one thing we will say is that mathematics is definitely useful in a lot of areas. We will focus on sports. Specifically, football. How does football associates with mathematics? In this presentation we show how mathematics links with football.   Firstly, with the use of probabilities, we will find the chance of each football team winning in a game. Secondly, we will find the percentage changes in the world cup statistics. For example, we will take the number of teams that played in the first world cup and the number of teams that played in the latest world cup and calculate percentage changes throughout the years. Lastly, we will show the greatest goals scored by famous football players and focus on finding the distance from the footballer to the net. Our aim here will be to find which goal was scored from the furthest and closest distance.

## MP12. MATHEMATICS PASS THROUGH THE PAST

Lazaros Zeniou
American Academy Larnaca, Cyprus

The visual world seems naturally effortless for us humans to understand. Over many centuries evolution has developed our minds so that we can now readily recognise images, patterns and faces of those around us in everyday life; in fact, the process of image recognition is so simple for us, that it seems we could easily teach computers to do the same. But if we try to formalise this process by means of conditional algorithms, it ends up being mission impossible.

Therefore, in areas of computer vision where formalisation would be very difficult, instead of providing explicit instructions, models such as Artificial Neural Networks (ANN) are used. Through these machine learning algorithms, computers of essentially no prior knowledge would be able to learn how to recognise different types of images based merely on sets of training data. The structure of neural networks is vaguely inspired by those of our own brains. But we don't have an accurate understanding of the brain's functions, so processes through which machines learn may likewise seem a mystery to us.

In this presentation I will explain the mathematical model behind the ANN - the structure of the network, the 'loss function' and the process of backpropagation. I will also demonstrate a sample neural network, and how specific changes in the initial parameters, loss function and training data can affect the speed and effectiveness with which the machine learns. Finally, the presentation will explore difficulties in using ANN for computer vision and how those issues are resolved.

## MP13. MATHS = MONEY?

Eyal Israeli

American Academy Larnaca, Cyprus

Buy or sell? This is the million-dollar question! Mathematics can solve complex questions and provides the answers to how the world behaves around us, but the most important thing is that it can make you rich. All the hedge funds or private investors that sit on Wall Street and make millions per day have one thing in common: mathematics. One of, if not, the best tools for the stock market is the Fibonacci extension tool which works by analysing the psychology of the masses. It allows you to locate and profit from exact timing and precise calculations done in a split of a second. In my presentation, I will show you how mathematics is closely correlated with the stock market and how it can make someone rich. My goal is to explain the magic behind the movements of the stock market.

## MP14. THE UNIVERSE IN A CALCULATOR

Petra Bušljeta, Zrinka Miškić, Nika Tomljanović, Lana Vučetić

Prva riječka hrvatska gimnazija, Croatia

Look through the window. What do you see? You either see the Sun, or the Moon and the stars. At first, it seems as if the universe is just a space filled with celestial bodies, but we can make it a little more complicated and a little more fun just by using basic mathematical principles. Mathematics has always been a means of space exploration, from the time of ancient civilizations and Erathostenes' calculation of the Earth's circumference to the latest discoveries.
Every planet is also a geometric body. Each of these geometric bodies has its own surface and distance from the other bodies. The distances among the planets are large,
so we present their values in the form of a scientific record with potentials.  The whole universe is actually a set of subatomic particles that can be represented by a number. So basically, the universe is made up entirely of numbers and there is no problem in the universe that we can't solve with mathematics.
In our presentation, we will present the application of Newton's law of gravity, Einstein's general theory of relativity, but also other mathematical theories in space exploration. Come with us on a mathematical journey through space filled with Pythagorean teaching, trigonometry, and geometric bodies.

## MP15. ESCAPE PLAN

Christoforos Panayi

The English School Nicosia, Cyprus

100 prisoners are given a choice. Each one has a number. They go into a room with 100 numbered boxes that contain randomly a slip with a number from 1 to 100.They all have to find their number. At first the try seams impossible but there is a way to increase the probability as much as we can and the answer is well quite astonishing. Using this fun problem we will see how using loops or grouping elements can manipulate probability and also discovered other versions of these experiment to see if this method can be used and finally explore the idea of a plan that can help the prisoners escape for sure. During the whole presentation we are going to investigate how probability works and the important of an algorithm and a loop. We will also see some variations of the same problem.

## MP16. DID YOU KNOW THERE IS A WAY TO WIN AT CONNECT FOUR LITERALLY 100% OF THE TIME?

Panayiotis Pantelides

The English School Nicosia, Cyprus

Connect Four is what mathematicians call a "solved game," meaning you can play it perfectly every time, no matter what your opponent does. You will need to get the first move, but as long as you do so, you can always win within 41 moves.

Connect Four is first-player-win. With perfect play, the first player can force a win, on or before the 41st move by starting in the middle column. The game is a theoretical draw when the first player starts in the columns adjacent to the center.

What is the Best Connect 4 strategy?

Create a '7' formation. One of the key traps in Connect 4 is to create the seven formations around the middle of the board. It is dominant because by building up the column next to it, the opponent cannot block both 4 in a row.

## MP17. CRIMINAL MATHS

Maya Maria Stavrinidou, Irene Yianna, Mariza Zembyla

The English School Nicosia, Cyprus

Did you ever wonder how criminal investigators manage to solve complicated crimes? The key to their success is surprisingly none other than math. In fact, Sherlock Holmes' great mathematical brain was what helped him become such a great detective, making people believe that he could have been a mathematician. In one of his famous cases, he used mathematics to estimate the length of peoples' strides and find out their height. Mathematics is playing an increasingly important role in crime scene investigations by helping forensic scientists work out a range of problems including the trajectories of bullets, fingerprint recognition and the speed of moving vehicles. For example, a PhD criminologist used geographic profiling to find the location of where the murderer might be living from the location of the convicted crimes. In addition, blood stain analysis using trigonometry can help determine the source of blood and the positions of the victim and the perpetrator. In conclusion, an understanding of mathematics could be key for the next great detective. It is incredible how much mathematics can achieve if you apply your knowledge correctly – it can even solve the most nerve-crashing cases of all.

## MP18. THE LABYRINTH OF MATHS IN OUR BRAIN!

Ioanna Christofidou, Andreas Anastasi

The English School Nicosia, Cyprus

Everyone of us use maths in our everyday life but how many of you know how uniquely each person's brain works and develops while doing and learning maths? It is remarkable how far a piece of information travels in our brain to solve a mathematical problem. Each person has a different or special brain structure and anatomy which makes them think in their own way. A combination of genetic factors and our life experiences develop and form our mathematical thinking. Many people who we face with stereotypes sometimes they have hidden, brilliant abilities that we are not aware about. Individuals with autism and the syndrome of synesthesia have extraordinary abilities in maths even though they are struggling with other themes. In the other hand people with depression and anxiety which is a very common metal state, find it hard to perform maths. However, each person is gifted in a different topic of maths depends on his mathematical perspective, logic, strength of metal math and observation skills. Therefore, to achieve standards high enough to be successful in this modern and demanding society, every day we are practicing, developing, and increasing our mathematical skills from a very young age.

## MP19. MATHS IN THE CASINO
Gerasimos-Georgios Panayides, Chariton Charitonos, Garry Petrossian
The English School Nicosia, Cyprus

Many people believe that the casino is all luck, however gambling games like Blackjack and roulette contain Probability and Statistics! In our presentation, we will explain the Maths behind different casino games-which will help you to dominate your opponents- and which of these games are the most efficient and profitable to walk out of the casino with your pockets full! We will present some probability graphs related to games like Blackjack and roulette! In addition, we will use tables to show our data and our findings and thoroughly explain the methods and theories behind these. Statistical records related to real life examples, will also be demonstrated. For example, skilled gamblers assess the risk of each round based on probability, odds of winning and length of play. Moreover, we will prove using statistics, if it's worth betting or not. We will also show the different risks and dangers of the games and how maths will allow you to avoid them. Through this presentation you will learn how to use your mathematical knowledge to gain a competitive advantage in gambling games. As a result, you will be able to confront and possibly win all your fellow opponents in the casino playing area!
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## MP20. MATHEMATICAL ESCAPES
Elena Potamiti
The English School Nicosia, Cyprus

Since ancient times there has been a correlation between learning and play. Plato had identified the close relationship between the word "play" and the word "education", given that mathematics should be made more attractive for students and fill them with optimism; it is noticed that something like this is possible if games or other playful activities are involved, like escape rooms. Escape rooms are live puzzle games played by dyads or groups of players, where players are usually locked in one or more rooms. The goal is for the team to escape within a short period, solving a series of mathematical puzzles or missions with the field of Cryptography playing a dominant role. The time interval varies and ranges from 60 minutes to 3 hours. Dealing with problems in an unfamiliar environment and under time pressure is a big challenge. It strengthens the abilities of perception, observation, cooperation, and more. One of the essential elements of escape games is attracting people of all ages. It is an activity for children or groups of friends and a way of having fun and strengthening relationships for the whole family. Here we will see how to build escape games using mathematics and develop skills to win in escape rooms more efficiently and in less time. Get ready for a beautiful experience. Let's escape together.


## MP21. IS YOUR BIRTH DATE JUST A NUMBER?
Riana Georgiadi, Theodora Constantinou
The English School Nicosia, Cyprus

All of us at some point have thought whether or not age is just a number: whether the day we were born really matters. Through the Birthday Paradox we will examine the hidden probability behind our birth date. Do you believe that in a group of 23 people, there is a 50-50 chance that two share the same birthday? Millions do not, but it is true. There is a group of 23 people in a room. What is the chance that two of them will share a birthday? One would expect the chance to be fairly small. If there were 23 names and 365 boxes (one for each day of the year), then most of the boxes would be empty. In reality, there is a 50:50 chance that two people will share a birthday in a group. We will explore solving and explaining the Birthday Paradox, as well as the underlying probability theory. The solution appears counterintuitive, even paradoxical, but follows from basic probability theory. We will explain this solution, as well as the problem in general, and the underlying probability theory. Although the birthday problem might seem like just a coincidence, there are mathematical proofs behind it!

## MP22. INFINITY
Giannis Stavrou, Giorgos Hadjikyriakou, Nicolas Anastasiades
The English School Nicosia, Cyprus

The Infinity Hotel is a concept that shows how mind-blowing infinity is. It is very complicated to understand such number as infinity even the countable. The Infinity Hotel is a hotel that has infinite rooms and can fit infinite guests. It only includes the countably infinite but cannot fit the natural infinite which includes negatives and decimals. If you add numbers to infinity, it stays the same number but there are another kinds of infinities that are larger than the others. For example, the natural infinite of 1 to 0 is larger the countably infinite of all the number.

## MP23. IF SOCIAL MEDIA IS A MUST, THEN MATHS IS THE MUST OF THE MUST
Aglaia Patsalides,  Athanasia Mavrotheri
The English School Nicosia, Cyprus

Social media is an efficient tool for sharing, creating, and spreading information locally and globally. Through reviews, advertising, and marketing strategies, social media can affect consumers' purchasing decisions and more generally, their life. The usage of social media has skyrocketed since the Covid19 outbreak. Instagram, TikTok, YouTube, and other platforms have ingrained themselves into our daily lives. Math and social media go hand in hand, in our presentation we first examine the crucial role of Math to such platforms' functioning and then its influence on personalizing users' online experience. Thus, we look at math behind how recommendations form and what makes an account successful. We discuss the impact of algorithms, data science, machine learning, social media marketing and how they collect users' data for future use. Meanwhile this causes many ethical implications and privacy issues. Therefore, we conclude by discussing the need for education to raise awareness on how to interpret data and the ability to distinguish what is reliable and safe in social networking platforms.

## MP24. HOW TO USE MATHEMATICS TO CHOOSE A LIFE PARTNER
Maria Christina Economides, Yiolanda Liveri, Alexandra Georgiou
The English School Nicosia, Cyprus

Everyone in their life will come to a stage where one will have to choose a partner. But who on earth would use mathematics to find their best match? Mathematics is probably the last thing you would have in mind, but it can be very helpful on an occasion like this. Mathematics is a tool, created by humans to formalize logic and communicate logic in an efficient way. The problem is, let's say you know your success criteria and you set off on a journey to go looking for the person you want, of which some may be bad, and some may be great. But how would you know when to stop looking. How would you know that this person is the one. You obviously cannot keep going on forever searching for the best and at the same time you wouldn't obviously want to compromise and miss out on the best possible match either. So, how can you maximize the likelihood of finding the best match as your life partner? The answer is, using applied mathematics.

## MP25. HOW MATHEMATICS IMPACTED THE COURSE OF WW2
Filaretos Ierotheou, Damianos Hambakis
The English School Nicosia, Cyprus

The connection between mathematics and construction has been around since ancient times. All the old nations applied mathematics to the construction of various buildings. At that time, architects were also mathematicians, and vice versa mathematicians were also architects. Some of the earliest examples of mathematical principles in architecture are the Greek temples.
Without a basic understanding of mathematics, it is impossible to build houses. In this presentation we will show how mathematics is related to house construction. How much material we need to build, what will be the dimensions of the house and how the appearance of  the house is related to geometry. We want to show that without mathematics there would be no houses and then neither the villages and the cities.
Math is not just calculus but something that is related to the whole world and we will show it on an example of building houses. Math is all around us.

