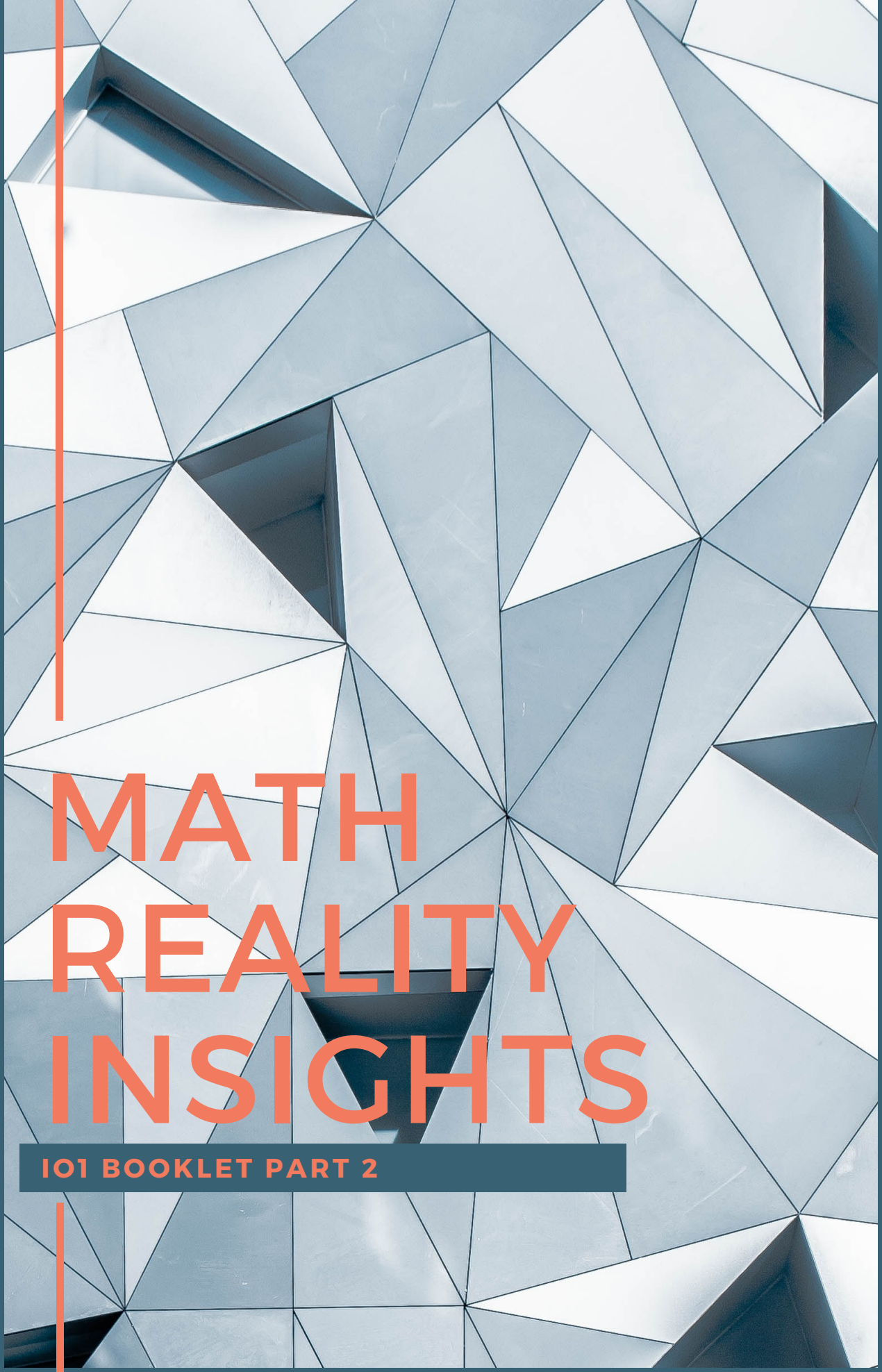

MATH REALITY INSIGHTS

IO1 BOOKLET PART 2

Math Reality

The only source of knowledge is experience

ALBERT EINSTEIN

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Introduction; What is the non-formal approach of teaching mathematics

