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WORKSHOPS

Workshop 1

DESIGN A PERFECT SCIENCE- OR MATHEMATICS-POSTER – SIX MOST IMPORTANT HINTS

Helmut Loidl – Loidl Art

We invite you to a workshop for Poster-Design. To communicate your science a poster is a key component in your scientific career. A poster offers a different medium from published papers or verbal presentation. It presents a snapshot out of your work.
I will show you six simply rules on the time-consuming process for preparing an ideal poster.
We will talk about: The purpose of a poster; how to start with a good idea; importance of briefness; layout and format; free-hand design or computer design.
To put some ideas to paper you need a sheet of paper (minimum size A3) some pencil, coloured pencil or wax crayon, felt-pen, marker …

Workshop 2

SMART SCIENCES: EXPERIMENTS USING SMARTPHONE/TABLET-BASED SENSORS (FOR STUDENTS)

Laura Longo – Student at Liceo Scientifico “Luigi Siciliani”, Italy
Rosario Francesco Scavelli - Student at Liceo Scientifico “Luigi Siciliani”, Italy
Francesco Scerbo - Teacher at Liceo Scientifico “Luigi Siciliani”, Italy

New media technology has already became more and more important for our daily life. Smartphones and tablets are everyday tools – for all of us and especially for students as well. They are widely used to chat with the others, to take pictures, to play games: the increasing use and technical development of these tools could enrich science teaching, too. Indeed every smartphone and tablet is equipped with a number of physical sensors that can be read by a huge on-line library of appropriate software applications (app): this hardware and software hi-tech can easily transform these devices into powerful scientific experimental tools. Aim of this workshop is to show how smartphones and tablets can used to perform experiments covering Cinematics, Dynamics, Acoustics, Optics, Electromagnetism, Sciences. A list of the required app, both for Android and iOS based devices, as well as a workshop Tutorial will be released to all participants 1 or 2 weeks before the Conference.

Workshop 3

SMART SCIENCES: EXPERIMENTS USING SMARTPHONE/TABLET-BASED SENSORS (FOR TEACHERS)

Laura Longo – Student at Liceo Scientifico “Luigi Siciliani”, Italy
Rosario Francesco Scavelli - Student at Liceo Scientifico “Luigi Siciliani”, Italy
Francesco Scerbo - Teacher at Liceo Scientifico “Luigi Siciliani”, Italy

New media technology has already became more and more important for our daily life. Smartphones and tablets are everyday tools – for all of us and especially for students as well. They are widely used to chat with the others, to take pictures, to play games: the increasing use and technical development of these tools could enrich science teaching, too. Indeed every smartphone and tablet is equipped with a number of physical sensors that can be read by a huge on-line library of appropriate software applications (app): this hardware and software hi-tech can easily transform these devices into powerful scientific experimental tools. Aim of this workshop is to show how smartphones and tablets can used to perform experiments covering Cinematics, Dynamics, Acoustics, Optics, Electromagnetism, Sciences. A list of the required app, both for Android and iOS based devices, as well as a workshop Tutorial will be released to all participants 1 or 2 weeks before the Conference.

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Workshop 4

MATHGAMES: HOW TO LEARN THE BASICS OF MATHEMATICS BY PLAYING GAMES?

Roland Schneidt - Volkshochschule Schrobenhausen, Germany

The European Erasmus+ Project "Math-GAMES - Games and Mathematics in Education – Compendiums, Guidelines and Courses for Numeracy Learning Methods Based on Games" will help to answer the questions
How can we reduce the number of people, who cannot count and calculate, to promote social integration and participation into our society?
How can we increase incentives in education by using games?
How can we offer tailored learning opportunities to individual learners by using games?
During the workshop MathGAMES the Co-ordinator of the project Roland Schneidt will explain the project and the material, which can be downloaded for free from the website and which will help the teacher to use a methodology based on games.
In addition, an example is discussed of how to use a selected game in the classroom to learn how to calculate. The workshop is aimed primarily at teachers who want to get to know the MathGAMES methodology. However, interested students may also participate.
As the MathGAMES project has not yet been finalized, the workshop participants' experiences and opinions can be incorporated into the results of the project.

Workshop 5

THE MILAGE LEARN+ TEACHERS APPLICATION FOR LEARNING MATHEMATICS

Mauro Figueiredo - Algarve University, Portugal

In this workshop, we explore the MILAGE LEARN+ Teachers Application for windows and OSX. This application is used for teachers to upload contents and follow the work and progress of students using the MILAGE Learn+ app for mobile devices. In this workshop, we will explore the production of videos explaining resolutions of problems. The creation of worksheets of problems for students and how it is available the e-portfolio with the work of students. The MILAGE Learn+ app was developed for smartphones and tablets to provide activities that students can do in the classroom or at home in a blended learning setup. With this app students solve mathematic activities and are helped by the presentation of videos with the problems resolutions. When students have difficulty in solving a problem they can watch the video resolution of it. In this way, we want to provide the same opportunities to low-achieving students that may struggle to learn the materials covered in class. Students have also access to complex problems that may provide additional stimulation for top performers students. In this way, we can provide a platform that is capable of accommodating students with different mathematic skills.

Workshop 6

THE MILAGE LEARN+ APPLICATION TO LEARN MATHEMATICS

Mauro Figueiredo - Algarve University, Portugal

In this workshop, we explore the MILAGE LEARN+ App that we developed for smartphones and tablets to provide activities that students can do in the classroom or at home in a blended learning setup. With this app students solve mathematic activities and are helped by the presentation of videos with the problems resolutions. When students have difficulty in solving a problem they can watch the video resolution of it. In this way, we want to provide the same opportunities to low-achieving students that may struggle to learn the materials covered in class. Students have also access to complex problems that may provide additional stimulation for top performers students. In this way, we can provide a platform that is capable of accommodating students with different mathematic skills.

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Workshop 7
ARRANGEMENTS IN ORDER
Sava Grozdev - VUZF University, Bulgaria

The workshop is dedicated to the method of arrangement in order, which is simple but powerful technique in problem solving. Several examples will be considered with arithmetic, algebraic and geometric context.

Workshop 8
INCIDENCES OF PLANE CURVES
Anna Ochel - Gimnazjum im. Jana Matejki w Zabierzowie, Poland
Tomasz Szemberg - Pedagogical University of Cracow, Poland

Lines and conics are often explored in the school geometry. Curves of higher degree are somewhat mysterious and rarely make it to schools. I will report on a phenomenon known as the Cayley-Bacharach property, concerning intersection points of two curves of degree three and show some surprising consequences in elementary geometry. Teachers are welcome to attend. This workshop is suitable for students from grade 8 on.

Workshop 9
MAGIC SQUARES AND OTHER MAGIC FIGURES
Anna Ochel - Gimnazjum im. Jana Matejki w Zabierzowie, Poland
Tomasz Szemberg - Pedagogical University of Cracow, Poland

A basic magic square is a table n x n filled with numbers from 1 to n2 in such a way that the sum of all numbers in each column and in each row is the same (sometimes one takes also the diagonals into account). I will speak about numerous variations of this basic idea. The students will be given an opportunity to explore magic figures on their own. Teachers are welcome to attend.

Workshop 10
AN EDUCATIONAL APPROACH TO L-SYSTEM FRACTALS THROUGH NEW TECHNOLOGIES
Anna Alfieri - Liceo Scientifico “Luigi Siciliani”, Italy

Information and Communication Technologies (ICT) impact more and more all the aspects of personal, social and professional life of people, pupils and teachers included. Social networks numbers exponentially increase and these tools are becoming always more influential; they deeply affect our communication, as well as our relationships with authorities and institutions.
All these changes also influence teaching and learning processes, they modify the relationships between teachers and pupils inside and outside the school and they generate new challenges and responsibilities. Therefore, it is essential for teachers and pupils to regularly access technologies.
The purpose of this workshop is to present an educational approach to L-system fractal theory through the ICT.
L-systems Fractals Theory has been conceived as a mathematical theory of plants growing: it was developed by Aristid Lindenmayer (1925-1989), a Hungarian biologist who studied a formal languages called Lindenmayer Systems or L-systems, through which fractals are generated.
In the L-system Theory, the use of new technologies is essential to manipulate geometric objects and to plot the fractal figures, to create new conjecture and demonstrate new hypotheses; ICT are meant to support and advance mathematical sense making, reasoning, problem solving and communication.
In the educational experience, we use Fractal Grower, a Java software created by the Department of Computer Science, University of New Mexico, which is based on Turtle Geometry.
Some links of the videos about L-system fractals, made by students and posted on youtube.com:
https://youtu.be/1tNfXrp2JXI https://youtu.be/EYCHgLr3YhY https://youtu.be/4E7ECRwEbu0

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Workshop 11

ARE YOU UP FOR SCICHALLENGE?