## MP26. HOW CAN MATHS TRAVEL AROUND THE WORLD
Sophia Anastasi, Efi Zanou, Mariella Leptou
The English School Nicosia, Cyprus

Our PowerPoint presentation will be about the impact that mathematics had in the course of WW2. In the presentation we are going to discuss the Enigma Machine, Encryption and Decryption, the Manhattan Project (atomic bomb development) and how Allied Mathematicians estimated the number of German Tanks.

German field agents utilized the Enigma machine as a field unit during World War II to encrypt and decipher communications. The Enigma machine was one of the earliest mechanical ways to encrypt text using an iterative cipher, much like the Feistel function of the 1970s. The Enigma Cipher's decryption, which allowed the Allies to read significant portions of German radio traffic on crucial networks, was an important source of military information throughout the war. Of course other countries had created their own Encryption and Decryption methods and machines.  Italy had the Hagelin Machine, the USA had the Magic cryptography program etc.

The Manhattan Project was a research and development undertaking during World War II that produced the first nuclear weapons. Its equation was E=mc2. It is a case in which theoretical calculations and simple numerical simulations using electromechanical devices such as Marchant Calculators and IBM punched-card machines with much less computing power than a 1980's Apple II computer were seemingly able to correctly design extremely destructive weapons that worked right the first time.

Allied nations managed to estimate the number of German tanks using math. Statisticians had one key piece of information, which was the serial numbers on captured mark V tanks. The statisticians believed that the Germans had logically numbered their tanks in the order in which they were produced. And this deduction turned out to be right. It was enough to enable them to make an estimate of the total number of tanks that had been produced up to any given moment. The basic idea was that the highest serial number among the captured tanks could be used to calculate the overall total.


## MP27. HOW ANIMALS USE MATH
Ioannis Ioannou, Platon Trapelides, Leonidas Sfaltos
The English School Nicosia, Cyprus

Mathematics are very useful in our everyday life, and this is shown through some very realistic examples of our reality such as travelling. There are thousands of people every day in the airports using maths to catch their flights without even realizing it. Also, they use maths when they arrive at their destinations and most of the times before even going, so do pilots. People use them to organize their trip by making equations and calculations. Sometimes, they are helpful with catching you're flight and with being there on time. The fact that even pilots use mathematics to fly the airplane breaks the stereotype that mathematics are only useful to mathematicians and accountants in their jobs. Not only this, maths are also helpful for the travelers to be able to pass through the gates to another country. Maths are not just a subject at school, it's a way of living. We use them daily, in many cases and in lots of things that we do. So lets buckle up and let the journey begin.


## MP28. THE STARS AND MATHS 2000 YEARS AGO
Alexandros Parikian, Panagiotis Charitou
The English School Nicosia, Cyprus

In this presentation we will be talking about how different animals like squirrels and cats use math in their everyday life. For example, we will talk about how squirrels cannot die from a terminal velocity fall and about how cats can almost always land on their feet. We will also be talking about how, many animals like bats use math to calculate the position of different objects in pure darkness. A lot of underwater mammals, on the other hand, manage to live in the ocean and by calculating the amount of time that they can go underwater after taking a deep breath.

## MP29. MATHEMATICS BEHIND GALAXIES'S SHAPE

Xenia Pierides, Elli Louiza Porfyridou, Anastasia Tantele
The English School Nicosia, Cyprus

In this presentation we will describe the mathematics behind galaxies' spiral shape and we will support this statement using detailed graphs and proved formulas. We outline a brand-new formula that can quantitatively describe the Hubble sequence of spiral galaxies, including barred spirals and grand design spirals. The analytical continuation of the same formula also describes special structures like ring galaxies with inward and outward arms. The formula is $r()\varphi = A/ \log B[ \tan( / 2\varphi N)]$ is the formula. Using the help of this function, a bar that is fixedly and continuously connected to an arm with arbitrary winding sweep can be produced automatically. With the exception of a scale factor, the formula can be recast so that it only depends on a single point of rotation angle of pitch. In contrast to logarithmic pitch, which exhibits weak correlation in this study and in prior ones, the pitch parameter of our formula provides a very tight correlation with the ideal Hubble type, showing that it is a good discriminator. Shown are representative samples of fitting galaxies. To sum up we will explain the reasoning for the natural form of galaxies.

## MP30. THE COLLATZ CONJECTURE

Vitos Fotios, Vrontos Dimitrios, Gourdoupari Nefertiti, Karpouzis Christos
Varvakeio Model High School, Greece

The Collatz problem was introduced by Lothar Collatz in 1937, also known as the 3n+1 conjecture or Syracuse problem, and has since troubled mathematicians who have tried and failed to prove the notorious problem. The Collatz conjecture is one of the most elementary unsolved problems in mathematics. It consists of a simple function on the natural numbers that generates a Collatz sequence after multiple iterations. The conjecture says that every Collatz sequence eventually attains the value of one, no matter which positive integer is chosen to start the sequence. The problem is so easy to understand as it is hard to solve. Paul Erdos once said, "Mathematics is not yet ripe enough for such problems". In this study, we will try to detect the properties of the Collatz sequences and study their morphology. We will prove the mean downward tendency of the sequences and disprove the existence of circles of length 5. We will also study various modifications, such as expansion to negative or if one modifies the Collatz sequences by sending an odd number n to 3n-1 or 5n+1 instead of 3n+1. Moreover, we will show that the integers in the Collatz sequences on a list of random numbers will approximately follow Benford's law. Finally, we will introduce the concept of dynamic systems to the problem and present ways of visualizing the conjecture through fractals.

## MP31. WHERE DO WE MEET FIBONACCI SEQUENCE ?

Igor Martyna, Igor Pajor, Oskar Tomasik
I Liceum Ogólnokształcące im. Kazimierza Brodzińskiego w Tarnowie, Poland

The presentation focuses on the popular subject of the Fibonacci sequence. At the beginning of the presentation, the authors focus on Leonardo of Pisa and the most popular applications of the Fibonacci sequence.
Then the authors present a less known application of the Fibonacci sequence, e.g. – Discovery of Simon Michael Toon, the designer behind an upcoming solar energy project based on artificial "trees". Successively, the authors show the representation of the Fibonacci sequence with the help of Antoni's carpet. The presentation concludes with a simulation on using the Fibonacci sequence in sports betting.

## MP32. SUMMATION, NUMBERS AND SHAPES IN GEOMETRY

Giorgi Ratiani, Lizi Katamadze, Mariam Jikia, Lela Ardoteli
Tbilisi International School, Georgia

Summation might seem a very simple task at first. And, yes adding a couple of numbers hides no difficulty in it. But what if we have to add more? In 7 houses there are 7 cats, each cat eats 7 mice, each mouse 7 grains. What is the total amount of objects? This problem in famous Rhind Papyrus, is one of the example of using sum of several terms of geometric sequence. Way more addends, that form geometric sequence are in the ancient legend of chess invention. Finding sums wasn't only entertaining. Using summation Archimedes found an area of parabolic segment, and volumes of some solids of revolutions. This method was used before invention of Calculus, where such problems are solved using antiderivatives and integration.

Finding sums is used not only in integral Calculus, but in number theory as well. A lot of the formulas were known to ancient Greeks, though were derived geometrically, using dots. Gnomons, triangular, square numbers etc. are examples of numbers that are sums of dots on a plane in specific shape. The dots on the plane can be turned into spheres, that are piled in pyramids. Results would be three dimensional triangular numbers - tetrahedral numbers, or pyramidal numbers. This is possible even in 4-dimentional space, though only theoretically.

## MP33. NON-EUCLIDEAN GEOMETRY

Kacper Maciuszek, Natalia Zając
I Liceum Ogólnokształcące im. Kazimierza Brodzińskiego w Tarnowie, Poland

The presentation focus on non-euclidean geometry, presents Euclid's postulates, expound spherical and hyperbolic geometry. It shows transparently how it works using numerous animations and compare well-known formulas with those which are used in spherical and hyperbolic geometry. It makes people aware of existence of non-euclidean models in reality. You will also understand why are Great Circles the shortest flight path or how the light in the space-time work.

## MP34. MATHEMATICS IN MEDICINE

Ana-Marija De Conti, Laura Mesar
Gimnazija „Fran Galovic" Koprivnica, Croatia

Medicine is developing more and more every day, and so is mathematics. Mathematics is a language that expresses ideas and concepts. It helps us to understand and to be part of the world around us. With the development of medicine, the application of mathematics develops proportionally with it. In medicine, mathematics is one of the most important factors. It can help us with the probability or effectiveness of surgery or drugs, to prescribe the correct dose of medication to patients, it can help us to draw statistical graphs during pandemics, and help estimate the spread of disease. We want to prove to you that there is more mathematics involved in medicine than just asking a patient to rate his pain from one to ten.

## MP35. MATH BEHIND THE DESIGN OF THE GREAT PYRAMID OF GIZA

Eva Pavlovic, Petra Pozgaj
Gimnazija "Fran Galovic" Koprivnica, Croatia

There are three pyramids of Giza. For our study we have chosen the biggest one, The Great Pyramid of Giza. It was built in the 26th century BC. What is interesting about it is that the knowledge of Pythagorean Theorem, trigonometry, and simple algebra were required to build it but none of these had yet been formulated. So, while technically ancient Egyptians were not using degrees, the Pythagorean Theorem, or trigonometry, they still managed to cut their stones, size them according to placement, and build pyramids with consistent dimensions, slopes, and angles. Moreover, they measured the angle of each direction so that each side of the pyramid was facing exactly north, south, east, and west. The aim of our presentation is to show that math is everywhere around us and to demonstrate its importance. It is so important that even ancient Egyptians were using it. They did not even know what they had discovered. All of this shows how advanced Egyptians were and that they knew more than we think.

## MP36. MATHEMATICS IN CAR INDUSTRY
Simon Sovic, Martin Majerus
Gimnazija „Fran Galovic" Koprivnica, Croatia

Cars and many different types of vehicles are around us all the time. The automotive industry is improving every day and new models of cars are being released constantly. But those new ideas could not be planned nor realized without the use of mathematics and geometry. A lot of geometry, trigonometry and calculation goes into the science of interior and exterior design and layout of a car. The position, shape and size of a car and it's parts must be precisely calculated. In exterior design maths is also needed to make some cars faster, lighter, heavier or more stable. We want to prove to you that maths and geometry are very important in the process of designing a car's interior and exterior.


## MP37. UNEXPECTED MATHEMATICS
Angelos Christoforou, Kyriacos Antoniades, Aris Pappalis, Theocharis Karatsiolis
The G.C. School of Careers, Nicosia, Cyprus

We have been puzzled by several unexpected outcomes in Mathematics.
Have you ever considered the possibility that another person in the same room might have the same birthday as you? Surprisingly, it happens more frequently than one might anticipate.
David Hilbert, the author of the "Über das Unendliche" first made the world aware of the Grand Hotel Hilbert's dilemma in 1924. This conundrum shows that an intimately large hotel with an endless number of rooms may still accept further visitors, and this process can happen infinitely many times!
If I tell you I have 2 kids and one of them is a girl, what is the probability that the other is a girl? Well the answer is 33%. But what is even more surprising is that if I tell you that her name is Angela then the probability of the other kid being a girl is now 50%!
Could you imagine being beaten by a tortoise which is ten times slower than you in a race?
Our project aims in answering these challenging and puzzling outcomes.


## MP38. THE ROUTE
Aikaterini Pilidi, Eva-Christina Christodoulou
The G.C. School of Careers, Nicosia, Cyprus

Have you ever wondered whether mathematics is necessary in a person's daily life? If you take a pragmatic approach in viewing your daily routine, you will realize that mathematics is a prominent factor of our reality.

Spending a lot of time in traffic is for sure tiring and frustrating for all of us. Especially when you have to go to work! You eagerly try to find the magic formula that will help you determine the fastest and easiest route...but is there a way to do this?
Nevertheless, you arrive at work and … you are surprised to find out that there are so many people in the same company with matching birthdays! A coincidence or a mathematical fact?
Surely mathematics has answers to all of the above questions and many more. Just follow *The Route* and you will be further able to understand mathematical concepts that will help you to pursue your everyday life.
Remember: "If people do not believe that mathematics is simple, it is only because they do not realize how complicated life is." *John von Neumann*

# MP39.MATHS IN SEA WAVES

Sotia Koukou, Konstantinos Patinios, Nikolas Xiouros
The G.C. School of Careers, Nicosia, Cyprus

Have you ever sat on the beach, watched the waves crushing through the surface of the earth and wondered': 'How are they generated?' 'How do they move?' how fast can they travel? Well in fact, the answer to all those questions is mathematics. A moving ridge or crest of water that develops near the sea's surface is known as a sea wave. Sea waves and mathematics are related in a variety of ways, including trigonometry, graphing, and numerous equations that determine a wave's velocity, acceleration, and other properties. Our project aims to explore how waves are connected to mathematics.

Wind waves, swell waves, tidal waves and tsunamis are just some of the hundreds of different types of waves found under the category of "sea waves". One can acknowledge that all those kinds of waves differ from each other, and yet they all have an indirect common feature; mathematics. Waves can be generated from the wind, gravity and even natural disasters like earthquakes and volcanic eruptions. Trigonometric functions offer a great representation of what waves look like and they are used to calculate their size, speed and shape.

It will never cross your mind how many various sorts, shapes, and sizes of waves there are and yet they are all connected to mathematics in almost the same ways.