Non-formal education: comprising an educational activity organised outside the formal system and designed to serve identifiable clientele and educational objectives

Coombs, Prosser and Ahmed, 1973

Non-formal education has several of the inherent characteristics of formal education, as they both share a commitment to learning and knowledge acquisition, thus being developed according to methodologically designed curriculum and scientifically sound resources. However, there are many points of non-convergence; the most obvious being that formal education takes place in a school building, while non-formal education can occur in any place that belongs to a community. Accordingly, non-formal education may use clubs, camps, group meetings, sporting or arts activities, or youth-led events for carrying out educational work, thus occurring in a variety of social and communal environments and in diverse forms.

"Democratic Education" through experiential learning

Non-formal education could be developmentally beneficial in various ways. As Van Horn, Flanagan and Thomson claim (1998) non-formal education promotes the experiential learning, the privilege of personal choice and it scatters different types of interpersonal relationships. Through the structured assignment of work, such as creative tasks and activities, young people are encouraged to take decisions related to the mode of working they prefer to be led to the successful absorption of knowledge, thus feeling flexible to extensively investigate their abilities and some of their emerging interests.

The basis of non-formal education underlines the connection of individuality with the community, in a way that all the activities may respond to the needs and demands of the individuals, but within the challenges that the social community itself calls for (Carver, 1998). In this sense the individual and the community have a mutual relationship of giving and taking.

Enfield (2001) also argues that the parameter of experiential learning nurtures the development of skills and knowledge, as it is designed in a fully engaging way that fosters both inter-personal skills and interactivity. He also claims that experiential learning boosts self-confidence within creativity and cultivates personal relationships in non-formal settings, not only between young people, but also among youth and adults. Additionally, research findings indicate that, apart from the cognitive level, non-formal methods of education 'foster positive youth development, regardless of the method, setting, or backgrounds of the youth involved (Russel, 2001).'

Under such experiential process, young people gain the opportunity to develop a series of soft skills -implying the possibility to explore personal skills, competences and values which are not always easily detectable within the educational framework of formal systems- such as: organizational management, teamwork, conflict management, 'planning, co-ordination and organizing', self-confidence and self-esteem, practicality, responsibility, leadership, sharpening of the ability to solve problems in a practical way, discipline, intercultural awareness and many other soft skillscorrelated with global education.

To conclude with, non-formal education seems to have a beneficial influence in four basic pillars that are interwoven with youth's life:

In personal development: it helps young people to emphasize their self-confidence and self-esteem, to realize their strengths and weaknesses, thus being encouraged to act outside the district limits of their comfort zone, as well as to discover the range of their abilities, gifts and talents;

In the development of active citizenship: it cultivates social skills and competences related to citizenship, as well as to the expression and understanding of different opinions in our increasingly diverse societies. It acquaints young people with important social and political concepts and structures, as well as with the duty of active and democratic participation;

In the abetment for employability: It is perhaps the best way to acquire the horizontal skills that the labour market requests: critical and creative thinking, initiative, problem solving, risk assessment, decision making, constructive management of emotions and resilience and;

Ways that Virtual Reality can change how we educate

Modern times demand modern educational methods. Virtual Reality, so far mostly used in the entertainment industry is making its place in the education sector aiming at providing a more immersive experience in the classroom. In many ways, it has a potential to transform the way students acquire knowledge.

There are many studies that consider visual experiences as very efficient to increase comprehension . By using VR, students are welcome to enter a new world where they can be transported into places they never saw before, experience objects from different dimensions and go from being passive recipients of information to become active participants. By different manipulations, they have a chance to receive an immediate result on their actions and be able to change a wrong decision by trying again. Experts believe that this can lead to an increase in the motivation for active engagement during the learning session .