Stela Stancheva - Project Manager, European Students' Union, Belgium
Alexandra Antonescu - Communications Manager, European Students' Union, Belgium
Laura Lacatus - General Manager, Universitatea Copiilor, Romania

Students will be walked through the process of submitting an application through a practical exercise (simulation). Using a projector, we will introduce the competition website and the promotional video. Students will then be encouraged to choose one of the 50 topics proposed and outline their ideas for a poster, video or presentation using a personal computer / tablet. Workshop facilitators will guide participants through the process and answer any questions or concerns.

Workshop 12

MEANINGFUL STUDENTS INVOLVEMENT: STUDENTS AS PHYSICS AND TECHNOLOGY "RESEARCHER". AN ITALIAN PROPOSAL FROM SPACE TO MICROWORLD: HUNTING FOR COSMIC RAYS AND NANOTECH AT LICEO "L. SICILIANI"

Rossana Centioni - Information and Scientific Documentatio Staff Manager, National Institute for Nuclear Physics, Frascati National Laboratories, Italy
Francesco Scerbo - Teacher at Liceo Scientifico "Luigi Siciliani", Italy

Teaching physics and technology is a challenging, rewarding and exciting arena where every day teachers get to share the fascinating concepts of physics and technology evolution in a room full of young and inquisitive minds. In the last PISA-OECD survey, Italian students performance in science (STEM) is below the OECD average. Moreover Italian and international surveys confirm that science learning motivation is strictly correlated to real world applications and appeal broadening of these disciplines. That is why during these last years Italian Educational Ministry (MIUR) has been particularly engaged in promoting a wide national plan to improve physics and technology learning. One of the actions promoted involves the most important Italian national scientific research institutions and, specifically, Frascati based laboratories (LNF) of Italian National Institute for Nuclear Physics (INFN). Since 2001 LNF has promoted an Educational Dept. whit the aim is to open laboratories to educational activities both for Italian teachers and European (not only Italian) high school students. The idea behind this approach is that meaningful student involvement can take the form of engaging students as researchers.
This workshop starts with an overview of LNF Educational activities. Then Siciliani's students fieldwork experiences are presented, with a special focus on the last 2017 Young Apprenticeship Programme This programme allowed a group of students together with LNF researchers to design and assemble a "muon telescope", already installed and operating in our school, and to get a rare hands-on learning experience in the nanotechnology field, complementing the theoretical work they do in the classroom.
Some students interviews with LNF Director P. Campana and researchers will complete the workshop.

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Workshop 13

SPARTIAL INTELLIGENCE DEVELOPMENT VIA MODEL CONSTRUCTION PROJECTS

Ph.D Sorin Alexe - XColony Project, USA
Ph.D Gabriela Dumitrascu - Eastern Michigan University, Ann Arbor, USA
Andrei Alexe - XColony Project, Romania
Mioara Manaila - XColony Project, Romania
Ph.D Petrus Alexandrescu - Archimede Association, Romania
Ph.D Gheorghe Duda - USH-Spiru Haret University, Romania

The workshop introduces a new platform for teaching and learning visually geometry, using project oriented collaborative activities. This platform emerged from the XColony project, and was successfully tested in USA, Romania and Singapore. Educational programs implemented in schools that are using this platform have been proven to increase the spatial abilities of fifth grade students by 17% based on a global score for comprehension, problem solving and reasoning. Followed-up in the sixth grade, the students that participated in the program achieved standard math grades half-point higher than their peers. Recently, XColony project was tested in pilot studies, engaging 6-9 graders in academic environments: Michigan University, USA; Princeton Robotic Squad, USA and Dunarea de Jos University, Galati, Romania. This workshop reports the accomplishments of these pilot studies as a way to create bridges between academic work and young student spatial education. The workshop also includes a set of hands-on of activities that will give the participants a direct understanding of the teaching and learning potential of the platform. Projects will include paper model building, 2D and 3D puzzle solving. Teaching domain composition/decomposition and packing of geometric objects are illustrated with manipulatives, puzzle solving and hands-on activities. Participants will have support from XColony trainers, video and written instructions. A brief brainstorming session will try to detect potential for new uses of this platform in the class day-to-day learning activities. According to longitudinal studies, spatial intelligence, especially discovered and fostered at young ages, helps students later with their academic achievements and professional career.

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STUDENT PRESENTATIONS IN MATHEMATICS

APPLICATION OF BINARY CODES AND GRAY CODE IN DETERMINING THE LOCATION AND DISPLACEMENT OF A ROTATIONAL MOTION IN ROTARY ENCODER SENSORS

Parisa Nouroozi, Yasamin Joz Ghasemi and Maryam Azizi - Sama Technical and Vocational Training College, Zanjan, Iran

The human has used decimal numbers (base-ten) to count, because of using fingers to numeration. Over the years, other bases have been considered. In those years the question has been posed that "If we convert the numbers between two different bases, how the digits of them will be changed?". In this article after describing how to convert the number between arbitrary bases, binary (base two) numbers and its applications in computer science has been discussed particularly. Plus the reasons for using different codes in digital system has been surveyed in this paper. Furthermore, the gray code as one of the most commonly used code in digital systems has been described. The main use of gray code is in the encoder shaft sensor. Due to significant errors of binary code in the rotary encoder sensors, this code has been replaced by gray code. In this research, at first, performance of rotary encoder has been explained. Then using of binary code errors in these sensors has been investigated. Finally the advantage of using gray code have been expressed in these sensors.

THE APPLICATION OF BOOLEAN ALGEBRA IN DESIGN OF DIGITAL CIRCUITS; A CASE STUDY OF SAMPLE CIRCUIT

Nikta Moghimi and Maedeh Ghaffari - Sama Technical and Vocational Training College, Zanjan , Iran

In computers ALU (Arithmetic and Logic Unit) in addition arithmetic operations, logic operations are used. In this paper logic operations and Huntington principles have been expressed initially. Then, it has been expressed how the theorems of Boolean algebra have been proven with these principles. In the following, properties of Boolean algebra and Boolean functions and there canonic forms have been stated and Karnagh map as an effective method of simplifying functions have been introduced. Finally, the application of Boolean algebra in design of digital circuits have been surveyed and A practical example have been presented.

SEVERAL ALGORITHMS FOR ADDITION, SUBTRACTION AND MULTIPLICATION OF FLOATING-POINT AND FIXED POINT NUMBERS AND THEIR HARDWARE IMPLEMENTATION IN DIGITAL SYSTEMS

Sina Sabaifard, Alireza Mohajeri, Amin Rasouli and Mohamad Sepehr Shahryari - Sama Technical and Vocational Training College, Zanjan, Isfahan, Iran

Arithmetic instructions in digital computers by changing data reach to desired results. The arithmetic processor is a part of a processing unit that executes arithmetic operations. Arithmetic instructions can operate on binary or decimal data. Data can also be fixed-point or floating-point. Furthermore fixed point numbers may also be integer or fraction. In addition negative numbers may also be displayed on sing-and-magnitude or two's complements systems. In this paper, several algorithms for addition, subtraction and multiplication of numbers (floating-point and fixed point) in digital systems, will be discussed. Finally, with the introduction of Boolean algebra and logic ICs, hardware implementation of these algorithms will be presented

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TINY CREATURES, GIANT MATHEMATICIANS

Maria Tsiarta, Lito Yiangou, Charis Christoforides and Giorgos Tomasides - The Grammar School, Nicosia, Cyprus

In a complex ecosystem with numerous threats and difficulties, honey bees have taken advantage of mathematics and developed various ways to ensure a better, easier and safer life. A remarkable fact is that the family tree of a male bee by its nature is in such a way that forms a sequence called Fibonacci. According to the discovery by Leonardo of Pisa, known as Fibonacci, the Fibonacci sequence is related to the golden ratio.

Those tiny black and yellow mathematical geniuses solved the travelling salesman problem, by finding the optimum root to minimise their 'costs'. Nature's mathematicians have developed a revolutionary mathematical method of sharing information about food source detection, known as the waggle dance. More analytically they manage to inform other bees about food location, the distance of it from the hive, as well as the quality and quantity of food using patterns of movement. Bees have developed a genius way of efficiently preparing their hives, ensuring maximum capacity and minimum wax used.

Moreover bees have come up with brilliant mathematically related defensive mechanism against one of their natural enemies, the giant hornets. They evolved a way of raising and carefully monitoring the temperature achieving to literally burn the hornet alive without harming themselves, concluding the sovereignty in the "war" of survival.

A DONUT IN NON-EUCLIDEAN SPACE

Savvas Karaiskakis, Melanie Nicolaou, Ioanna Kyprianopoulou, Christia Mouzoura and Andreas Vrikkis - The Grammar School, Nicosia, Cyprus

Have you ever thought of catching a glimpse into a world not confined in 3 dimensions?

Submerge yourself in alternative theoretical spaces bounded only by your imagination that can change your surroundings and perspective. How would objects transform when transpacing the third dimension? Mathematicians demonstrate situations that do not exist in our world using the mathematical branch of topology. For instance, in a topological space, a cup is identical to a donut. How is this possible? To understand this, one needs to clarify what a topological space is.