# MP40. MATHS IN MAGIC TRICKS

Michalis Dionysis Vassiliou
The G.C. School of Careers, Nicosia, Cyprus

Prepare to be amazed, to explore the uncharted, to find yourselves confused and bewildered. I'm certain that's how you feel every time you observe a magician perform a magic trick. I am not so certain however, that you are aware of the mathematics taking place behind that act.

Magic tricks can be split into tricks that involve either sleight of hand, or tricks that have a mathematical basis behind them, so called "self-working" tricks. The latter category is discussed right here!

Tricks can be of varied mathematical complexity and depth, as some tricks only rely on simple addition and subtraction while others require way more sophisticated mathematics. Together we will explore key numerical concepts, such as the modulo function that allows the magician to reach the desired effect, usually locating the spectator's card. A large number of books have been written to explain the mathematics behind the tricks. In this presentation we will take a quick peek into the world of mathematical magic and the role of concepts such as factorials.

Magicians implement such tricks in their repertoire, with many magicians being mathematicians themselves. As stated by Peter McOwan, who is both a magician and a mathematician: *"With an imaginative story, you can take a simple mathematical trick and turn it into a jaw-dropper."*


# MP41. THROUGH THE VIVIANI'S WINDOW

Antonina Dulak, Joanna Szczęsna
VII Liceum Ogólnokształcące im. Zofii Nałkowskiej, Poland

Our presentation will deal with one of the most interesting curves in the world of mathematics, Viviani's curve. We will jump through the centuries presenting this curve's fascinating properties. We'll start with its origins, a challenge that Vincenzo Viviani posed to European mathematicians around 1692 to solve a problem of the quadrature of a part of the surface of a sphere. The solution presented by Viviani himself is behind the most popular way to obtain the curve later named after him – as the intersection of a sphere with a cylinder. Then, we will mention Leibniz and the impact of Viviani's challenge on the development of differential and integral calculus. In the next step, we will present different ways the Viviani curve can be generated. On the one hand, it is the intersection curve that arises when two of the three surfaces: sphere, cylinder and cone penetrate each other. It is also obtained as the trajectory of a point on a sphere that moves in a particular way. Furthermore, it is a locus, namely the set of all points on a sphere with a constant sum of the distances to two foci. In presenting spatial relationships related to the Viviani curve, we will use the possibilities of the 21st century, i.e. graphics and animations made using popular computer programs.

## MP42. TO HEAL MATHEMATICALLY

Vernacchio Erika, Guerrera Salvatore, Del Gaudio Matteo
Liceo scientifico "G. Rummo" Benevento, Italy

Speaking of plastic surgery, celebrities with their entire faces redone immediately come to mind, but in reality this particular type of surgery is mainly used to reconstruct deep wounds or severe burns. A team of surgeons has tried to revolutionize the world of surgery, studying and analyzing blood vessels and blood flow, in order to increase the chances of success of the skin graft, a particular type of technique that is used to heal wounds , taking flaps of healthy skin to export them to the affected areas.
How did they succeed?
Using mathematics.

## MP43. MATHS & ARTIFICIAL INTELLIGENCES

Del Gaudio Matteo, Fusco Antonio, Manocchio Giuseppe
Liceo scientifico "G. Rummo" Benevento, Italy

Computers have been helping us in problem-solving for more than 50 years. However, thanks to a large number of experts, the world of Artificial Intelligence (also known as A.I.) is expanding more and more. What we want to prove with this project is that everything nowadays is connected to technology. A striking example is that of Chess.com, which thanks to the application of Bayes' Theorem on Probability ,allows players to play chess online even against robots with different learning styles and abilities. But even in the medical field, through prostheses, Artificial Intelligence has found its space, even replacing human limbs. Mathematics also allows us to predict cyber threats, especially those targeting enormous systems, such as government databases. In this presentation, we analyzed and subsequently reproduced with Python a simple biometric recognition algorithm.

## MP44. ALL SUSPENDED ON A CATENARY

Landolfi Domenico, Boscaino Bruno, Mancini Luigi, Poppa Gabriele, Petraccaro Mario, Cocca Martina
Liceo scientifico "G. Rummo" Benevento, Italy

Ever wondered on what physics base do the suspended bridges sustain themselves? If your answer is yes, this is the perfect paper for you. What makes possible this is a special curve, called catenary. First, we will give you an explanation of the concept. More specifically we will analyze how it works concerning to rope bridges. In the beginning of the paper, we will present the catenary from a physical point of view, more theorical. We will introduce how the idea was developed by Galileo Galilei and how he was followed by other mathematicians that went deeper in the topic implementing new demonstrations. Furthermore, we will move to a more practical zone where we will illustrate how this notion is useful for the creation of the over mentioned structure. To do this we will serve of representations on digital software such as Geogebra. In addition, we will list examples of bridges that exploit this concept: the Golden Gate Bridge of San Francisco, the Storebealt Bridge in Sweden and the japanese Akashi Kaikyo, the longest worldwide suspended bridge.

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## MP45. GÖDEL AND THE PUZZLE OF INCOMPLETENESS: A WINDOW TO INFINITY

Mario Petraccaro
Liceo scientifico "G. Rummo" Benevento, Italy

In a town, there is only one barber who shaves only those who do not shave themselves. Does the barber shave himself? If so, he cannot; if he doesn't shave himself, he should be shaved by the barber, who is himself(self-referentiality). It's a contradiction, try to believe! This sentence, the Russell's paradox, is a statement that questions the concept of true or false propositions, establishing their undecidability: This paradox is one of many "analogy" of Gödel's incompleteness theorem, one of the most influent discoveries in the history of mathematical logic, which had as its main point the creation of a self-referential statement. In my presentation, I will show you this revolutionary theorem and its applications, coming to discuss the completeness of various formal system. Is arithmetic complete? Gödel's incompleteness theorem open a window to infinity…

# MP46. MATHS AT THE MOVIES

Vittoria Panarese, Chiara De Nigris, Christian Ianaro, Simone Ianaro
Liceo scientifico "G. Rummo" Benevento, Italy

The aim of our project is to explore the interrelation between mathematics and cinematography. Each time we watch a movie we are suddenly stunned by the realistic images shown. However, how are these frames created? CGI, ray tracing, motion interpolation and keyframing, stop motion and complex numbers are compulsory for the development of the characters and the spaces in which they are animated.

The research has been carried on through deep readings of scientific articles, debates and exchange ideas with teammates and teachers, websites research and IT laboratory.

The most impressive starting formulas considered have been, for instance, the vector formula: $2v=2(a,b,c)= (2a,2b,2c)$, considering a, b and c, coordinates of a three dimensional system; the use of geometry for the character base structure and the motion interpolation for its movement.

Our studies have brought out how an original and creative interpretation of formulas might be the base of the shaping of new elements that will contribute to the birth of new movies, new emotions and opinions.


# MP47. GEOMETRY OF EUCLID AND GEOMETRY OF LOBACHEVSKY

Sofiia Andrusenko
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In his "Elements", Euclid developed an axiomatic approach to the construction of geometry. The meaning of this approach lies in the fact that first, the main provisions (axioms or postulates) are formulated, and then other statements are proved on their basis, i.e. theorems.

Of all the axioms of Euclid, his 5th postulate caused the most controversy.  For simplicity, it is replaced by the following formulation: through a point not lying on a given line, only one line passes, parallel to the given one. This postulate is called the axiom of parallelism.

Nikolai Lobachevsky was the one who developed and substantiated that Euclid's 5th postulate is just an arbitrary limitation.  All studies based on the rejection of Euclid's axiom of parallelism refer to Lobachevsky's geometry.

The differences between Lobachevsky's geometry and Euclid's geometry lie in the understanding of the very nature of space. The physical three-dimensional space is curved, and only in infinitely small areas can it be considered flat, Euclidean.

This curvature within the earth's limits is so small that it can be neglected. That is why Euclidean geometry is used in applied problems and all measurements and calculations are carried out based on its theorems and rules.

But when studying the Universe, black holes, gravity, cosmic distances, Lobachevsky's theorems of geometry are used.


# MP48. BEES AS MATHEMATICIANS

Andriana Hadjisophocleous, Erato Gavri, Christina Prodromiti
The Grammar School, Nicosia, Cyprus

Bees are insects, but after all, what do they know about mathematics? The tiny bee brain is capable of numerical skills, such as arithmetic, showing proficiency in addition and subtraction, and they can even comprehend the concept of zero. They live in one of the most mathematically efficient architectural designs existing: the beehive, which consists of hexagonal honeycombs. Not many polygons can be as mathematically efficient, thus this, examines some of the mathematical advantages of the hexagonal tiling. The hexagonal honeycomb structure gives bees the ability to store the most honey and simultaneously require the least amount of wax. In other words, it gives them the ability to maximize the ratio of the surface area of the honeycomb cells to its perimeter. If other shapes were used for honeycombs, such as circles or octagons, gaps would be created, and wax would be wasted. Using the hexagon though, every honeycomb cell fits perfectly with each adjacent cell, like a jigsaw puzzle. Geometricians prove that the hexagon inscribed in a circular figure encloses the greatest amount of space, and it is an example of the more general mathematical tiling or tessellation in any number of dimensions. Therefore, mathematics can prove the efficiency of the hexagon shape, and thus of the hexagonal honeycomb that bees have been building for centuries.

## MP49. MATHEMATICS AND THE ART OF POKER
Marios Varnava
The Grammar School, Nicosia, Cyprus

Many people think that poker is pure luck. Little do they know how much mathematical knowledge there is in that game. There is a physiological struggle that players go through while trying to make the best mathematical decision that would put them in the best position possible to win. The game has much more depth than what meets the eye with every action/reaction during the unfolding of the cards, every call, every raise, fold, the amount of each bet. Everything! All this have an impact on the player's chances, positive or negative, to win the game. In the end though everything leads to two things CHANCES and PROBABILITIES.

## MP50. RISK IT FOR THE BISCUIT: CAN WE USE RISK AND PROBABILITY TO MAKE BETTER LIFE CHOICES AND SUCCEED?
Odysseas Leonidou
The Grammar School, Nicosia, Cyprus

50 Billion US dollars.
That was the US gambling industry's gross gaming revenue in 2021. It has been proven repeatedly that, with almost inexcusable precision, the house always wins. Casinos all around the world employ a plethora of statistical phenomena to tip the scales in their favor, ALL THE TIME. Yet, individuals are still willing to repeat biased, unfair, and disadvantaged bets, knowing full well that they will stumble home with dried-out pockets and a mouthful of frustration. Is it possible to teach people to make better bets? Life is a risk and a bet in and of itself ranging from risks as simple as wagering an extra 10 minutes in bed despite knowing this might affect your punctuality at your job or something as big as potentially risking your future to finally pursuing that business you always wanted to start. Eliminating risk is NOT the answer, simply because life is riddled with probabilistic risk. Rather, a more sustainable pathway could be educating people on Risk intelligence and how to embrace and tackle the probabilistic nature of life and make better decisions overall based on statistical hygiene. Many mathematical concepts can be taught like the Gamblers fallacy to avoid disaster and others like Expected value and Monte Carlo's principle to promote success. Embracing risk is embracing life.

## MP51. THE RAMANUJAN SUMMATION
Stephanie Antoniou, Marian Rostandi
The Senior School, Nicosia, Cyprus

The Rammanujan Summation is a Mathematical series that states that the sum of all natural numbers is equivalent to –1/12. This statement is counterintuitive *(and wrong)* as a series that consists of the sum of strictly positive integers cannot possibly generate a sum that is not only negative but also a fraction. The point of this presentation is to show how this process of workaround to the series was made using mathematical proofs and steps that look like they make mathematical sense. In addition, we will attempt to find the mistake within the proof which will explain why the result is completely wrong. This summation was originated by the mathematician Srinivasa Ramanujan whose name was given to it. The debate of its consistency still bisects the mathematical community. Let's try to put an end to it.

## MP52. BREAKFAST PROBLEMS

Stephanos Artemis

The Senior School, Nicosia, Cyprus

Mathematicians often use a very abstract language, but sometimes they pose real-life problems like the Ham Sandwich Problem (not to be confused with the "Squeeze Theorem,", sometimes also called "Sandwich Theorem,") and its subversion Pancake Problem. This presentation will demonstrate the proof of the so-called "Ham Sandwich Theorem" by the renowned Polish mathematician, Stefan Banach, for n=3, with a reference to a subcase of n=2 ("Pancake Theorem,"). In other words, this presentation uses the questions "Can one bisect a simple, 3-layered sandwich in such a way that the quantity of the ingredients in both parts are equal, without worries about symmetry?" and "Can one do the same for an n-layered sandwich?" to aid in explaining the solutions to these theorems. Stefan Banach is considered to be the father of the branch of functional analysis in mathematics which deals with the study of vector spaces which have some limit-related structures (for example, topology) and the linear functions defined on these spaces. Together with several others, Banach established the Scottish Book, a notebook containing mathematical problems, which would later become the basis for the journal "Studia Mathematica". To prove the "Ham Sandwich Theorem", Banach assumes that the "Ulam-Borsuk Theorem" is correct, therefore solving the theorem for n=3. Literally, we can assume that this n=3 refers to the layers of a classical ham, cheese, and tomato sandwich.

## MP53. FINDING PRIME NUMBERS

Michalis Gonatas

The Senior School, Nicosia, Cyprus

Mathematics is a natural science which allows explaining the laws that are naturally governing us and the environment we live in. Patterns appear all around us and are not considered to be unusual to find in nature. Prime numbers have been essentially important in the understanding of the above-mentioned process. For example, certain insects have a periodic life cycle which lasts 17 years. This saves them from coinciding with the rising of other predators, who have a life cycle of 4 years for example. Therefore 17, which is a prime number, can never be a multiple of any other number other than itself.