The way VR can be applied in the classroom environment depends on many factors but when the hardware is available, the rest is up to the educators, their creative approach to the topic, knowledge about technicalities of the device, their facilitation skills and classroom setting.

Educating in an entertaining way

Students of all ages and educational levels are allowed to get engaged, as it provides various levels of complexity. Participants can “visit” places like a zoo, a laboratory, a park, the space, without leaving their classroom. The study of anatomy, zoology, geography and history are now more interactive and joyful. Virtual Reality offers students the unique opportunity to study the anatomy of the human body by seeing a “real” heart from a close distance and even “touch” it, learn about the rivers in Africa “walking” next to the Nile, study Australia’s fauna and flora by “visiting” Melbourne, exploring space as an astronaut and learn about history by “travelling back in time”.

1. Yildirim et al., 2018, Analysis of Use of Virtual Reality Technologies in History Education: A Case Study, Asian Journal of Education and Training Vol. 4, No. 2, 62-69, 2018
2. Pantelidis, 2010, Reasons to Use Virtual Reality in Education and Training Courses and a Model to Determine When to Use Virtual Reality, Journal: Themes in Science and Technology Education

Facilitate easier understanding of complex concepts

When using VR methods, students are more attentive, interact with the environment, increase their creativity as they construct a three dimensional world, have a close-up examination of the objects, discover new areas, participate in a detailed study of the object both from a close and long distance where they can study and observe the whole process. Virtual Reality acts as an additional tool to vocabulary building and awareness of sentence structure, providing a diverse learning environment and eliminating distraction.

Create chances for embracing empathy

Values like empathy and kindness can be enhanced, given that students are able to gain new perspectives, by putting themselves in the position of a parent, a teacher, an elderly person or people in need. In addition, critical thinking can be increased when participating in interactive videos, having to make important decisions regarding the flow of a story. Furthermore, VR can be applied for students' professional orientation, allowing them to "visit" professional places and get familiar with the environment.

Possibility to overcome some barriers

Another important use of Virtual Reality is for students with disabilities, as it allows to overcome different physical limitations, provides a safe experience and a personalized training. Virtual Reality could offer students with disabilities the chance to participate in activities and experience movements like climbing, swimming or running, not possible for them in real life. Getting familiarized with a new place before visiting it and practise the planned route can reduce anxiety and also increase safety by informing the students regarding the safe behavior in the street.

To conclude: pedagogical innovation should equip learners with the skills and competencies to function in a digital culture and digital literacy is considered as one of the key skills of 21-century pedagogy. That requires different ways of not only learning but also teaching. VR should not replace face to face teaching methods. In the project we believe it is more of a transition from a lecture model to a methods where the role of teacher evolves to be a mentor, guide, facilitator and even a designer of the content. In the MathReality project we take that matter very seriously as the partners will be in constant testing and evaluation process with the educators who will co-create the lesson scenarios.

10 Fun Mathematical Facts

Mathematics sucks. Mathematics is hard and it is useless..

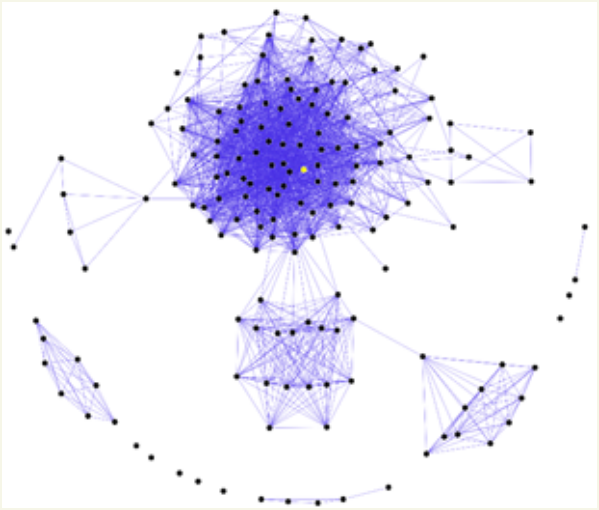
Here are the sentences we can hear every day about mathematics, a discipline that is so important! And so much fun if you take the time to take a closer look.