You are probably used to mathematics in a metric space, where distances are defined with certain values. The most familiar metric space is three-dimensional Eucledian space. In contrast, a topological space can be distorted, rendering distance insignificant. This allows us to work in our space, set its dimensions and change its properties. The result - impossible transformations that will surprise you!

Topology is all about that. This non-convectional way of using mathematics will let you see mathematics from a different angle.

TO INFINITY AND BEYOND

Giorgos Zaphiris - The Grammar School, Nicosia, Cyprus

If you were to ask a person what is the largest number you can think of many of them would say infinity. However, infinity is not a number, it is a kind of number. For example, there are infinite (unending) amounts of numbers, some of which are bigger than others, such as the natural, rational or the real numbers.

Infinity is an abstract concept describing something without any bound or larger than any number. The concept of infinity has fascinated and confused mankind for centuries, with theories and ideas causing even seasoned mathematicians to wonder or even try to avoid using it, because of its many paradoxes.

In this presentation, different sizes of infinities will be presented to show that some are equal and some are bigger than others. For instance, matching their elements one to one or using Cantor's diagonal argument. Cardinal and ordinal numbers will be distinguished and certain methods will be used in order to count beyond them.

Finally, some axioms will be introduced to make bigger and more numerous jumps than before, leading to an accelerating loop of infinities that keep going, reaching larger and larger infinities.

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THE ULTIMATE SOLUTION FOR LOVE

Styliana Stylianou - The Grammar School, Nicosia, Cyprus

Mathematics offers a valuable new perspective on matters of love. Solutions can be extracted from actual data and equations linking love and Mathematics. Have you ever been involved in a never-ending search to find the perfect mate? Can you imagine how difficult it is? Problems, such like deciding who to settle down with, have the mildly disturbing maths name of "optimal stopping problems." Based on the "optimal stopping theory", you can predict the point at which you'll maximize your likelihood of finding the perfect partner.

However, even if you manage to find your "perfect partner", how can you be sure that your love will last? Scientists have found a way to predict this. Consequently, you can find your "optimal" proposal age using the equation discovered by the UNSW School of Mathematics and Statistics.

In conclusion, if you are already married, you can also predict your spouse's reaction. Dr Hannah Fry, a lecturer in the Mathematics of Cities at UCL, offers this unique opportunity. All in all, Mathematics is ultimately the study of patterns and love; patterns that Mathematics is uniquely capable of discovering.

PASCAL'S SECRETS

Mac Mackenzie, Nestoras Papageorgiou and Afek Shamir - The Heritage Private School, Limassol, Cyprus

A collection of numbers often found in real life situations. A triangular array consisting of the Binomial coefficients. A triangle named after the French mathematician Blaise Pascal, well known of course as Pascal's triangle. The idea behind it is simple and one can easily understand how to form it. What intrigued us is that even though it is built on such a simple concept it has a lot of patterns and extensions, combining many different areas of mathematics. Among the first things we came across, in the triangle, are the Natural numbers and the Fibonacci sequence. In the triangle we can also encounter the Triangular and Tetrahedral numbers which make an extension to Geometry. Furthermore, we have found additive and visual patterns, as beautiful as fractals are. Finally the extension to Pascal's pyramid and the triangle's applications to Probability are among the things that kept us researching. Let us share our research and inspire you by presenting some of the elegant ways in which different areas of the world of mathematics are related.

ALICE IN WONDERMATH

Josel Abigail Ambon, Ioanna Elia and Haram Saouri - The Heritage Private School, Limassol, Cyprus

Have you ever wondered why Alice in Wonderland is so absurd? It always made us curious because of its peculiarity; Now that we have done our research we can say that this is because of all the mathematics hidden in the tale. Under the pseudonym Lewis Caroll, Charles Lutwidge Dodgson, a mathematician at Christ Church College in Oxford wrote the story of Alice in Wonderland. Dodgson being a stubbornly conservative mathematician in 19th century, made an attempt to satirise his colleagues' new ideas through his story.

In this magical tale full of wonder, Alice's knowledge of multiplication tables slips out of the base-10 number system while she is falling through the rabbit hole. In this erratic land we meet a very rational Caterpillar who is advising Alice to keep her "temper", meaning she should keep her body in proportion, no matter what her size was. Furthermore, we meet the Duchess whose baby is unfortunately transformed into a pig in the context of projective Geometry following Poncelet's continuity principle. Finally we attend a t-party where only the three terms of Hamilton's Quaternions are invited. Time is unfortunately absent hence the characters do not know when to stop moving around the table and enjoy their tea; and these are just some of the mesmerising hidden mathematics we would like to present. Let us take you on a new Adventure in Wondermath!

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AROUND THE WORLD IN... N FRACTALS

Martina Colosimo and Laura Cuda - Liceo Scientifico “Luigi Siciliani”, Catanzaro, Italy

Digital technologies are impacting all aspects of personal, social and professional life now, spreading out at an incredible speed. We should take into account all these changes also in the teaching and learning processes of mathematics, taking on new challenges and responsibilities. It is necessary that the new technologies (ICT) have a relevant role in the classroom to improve the educational approach to mathematics.
In our presentation, we combine together the theoretical contents of Iterated Function System (IFS) Fractals Theory (s.a.: affine transformations, matrices, some well-known fractals) with multimedial tools (Moovly, Maple, IFS kit software) in order to wander around the world, using fractal geometry.
A fractal is a mathematical set that exhibits a repeating pattern that displays at every scale.
In our work, we connect some fractal figures to the symbols of some countries; we use IFS fractals to represent the Eiffel Tower in Paris, the temples in Bagan, the Cathedral in Prague, the Cathedral in Milan and so on.
We present the codes of affine transformations of each fractals, in one case, we change the fractal codes to generate a new figure, for example the fractal for the temples in Bagan.
Fractals and codes are protagonists of the video we prepared (https://www.youtube.com/watch?v=YyNH-vZWYO4), which was selected and shown at the IMAGINARY CONFERENCE 2016
We would like our video to represent a symbol of peace and friendship in the world in the name of Mathematics.

MATH AND CARS; CONNECTION THAT MOVES THE WORLD

Borna Brlosic - Centar Izvrsnosti, Koprivnica, Croatia

A long time ago when Karl Benz has started to develop his first car he probably didn't think about the impact on the humanity that he and his patent will create. Today our lives are based on daily commutes to school, work, meetings etc. Cars and motorcycles became an important part of our lives.
Today, connection of mathematics and cars literally moves the world – our lives would be completely different if there was no cars, motorcycles and trucks which transport food from the fields to our closest store.
In this presentation, I will explain how the mathematics relates to the cars, from simple mathematical operations to complicated thermodynamics law that propels the engine, and how we can mathematically explain everything that is related to cars. From starting the engine, shifting the gears and accelerating during drive to fuel consumption and braking.

APPLICATION OF MATHEMATICS

Ena Omrcen-Ceko and Patricija Mihoci -Centar Izvrsnosti, Koprivnica, Croatia

The question that always bother us is: what is mathematics really?
We all know that mathematics is a science which is divided into branches like arithmetic, algebra, geometry, trigonometry...
But where is the connection between mathematics and our everyday life? Different kinds of functions are performed by mathematics. It works with numbers, counting, and numerical operations. Pupils can't avoid it. For example, we have math lessons every day of the week in
Croatian schools to learn mathematical operations which are necessary in our lives. We use a lots of math in life and people aren't even aware of it: in our kitchen, in stores, in banks… More math can be found in the kitchen than anywhere else. After all, recipes are really just mathematical algorithms or self-contained step-by-step sets of operations to be performed.
Finally, we conclude that we use a lots of math in our lives and it is one of the most important sciences. We can say that our everyday life depends on mathematics - with mathematics it is easier, interesting and creative, too.

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MATH IN VIDEO GAMES

Stjepan Delekovcan -Centar Izvrsnosti, Koprivnica, Croatia

When people play video games, most of them do not really think about how the game works. They just see good gameplay accompanied by good graphics that seem just to be drawings or objects, but what they do not think of is the math that goes into it. I am here to show you that.

Math has a really big role in the making of videogames. Except in the base of the game which is the code, math is also important in calculations such as car acceleration, bullet trajectory, ball bouncing, etc... Let's not forget about all the geometry that goes into game graphics. Different perspectives, shapes, models, just to name a few, all include math and are the core of the looks of a video game. There is a variety of different types of video games which all involve different physics, graphics and mechanics which are solved and coded using math to make the game both look and work well.

By playing video games and trying to understand how they work, you can learn math in a fun and motivating way and get a positive attitude towards maths. Video game development requires logic, combination and lots of math, so you can become a little developer and make your own games after you learn how it is done.

TELL ME WITH AN EQUATION

Jakov Dolenec and Andrija Njers - Centar Izvrsnosti, Koprivnica, Croatia

Can I work out the population of the place I live, 50 years from now? How fast does grass grow? What is the equation of love? These are just some of the many questions one could ask. Can mathematics provide answers? Of course it can. Although many think that maths has nothing to do with grass or love, we'll prove them wrong.