However, prime numbers are believed to have no pattern in the way that they emerge. Mathematicians have dedicated their lives to recognize hidden patterns. These patterns help us find new prime numbers. However, no easy solution has been found yet to identify them. Nonetheless, especially after the introduction of Mathematical computing, it has become even more feasible to find bigger and bigger prime numbers.

In this presentation, some of the methodologies used by Mathematicians to find new prime numbers will be presented as well as the difficulties they face in this process.

## MP54. OPTIMAL STOPPING THEORY

Raphael Son Ikossi Le

The Senior School, Nicosia, Cyprus

What do you eat for breakfast? What clothes do you wear to work? Which radio station do you listen to in your car? How do you choose exactly where to park your car every morning? These are some of the questions/dilemmas that our brains are dealing with every day, sometimes even without us realising it. This presentation is based upon the concept of the Optimal stopping point in game theory, which is a problem that we encounter in our daily lives more frequent than none. The presentation will cover what optimal stopping theory is, how it works and how we can deal with problems relating to it. The application of this concept in our daily lives is another concept this presentation will be covering as throughout our lives we have encountered many situations which require understanding of the optimal stopping point theorem.

## MP55. GUILTY OR NOT, MATH NEVER LIES
Nicolina Christodoulou
The Senior School, Nicosia, Cyprus

This presentation is about the relationship of mathematics with criminal law. More specifically, it illustrates how Mathematics help judges decide whether to convict or acquit an accused. It takes the example of Section 210 offence in the Cyprus Criminal Code which refers to causing the death of another as a result of a dangerous act or behavior. This criminal offence has wide application in the context of road traffic accidents. A defense to this offence is the so-called 'inevitable accident' defense. Human beings biologically need some time to react to a detected hazard in the road. This 'perception reaction time' is 1,5 seconds. If the distance between the hazard detection point and the point of the hazard were to be covered in less than 1,5 seconds, then the accident would be considered inevitable, and the accused should be acquitted. If, on the other hand, the driver would need more than 1,5 seconds to cover that distance, the accident was probably not inevitable and could have been avoided if the driver reacted (such as applying breaks) right after he detected the hazard. If it appears that the driver failed to react in any way right 1,5 seconds after he should have detected the hazard and killed somebody as a result, he will probably be considered to have acted thoughtlessly, recklessly, or dangerously causing the and therefore, to be guilty of the Section 210 offence. Mathematics and more specifically, direct proportion with the help of science that explains perception reaction time, help judges see whether an accused driver could possibly have avoided the accident and therefore, whether he should be found guilty or not.


## MP56. THE DYNAMICAL BEHAVIORS OF THE LOTKA-VOLTERRA PREDATOR-PREY MODEL
Nikolas Manousakis
Moraitis School, Athens, Greece

The interactions between two species—one the predator and the other the prey—in an ecosystem are mathematically represented by the Lotka-Volterra predator-prey model. A set of nonlinear differential equations that explain how the populations of the predator and prey vary over time. The model's essential assumptions and constraints are first covered, followed by a thorough derivation of the model equations. It is deduced that the rate of change of the predator population depends negatively on their intrinsic death rate and positively on the increase in the prey population, as they serve as food for the predators, while the rate of change of the prey population depends positively on their intrinsic growth rate and negatively on the increase in the predator population due to predation. The paper then shows how the Lotka-Voltera model predicts the characteristics of their population – time graphs when plotted in the phase-plane, such as their oscillation, their periodic behavior, as well as their inverse relationship.
Lastly the stability of the system is analyzed by finding the equilibria, which are the points where the rate of change of both species is zero.


## MP57. INNOVATIVE SOLUTION OF FRACTIONAL PROBLEMS AND A SUMMARY OF ITS METHODS
Nahal Mannani
Zanjan Sama Elementary School, Zanjan, Iran

Today, in the problems related to basic sciences and engineering, we encounter various fractional relations, which are sometimes very difficult and time consuming to solve. For this reason, the author of the article has tried to collect such relationships and equations as much as possible and to the best of her knowledge. Then, appropriate and innovative solutions have been presented for these issues. This article can be a comprehensive resource for students, engineering students, etc.

## MP58. VISUAL SOLUTION OF FRACTIONAL PROBLEMS AND EQUATIONS

Shayan Hasani

Zanjan Iranin First Grade High school, Zanjan, Iran

One of the important parts of mathematical sciences is fractions and fractional equations. Sometimes solving fractional problems using fractional equations is difficult and time-consuming. In this article, a special visual solution for solving some of these equations is provided. At first, these problems are categorized and then a special method is presented to solve each category of problems.

## MP59. APPLICATION OF BOOLEAN ALGEBRA IN THE DESIGN OF DIGITAL COUNTERS

Diana Mannani

Farzangan Zanjan First Grade High School, Iran

One of the important tools in basic sciences, laboratories and various industries are digital counters, which have very important applications today. The author of this article has tried to first provide a brief explanation about Boolean algebra and then explain the application of this type of algebra in the design of digital counters. In the following, the development and control of these counters is explained in detail.

## MP60. APPLICATION OF THE REMAINDER OF DIVISION IN SOLVING IMPORTANT MATHEMATICAL PROBLEMS

Seyedeh Elisa Hashemi

Zanjan Sama Elementary School, Zanjan, Iran

One of the main components of numerical division is the remainder of the division. Today, the remainder of division has been widely used in basic sciences, engineering and laboratory. In this article, an attempt has been made to categorize the various problems that are solved using the remainder. Then a suitable solution is provided for each category. With this action, a favorable resource will be provided for the students.

## MP61. SKETCHING GRAPHS OF POLYNOMIAL FUNCTIONS WITH A RESTRICTED NUMBER OF CUES

Shin Ji Min, Shin Jung Heon

Osung Middle School, Daegu, South Korea

By using the basic principles of polynomial functions including the concepts of leading coefficient test and multiplicity, we can briefly sketch the graph of polynomials regardless of their degrees and signs of leading coefficients without any theoretical basis of calculus. In our presentation, we'll introduce each step for obtaining the graph of the given polynomials and compare the results with those of applying them to a graphing calculator.

## MP62. FRACTALS AND ITS IMPLICATIONS WITHIN ARCHITECTURE

Emily Namhyun Cho
Asia Pacific International School (APIS), Seoul, South Korea

In our everyday lives, we come across a variety of patterns, such as numerical, musical, and physical patterns, and many tend to correlate these patterns with beauty, nature, and our own lives. Of these many patterns, one of the patterns that are seen often are those of fractals – geometric figures that are repeated to form the shape of itself. Fractal patterns in particular allow for the production of complex and irregular forms of nature by using geometrical composition. Fractal patterns are ubiquitous in our everyday lives, and is usually correlated with natural fractal patterns observed in leaf veins, snow structures, and the formation of crystals. Well-known fractal patterns include the Koch snowflake - a repeating triangular pattern that exponentially grows into the shape of a snowflake - and the Mandelbrot Set - a mathematical interpretation which does not diverge to infinity, growing in equal size. However, another aspect of our lives in which we can observe fractals can be in architecture and artworks, with many famous structures around the world adopting a fractal design for the geometric aesthetic of their buildings. Many architects over time managed to imitate the naturality of fractals within their works, thus showcasing the integrated relationship between fractal geometry and architectural design complexity. Though there may have been obvious examples such as the Louvre Abu Dhabi, Beijing Olympic stadium, or Institut du Monde Arabe, this presentation will explore the full implications of fractals within creative structures around the world.


## MP63. EULER'S GRAPH THEORY AND ITS APPLICATION IN REAL LIFE

Park Seoyul, Kim Donggeon
Daegu International School, Daegu, South Korea

Graph theory, which was started by mathematician Euler, is currently used in many fields in our real life. Euler was able to develop this theory in the process of solving the problem of deciding where to build a bridge over the Pregel River in the city of Konigsberg, Germany. Later, Euler completed "Eulier's circuit" and "Euler's path".
Graph theory have developed a lot since Euler's time (about 300 years). It is very useful in many industries such as electronics, logistics, engineering, social media and marketing, etc.


## MP64. EQUIVALENT GENERATION IN REAL CASES

Zicheng Wang
The G.C. School of Careers, Nicosia, Cyprus

Have you ever wondered how people in the past managed to solve problems with multiple unknowns without having the knowledge of high-level calculations and mathematical concepts that we have today?
While the famous mathematician Sir Isaac Newton was travelling, he saw a herd of cows in a pasture on the hillside. As he was enjoying the scenery he came up with a great idea as if a lighting hit him. This idea was published in the book "Ordinary Arithmetic" under the Newton problem and it examines the number of days a patch of grass can feed a certain number of cows. As Newton said in the foreword, the equivalent generation is used throughout the whole book.
Nowadays, the same situation that Newton describes occurs in several other situations. For instance, the number of people crossing a gate and the amount of water passing through a drainage system are both equivalent to a constant used in calculations.
This presentation aims to explain how one can define this constant and use equivalent generation skills to come up with solutions in a variety of similar problems.

# STUDENT PRESENTATIONS IN SCIENCE

## SP1. BERMUDA TRIANGLE

Yali Vaknin, Gracie Chalhoub, Andreana Zardi,  Rafaella Charalambous
Med High Private English School, Larnaca, Cyprus

The Bermuda triangle, also known as the devils triangle is a section of the ocean located between Miami, Puerto Rico and Bermuda. For decades, the Atlantic Ocean's famous Bermuda Triangle has captured the human imagination with unexplained disappearances of ships, planes, and people.

Methane gas plays a vital role in the explanation of the Bermuda triangle as it may escape into the air thus causing turbulence and increasing the possibility of plane crashes. According to scientists in Norway, immense craters in the Barents Sea were created using exploding natural gas, suggesting an explanation to the Bermuda triangle phenomenon. Research done at the Arctic University of Norway proved that craters off the shore that are 0.8km wide and 45m deep may have been caused by the explosive release of methane that was trapped in sediment below.

Fear concerning the Bermuda triangle and its bizarre disappearances has been going on since decades ago. Due to multiple U.S Navy planes that took off from Florida vanished without a single trace. Historians began searching the records of previous travels made through this triangle and discovered that, 300 ships and many planes were lost in the area throughout the 20th century. There have been infinite conspiracy theories revolving around this mind-twisting mystery although some scientists even doubt its existence to this day. So is there a scientific explanation behind this conundrum? Is it something beyond the human knowledge and the scientist's capability? Does it even exist?

 To conclude, we will be delving into the puzzling mysteries of the Bermuda triangle and uncover the science behind this mind-blowing, marvelous mystery and what scientists have to suggest as the solution to this puzzling questions mark.

## SP2. NEURALINK

Naomi Gerber
Med High Private English School, Larnaca, Cyprus

The neuralink is a brain machine interface (BMI) founded in 2016 and will be utilized for a wireless connection from the human brain to a computer device. The neuralink will help pave the way to a cybernetic future. Humanity will be improved in multiple paths of evolution and this will be a break-through in the world of science.

The structure of the neuralink is complicated yet simple. There are three main components: ultra-fine polymer probes, a neurosurgical robot, and custom high-density electronics. This device would have to be surgically implanted by the neurosurgeon creating a small vent through the skull, in order to insert the micron-scale threads (of the device) into the exposed brain tissue. This device has been already successfully operated on two monkeys and three pigs. The surgery- when the device is official- would be around 900 euros. Making it the average price of a new iPhone.

In this project, I will be discussing step by step how the neuralink works and give a more detailed explanation. Furthermore, the difference and the impact the neuralink would make will also be brought up in the presentation. And an example of how this device would eventually allow humanity replay memories.

## SP3. PERFECT FREQUENCY

Marina Mavros
Med High Private English School, Larnaca, Cyprus

The drums are one of the world's oldest musical instruments and their design has remained the same for thousands of years. Drums are made of at least one acoustic membrane or skin that is stretched over a cylindrical frame made of wood or metal. When the drum skin is hit or struck by a wooden stick, hand or brush stick, the membrane vibrates and sound is produced.

The word cymbal derives from the greek word κυμβη, meaning cup or bowl. The cymbal is one of the most common percussion instrument and like the drum it has been around for many centuries. The sound a cymbal produces relies heavily on the way it's designed, the way it is positioned and the way it is struck. The larger the cymbal, the louder and the longer the sound lasts.The profile of a cymbal will affect its pitch or sound.

In this project, I will try to explain the importance of the equipment used, the tuning of each piece in order to achieve the perfect frequency when installed in different environments on a standard drum set. Finally, I will also demonstrate how external factors affect the drum set's perfect frequency.

## SP4. TESLA MODEL 3

Dariia Khudobiak, Olga Georgiou, Maria Gryshko, Maria Karevina
Med High Private English School, Larnaca, Cyprus

The Tesla Model 3 is an extraordinary car. It can exhilarate from 0 km/h to 100 km/h in just around 3.3 seconds, with a top speed of 261 km/h.

Model 3 is fully electric; meaning that gas stations will be abandoned by owners. It can be charged with a Type 2 connector at home, work or a public charging point. Currently, there are 4,400 stations with 40,000 Supercharges worldwide. Just in 15 minutes, you can recharge up to 275 km at Supercharger locations.