In La Maison de Fermat in the South of France, and in many math spaces like this one, we are trying to change the way young (and not so young) people look at mathematics. We are developing another idea of math... and that vision is much more fun!

Here is the proof with 10 amazing facts seen with another look at mathematics!

1/ My friend Cédric Villani

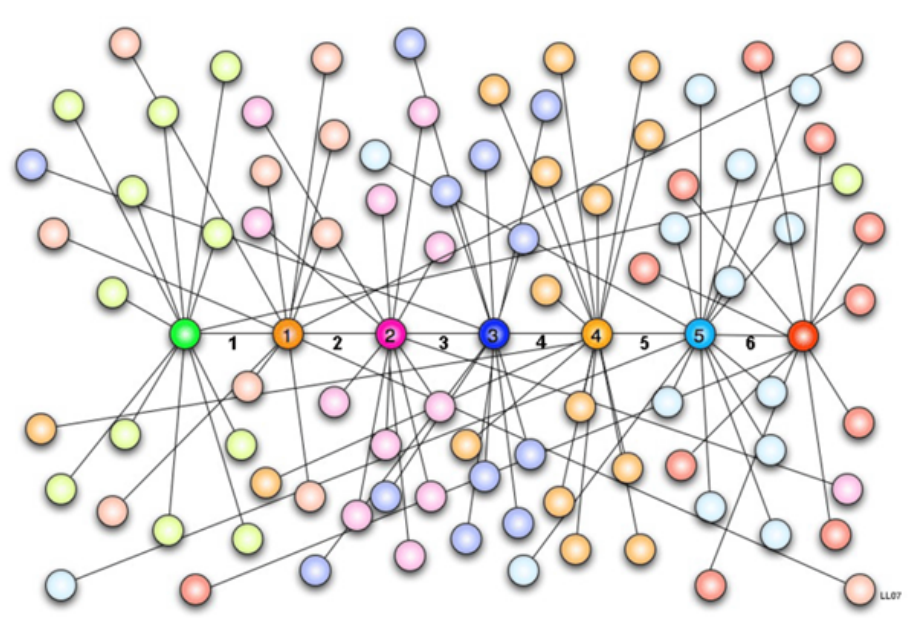
For mathematicians, social networks can be represented by giant graphs (a graph is a diagram containing points called vertices, connected or not by segments called edges or links). There can be hundreds of millions of vertices (profiles) and links (friends).



A fictional social network diagram. It consists of 165 vertices and 1851 edges. [Source https://en.wikipedia.org/]

Many mathematicians have been interested in the density of exchanges, the popularity or not of certain accounts... They have seen that all social networks work in the same way. A majority of people have few (friends) links and a minority has many. Moreover, and this seems logical, two people who have a common friend will have a better chance of becoming friends in turn. That's why your favorite social network often suggests friends of friends. All this is calculated....

Another theory related to networks is the theory of six degrees of separation, established by the Hungarian Frigyes Karinthy in 1929, which evokes the possibility that any person on Earth can be connected to any other person, through a chain of individual relationships comprising at most five other people.



Artistic visualization of the Six Degrees of Separation principle [Source https://fr.wikipedia.org/]

With the development of social networks, this degree of separation was measured at 4.74 on Facebook in 2011 and around 3.5 degrees in 2016. The latest study was conducted following the exchange of several billion instant messages studied in 2008 by Eric Horvitz and Jure Leskovec, researchers at Microsoft.

This theory is most effectively used on the LinkedIn professional network which reports the degree of separation between two individuals as well as the possible "paths" that connect one individual to another through their respective relational networks.