We'll even show the link between maths and football. In our presentation we'll demonstrate that these equations and mathematical rules really exist, and what they are. We'll show you how to calculate your savings in the bank, how long it takes to breed cattle, how many viruses there are around and how mathematicians draw the christmas tree. To illustrate our examples, we'll use a dynamic geometry program Geogebra.

Our examples will catch the eye even of those who don't like maths. We'll demonstrate the importance of using mathematics, and its beauty. Truly can we say: maths is all around.

MATHEMATICS AND MUSIC

Elizabeta Evacic -Centar Izvrsnosti, Koprivnica, Croatia

With all that sets them apart, all the objects have certain similarities, including mathematics and music.

As there are numbers in mathematics, there are notes in music.

Placing more than one number in parenthesis and identifying itself with a musical clock, a mathematical formula can be viewed as a combination of certain tones.

As the start of the song resembles on setting up a mathematical task, the end of the song represents the solved math problem.

Lots of people like to relax by listening to music and other by solving complex mathematical problems.

While mentioning similarities between mathematics and music, people cannot be left out because music is developed by top artists (composers, conductors, tenors) just like mathematics is developed by the greatest human minds for the benefit of all mankind.

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MATHEMATICS AND TECHNOLOGY

Fran Filipovic and Petar Socev - Centar Izvrsnosti, Koprivnica, Croatia

People often learn from nature. For example, whay does corn have so many layers? I think that's smart. And here's why.
When it is cold outisde I dress in several layers, just like corn. And it works. My father isolated house with few levels of materials and that works same just as well. We practically dressed our house.
This formula is very simple. We learnt from nature and took required methodes and resources from mathematics. A few calculations gave clear resaults. Of course, you must invest some money to begin with.
But in the end you will be satisfied. „Smart" house would lose less warmth, you'd need less energy and, of course, you will spend less money. In approximately 5 years investment will be returned. Our smart house is called „Smart and green". It is practically a system which protects nature because we use less gas. This means that we release less CO2 into the air.
Maths provided us with methodes and resources we couldn't do without. We can calculate everything we need for this project.
This is a very good plan that I want to distribute around the globe for everyone to save energy, help our planet and save some money.
In the end, you'll have some extra money to spare. For that money, you could visit Croatia and spent unforgettable holidays in a country with many islands and beautiful heritage.

MATHEMATICS IN CRIME SOLVING

Filip Jakupec - Centar Izvrsnosti, Koprivnica, Croatia

Mathematics in crime solving… but that is just pure logic and chemistry. Yes it is, but there is so much more mathematics in this then you actually think.
For example: a bank has been robbed, and 200.000$ have been stolen. The first thing that comes to my mind is to look for fingerprints. If there are some, then you take them to a crime lab and try to look for suspects in AFIS (a program used to find a person by their fingerprints). AFIS is based on mathematical operations of adding and subtracting points on the suspect's fingerprints. If there are any results, you look for that person to bring them down to the police station.
But that's too easy. Most of the times you won't be able to find fingerprints because they used gloves and no chance of facial recognition system because the robber/s wore masks. You have to look out for an another solution. There are traffic camers, and with help of counting you can find out where did the robbers flee to. After that it is just common logic to catch the bad guy.
As you can see, in crime solving, there is a lot of mathematics put into crime solving and catching the bad guy.

MATHEMATICS AND LIFE

Hana Rajtarić - Centar Izvrsnosti, Koprivnica, Croatia

In everyday life you can see mathematics everywhere around us. Math is very important and we use it every day. When you go to the store, chances are, you will use math. If you're intending to buy something, you need to know if you have the founds for it. After you pay, you need to check how much money the clerk returned you.
People use math in many different ways. For example, architects use math to draw the draft with all the measures, so they can allow interior designers to decorate the house inside. Math and architecture have always been related, whether it comes to building or just decorating a home.
During party organisation at home we have to calculate how much food and drink we will need and how much money we will spend. Some people´s job is to organize parties and during that they use a lot of math.
You want to travel, and for example you want to go to Zadar(Croatia), you need to calculate the expence of the trip. You can do that simply by using basic maths. In conclusion, math is very important part of our lives and it affects on our lives.

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MATHS IN SPORTS

Igor Vrdoljak - Centar Izvrsnosti, Koprivnica, Croatia

Sport does not consist only of the game, 60% of sport is maths. For example, in football we use subtraction and addition, in handball we measure meters and count points and fouls. In wrestling we add points and measure time and passivity.

There are also Olympics and sports like running where we measure time and distance. When football players want to pass the ball, computer measures the passing and decides was it good or bad. In football, as well as handball and basketball, we use lots of mathematical actions for calculations and assessments when shooting the goal or basket, and goalkeeping.

At the annual best player's awards, when coaches decide which player was the best in the previous year, they count medals, trophies and successes. There is a lot of maths and geometry in all kinds of sports.

MATHEMATICS AND MUSIC

Lana Zagorscak - Centar Izvrsnosti, Koprivnica, Croatia

Music writers use mathematics to understand music, and mathematicians use music in certain situations to improve their focus on computing. This presentation will give you a better insight into the relationship between Mathematics and Music.

Mathematics needs music and music needs mathematics. A case in point of such mutual reliance would be the mathematical symbol Pi (π), which is in fact a musical symbol for tones, as well as instrument keys and important parts of musical instruments. When it comes to the pulse in music, it is, essentially, a musical wave which marks tone pitch. However, the wave is produced by means of mathematics – computing, to be precise.

It goes without saying, mathematics uses the music language of tones, marks, vibrations and much more. The most important point of this, though, is that, „Mathematics is the basis of music." Naturally, mathematics is the beginning of everything, but it is most needed in music. To find out more about the intriguing connection between mathematics and music, we encourage you to watch and listen to our presentation.

RIEMANN AND THE MUSIC OF THE PRIMES

Enrica Barrilli - Liceo Scientifico "Luigi Siciliani", Catanzaro, Italy

Prime numbers are the "building blocks" of every number. The distribution of prime numbers throughout a list of integers leads to the emergence of many unanswered and partially answered questions.

In my presentation, the topic is Riemann's Hypothesis. The mathematician discovered that music could explain how to change Gauss's Graph into the Staircase Graph that really counted the primes. Riemann had found one very special imaginary landscape, generated by something called the Zeta Function, which he discovered held the secret to prime numbers.

The Prime Number Theorem (PNT) describes the asymptotic distribution of the prime numbers among the positive integers. It formalizes the intuitive idea that primes become less common as they become larger by precisely quantifying the rate at which this occurs. The theorem was proved independently by Jacques Hadamard and Charles Jean de la Vallée-Poussin in 1896 using ideas introduced by Bernhard Riemann (in particular, the Riemann zeta function).

Riemann's discovery represents a real triumph of the pattern searcher over the chaos Nature throws at us. Through Riemann's imaginary looking-glass world, the randomness of the primes is transformed into the order of these points at sea-level he was able to prove an important relationship between its zeros and the distribution of the prime numbers.

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THE PROOF OF COMPUTER DISCOVERED THEOREM ABOUT THE GIBERT POINT

Artyom Tiunelis - Haileybury Almaty, Almaty, Kazakhstan

Nobody can read all about his research theme, but machines are making discoveries in their own right by mining the scientific literature and now it is the most topical field in research.
The computer program “Discoverer”, created by Bulgarian mathematicians S. Grozdev and D. Dekov, is the first computer program, able easily to discover new theorems in mathematics, and possibly, the first computer program, discovered new knowledge in science.
The aim of our project is to mathematically prove the theorem, derived by “Discoverer” program, which stays: The Gibert Point lies on the circle defined by the Centroid, de Longchamps Point and Kosnita Point. Our prove used the Dergiades Method, which is based on barycentric coordinates.

MIQUEL’S POINT AND OTHER TRIANGLE CENTERS

Siel Rien Shefketova - Petko Rachov Slaveikov” Secondary School, Kardzhali, Bulgaria

In the following project we are looking at points, which have a specific property, connected to Miquel’s point – The three cevians go through a triangle center, from the cross points of the cevians with the sides of the triangle we build perpendiculars, which also intersect in a triangle center, which is Miquel’s point with Miquel’s angle being . A condition for that is that both Ceva’s and Carnot’s theorems have to hold true.
An author statement is formulated and proved, as is a corollary to it. Remarkable points from Clark Kimberling’s Encyclopedia of Triangle Centers, which fulfill the property are included. The points are checked using GeoGebra - orthocenter, centroid, Gergonne’s point, Nagel’s point, X(69), X(189), X(329).
Points fulfilling the property which are not included in Clark Kimberling’s Encyclopedia of Triangle Centers are found using other methods – Gergonne’s external points and Nagel’s external points.
Trilinear coordinates are to be studied in order to provide formal proof for the points checked via GeoGebra.