The most important part of the overall Model 3 design is safety. Its metal structure is a combination of aluminum and steel, for maximum strength in every area. In a roof-crush test, Model 3 resisted four times its own mass, even with an all-glass roof.

One of its special, well-known features is Autopilot. Autopilot enables the car to steer, accelerate and brake automatically within its lane. Full Self-Driving capability improves existing functionality and introduces additional features, such as Autopark.

In this project, we will zoom into the exterior design and structure of the car with the help of a model. We will also analyze the Model 3 motor, explaining its technologies and advantages. We will also further clarify its charging capabilities. A brief explanation of its special features–Autopilot for example–will also be discussed further.

## SP5. GUT BACTERIA

Destine Akokcu
Med High Private English School, Larnaca, Cyprus

Bacteria are single-celled microorganisms with some distinctive cell structures. They make up around 90 per cent of our gut's population. The bacteria in the gut produces many neurochemicals that the brain uses to regulate basic physiological processes as well as mental processes like learning. Gut bacteria directly stimulate different neurons of the enteric nervous system to send signals to the brain with the use of via the vagus nerve.

Gut bacteria have some important functions like breaking down the food, manufacturing vitamins and training our immune system. Family genes, environment, medication and diet have seem to cause gut bacteria. Yogurt, kefir, bananas, and whole grains provide good gut bacteria. We can increase the good bacteria in our guts by limiting the fats in our diet, filling up our diet with more probiotic foods.

The new research presented at the Alzheimer's Research UK Conference 2022, determines newly identified links between gut bacteria, inflammation and brain changes linked with Alzheimer's disease. Lipopolysaccharides known as LPS which are inflammatory molecules are also associated with Alzheimer disease.

In this project, I will be discussing the effects of gut bacteria on our brain and how it stimulates the disease Ailzheimer. This project will also include researches made by different scientists on this topic.

## SP6. TIME TRAVEL
Lilian Michael, Lina Constantinou
The English School Nicosia, Cyprus

Traveling through time is something everyone would want to do. Imagine being able to break the laws of physics and travel to the past, where your ancestors lived, or to the future of your kids! Isn't it fascinating? Let's start with something simple: what is time? In our presentation, you will discover how it's theoretically possible to time travel and explore its effects within the Earth's history and the events yet to come. In 1905, Einstein's theory of relativity was introduced, to show how to travel to the future, by simply traveling faster than the speed of light, using negative mass, meaning that if you move particularly close to the speed of light, the future comes quicker. To time travel to the past, it is a whole different theory, which is not included by Einstein's theory of relativity. You would need an infinite amount of energy -infinite mass- to travel at light speed (opposite of negative mass and travelling to the future) something that is in our universe considered impossible. If something like this existed and somebody could travel to the past they would arrive before they departed. Even the greatest mind in history gets lost when it comes to time travel. The truth hasn't been discovered yet… "The distinction between the past, present and future is only a stubbornly persistent illusion." Albert Einstein.

## SP7. HOW COULD A WORLD NETWORK CURE CANCER WITH THE HELP OF MRNA VACCINES
Konstantinos Zisimos
2nd High School of Chios, Greece

In 2021, more than 10 million people died from cancer worldwide. Under normal conditions, our cells display a "social" behavior and work harmoniously within the framework of a large colony of cells that we call the human body. The change in DNA leads some of these cells to behave "absurdly." They multiply uncontrollably and form one or more tumors that disrupt the body's normal functions by multiple mechanisms. Since cancer cells are very different from normal cells in the body, the immune system attacks them when it can recognize them. However, the cancer cells often find ways to disguise themselves and present themselves as normal cells, resulting in the immune system not always recognize them as dangerous. These recent years scientists have been trying to cure cancer with the help of mRNA technology. After sampling and analyzing the patient's cancer, with the help of algorithms, scientists can construct a personalized mRNA vaccine. Once inside the body, the mRNA instructs cells receiving the vaccine to produce proteins that can stimulate an immune response against those same proteins in cancer cells. Making a personalized vaccine takes a few weeks to 2 months, which in many cases is prohibitive for treating patients. We also understand that such a personalized process is also very costly. The solution to these problems could be provided by a global network that would combine laboratories, hospitals, and pharmaceutical companies worldwide. The sampling and analysis of the cancer cells will be realized in specialized laboratories. The resulting data will be uploaded to the network database. They will be analyzed, compared with other samples, and linked to manufactured vaccines. The network will assist in the rapid yet cost-effective production of mRNA vaccines accessible to all patients worldwide without discrimination.

## SP8. CAUSES OF POTATO BLIGHT AND WAYS TO COMBAT IT
Nikoloz Chkareuli, Dachi Bitsadze, Bachana Ardoteli
Tbilisi International School, Georgia

Bacteria are single-celled prokaryotic organisms, belong to the Kingdom Monera and are widespread. Bacteria can be found in the air, water, soil and generally everywhere where there are favorable conditions for their existence. There are pathogenic and non-pathogenic bacteria. The damage caused by pathogenic bacteria has a wide spectrum both from the health and economic point of view.
Today, in the conditions of the current globalization, there is a great danger that the spread of some highly harmful pathogens will take a large scale and cause significant economic losses to the countries. According to the available data, a widespread disease is bacterial rot, which is caused by a gram-negative, soil bacterium - Ralstonia solanacearum. It infects especially economically important crops such as potatoes, tomatoes and others. Out of the 6 genera of Ralstonia species complex, the most harmful is potato blight.

## SP9. A THEATRICAL REPRESENTATION OF THE CHROMOSOMAL MECHANISM OF CELL DEGENERATION

Anastasia Nikoladze, Barbare Tabidze, Nia Jikia, Lindi Chokheli, Sandro Cercvadze, Luka Janadze
Tbilisi International School, Georgia

Human health is greatly influenced by the environment, it can be said that health is directly related to environmental conditions. For the last several decades, people have had to live in significantly polluted conditions, as a result, health care has faced a serious problem. The cases of cancer have increased dramatically, the reason for which, in many cases, is a change in the chromosomes or hereditary material in the cell.These changes are caused by negative factors of the environment - mutagens, such as radiation, emissions, air and water impregnated with chemical substances, unhealthy food. These factors change the number of hereditary material and cause pathologies.

Human cells contain 46 chromosomes, more specifically - 23 pairs. There are tens of thousands of genes on these chromosomes that "dictate" to the organism how to develop and how to perform its functions every second. If one entire chromosome from a pair or its part is lost or added, the exact order and health of the organism will be disturbed.

In the human body, old/dead cells are continuously being replaced by new ones, it is at this time that it is most important to maintain the order between chromosome pairs and genes in general (like these two words should definitely be "genes in general"), because most of the time errors occur during cell division and they multiply uncontrollably.

How can the number of chromosomes be changed? To answer this question, we present a performance with theatrical and digital effects, where it will be shown what morphological changes the hereditary material undergoes in the cell, which is the basis of diseases (pathologies) caused by both sex and somatic mutations, and advice on what to do to prevent these pathologies.

## SP10. NUCLEAR FUSION: ON THE WAY TO BECOME A TYPE I PLANETARY CIVILISATION

John-Luke Ampatzidis, Michael Betzounis, Orestis Gkitersos, George Tsalikidis,  Lampros Tsivelikas
De La Salle College, Thessaloniki, Greece

Nuclear fusion is a reaction, in which multiple atomic nuclei are combined to form one or more different atomic nuclei and subatomic particles. This kind of fusion occurs naturally in every active main-sequence or high magnitude star, like our sun. The first ever artificial nuclear fusion with positive energy balance took place at Lawrence Livermore National Laboratory (LLNL). This scientific breakthrough was attained with the assistance of 192 laser rays and the consumption of 322 MJ of energy. By using the world's highest energy laser system, the LLNL scientists destroyed the tiny frozen pellets of hydrogen isotopes, through temperatures higher than the ones on the sun's surface. As a result of this procedure, the phenomenon of ignition is being created, causing a nuclear reaction that generates more energy than it consumes. The achievement of nuclear fusion will benefit humanity, by ending its energy dependence on fossil fuels. This breakthrough could potentially grant the humankind the ability to become a type-I planetary civilization according to Kardashev's scale.

## SP11. BLACK HOLES. STRANGER THAN FICTION

Christos Charalambous, Giorgos Hadjiconstantis
The Grammar School, Nicosia, Cyprus

Gravity, for the large majority is as simple as an apple falling from a tree, for others it is one of the most tangled and serpentine fields of physics. How is gravity so special after all and why does it puzzle many? From Newton's theory to Einstein's general relativity this distinctive fundamental force is yet to be fully explained, however provides the foundation for our current understanding of black holes. These mysterious vast bodies not only have altered our perception of many modern astronomical discoveries but also revamped our view of the space-time continuum. We've all stumbled across fictional movies about black holes or time travel and have created a false construct regarding these topics but in actuality such concepts are not that farfetched when you truly grasp gravity. Maybe it's not as similar to "Back to the Future" as you may think but time behaves in a peculiar way around black holes, all leading back to gravity and how this seemingly elementary concept affects everything in our cosmos.

## SP12. REGENERATION OF THE WORLD
Nefeli Kosti, Nikoletta Strati
The Grammar School, Nicosia, Cyprus

Have you ever thought what life would be like if you had a second chance to live? Tissue Engineering holds the answer to this question by bringing back to life dead tissues and organs. Imagine your life changing just in a glimpse of seconds due to an injury or an illness. However, tissue engineering opposes this by giving promises for the medical care as well as defense medicine to advance and be able to offer people a better quality of life. Even though, still today tissue engineering has limited uses in human patients, think about all the prospects and evolution it will bring in the world of medicine once fully established. This topic is to inform people about this emerging fielding, ranging from: principles, materials involved and the whole process behind it as well as ethics and limitations.

## SP13. THE CONSTRUCTION OF REALITY BY THE BRAIN. A STUDY OF CONSCIOUSNESS
Chara Siekkeri, Anthi Raftopoulou
The Grammar School, Nicosia, Cyprus

Have you ever wondered how the myriad of sights, sounds and smells around you become integrated to form your current reality? How something such as lifeless particles can arrange themselves into living matter that gives rise to this fascinating but elusive phenomenon -consciousness? Imagine spending some time with your friends or going out for a walk or maybe a day where you felt sad or lost. These are all examples of a conscious experience, but it is a fact that we have yet to understand what being conscious actually means. Definitions of consciousness vary from researcher to researcher with some supporting that consciousness is everything that someone experiences and with others saying that consciousness is just the awareness of external and internal stimuli. How can we conclude and mutually agree to a universal meaning of consciousness? To understand what it is, it is required that we discover what causes it, how it arises, what its functions might be and how it is connected to non-conscious processing in the brain. The great mystery of consciousness is something that to this day remains unsolved and has been troubling scientists for generations, however, recently researchers have been able to scratch the surface of this complicated problem.

## SP14. QUANTUM COMPUTING
Lovro Golubic
Gimnazija „Fran Galovic", Koprivnica, Croatia

Quantum computing uses quantum phenomena to enable the faster problem-solving and safer transfer of data between quantum computers. Normal computers solve logical operations using binary code which uses bits, but quantum computers use the quantum state of an object to produce qubits. Qubits are made by using physical systems, like the spin of an electron or the orientation of a photon. These systems can be in many different arrangements all at once, and it is known as quantum superposition. Today scientists and engineers use supercomputers to solve more complex problems, and even supercomputers can struggle with some tasks, but quantum computers can solve those tasks much easier. Quantum computing is the future of computing and it will enable solving much more complex tasks much faster. In my presentation, I will explain how does a quantum computer work and how it could affect the world.

## SP15. VOLCANIC CHEMISTRY
Antonis Pissarides
The G.C. School of Careers, Nicosia, Cyprus

This project discusses volcanoes and the science behind them. Volcanoes are conical, mountain-like structures that form in a remarkably interesting way. The inspiration for this project arose from the Fuego volcano eruption which took place on December 11th, 2022 in Alotenango, Sacatepequez, Guatemala.

In this project, how volcanoes form, their structure and the science behind volcanic eruption are discussed. The project discusses certain chemical reactions that take place when lava is in touch with oxygen, the state of volcanoes and how it changes constantly, which is an important subject that regards our own safety and wellbeing.

When a volcano erupts it causes massive amounts of ash to come out of it which can pollute the atmosphere. A simple and easy- to-build volcano model has been constructed, experiments performed using simple kitchen supplies to demonstrate volcanic eruption and hence study how volcanoes work under different conditions. Using simple chemicals that are safe to use help get a closer look at the reactions that occur when certain chemicals are mixed.

The science behind volcanoes is very exciting and this project can be pursued further in the future, studying volcanoes and creating a more detailed analysis.

## SP16. VOLCANIC CHEMISTRY
Giorgos Alexandrou, Marcos Phinikarides
The G.C. School of Careers, Nicosia, Cyprus

Are you a logical, precise thinker, or would you say that you're more chaotic-minded and artistic? Most people would say that they are a mixture of the two, as most people are. But if you feel that you are the former, you are dominantly left brain oriented, and if you are the latter, you are right brain dominant. The purpose of our research is to understand what the right-left brain dominance theory is and further our knowledge on how the brain works to find out how accurate the theory really is as well as delving into the psychology of society's views on the theory.

We have conducted a test applicable for two age groups to see if we can find a trend towards one of the personality types in either group. We analysed the collected data and combined all of the information together. We researched the theory in detail, exploring aspects such as who created it, when it was created, what the theory fundamentally is, and what people's views are on it. We have also zoomed in on the neuroscience of personality, how the brain works and how it affects and connects to the left and right brain theory.