2/ Holy π !

Pi, sometimes called Archimedes' constant, is a number represented by the lower-case Greek letter of the same name: π. The use of this Greek letter π, the first letter of περίμετρος ("perimeter" in ancient Greek), did not appear until the 18th century. Previously, its value was referred to by various periphrases as the "constant of the circle" or its equivalent in various languages.
This constant is found in everything that is round or animated by a circular movement. It's up to you to check it out! Take any round object, such as a plate or bicycle wheel, measure its circumference and then its diameter. Divide the circumference by its diameter, you will get a little more than 3, and more precisely π.

3/ Gauss and mental calculation

Gauss

Nicknamed the Prince of Mathematicians, Carl Friedrich Gauss studied all fields of mathematics and contributed to the development of most branches of science.
A child prodigy, it is said that he was able to read and count from the age of three and it is also said that he demonstrated a remarkable talent for mental calculation. On a school day, his teacher asked him to calculate the sum of the numbers from 1 to 100. After a very short time, the then 10-year-old Gauss gave the answer to this complex operation using a technique that consisted in grouping the extreme terms in pairs. Without knowing it yet, Gauss had discovered the formula for calculating the sum of the terms of an arithmetic sequence.

He did:

(1 + 100)

+ (2 + 99)

+ (3 + 98)

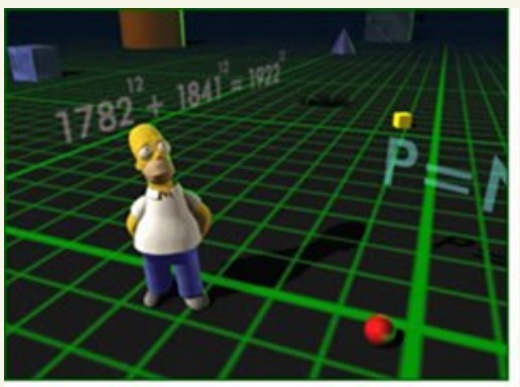
+ ...

+ (50 + 51)

= 101 x 50 = 5 050

4/ Simpson and Fermat

In one of the Simpsons' episodes, we can see an equality that will recall a famous theorem of the mathematician Pierre Fermat:



1782 + 1841 = 1922

In mathematics, and more precisely in number theory, the last Fermat theorem, or great Fermat theorem, or since its demonstration Fermat-Wiles theorem, is stated as follows:

There are no strictly positive integers x, y and z such that x n + y n = z n as soon as n is an integer strictly greater than 2.

Would Homer have demonstrated otherwise?

Of course not! But, strangely enough, if we try to prove this equality with our calculator, we see that it is correct... What happens then?
Quite simply the numbers are so large that the calculator will round them off... Indeed, these two numbers (the sum of (1782 + 1841) then 1922) have their first eight identical digits but are not equal!

5/ Google

Some numbers are so large that we have difficulty imagining them. Googol for example is a number equal to 1 followed by 100 zeros (or 10100). The word googol is first mentioned by the American mathematician Edward Kasner in his book Mathematics and the Imagination published in 1938. Kasner is said to have asked his nephew, then 9 years old, to baptize the number he had just created. He would have simply replied: "Googol".

Gogol is explicitly claimed by Google's founders as a model for their company's name: "Google chose this term to symbolize its mission: to organize the immense volume of information available on the Web. ».

6/ Birthday Paradox

If you put 23 people in a room, there is a 50% chance that 2 of them share the same birthday... The birthday paradox results from the probabilistic estimate of the number of people that must be gathered to have at least a one in two chance that two people in this group have their birthday on the same day. It so happens that this number is 23, which shocks the intuition a little. From a group of 57 people, the probability is greater than 99%.
This is a paradox not in the sense of a logical contradiction, but in the sense that it is a mathematical truth that contradicts intuition: most people believe that this probability is much lower than 50%. This study is by Richard von Mises.