PASCAL’S TRIANGLE

Aleksa Pokrajac, Milos Basic, David Vogronic and Mirjana Jovanovic, Isidora Sekulic" Grammar School, Serbia

The paper before you presents the triangular array of the binomial coefficients (known as Pascal’s triangle), as well as its properties. In the Western world, it is named after French mathematician Blaise Pascal, although numerous other mathematicians had studied it centuries before him in India, Persia (Iran), China, Germany, and Italy.
The rows of Pascal's triangle are veiled with mathematical mysteries. Namely, apart from the triangle's most famous features - Binomial expansions and symmetry, there is a hidden pattern obtained by coloring only the odd numbers in it, which turns it into another famous triangle - the fractal called Sierpinski triangle. Also, it can be used in solving various combinatorial problems. We will do our best to try to reveal these mysteries to you.

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METHODS OF CONSTRUCTIONS IN SPACE BY MEANS OF COMPUTER TECHNOLOGIES

Assema Chaimardan - National Physics and Mathematics school (NPhMS), Almaty, Kazakhstan

This project is devoted to creating of automatically built solid geometry drawings and measurements of its parts. Project have been performed in the program “MathProject”, which was created by my supervisor Vladimir Zhuk. Program “MathProject” is the Windows application, which allows to construct interactive three-dimensional interactive drawings.

10 detailed algorithms of solving a range of different types of solid geometry problems were developed in the project. Moreover, there are around 20 three-dimensional drawings, which reveal the work of pre-written scripts.

Algorithms in this project were made up for that types of mathematical problems as: perpendicular recovery and calculation of that measure, calculation of length between two skew lines, measurement of dihedral angle and other difficult solid geometry problems. There is a possibility to type into the program relevant values to solve the specific problem in one of the following topics. Also program supports outputting complete solvation and step-by-step drawing.

This project aims at utilization in High Schools.

The main purpose of the projectis to help students who have any difficulties with solid geometry in school whose number is quite high. Project gives possibilities to observe the constructions from different sides, which improves students' perception. Project may be the first instrument in teaching elementary course of solid geometry.

BENFORD’S LAW AWAY TO DETECT BANKING FRAUD

Christos Tolis - Varvakeio Model High Secondary School, Athens, Greece

Finding a system which would enable the continuous detection of accounting frauds in companies, and more specifically, banks, may sound an easy task; in reality, however, it is a process which has to take into consideration several economic parameters, as well as mathematics. Thus, the question whether a method used by the authorities in order to uncover a company’s accounting frauds is effective has concerned economic analysts and mathematicians for years.

In 2012, however, there was made significant progress in this field. Mark J. Nigrini, Assistant Professor of Accounting at the West Virginia University, published a study, in which he stated and proved, through various examples of notable cases of accounting fraud in the business sector, that Benford’s law, “an observation about the frequency distribution of leading digits in real-life sets”, could be a valid way of detection.

In this paper, by taking Nigrini’s study into consideration, we are going to examine whether Benford’s law applies to accounting in the banking sector. More specifically, through the collection of accounting data of certain banks and the following control of the digits’ distribution in these numerical data, we will try to check whether they obey to Benford’s law. Finally, through the assessment of the results of this research, we are going to check the possibility whether Benford’s law is an accurate means of investigation for the detection of banking frauds.

HURST EXPONENT IN STOCK MARKETS

Petko Petkov Kazandzhiev - High School of Mathematics and Natural Sciences “Vassil Drumev”, Veliko Tarnovo, Bulgaria

This study expands on summaries of research related to the use of fractals in financial analysis. An algorithm is presented to calculate the Hurst exponent - one of the most popular methods in the fractal analysis of financial time series. Examples of each case arising from the computing of this exponent are shown. In practice, the Hurst exponent is used by various companies, in analyzing the course of their financial assets on the stock market. It is also used by traders on the stock exchanges for predicting future trends.

A program is written in C#, based on Visual Studio, which calculates the Hurst exponent after entering the number of observations and the prices themselves.

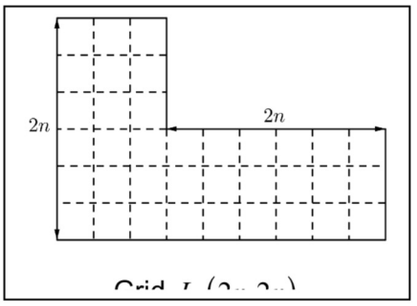
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DOMINO TILINGS AND PERFECT MATCHINGS IN GRAPHS

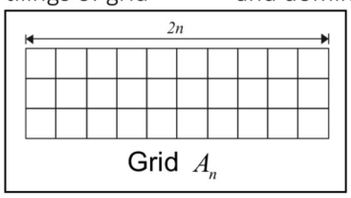
Tsvetelina Milkova Karamfilova - *Petko Rachov Slaveikov" Secondary School, Kardzhali, Bulgaria*

These are reviewed domino tilings of different types of square grids and perfect matchings of the graph grids.
There are derived formulas of domino tilings of strip grid with width three squares and a special grid $L_3(2n,2n)$:

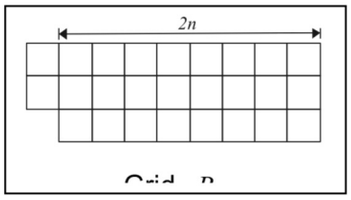
$$L_3(2n,2n)=\frac{1}{2\sqrt{3}}\left[\left(1+\sqrt{3}\right)\left(7+4\sqrt{3}\right)^n-\left(1-\sqrt{3}\right)\left(7-4\sqrt{3}\right)^n\right].$$



There is proven connection between the number of domino tilings of grid $3\times 2n$ and domino tilings of $L_3(2n,2n)$ exactly $L_3(2n,2n)=A_{2n}$. This formula is not included in The On-Line Encyclopedia of Integer - I received a new original result. This author's result was proposed as a new problem, which was approved by the editors and published recently in the Canadian journal Crux Mathematicorum, Vol. 42(3), 2016, Problem 4128.



Formulas for perfect matchings of the graph grids were bring out too. For graph grid



$C_4\times P_n$ I proved formula for perfect matchings

$$I_n=\frac{1}{6}\left(2+\sqrt{3}\right)^{n+1}+\frac{1}{6}\left(2-\sqrt{3}\right)^{n-1}+\frac{1}{3}(-1)^n.$$

I also proved that I_{2k} is perfect square and I_{2k-1} is doubled perfect square, I even **proved new unique connection between domino tilings of strip grid and of graph grid** $2\times 2\times n$: $I_{2k}=A_k^2$ and $I_{2k-1}=2B_k^2$.
For graph grid $C_3\times P_{2n}$ I also proved formula for perfect matchings

$$W_n=\frac{1}{14}\left[\left(7+\sqrt{21}\right)\left(\frac{5+\sqrt{21}}{2}\right)^n+\left(7-\sqrt{21}\right)\left(\frac{5-\sqrt{21}}{2}\right)^n\right].$$

SPECIAL CONCURRENCES IN MIXTILINEAR CIRCLE CONFIGURATION

Ana Maria Radu - International Computer High School of Bucharest, Romania

A mixtilinear circle of a triangle is tangent to two sides and to the circumcircle. In the past few years mixtilinear circles have appeared more and more in contests, olympiads and other activities. The purpose of this paper is to provide a closer examination of the configurations having these circles in the foreground. I study the configuration of the three mixtilinear incircles with their centers and important points on arcs. Moreover, I focus on the three small circles, each tangent to the mixtilinear incircle and the circumcircle of the triangle in its corresponding vertex. I obtain a significant number of interesting points of concurrency on the line joining the circumcenter and the incenter of a triangle.

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PROBABILITY AND WINNING LOTTERY

Mohammad Mostafa Ansari - Shahid Beheshti High School, Zanjan, Iran

A lottery is a form of gambling that involves the drawing of numbers for a prize. The aim of this paper is to explain the role of math rules in lottery and to calculate the chances of winning. In a simple 6-from-49 lottery Which a player chooses six numbers from 1 to 49 (no duplicates are allowed), If all six numbers on the player's ticket match those produced in the official drawing then the player is a jackpot winner. By a quick review of math we will show that the chance of winning is 1 in 13,983,816. The chances of winning are reduced even more by increasing the group from which numbers are drawn. Findings of this study reveal that a basic understanding of statistics and mathematics is enough to understand that lottery players are often losers.

MATHEMATICS AND PARADOXES – A RELATION OF LOVE AND HATE; MONTY HALL PARADOX

Irini Zouganaki, Petros Bentros, Pantelis Mexas, Panagiota Mouteveli, Elena Tziveleki, George Kavalieros, Maria Christina Mouzaki,Athena Mela and Petros Vrakopoulos - Zanneio Experimental Lyceum of Piraeus, Greece

The paradox concept is closely connected with the evolution of mathematics. Most often it gives rise to the creation of new notions and theories, while it leads to mathematical interpretations of the issue of which is related. Some of the most famous paradoxes consist of Zeno's, Galileo's and Russell's, which are closely related to the concept of infinity in mathematics. On the other hand, the existing mathematical theory is sufficient to interpret paradoxical situations, which are contrary to common sense, such as Monty Hall paradox.
In this paper we describe the paradoxes associated with the infinity while in addition we will focus on the Monty Hall paradox, analyzing in the process all the necessary mathematical background and showing, that the relationship between mathematics and paradoxes is a relationship of love and hate.