## SP17. THEORY OF RELATIVITY
Loucas Nicolaides, Andreas Stylianou, Antonis Pissarides
The G.C. School of Careers, Nicosia, Cyprus

Have you ever wondered how objects move in a gravitational field? Theory of relativity is a theory made by Albert Einstein and can be explained with three different sub-theories: theory of general relativity, the theory special relativity, and the theory of the multiverse.

General relativity explains the movement of objects in the presence of gravity. The presence of mater of energy causes the curvature of spacetime which explains the effects of gravity in general relativity. The principle of equivalence in general relativity states that the effects of gravity and acceleration are indistinguishable, and this has important implications for the theory.

Special relativity can only be applied in the absence of gravity. Special relativity states that when an object comes close to the speed of light its mass becomes infinity as well as the energy required to move, this means it is impossible for an object to come close to the speed of light!

The theory of the multiverse puts forward the existence of multiple parallel universes, potentially with different physical laws and properties. In theory it is possible to travel this "multiverse" and come across another you. This would be incredible and would be characterized as "game changing" by scientists. But, if this is true then somebody or something else could have travelled to us in the past and affected our future, present time.

## SP18. RADIO COMMUNICATION WITH THE INTERNATIONAL SPACE STATION

Andreas Tsiakkouris
The G.C. School of Careers, Nicosia, Cyprus

The objective of this project is to design and build equipment that will enable communication with the International Space Station (ISS) using frequencies allocated to the amateur radio service. To achieve this, three basic components are required: a portable vertically and horizontally polarized antenna that operates in the VHF and UHF bands, a transceiver which can transmit 5W in the VHF band (145-146 MHz) and receive in both the VHF (145-146 MHz) and UHF bands (438 MHz) and a software that can predict when the ISS passes overhead. It is not possible to communicate with the ISS at all times, as it moves in low earth orbit (LEO), rotating around earth every 90 minutes at a speed of 28,200 km/h. Passes last for around 10 minutes from acquisition of signal (AOS) until the loss of signal (LOS) and need to be accurately predicted. Using the equipment built in this project, we can establish contact with the ISS in a number of ways. Using our voice to communicate with the astronauts on-board the ISS, receiving images sent from the ISS using a communication protocol called Slow Scan TV (SSTV) or by using the ISS as a repeater bouncing signals off it to communicate with other amateur radio operators on earth. Contacting the ISS is a great opportunity to learn first handily about life in space, our new frontier, while experimenting with new ideas and technologies.

## SP19. ROCKET FUEL FROM EVERY-DAY MATERIALS

Ioannis Theocharides, Charis Charilaou, Konstantinos Kaniklides, Andreas Iacovides
The G.C. School of Careers, Nicosia, Cyprus

Space exploration has never been more relevant. What was a monopoly of government institutions is now an open market where private companies are competing. The technology that is readily available to almost everyone today, could not have even been imagined by NASA 60 years ago when they first went to the moon. There is therefore tremendous potential in this very exciting area, and this was the main reason we decided to pursue our project: How, using every day materials, one can create his own rocket engine. One of the key factors that makes our project interesting is the decision to use 3D printed plastic as our fuel. Plastic, specifically ABS, is a very energy-dense material, making it ideal for being used as fuel. 3D printing also allows for different, specialized fuel grain designs for different applications. The key difference is that, unlike hard-to-build fully liquid rocket engines, our fuel is a solid and our oxidizer is ordinary oxygen gas. The abundance and low cost of both these materials makes this hybrid design attractive, not only to large space organizations, but also feasible even for hobbyists like ourselves. A model rocket engine using this principle was designed and built by our team, and is about to be tested very soon, once we establish the right safety environment. Using experimentally derived values on mathematical formulas from NASA's website, efficiency was verified. We believe our project provides a new and exciting approach for building rocket engines which can greatly benefit the space industry.

## SP20. FORMATION OF COPPER METAL CRYSTALS BY ELECTROLYSIS

Jingwen Fu, Aimilios Papasotiriou
The G.C. School of Careers, Nicosia, Cyprus

The objective of this experiment is the relationship of copper crystal growth under different currents applied. Copper metal crystals form during the electrolysis of copper sulphate solution, as the copper ions are attracted to the negative electrode and are reduced to copper atoms. This results in a coating of copper metal at the cathode. By using two copper electrodes, we are able to achieve a continuous stream of copper ions flowing from the anode, while providing the source of copper to the cathode. Crystaline deposit of copper at the cathode can be achieved by using a low electrical current.
Currents of 10, 20, and 30 mA were tested, achieved by using phone chargers with a 5V output and additional resistors were calculated accordingly. The apparatus was set up using beakers and copper wires, which were bent into shape. The formation of copper crystals was monitored over the course of 5 weeks, until all three crystals reached ~ 17 grams so as to be able to compare them.
Concluding, according to the project results, the current seems to be directly proportional to the mean growth speed of the crystal, and the appearance of the crystal becomes spikier and protruding as the current increases.

## SP21. THE FUTURE OF CANCER IMMUNOTHERAPY: CAR-T CELL THERAPY

Anna Mouzourou, Andrea Miltiadous, Panayiotis Aristotelous
The G.C. School of Careers, Nicosia, Cyprus

With cancer being the highest cause of premature death, it is one of the most feared killers in the world. However, just two Nobel Medicine prizes have been awarded in the battle against cancer, while both being for immunotherapy. With the rising success of this type of treatment, immunotherapy presents us with a newfound hope for battling cancer. Contrary to traditional cancer treatments, immunotherapy utilises the body's own immune system while boosting its natural defences to fight cancer.
Chimeric Antigen Receptor-T cell therapy has been a progressive new pillar in immunotherapy. It is currently used in the USA, UK, Australia, China as well as some European countries, for example, Spain. It involves genetically modifying the patient's own T lymphocytes so that they are effective and specific against cancer cells. It has claimed itself successful against hard-to-treat cancers, such as B-cell leukaemia and lymphomas. Despite CAR-T cells having extremely potent antitumor activity, this therapy has been the topic of many debates as it introduces toxic side effects. This presentation's aim is to illustrate all aspects of this new intriguing, promising, and encouraging therapy and tackle its issues and debates by considering its success rates so far, while also showcasing the evolution of cancer treatments through the years.

## SP22. LICHTENBERG FIGURE

Chrysi Topouzidou, Anastasia Perentzi, Dimitra Taltampani, Terpsichori Loupi
De La Salle College, Thessaloniki, Greece

Lichtenberg figures are electric discharges of a tree-like infinite pattern which come from high voltage use. Sometimes, they appear on the surface of insulating materials and resemble the shape of natural phenomena, such as lightning. Known to take place in all states of matter during electrical breakdown- in other terms an insulation failure- Lichtenberg figures may appear on the skin of lightning strike victims due to the high volt discharge that occurs. Furthermore, they exhibit fractal properties. They are thus linked to the major geometrical theory of fractals that lead to the discovery of non-integer dimensions and explain other natural shapes such as coasts and clouds. It is important to note that Lichtenberg figures exhibit other intriguing properties such as fluorescence and solarization. Despite the fact that it is feasible to disclose the scientifical process behind this phenomenon, it is hard for experiments to reveal the internal details of high voltage discharge. Additionally, these methods maintain dangers and high instruments cost. In this paper, a presentation on a simplified version of the experiment of the creation of a Lichtenberg figure will be conducted, whereas its methods and its risk will be analysed. The attempt was conducted inside a laboratory with all safety measures. Moreover, the history behind Lichtenberg figures and their development throughout time will be highlighted, along with their properties. The presentation will introduce the connection of Lichtenberg figures to fractal geometry, whilst especially focusing at their self-similarity.

## SP23. THE END OF CERTAINTY: PROJECTION OF QUANTUM BEHAVIOR ONTO THE MACROSCALE

Athanasia Dalakoura
Axion Schools, Xanthi, Greece

When Isaac Newton elucidated the laws of motion, humankind, for the first time, was given precise predictive power over nature. If we know the initial conditions of a dynamical system, then the solution of the differential motion equations allows us to know with certainty not only the past but also the future of that system. Therefore, under a macroscopic prism, one could argue that "God does not play dice", as Albert Einstein once said, expressing his contempt for the notion that the universe is governed by probability - an idea fundamental to quantum theory. Nonetheless, quantum theory's indisputable successes have convinced all but a handful of contemporary physicists that "God" does indeed "play dice". Even though the theory is widely accepted, quantum physics is very difficult to grasp, since systems with quantum behavior do not behave like our everyday objects, they do not follow the rules we are used to, they exist in several states simultaneously and even change depending on whether they are observed or not. The aim of this paper is to bridge two realms: quantum theory and human perception of the macro-world, by projecting the behavior of quantum objects onto the macroscale. If our everyday objects like tables, chairs and tennis balls behaved like quantum objects such as electrons and atoms, what would we see?

## SP24. ARCHITECTURE ON PLANETS!
Mohamed Ben Zerti
Med High Private English School, Larnaca, Cyprus

We are at a critical point of human history where we've figured out how to go to other planets and such. So much so that we might be on the verge of colonizing other planets in a few decades. This euromath project will focus specifically on how the architecture on other planets could look like. There are many different factors on another planet which may affect the design and architecture of buildings on planets. Factors being: different gravitational pull, different environment, different atmosphere and so on. For example the environment of mars has about an average of -63 degrees Celsius, possesses a rocky surface, has an atmosphere with about 95% carbon dioxide and a mass of 6.39x10^23 kg which is a lot however significantly less compared to earth which has 5.972x10^24 kg thus allowing for easier construction for taller buildings on mars. Having so many different variables and factors affects buildings built on foreign planets and this euromath project will focus in on that and will try to showcase the many different kinds of building designs which could be built on different planets and exactly how different variables may affect them as well as their materials and use. For example as mentioned earlier a lower gravitational pull will allow for taller buildings or an extremely cold temperature may cause buildings to be insulted significantly more than the average building on earth.

## SP25. THE TOXICITY OF HEAVY METALS AND THEIR EFFECTS ON HUMANS AND THE ENVIRONMENT
Avramidou Panagiota, Dedousi Ismini
De La Salle College, Thessaloniki, Greece

Heavy metals are natural elements that have a high atomic weight and density, and some of them are required for the various biochemical and physiological functions of organisms. Because of the multiple industrial, domestic, agricultural, medical and technological uses in humans' daily life, these metals accumulate in the soil and water. As a result, they pass into the food chain and through it they end up in humans' bodies with particularly harmful consequences. The three heavy metals that pollute the environment the most are: lead, cadmium and mercury. There are also other harmful elements, such as nickel, chromium, thallium, antimony, selenium and copper. Chronic and excessive exposure to heavy metals causes damage to the brain, leads to various toxic effects on the human immune system and causes many immune responses, such as increased allergies, infectious diseases, autoimmune diseases and cancer. The last decades, due to the significant increase in chronic and intense damage to nature and humans, new methods to decrease these effects have been developed. In this research the issues to be analyzed are: the possible consequences of these metals, where they can be found and what can be done against them, such as nanotechnology applications, activated carbon adsorption, biosorption, phytoremediation etc. In the last chapter there is a presentation of an experiment, which was carried out in our school's lab of science, about the quantitative determination of the presence of lead in water.

## SP26. THE EFFECT OF INTESTINAL MICROBIOME ON HUMAN MENTAL AND PHYSICAL HEALTH – A CONNECTION  BETWEEN THE INTESTINAL AND NEURAL SYSTEM
Stathi Krystallia-Maria, Fragkoulidou Sofia, Timamopoulou Angeliki
De La Salle College, Thessaloniki, Greece

Have you ever wondered whether our intestinal system affects the way our brain functions? Our team's presentation will provide insights on the latest initiatives surrounding the connection between gut microbiome and mental health. Consisting of a bibliographic part as well as an experimental, our team will present the results of the most up-to-date studies based on the impact of gut bacterias in human psychology and the result of a relative experiment on its physical effects. The investigation of the differences in the gut composition of patients suffering from mental disorders as well as the differences across the disorders reached to the conclusion that there is indeed an axis between the intestinal and the human neural system. Except for its primary role in digestion and metabolism, the human gut microbiome  is related to mental diseases and therefore connected to the nervous system. Across mental disorders such as bipolar disorder,

schizophrenia, major depressive disorder and obsessive compulsive disorder, it has been proved that multiple systems are dysregulated including mitochondrial function and neurotransmitters.

The impact of the intestinal microbiome will be examined through an experiment.

Regarding the experimental part of our presentation, we made an effort to decide whether probiotic bacteria could also have an effect on the human body, by experimenting in mice. Many experiments have been carried out on rodents, due to their close similarities to humans. According to a recent study in laboratory mice, the intake of probiotics  positively affects the coat and the weight of the rodents, which is an indication of good physical condition and health. Taking these into account, we set the goal of our research to verify the results in a non-sterile, everyday environment, providing the normal intestinal microflora to the mice under study.