7/ Pringles and maths

Pringles [Source https://fr.m.wikipedia.org/]

The particular shape of these chips has been designed from a supercomputer. Especially to keep the chips from flying... From flying?

Indeed, during their manufacture, the chips used a conveyor belt. To increase production, the speed of this conveyor had to be increased and the chips started to fly away. So engineers looked into the issue, and using a supercomputer, a form of hyperbolic paraboloid was developed to solve the problem.

8/ Long live queens and kings!

IHow likely is it to find the bean when cutting a cake of kings? Mathematicians have tried to clarify this question!

For this probability calculation, the following hypotheses were considered: guests (8 precisely) equally share a 25 cm diameter cake with a circular bean 2.5 cm in diameter. It should also be remembered that the position of the bean has a very strong influence on the probability of finding it when the cake is cut. Indeed, if the bean is in the center of the cake, the person who cuts it is sure to find it.
After a careful calculation, and taking into account these hypotheses, it has been demonstrated that there is at least a 1 in 4 chance of finding the bean by cutting the cake for these dimensions.
That's why we come across it so often!

9/ Get into the round!

Whether there are 10, 100 or 1000 of us in a round, everyone has to move back 28 cm to add a person to a circle... Really?

Instinctively, there is a tendency to believe that adding a person to a circle of 1000 people will only make each person move back a few millimetres so that they have their place in the circle. However, this is not the case because the perimeter and radius of the circle are proportional: $P = 2 * \pi * R$

So if we change the perimeter by 1.75 m (which is approximately the size of a man), we must change the radius by $1.75/(2 * \pi)$ or approximately 0.28m so that the circle remains homogeneous.

10/ A question of form...

It is no coincidence that the manhole covers are round. This choice is linked to security reasons.
By giving it this shape and a slightly larger diameter than the hole, its designers have ensured that it cannot physically fall into the hole.
A square, rectangular or triangular plate could not have offered the same guarantees, as it could have fallen into the hole by its diagonal.

Find all this information and more in the articles below (in French):

1. https://fr.spontex.org/le_saviez_vous/
2. http://www.motivationfactory.com/blog/innovation/belle-histoire-pringles
3. https://www.cnews.fr/racines/2014-09-02/pourquoi-les-plaques-degout-sont-elles-de-forme-ronde-690604
4. https://www.wellcom.fr/wnews/2011/12/la-fin-du-six-degres-de-separation/]
5. https://www.maths-et-tiques.fr/
6. https://www.babelio.com/livres/Louart-Cest-mathematique-/616675
7. http://www.topito.com/top-fun-fact-mathematiques-cool

Let's indulge in the concept of non-formal mathematics

Math Reality Project is seeking to transfer non-formal math scenarios and activities into the virtual world, primarily through the creation of virtual reality tools which will be applied in parallel with the official math curricula in all the six partner countries, namely France, Belgium, Cyprus, Italy, Croatia and Romania.