PROBABLE PARADOXES

Faidra Antoniadou, Jessica Lambert, Andreas Petrou and Christos Petrou - The GC School of Careers, Nicosia, Cyprus

Have you ever wondered why certain outcomes, although seemingly equally likely, are more probable to occur than others? Such occurrences can be explained through probability. Probability can be found everywhere, from the simplest decisions, to everyday life concepts and events.
For instance, when observing the heights of manmade and/or natural structures one may notice that the first integer is highly likely to be a smaller number, like 1. Known as Benford's Law this phenomenon has even aided in tracing fraud demonstrating the usefulness of probabilities.
Have you ever considered the probability of you sharing the same birthday with someone else in the same room? Surprisingly it occurs more often that one would expect. In a room of just 23 people there is a 50% chance of this happening.
Even in a simple riddle, probability is many times the key necessary to solve it. In the "100 Prisoners 100 boxes" riddle the escape of all prisoners, which originally seems an impossible feat, becomes feasible using probability by simply following a particular strategy.
Moreover, through the 'Monty Hall' example, one can understand the role of conditional probability behind a simple "switch or hold" question.
Often times what seems as a logical outcome to multiple events may very well be contradicted through the application of probability. As Claude Elwood Shannon once said:
'Information is the negative reciprocal value of probability'

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WIN THE GAME! – GAME THEORY

Egli Metaxa, Gregoris Georgiou, Glafkos Kronides and Kyriacos Rouvas
The GC School of Careers, Nicosia, Cyprus

Win Win Win!
Isn't success the purpose when playing the game of life? From a very young age we have always wanted to end up being the winners. Having in mind that the opponent also wants to dominate and always follows a strategy that benefits oneself, your victory depends on the opponent's decisions. The optimal situation for any player is when no matter the strategy of the opponent, your own strategy will lead you to being victorious.
This project is about the theory behind winning strategy games, while organizing our minds and our thoughts so that we always benefit from these dilemmas. Game theory, 'the study of mathematical models of conflict and co-operation between intelligent rational decision-makers', is the key to making successful decisions. In our research we look deeper into particular sectors of game theory. We introduce equilibrium and in particular the Nash equilibrium along with some of its developments. We look at the Prisoner's dilemma, Split and Steal game and the Bertrand economic model. With the aid of matrix tables and probabilities, difficult games and hard decisions are not a problem anymore!
These mathematical concepts are a life hack that can save you from difficult and complicated situations where negotiation or thorough planning is required.
'The concept of Nash Equilibrium is perhaps the most important idea in non-cooperative game theory.'- Peter Ordershook

WHY THE MUSIC AFFECTS US

Maja Juric, Joel Anicic and Karlo Andlovec - Prva Riječka Hrvatska Gimnazija, Frana Kurelca, Croatia

Science and music might look like completely two different things. Science studies regularities and facts while art deals with subjective experience and individuality. Still, science can be found in everything around us, hence also in the music.
The subject of this project is the connection of mathematics, physics, biology, chemistry with the music.
Music is an art whose medium is sound. Biology explains the physiology of the ear and the way we hear sounds. Sounds we can hear, but also see. It is described how the sound can display colours. Physics can help us to explain how the characteristics of wire affect the pitch which the wire produces.
If you ask the question, why we listen to music, we are likely to say that because of it, we feel good. However, besides it encourages us in a good mood, it improves the ability to focus on something, evokes creativity, improves memory...
But why the music affects us so?
All musical compositions possess certain mathematical structure, and these structures are described in the mathematical group theory. Group theory describes the ways in which sets of tones are connected and how they can be transformed from one to another. In this way, it helps the listener to hear music in a new way.

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MATH-MAGIC

Irene Andreou, Andreas Antoniou, Erica Christofi, Phivos Samuel and Louis Phidia
The English School of Nicosia, Cyprus

Mathematics, originating from the Greek word «μάθημα», meaning learning, is a profound way of understanding the natural world. Elegance, tinged with an element of surprise and sheer beauty, are words used since the eras of Newton to describe the marvel of the science of Mathematics. In a simple phrase, Mathematics is the cradle of all creations. We will take you on a journey from the late 1600's to modern times, showing you how Mathematics, being a world-wide understood language, has changed the world by searching for the shortest time path from A to B, or learning the magic behind the number 1089, or even predicting the state of a Thomson lamp after two minutes. No other science has ever done that. Therefore, our aim is to do just that and no less. Pay tribute to the evergreen Mathematics and its constituent fields of Calculus, Number Theory and Series respectively. By exploring the development of the idea behind the brachinstochrone and its applications to modern day surfing, aiding to break world records, we get a glimpse of how Newtonian Mathematics meet Euler and Lagrange in a magnificent blend of pure splendour. Furthermore, we discover why number theory has been misunderstood as magic with the example of "Magic 1089" that can be easily proved using simple algebra. Lastly, indulging in the grandeur of Grandi's series through a paradox about Thomson's lamp, the beauty of Mathematics can truly be conceived. The simplicity and avant-garde nature of Mathematics is what makes it so unique and special.

THE BLACK AND WHITE CHALLENGE

Agiostratitis Alexander, Dimopoulos Alexander, Koskinas Sotiris and Vasilopoulou Danae
The Moraitis School, Athens, Greece

In this paper we discuss the black and white challenge. This problem includes a rotating square that contains four square tiles. Each one of these tiles has two different sides, a black one and a white one. While being blindfolded, the player gives orders to a second person who executes the moves and rotates the square after each move. Which are the moves that the player has to do in order to achieve monochromy? Firstly, we present the factors that must be taken into consideration in order to answer the aforementioned question. Afterwards, we solve the problem both intuitively and by utilizing tools from Graph Theory. Lastly, we delve into some extra generalizations which emerged while we were working on the project.

INFINITY AND MATHEMATICAL PARADOXES

Alexiou Polyxeni, Dorkofikis Giannis, Zournatzis Thodoris, Kontomihalos Konstantinos and Konstantaropoulos Orestis - The Moraitis School, Athens, Greece

"Don't just sit there counting stars, they are infinite, you will never finish" is what we were told when we were young. "I love you infinitely" is one of the first phrases one hears from his parents. What is truly infinite?
In this paper we discuss the multifaceted and complex meaning of infinity, which we approach through various mathematical paradoxes: An imaginary hotel with infinite guests, which varies from other hotels, envisioned by David Hilbert, a bag which fits an infinite number of ping pong balls, a turtle that is so slow, but at the same time unapproachable, and a lamp capable of flashing on and off infinite times in a limited time span. All these paradoxes compose a journey to the most intricate but at the same time most attractive mathematical concept: infinity.

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GRAPH COLORING

Feidakis Leonidas, Melas Dimitrios, Papadopoulos Dimitrios and Sapountzis Nikolaos
The Moraitis School, Athens, Greece

This work focuses on the concept of Graph Coloring. We introduce the notion of the chromatic number and an algorithm that is used to calculate it in simple combinatorial problems that arise in Graph Theory. We analyze simple examples of graph coloring and present the proof for the five-color theorem. This theorem states that every planar graph can be colored by using at most five colors. In conclusion, the notorious four-color theorem, together with the controversy over it, is mentioned and an outline for its (difficult, 61-page, computer-assisted) proof is attempted.

INSTANT INSANITY

Sfyris Dimitris, Lymperopoulou Eleni, Vafea Alexandra and Christodoulou Erianna - The Moraitis School, Athens, Greece

Instant insanity is a puzzle, a mathematical problem which we present and solve. We are given four cubes, all sides of which are colored with different variations of the colors: red, blue, yellow and green. The goal is to place the cubes in a such a way in order to form a tower, so that all four visible sides maintain all four colors once. Are you capable of solving the puzzle without becoming instantly insane?
Indeed, one may be too lucky and solve it on the spot. However, luck is not what we seek; rather, a mathematical approach that guarantees a solution regardless of the initial configuration of the cubes.

SHORTEST PATH PROBLEM

Therianos Panos, Karakostas Philip, Kariotis Pavlos and Benopoulos Vassilis - The Moraitis School, Athens, Greece

Say it's a typical weekday and you are on your way to work or school. You probably follow a certain route you've grown used to. It usually gets you there on time, but often there are traffic jams and sometimes you are in a hurry and end up arriving late. You begin to wonder: what is the fastest way to get to my destination? Can I take a shortcut? How can I find the shortest route?
In this paper we examine algorithms that find the shortest path between predetermined locations. Through concrete examples and practical simplifications, we explain and analyze the most well known algorithms of said type. Moreover, we report on their applications in our everyday lives in various areas, which include navigation, telecommunications and data transfer. Thereby, we demonstrate their pervasive use in the modern world and the great value they hold across all scientific fields.