## SP27. THE CONSEQUENCES OF THE POLAR ICE MELTDOWN AND THE GREENHOUSE PHENOMENON
A.Samaras, S.Drepanidis, O.Arampatzis
De La Salle College, Thessaloniki, Greece

It is widely known that the climatic condition of the Earth threatens life on our planet. Most of the time, experts refer to the melting of the ice and how the rise in sea level due to this phenomenon will flood many coastal areas, causing massive population movements and disrupting the balance of the planet. However, this delicate balance is disturbed not only by mass movement, but according to the laws of physics, the transfer of the huge amount of water from the poles to the equator will slow down the rate of rotation of the Earth, based on the conservation of the Earth's momentum. So we decided to study both the physical effects of this phenomenon on the planet, as well as the social ones by examining statistical studies and models provided by the field of science. At a climatic level it will result in an increase in the length of the day and our exposure to solar radiation. The only protection we have against it is our planet's atmosphere, but these air masses that make it up are held in the stratosphere by the Earth's magnetic field, which is a result of its rotation. However, due to its deceleration, its magnetic field weakens, resulting in a thinning of the atmosphere. All of the above entail problems of overpopulation, water scarcity, and a large part of the planet will become unexploited.

## SP28. INVESTIGATING THE FUTURE OF AVIATION IN REGARDS TO THE DEVELOPMENT OF HYDROGEN CELLS AND THEIR APPLICATION
Desislava Markova, Meriem Fereva, Valeria Topalova
American College of Sofia, Bulgaria

Nowadays, the world slowly transitions to changing its aircraft power supply from kerosene to hydrogen because of hydrogen's efficiency and eco-friendly characteristics. Even though no commercial aircraft currently operate on this byproduct, the world is inevitably getting more optimistic about the success of hydrogen energy in the aviation industry. In soon times, we might see many companies developing fully functional and operating hydrogen planes. Because of its lack of emitting any greenhouse gases, hydrogen can become a milestone in the evolution of the industry by making it more environmentally safe. In our research, we will investigate the advantages and disadvantages of the hydrogen cells implemented in aircraft and their possible successful future development and application.

## SP29. THE SKIN OF THE EARTH
### Raman Vasiuk
### The Senior School, Nicosia, Cyprus

The 21st century has witnessed the rapid spread of multi-drug resistant bacteria, posing a grave threat to human health and survival. The superweapon arsenal, which once was the miracle cure against a massive number of diseases, became ineffective against these superbugs. To effectively battle this escalating menace, we must delve deep into "The Skin of The Earth", the treasury of immense biodiversity that lies directly beneath our feet.

We are studying and analyzing the soil using special growth media and examining under microscopes to expand our understanding of the manifold unique bacterial and fungal life stealthily hidden within this underappreciated resource. Our goal is to find bacteria or fungi which may evade drug-resistant strains and help us in the escalating battle against superbugs.

The findings of this research project have the potential to be lifesaving for mankind. By uncovering the treasury beneath our feet, we are not only exploring the unknown, but we are also providing a feasible solution to one of the biggest challenges of our time. The benefits for humanity are immense and cannot be overstated.

What this research project delves into is the depths of what is truly the "The Skin of The Earth" in order to reveal the secrets of the diverse and dynamic interactions between microorganisms and their environment, and find new ways to battle the spreading menace of the 21st century bacterial antibiotic resistance. We are currently facing a daunting challenge, but with the big chances of eventually saving billions of lives and ensuring a healthy future for mankind, this research is an exciting and imperative step forward within the ongoing fight against the biggest threat of our time.


## SP30. DESTINATION (UN) KNOWN
### Stephanos Artemis, Simona Mitsi
### The Senior School, Nicosia, Cyprus

It is known to all that humans have been evolving since the beginning of time, but what a lot of people do not know is the fact that the human race is continuing its journey of evolution. However, with the development of new technology, the entire perception that humans hold of evolution may shift. This presentation will discuss and analyse the many possibilities for the future of human evolution, upon providing a brief historical background into human origins and how far the species has developed currently, whilst battling both environmental and artificial factors. Furthermore, the presentation studies if Charles Darwin's theories of evolution can still apply to the unsure journey ahead for humans as a species. Moreover, this presentation examines the likely possibility of Human Genetic Modification and Artificial Intelligence, and how these carefully cultivated, progressing and upcoming technologies will shift the whole course of natural evolution. Due to the sheer uncertainty and large controversy surrounding these multifaceted topics, it is of utmost importance to debate and discover to what extent is advancing technology a threat to humans. All in all, the presentation will aim to answer the burning questions society has, such as "Are Artificial Intelligence and Human Gene Modification a threat to human evolution?", "What would the path of natural evolution look like for humans?", and "Will humans be able to adapt and evolve to survive the changing environment?", by breaking these key questions down to their fundamental cores.

# SP31. FERROMAGNETISM

Alexander Anton Faskevich
The Senior School, Nicosia, Cyprus

My presentation is on the concept of magnetism. Magnetism when looking at it on a surface level should be something that can't exist however, it does. The answer as to why it exists can only be found when looking at what happens at the subatomic level otherwise known as the quantum level. To explain different types of magnetism will require me to explain how electrons and more specifically orbitals work which I will also present visually as orbitals are a concept that are best presented visually. Additionally, this presentation will make distinctions between each type of magnetism such as Paramagnetism, Ferromagnetism and Diamagnetism.

# SP32. CAN WE LIVE ON MARS?

Theodora Gorman
The Senior School, Nicosia, Cyprus

This project is a theoretical study examining how humans can inhabit Mars. In this study we will first assume that a moon base has been created, there have been prior missions to Mars to scout out locations for an outpost which can store resources and equipment. There are several obstacles to inhabiting Mars. First, low atmospheric pressure combined with cold temperatures mean liquid water is not stable at the surface and with reduced sunlight, it can be difficult to grow anything. Second, dust storms are a regular occurrence on Mars. Third, radiation exposure is a serious risk in such a thin atmosphere. To overcome these obstacles we need to understand how to warm the surface, thicken the atmosphere, and alter the environment to something human friendly. For example, this can include creating the outpost close to the polar caps to easily access ice that can be melted for drinking water. We could use Greenhouse gas-producing factories to trap solar radiation. This would melt the ice sheets and water would be able to flow. To create energy, we could use nuclear technology since solar and wind are unreliable. We can also use orbital mirrors which concentrate solar radiation and direct it toward the surface. However, to prevent radiation exposure, the facilities could be located deep enough underground. Finally, because Mars is only 1% as dense as earth, in order to breathe we would need to create an artificial atmosphere made up of nitrogen and oxygen. A nuclear plant can help generate this.

# SP33. NERVOUS SYSTEM, NUROTRANSMITTERS AND DRUG ADDICTION(ESPECIALLY IN TERMS OF DOPAMINE AND OPIOIDS)

Tae-Won Kim, Tae-Hoon Kim, Jae-In Kim
Osung Middle School, Dae-Goo, South Korea

For the last few years, opioid drugs like fentanyl has emerged to one of the major problems around the world. To understand the danger and severity of drug addiction better, we are going to take a look at how nervous system works, what does dopamine do as a neurotransmitter, and how drug addiction occurs in terms of dopamine-releasing processes.

# SP34. CONNECTING NEWTON'S LAWS OF MOTION INTO THE WORLD OF SUBATOMIC PARTICLES WITH APPROACHING FOUR FENDAMENTAL FORCES

Kwon Min-Hyeok, Choi Si-woo, Jung Joo-Won, Bok Min-Jae, Kim Nam-Ho
Osung Middle School, Daegu, South Korea

In our presentation, we're going to take a look at indivisible world of elementary particles in correspondence to the fundamental forces. In order to explain those profound theories of quantum physics, it's inevitable to cover the related minimum range of classical physics. We'll take gravitational force as an example for the analysis on the aspect of Newtonian Mechanics, then we'll introduce the forces, elementary particles, and their relationships on the theoretical basis of quantum physics, with a brief recap of the atomic models, as well.

## SP35. UNDERSTANDING WORK-KINETIC ENERGY THEOREMS IN TERMS OF SCALAR QUANTATIES

Seung-Heon Jang, Jun-Hong Park, Ji-Won Jung, Do-Yeop Kim
Osung Middle School, Daegu, South Korea

When it comes to learning physics through the curricula of secondary school education, we all start off with the definition and examples of vector quantities, which are undoubtedly distinguished from their counterparts of scalar quantities. Through the processes of being familiar with sort of those exotic concepts, we often tend to misidentify all the quantities covered within the course of physics as vectors, even though some of them are in fact, scalars. We will take the concepts of work and energy as good examples of those misunderstanding, and will also have a look at the relationship between the two significant terms by very prominent theorem, Work-Energy theorem.

## SP36. INVESTIGATING THE IMPACT OF ANGULAR DISTORTION ON COLOR AND WORD PROCESSING: A ROTATED STROOP TEST STUDY

Ruda Lee*, Jiho Song**
*Korea International School (KIS) 27, South Korea
**Saint Paul Preparatory Seoul 14-8, South Korea

The original color and word stroop test was created to assess our ability to inhibit language information processing. Our test was expanded on this model and includes another factor, the angular distortion of words. This allowed us to study the effect of angular distortion on our ability to differentiate the color of the word from its text.
This study was conducted on six international school students between the ages of 16-17, but only four were viable for analysis. Our test had a total of six tasks, three of which we used to validate our hypothesis; the more angular distortion, the less time is required. to identify the color. After successfully validating our hypothesis, we continued on to the remaining three tasks which contained unknown distortion levels, and identified the level of each type of angular distortion.
The findings revealed that time taken for a task and amount of distortion were inversely proportional, meaning that participants took more time to differentiate the color of the word from the text when there was less angular distortion. This suggests that less angular distortion makes it harder to inhibit language processing and focus on color information processing.
In conclusion, the rotated Stroop Test study provides valuable insights into the impact of angular distortion on color and word processing, and highlights the importance of considering the amount of angular distortion in language and memory experiments.

## SP37. ENERGY EFFICIENT CLIMATE CONTROL

Ko Aiden Sungmin
Korea International School (KIS) 27, South Korea

In a world with a growing energy crisis, South Koreans, faced by a need for optimized climate control, have adopted two popular yet contrasting strategies used in residential apartment rooms with modern HVAC systems, defined as intermittent and continuous. Both are intended to satisfy human thermal comfort parameters, while using the minimum amount of energy, effectively minimizing the cost of use. Intermittent control activates discontinuously, allowing for natural heat transfer between the room and the outside environment until the point that exceeds thermal comfort parameters, whereas continuous control operates uninterrupted, constantly adjusting for the heat transfer. In the context of this research, continuous control also includes the utilization of different set point temperatures at different times, such as during sleep, yet will remain on as long as the occupant is in the room. Previous case studies done by Tunçbilek et. al., Benakopoulos et. al., and Wang et. al. in Denmark, Turkey, and England respectively suggest that there was a significant decrease in energy usage under intermittent control.  This corroborates the second law of thermodynamics and its entailing equations, which were also utilized to show less heat transfer ergo less energy usage under an intermittent strategy rather than continuous. As the rate of heat transfer varies under different types of insulation, research was also conducted under different types, thicknesses, and areas of insulation. To minimize energy and cost, this research concludes that an intermittent climate control strategy should be adopted.

## SP38. WEARABLE TECHNOLOGY IN SHOES

Kwon Roy Byeong Jun*, Kim Morgan Jae Hyun**, Shin Woong Jay***
*Cornerstone Collegiate Academy of Seoul (CCAS), South Korea
**Seoul Foreign School (SFS) 39, Seoul, South Korea
***St. Johnsbury Academy (SJA) 10, Special Self-Governing Province, South Korea

Wearable technology refers to a range of electronic devices that are designed to be worn on the body. These devices typically contain sensors and other components that allow it to collect, analyze, and transmit data about the user's activity and environment. Some examples of wearable technology include fitness trackers, smartwatches, shoe insoles, medical devices, etc. In the context of shoe insoles, wearable technology refers to the integration of sensors and other electronics into the insole of a shoe. These devices can track a range of metrics related to the wearers foot, including steps taken, distance travelled, and force distribution. There are several pre-existing solutions for technological shoe insoles, including products from companies like Nike, OpenGo Sensor, and Sensoria. These products typically contain sensors that are embedded into the insole of the shoe and can track metrics such as steps taken, calories burned, and distance travelled. However, there are some challenges associated with wearable shoe insoles. One of the main challenges is ensuring the durability and stability of the sensors and electronics in the insole. As such, our main goal through this research is to make sure that the wearer is comfortable and can easily access the collected information and view real-time reports. Ultimately, by selling shoe insoles with wearable technology, it can not only create a market in which a business can grow in line with the trend of wearable technologies being developed, but also bring about great health and statistical benefits to the everyday user and the world of athletics.

## SP39. THE BENEFITS OF VITAMIN C

Hermes Arampatzis Charistos
De La Salle College, Thessaloniki, Greece

There are many fruits and vegetables that are higher in Vitamin C content than an orange. It is true that Vitamin C is very important for our health especially in winter season. Orange is said to be the king of Vitamin C although according to recent research there are many more fruits and vegetables that have got more Vitamin C content. In this research or study, we will focus on other fruits and vegetables which are also a rich source of Vitamin C (like kiwi, pineapple, strawberry, mango, papaya, broccoli, kale, Red and Yellow Bell Peppers, lemon etc) and we will find out which fruit is the king of Vitamin C (Extended research will be done to support our views). Also, we will demonstrate the benefits of Vitamin C and how it contributes to our immune defense system. Moreover, we will indicate that high doses of Vitamin C decrease cold symptoms. Last but not least, due to Covid-19 more and more people focus on their diet to protect themselves from illnesses and infections by strengthening their immunity . This study will be of some help to everyone who wants to improve his diet.