A SYLVESTER-GALLAI THEOREM FOR CIRCLES

Radoslaw Peszkowski and Andrzej Szablewski - Gimnazjum im. Jana Matejki, Zabierzów, Poland

The Sylvester-Gallai theorem is about configurations of points and lines. Sylvester asked a question at the end of 19th century and this question was answered by Gallai around 1944. The statement of the theorem is very simple: Given a set of points in the plane, either all points are collinear, i.e. they lie on a single line or there is a pair of points such that the line connecting them does not contain any other point from the set.
In a paper published in 2016, a group of mathematicians from Cracow proved the following generalization: Given a set points in the plane, either all points are contained in a conic or there are exactly 5 among these points such that there is only one conic passing through them and this conic does not contain any other point from the set.
We will present the following version of this generalization, which is much more elementary. Given a set of points in the plane, either all points are collinear or they are contained in a single circle or there exist three points such that the circle determined by these points (circumcircle of the triangle with vertices at the three given points) does not contain any other point from the set.

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FROM LO SHU THROUGH SUDOKU TO KEN KEN

Gabriela Walczowska - Gimnazjum im. Jana Matejki, Zabierzów, Poland

In my talk I will speak about magic squares. Apparently the first appearance of a 3 by 3 magic square is connected to an ancient Chinese legend about the Lo Shu turtle which emerged from the Yellow River with a very peculiar pattern on its shell.

I will present this legend briefly. Then I will pass to the Renaissance and speak about a magic square invented by a German artist and scientist Albrecht Duerer. Finally, I will show how magic squares come up in puzzles. Actually, this was the main motivation for my research. I like master mind like challenges and puzzles and I want to share my enthusiasm for them in my presentation.

ON PECULIAR PROPERTIES OF THE PASCAL TRIANGLE

Jan Dabrowski and Jan Wierzbicki - Gimnazjum im. Jana Matejki, Zabierzów, Poland

The Pascal triangle is a triangle consisting of numbers arranged in certain pattern. It is named after French philosopher and mathematician Blaise Pascal (1623-1662). The k-th number in the n-th row of the triangle we denote for simplicity and in order to honor Pascal by P(n,k). This number is exactly the binomial coefficient

$$P(n,k) = \binom{n}{k}$$

which counts how many subsets of k elements can be chosen from a set of n elements. There is the well-known formula:

$$P(n,k)=(P(n-1,k-1)+P(n-1,k),$$

which allows to build the triangle in a recursive way. The k-th entrance in the n-th row is the sum of the entrances (k-1) and k in the (n-1)-st row.

Playing with triangle and browsing through the literature, we have discovered that there is a big number of other very interesting properties of Pascal's triangle. In our presentation we will show some of them and encourage the audience to seek for more of them.

MATHEMATICS IN FOOTBALL

Eleni Demosthenous, Kyriaki Constantinou and Raphael Stavrides
Pascal English School & Pascal Greek School, Nicosia, Cyprus

Mathematics' concepts are the basis for almost all sports, including professional football. Applying mathematics in football, helps coaches to change the team's formation, find the "where the problems on his formation are" and rearrange the plan or even to invent a new football strategy. In addition to obtaining someone's performance throughout the year, several statistic aspects are applied, the same goes for team statistics throughout a year.

A question that many people ask is "wow, how does he bends the ball like that?". This is done by the magnus effect, where mechanics are applied, and specifically projectile motion. Projectile motion depends on several variables that many football players apply even without having any knowledge of what this is, because to score a goal they have to have these variables in mind.

Another aspect of mathematics that applies in football, is the probabilities, where goalkeepers work out to intercept a penalty and strikers bear in mind before deciding whether they should shoot or assist a teammate outside of a box.

Therefore this paper is focused on how mathematics makes a footballers' life easier. It is an analysis of the facts, "when to take the correct decision on how to shoot", "where to pass", "which is the best position to take when the ball is at different positions" and even to "deduce someone's individual stats and his overall performance".

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CHAOS GAME PRESENTATION OF GENE STRUCTURE

Panagiotis Paslis, Evangelia-Dafni Prifti, Tassos Ntouras and Filippos Raptakis
Varvakeio Model High School, Galatsi, Greece

How could mathematics correlate with genetics? In the branch of genetics, the decoding and study of DNA have always been of interest to the scientific community. DNA is the sequence of the nucleotides thymine (T), adenine (A), cytosine (C) and guanine (G). Irregularities in this sequence can cause many diseases in human body. For instance, the constant repetition of the triplet of nucleotides CAG is implicated in Huntington's disease. Nowadays, generally, only the standards of repetitions CAG, CCG, CGG, CTG and GAA have been related to the cause of many genetical diseases, especially neurological ones.
On the other hand, the science of mathematics could correlate to genetics with the help of Chaos theory. Chaos theory is the collection of results, methods and visual techniques, which are used for the study of potential systems. ''Fractals'', a category of Chaos theory, are geometric shapes that are repeated and can result from a formula, which states a mathematical, numerical or rational procedure or a combination of them. Their main characteristic is that they are complicated as regards to the figure and appear irregularities, compared to conventional geometrical shapes.
So, by utilising the Chaos theory and specifically the ''fractals'', we could represent and study the sequences of nucleotides in numerous diseases. In this specific project, we intend to study myotonic dystrophy, which is an autosomal dominant form of muscular dystrophy.

HOW BIG IS EARTH

Kontostoli Anastasia, Pantazopoulos Nikos and Raptis Aggelos - Nea Genia Ziridis School, Spata, Greece

How big is earth? Can you think of a way to measure such an enormous magnitude having no scientific instruments at all? The answer to this question has been around for almost 2500 years. However it is pretty interesting the fact that during that time, Earth was considered to be flat. In this paper, we will examine the method of measuring the circumference of earth, proposed by Eratosthenes 300 years BC. Eratosthenes was inspired by the sun's full reflection at a well. We will follow his historical footsteps as he measured in a specific day and time, the different shadow length of two sticks which were placed in two cities. Furthermore we will connect the contemporary methods used to measure the earth's circumference with the use of satellites and lasers. Last but not least we will attempt to prove that the accuracy of Eratosthenes method is impressive due to the fact that its result was almost the same as in modern calculations.

SUPERPOWERS DEBUNKED USING SCIENCE

Paulos Karagrigoris, Dafni Kampitsi, Eleftheria Maria and Myrto Gkritzapi
Nea Genia Ziridis School, Spata, Greece

We often ponder about the possibility of having a superpower. Wouldn't having the ability to fly or super strength make our lives a whole lot easier? On a first thought, yes it would. Just think about it, why wait in traffic when you can just fly soaring through the sky to get to your destination or being invisible and using this ability to enter any place on earth without repercussions. It might sound good on paper but once you start adding logic to the mix, the whole notion of superpowers actually becomes an inconvenience without any real benefits. In this paper, we are going to examine the science behind three superpowers. These are super senses, the ability to fly and invisibility. By the term "super senses", we mean that someone is able to hear, see, smell, and taste in a wider spectrum that normal people can, but it's surely not as dreamy as it sounds. Invisibility, which is pretty self-explanatory, has a serious prize that comes with it, blindness. Finally being able to fly is one of the primary powers, but the sky hides many dangers.

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MATHEMAGIC

Maria Christodoulou, Grigoria Fousteri, Christina-Ioanna Mania, Mary Petraki, Athena Rova and Alexandra Sotiriou - Nea Genia Ziridis School, Spata, Greece

Thinking about cards the first thing that comes to mind is games and gambling. Well, apart from that there is a whole other world that lies beneath these unexplored waters. This world is in correlation with logic and mathematical thinking. In our paper we will refer to the history of playing cards and all the mathematics behind mind boggling tricks. We will start by mentioning the origins of the names of all different suits and figures. Furthermore we are going to discuss the theory of possibilities behind cards and their never ending permutations. The core of our paper will be the detailed mathematical explanation of two magic tricks, the 27 card trick and the 44 card trick. We will attempt to demolish the illusion of magic and prove that mathematics is the reason hidden behind the magic curtain. Mathematics is hidden everywhere in the most unexpected places in our daily lives. The most important thing in order to develop critical thinking is to uncover and understand the omnipresence of mathematics. Shall we deal?

HOW SAFE IS YOUR EMAIL?

Tsalezas Theodoris and Tsintsilonis Antonis - Nea Genia Ziridis School, Spata, Greece

Many times we feel that all the information we share on the Internet is safe. But how can we be so sure? The answer lies in the art of Cryptography. In this paper, we will attempt to uncover the secrets of a technique that protects our data. The use of Cryptography seems to be almost primitive. The first ever example of Cryptography can be seen in a royal tomb in Egypt, around 1900 B.C. Cryptography has a strong connection with mathematics, as it includes various mathematical patterns. This can be supported by the fact that, people who decrypted the hardest cipher codes were mathematicians. What we will be examining is the connection of cryptography, through mathematics, with the need of encryption in the “world” of Emails. How can we be certain that our data will not be tampered with? Encryption is the best way to protect your online communications from the people who have malicious purposes. What emails use is known as “Public Key Cryptography”. In short, this creates “keys” with which Emails get decrypted by the receiver. The mathematical beauty behind this is that everything gets “translated into another language” through algebric algorithms. In the case of emails, this “translated” message gets decrypted by a “key”.

THE UNBEARABLE LIGHTNESS OF GRAVITY

Alevrogianni Despoina, Galanaki Georgia, Grigoriou Eudoxia, Grigoriou Katerina, Mavropoulou Natalia, Papadede Anna-Maria and Papaefthimiou Loukia - Nea Genia Ziridis School, Spata, Greece

Gravity or gravitation is a force that exists among all material objects in the universe. One of the main reasons that contribute to our existence is gravity. So someone could say that gravity is everywhere, it pulls on everything and it is something we can never escape from. In this paper we will explore what would happen if gravity suddenly switched off. What would unexpectedly happen to human beings, animals and the planet itself? How would the solar system look like? The world itself would not be the same without the existence of gravity let alone planet earth. In our research we will examine the training of Astronauts and Cosmonauts who lived for some months on ISS. As we can never escape from gravity on Earth there are some extraordinary ways for the astronauts training. Their experience on an environment without gravity will be our starting point in this attempt to describe how human life would be without the existence of gravity.

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DOUBTFUL STUDENTS: MATHS IS THE ANSWER

Daniele Diaco, Daniele Sorrentino and Martina Zerilli - Liceo Scientifico “Luigi Siciliani”, Catanzaro, Italy

Our project shows statistics,initially at a local leveland afterwards nationally, regarding the choice of university studies made by Italian students. Our work started from our desire to know how our predecessors made this difficult decision,since we are ourselves teenagers about to make this particular choice. Our analysis started from a survey carried out on a sample of students attending the fifth year of our school, Liceo Scientifico “Luigi Siciliani”, and then we searched for data on a wider scale, using national platforms such as Almalaurea. In particular, we took into consideration factors such as the school attended, the final school-leaving certificate mark and job opportunities. When we examined the trend of university preferences, we noticed some appreciable discrepancies, which could not but attract our attention. The aim of this project will therefore be that of creating a mathematical model,as realistic as possible for a group of young students,of the best university choice for each individual.

MATH MISTAKES IN HOLLYWOOD

Sofronis Michael and Petros Vassiliades - The English School of Nicosia, Cyprus

In this presentation, we will be counting three of the most hilarious mathematical mistakes in Hollywood. The three explained mistakes come from the animated comedy series The Simpsons where Homer gives a very interesting “parody” of Pythagoras’ Theorem, the world famous Christmas movie Home Alone in which the burglars should not have survived the traps, and finally the 6th addition in the highly recognised movie franchise Fast and Furious where a chase on a runway, including a plane moving at take-off speed lasts for 15 minutes. Clips from all movies will be added in order to visualise these mistakes and explain the details. In addition mistakes from other TV shows will be added. These honourable mentions include many miscalculations of Pi as well as other funny mathematical mess-ups on television. This will be done to increase awareness over how insignificant movie creators find mathematics in filmmaking, and to show that their mistakes do not go unnoticed.

MUSIC AND MATHEMATICS

Ana Maria Badea, Iulia Stoian and Ana Maria Cristina Ureche - Colegiul National "Vladimir Streinu", Italy

A renowned quote states that „mathematics is the music of rationality”. But what do these two sciences have in common? It’s a well known fact that listening to classical music leads to the improvement of one’s mathematical abilities, and, moreover, mastering some basic mathematical notions helps understanding the music theory. However, the bond these two share is much deeper.

Mathematics is the science of numbers and shapes, a science which emerged from men’s desire to understand and express the surrounding world. And as sound is a part of this world, it’s no wonder that mathematics can be used to describe or build this harmony of sounds named music.

Because this topic has always represented a challenge for us, we have decided to uncover its secrets and, indeed, what we’ve discovered is amazing. In a few words, we can say that there is no music without mathematics. If you, too, have a preference for this subject and want to find out more about the relationship between mathematics and music, you will have to attend our presentation.

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STUDENT PRESENTATIONS IN SCIENCE

THE MESSENGER OF LIGHT

Vrabie Andreea-Stefana, Ghilea Maria-Raluca, Covaci Tudor-Stefan and Zavate Teodor-Octav - Colegiul National "Calistrat Hogas", Romania

We live in a world enlightened everyday by people who strive for the new, the extraordinary. We believe that everything, from photosynthesis to solar energy, has at its core the most powerful form of energy: light. So I dare you to believe in our revolutionary concepts that broaden the spectrum of possibilities regarding the use of light. The first experiment aims to digitally communicate information from one computer to another via light transmitted by LEDs. The results are fascinating and we can assure you that, if developed correctly, they can shape a new way of communication in the future. Slotting in every part of our life, from schools and hospitals to airships and even spaceships, such an exciting and innovative project has endless opportunities lying ahead. The second experiment intends to send audio signal analogically using a laser beam. Not long ago, such an idea would have been considered magic, but now, by modulating the amplitude of the laser wave and reconstructing the signal with a solar panel, the means of communication could be forever changed. The two experiments differ greatly by analogical and digital means, but they have one goal in common: to push forward what was previously thought of as impossible and to demonstrate the unlimited opportunities that light can offer if used at its fullest potential.

COMPLEX SYSTEMS AND CHAOTIC DETEMINISM: BEYOND "BUTTERFLY EFFECT"

Annarita Battaglia, Eleonora Verbaro, Ilaria Verbaro and De Fazio Claudia, Liceo Scientifico "Luigi Siciliani", Catanzaro, Italy

The development of computer science has made possible to deepen the complex systems studies and to highlight some of their general features. The concept of complex systems regards physics, humanistic and social science as well as economy: for instance a gas ,a crowd, a flock of birds and economic transitions in financial markets are all examples of complex systems.
Despite differences, the systems show some common features in their evolution: unpredictability and chaos.
In the presentation ,starting from the deterministic systems, is introduced the concept of chaos and chaotic systems in order to prove that they show a sort of regularity described as "deterministic chaos". Moreover, some simulations of systems related to the sensitivity of initial conditions are shown.
The final part deals with the chaotic determinism that is related to the existence of "attractors" that cause the butterfly effect.

INSPIRED BY NATURE

Mario Tommaso Scerbo - Liceo Scientifico "Luigi Siciliani", Catanzaro, Romania

Since dawn, human beings, thanks to their intelligence, have been exploiting "Nature" not only to guarantee species preservation but also as source of inspiration for new knowledge , for mimic new behaviours, for inventing and creating new items, for new ideas and thought processes. The science of learning from animals and plants is called "Biomimicry". With scientific and technological progress biomimicry approach is increasingly spreading both to scientific/technological and social areas of interest.
Discovering animals and plants behaviours is always more frequently inspiring (not only) scientists towards huge everyday human problems solving as well as new technologies, processes and social organizations development. We can say that "Biomimicry" has already changed our life and will continue to do so.
In this work, after introducing "Biomimicry", I'll show you several applications regarding not only mathematics and informatics but technologies and human sciences too.

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AMARA – A NEW PUBLIC CRYPTOSYSTEM

Radosław Peszkowski and Andrzej Szablewski - Gimnazjum im. Jana Matejki w Zabierzowie, Zabierzow, Poland

In 2016 at the Euromath conference in Thessaloniki we presented a talk on a problem of bulbs wired in an unusual way with the switches (the material of that talk is available in the conference proceedings from 2016). We ended the talk pointing out a possible application of our considerations to building a cryptosystem. Over the year this possibility has turned into an application. It is available on the web page:
http://amarasystem.pl/
for the time being partly in Polish.
In our presentation we would like to explain the mathematics behind the cryptosystem and show how it works. In the times of increased invigilation, it might be a real way to maintain some privacy.

THE UNBEARABLE LIGHTNESS OF GRAVITY

Alevrogianni Despoina, Galanaki Georgia, Grigoriou Eudoxia, Grigoriou Katerina, Mavropoulou Natalia, Papadede Anna-Maria and Papaefthimiou Loukia - Nea Genia Ziridis School, Christoupoli, Spata, Greece

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PLANETAULA

Fabiana Pirozzi, Ilaria Calcagno, Ilaria Cirella, Sara Agovino, Carmine Galluccio,Viviana Iacuelli and Sabrina Tripaldelli - Institute State Institute Senior "Europa", Italy

On 23th november 2014, with Samantha Cristoforetti, the first woman in space, all us young dreamers, we have undertaken a trip that us shown the world in a new perspective. Also a little trip contributes to the growth of a person, and this adventure with Samantha makes us aware that anything is possible!!
This event has brought to light the question of what is beyond our planet?
to find the answers we have decided to create a space museum in this way, through mathematic formulas, scientific laws and an interdisciplinary work that embraces subjects like italian, mathematics, physics, geography and science of earth, Planetaula was born. It is an innovative classroom that allows us to immerse in that famous strip of planets in our solar system.

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