# WORKSHOPS

## WS1. BLINKING LIGHTS: SOLDER YOUR OWN CIRCUIT

*DEUTSCHMANN Bernd, **MAIER Christoph, **JUCH Nikolaus**
**TU-Graz, Head of Institute, **TU-Graz, Master Student, ***TU-Graz, Bachelor Student, Austria

Our world would not be the same without electronic circuits. Mobile Phones, TVs, computers, etc., practically everything has electronics inside. Building a circuit by yourself is easy, and we will show you how.

First, we will explain a little bit about all the different electronic components used, after which, we will start working with the soldering iron to create a small circuit, called astable multivibrator. Of course we provide help if needed. Hopefully everything works at the end, but if not, we are here to learn and make it work, like real engineers do, with patience and measurement equipment.

Of course you can keep the circuit you have soldered.

## WS2. MATHEMATICS THROUGH MOVEMENT

*Mara Grašić, **Željka Hanžek
*Osnovna škola „Braća Radić“, Koprivnica, Croatia
**Osnovna škola „Antun Nemčić Gostovinski" Koprivnica, Croatia

Students learn best through active participation and when they invest themselves in the lesson at hand. Learning mathematics through movement implies a more active position of students and their mutual interactions, which at the same time improves the classroom atmosphere, contributes to connecting knowledge from different subjects and more meaningful and active learning. What's the best way to learn mathematics then dancing and playing?

The very process of mobile teaching develops understanding and learning. Permanent memory is the result of stimulating the student's intrinsic motivation and successive rhythmic repetitions. The game on a dance floor will allow them to experience a unique, mysterious challenge and fun with the impression that they have entered another world by students' acquisition and enrichment of various experiences and abilities.

Through this workshop, students will move through space and learn about symmetry, translation and triangles.

## WS3. MATHEMATICS AND ROSETTE

*Mara Grašić, **Željka Hanžek
*Osnovna škola „Braća Radić",Koprivnica, Croatia
**Osnovna škola „Antun Nemčić Gostovinski"Koprivnica, Croatia

A rosette (French rosette – rosette) is a round ornament in the shape of a rose or a round window with various decorations, usually on the facades of Gothic churches or a geometric figure bounded by two concentric circles.

The goal of this workshop is to show how to encourage students to develop creative activities and active learning through mathematical content and artistic expression. Students connect the drawing of acute angles, angles, calculating the measures of angles in a rhombus, apply the property of the sum of internal angles in a quadrilateral, draw/construct a regular hexagon (octagon, octagon).

Working in pairs, they will discover and calculate the mutual relations between the measures of the internal and external angles of the quadrilateral contained in the geometric figure (rosette). They will use their knowledge and skills in creating methodical materials for active learning.

In addition to the application of mathematical knowledge, students in this way develop persistence, precision, attention, courage and openness when encountering new situations.

## WS4. A METHODOLOGY FOR ADDING ELEMENTS OF MATHEMATICS COMPETITIONS TO THE EDUCATIONAL PROCESS IN THE UPPER GRADES OF BASIC SCHOOL

Maksim Ivanov, Natalia Ivanova, Julia Klochkova, Hiie Asser
Tartu Annelinna Gymnasium, Tartu, Estonia

One of the main challenges for a teacher of mathematics is to organize differentiated learning, corresponding to students' abilities. It is especially true if there is one or more gifted students in the class, for whom the tasks given in the mathematics textbook are obviously not enough. In most cases, they can solve almost any problem from the textbook in their head or immediately understand the process of solving it, and therefore do not want to spend their time on writing down the solution to such problems.

Teachers approach this challenge in different ways. Some suggest that students continue to solve the problems from the textbook on their own, some advice students to look for different solutions to the same problem, others look for additional materials suitable for gifted students.

During this workshop, the author will present his vision of the successful implementation of differentiated learning, which is based on the transformation of textbook tasks by adding some elements of maths competitions to them. The author will present materials developed by him, where all the tasks connected to several topics of the textbook have additional options for more gifted students. This approach allows all the students in the class to deal with approximately the same problem at their own level, and also have the opportunity to get acquainted with more interesting and complex problems and ideas for their solutions. At the same time, for more advanced students, this approach is a natural preparatory process for various mathematical competitions, which does not require special additional lessons.

## WS5. MATHEMATICAL THEATRE

Yiannis Lazarou
Mathematics (STEAM) Teacher, Pancyprian Gymnasium Nicosia, Cyprus

This workshop aims to present the main aspects of a mathematical theatre performance by students and the benefits inside a STEAM Education environment. It also aims to help the teachers/colleagues of primary and secondary education get familiar with the concept of mathematical theatre. By working in small groups (also helped by a handout), teachers attending the workshop will be asked to follow certain steps, in the process of writing/creating their own small theatrical play. I will provide constant monitoring of the groups' progress, by discussing their ideas, advising them on several issues covered in my previous presentation and supervising the group work taking place during the workshop. Some groups will have the opportunity to present the mini theatricals they prepared at the end of the workshop. The duration of the workshop is estimated around 80 minutes.

## WS6. KAHOOT QUIZ

Mara Grasic*, Bojana Habek**
OS „Braca Radic" Korivnica; Gimnazija „Fran Galovic" Koprivnica, Croatia

Students will be presented with Kahoot quiz. Teachers decide how much time students have to complete each task. (In this case the game will last about 45 minutes.) The tasks will contain math problems. For this game every group of students needs to have one smartphone with an internet connection and a QR code reader application. Every correct answer brings them some points and also their speed gives them more points . The group with the most points is the winner. First three groups will receive small rewards. The tasks will be prepared for primary school students but also applicable to secondary school students. This activity is great for team building activities, and for students just getting to know each other! We hope both the students and the teachers will have lots of fun.

## WS7. HAVE FUN WITH SECRET CODES

Eleni Papageorgiou
Teacher Trainer in Mathematics, Cyprus Pedagogical Institute, Cyprus

The purpose of this workshop is to encourage students and teachers to participate in coding activities, using the binary system. The participants will have the opportunity to code their name and write their own secret message, using the binary system or the ASCII code. Furthermore, they will try to make their own code system for coding and decoding messages.

# EUROPEAN STEAME CONFERENCE

## STEAME1. SCIENTIX: THE COMMUNITY FOR SCIENCE EDUCATION IN EUROPE. TAKE PART IN THE STEM DISCOVERY CAMPAIGN!

Katarzyna Kwiatek-Grabarska
Scientix Ambassador / Complex of Schools No. 5, Zabrze, Poland

Scientix is the leading community of science education in Europe. It aims to promote and support a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other educational stakeholders to inspire students to pursue careers in the field of Science, Technology, Engineering and Mathematics.

Scientix was born in 2010 at the initiative of the European Commission and is coordinated by European Schoolnet. Now, it is the fourth edition of the Scientix Project, which has received funding from the European Union's H2020 research and innovation programme. The European Schoolnet and Scientix are based in Brussels, however the Project has also developed a network of Scientix National Contact Points and Scientix Ambassadors across the Europe.

Teachers, researchers and project managers in STEM education, as well as policymakers can benefit from Scientix activities and events. The Scientix platform contains a huge amount of almost 3 000 teaching materials. It is also a place for sharing experiences, a source of inspiring activities and educational news and it is also a meeting place for teachers. Through the Scientix community new contacts can be made and school collaboration projects can be developed. Scientix also hosts workshops in the Future Classroom Lab in Brussels - a high-tech educational space.

Scientix supports a number of initiatives. One of these is the STEM Discovery Campaign, which promotes Science, Technology, Engineering and Mathematics. In 2023, the 8th edition of this unique European initiative will take place. Educators, projects, organisations, libraries, schools, universities, youth clubs and interested stakeholders around the world are invited to carry out STEM-related actions.

## STEAME2. OPEN-ENDED PROBLEMS FOR EMPOWERING STUDENTS THINKING AND UNDERSTANDING

Valentina Gogovska
UKIM University, Faculty of Natural Sciences and Mathematics-Skopje, Institute of Mathematics

Development of thinking and in particular development of mental qualities – width, depth, independence, logic, mobility, concreteness, criticism, speed, creativity, target orientation, generalization, insight, and more, is one of the most important and consistent goals and objectives of math teaching. Simultaneously, the degree to which this aim is fulfilled determines the level and effectiveness of the teaching process for the overall development of the student's personality. An important psychological and pedagogical condition for the development of quality of thinking is student's reflexive understanding of thinking as a process and their own mental capabilities.

This work attempts to promote the use of open-ended problems during everyday mathematics classes, especially during classes for exercises through a few examples. Well-chosen examples not only improve and empower the process of doing mathematics, but also stimulate the process of creative thinking and motivate student's individual development in their current learning and understanding, thus leading to the formation of intellectual reflection. Encouraging this kind of endless possibility thinking is an effective way to teach students to challenge themselves and think outside of the "normal" problem solving thinking.

## STEAME3. ENGLISH, KITES AND STEAME SKILLS

Daniela Florescu
Liceul Teoretic Tudor Arghezi, Craiova, Romania

One may wonder what the connection between English, kites and STEAME skills is. The beauty of language teaching is that we can cover any subject or topic in our attempt to develop our students' linguistic skills. Interdisciplinarity has become a frequent topic of debate and new terms have been coined to cater for this combination of subjects, one of which is the acronym STEAME. The activities based on STEAME skills focus on exploring the familiar fields of mathematics and science while using the creative problem-solving and inquiry-based techniques usually seen in more creative fields. The final letter  E - Entrepreneurship - shows that science is put to the service of the business world.

Taking all this into account, an English class was planned in such a way as to teach language not in a traditional way, but by developing STEAME skills while building, decorating and flying a kite, as part of celebrating the International Kite Day. The students got a better understanding of concepts related to Physics and Mathematics; made use of their Engineering, Technology and Artistic skills when drawing, designing, building kites; Entrepreunership, ICT and Art skills when creating advertisements/ commercials for the kites; Social skills when working in teams and doing interviews about their participation at the activity; Multiple Intelligences when playing the guitar and singing a song about Flying Kites; linguistic skills when speaking, writing, listening and reading in English.


## STEAME4. THE EU PROJECT: FACILITATE ARTIFICIAL INTELLIGENCE

Andreas Skotinos
Vice President, Cyprus Mathematical Society
Gregory Makrides, President, Cyprus Mathematical Society

The FACILITATE-AI project is a project funded by the ERASMUS+ Programme, with reference number: 2021-1-CY01-KA220-SCH-000032567. It is coordinated by the Cyprus Mathematical Society.

The FACILITATE-AI project's aim is to support school teachers (the facilitators of learning) in developing an inquiry base and evidence-based understanding of the complexities and principles of AI, the algorithmic creative thinking, and how these can be integrated in the school students' learning process for promoting creative problem solving.

The coordinator is the Cyprus Mathematical Society and the partners are: Plovdiv University Paisii Hilendarski (Bulgaria), Instituto Politecnico Do Porto (Portugal), Universitatea Spiru Haret (Romania), Prof. Ivan Apostolov Private English Language School (Bulgaria), ITC Pacle Morante Limbiate (Italy), Institute of Accelerating Systems and Applications (Greece), Doukas School (Greece) and University of Cyprus (Cyprus).

The project's official website is: www.facilitate-ai.eu

# STEAME5. STEAME GOES HYBRID: BLUEPRINT GUIDELINES AND POLICY RECOMMENDATIONS

Gregory Makrides, President, Cyprus Mathematical Society
Andreas Skotinos, Vice President, Cyprus Mathematical Society

The STEAME GOES HYBRID project is a project funded by the ERASMUS+ Programme, with reference number: 2020-1-CY01-KA226-SCH-082675. It is a continuation of the STEAME project, coordinated by the Cyprus Mathematical Society. The aim of both projects is to design and develop STEAME Schools. STEAME stands for "Science, Technology, Engineering, Arts, Mathematics and Entrepreneurship".

The STEAME GOES HYBRID project has developed innovative learning practices in the Digital Era we live in, by developing new educational, learning and training methods for moving school based STEAME activities to online and distance STEAME activities so to formulate a hybrid approach.

The coordinator is the Cyprus Mathematical Society and the partners are: Leafnet Ltd (Cyprus), DOUKAS School (Greece), University of the Aegean (Greece), Pedagogical University of Krakow (Poland), ITC Pacle Morante Limbiate (Italy), European Digital Learning Network (Italy), Asociatia "Institutul Pentru Dezvoltarea Evaluarii in Educatie" (Romania).

The project's official website is: www.steame-hybrid.eu

# CONFERENCE VENUES FLOOR PLAN

## PEDAGOGICAL UNIVERSITY OF KRAKOW & NOVOTEL KRAKOW CITY WEST HOTEL



Podchorążych st.

118 first floor
REGISTRATION
216 second floor
WORKSHOP

A1 ground floor
A2, A3 first floor
PRESENTATIONS

Warmijska st.

M. Smoluchowskiego st.

A. Chmiela st.

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euro SCIENCE
2 0 2 3

Pedagogical University of Krakow
Podchorążych 2 st.

Registration - 118
Presentations - A1, A2, A3
Workshop - 216

Podchorążych st.

Warmijska st.

A. Chmiela st.

M. Smoluchowskiego st.

ENTRANCE HERE

Juliusza Lea st.

Novotel City West
Armii Krajowej 11 st.

Opening Ceremony
Math&Science Factor
Award Ceremony
Poster exhibition
Steame Students

Armii Krajowej st.

Piastowska st.

Bistro Piast
Piastowska 47 st.

Math Theatre
Lunches

Nawojki st.