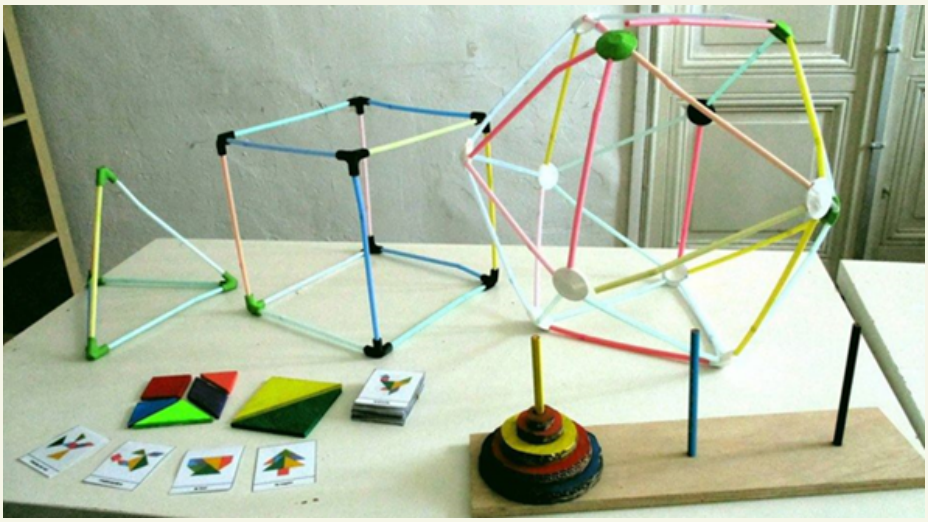
Accordingly, before the official launch of the virtual tools, which will arise as a part of the project derivatives and which will be free of charge for anyone who would be willing to use them, let's indulge in the concept of non-formal mathematics; inasmuch, by indulging in the term of non-formal mathematics, one would be capable of comprehending in depth the alternative way in which Math Reality's VR tools will be approaching mathematical theories and concepts.

Let's start by providing the official definition of the term; according to Coombs, Prosser and Ahmed (1973) who had been of the firsts who attempted to approach the concept, non-formal education refers to any "educational activity organised outside the formal system and designed to serve identifiable clientele and educational objectives".

Consequently, non-formal education has several of the inherent characteristics of formal education, as they both share a commitment to learning and knowledge acquisition, thus being developed according to methodologically designed curriculum and scientifically sound resources. However, there are many points of non-convergence; the most obvious is the fact that formal education takes place in a school building, while non-formal education occurs in any place that belongs to a community, without any limitations in terms of spatial nor temporal axes.

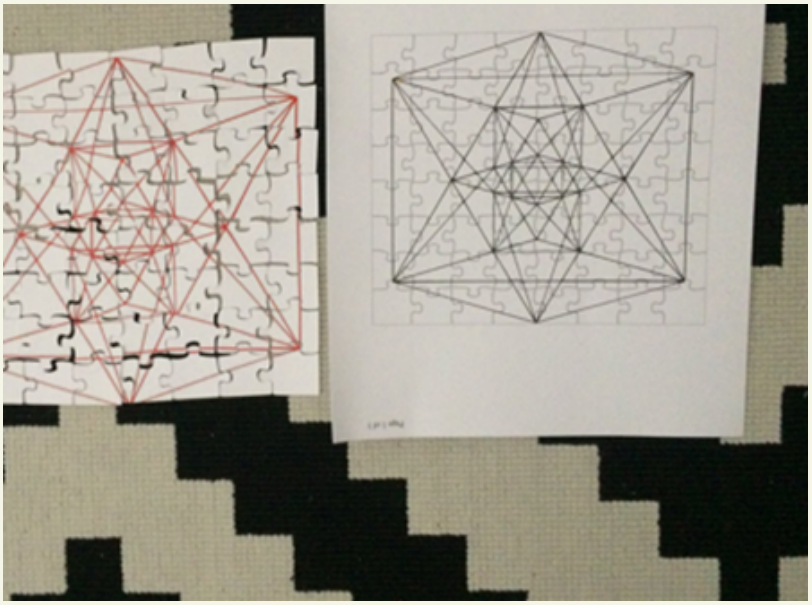
Non-formal education could be developmentally beneficial in various ways. As Van Horn, Flanagan and Thomson first claimed (1998), non-formal education promotes the experiential learning, the privilege of personal choice and it scatters different types of interpersonal relationships. Through the structured assignment of work, such as creative tasks and activities, young people, but also adults, are encouraged to take decisions related to the mode of working they prefer to be led to the successful absorption of knowledge, thus feeling flexible to extensively investigate their abilities and some of their emerging interests.

It is also proven that non-formal education has a beneficial influence in basic pillars that are interwoven with youth's and adults' life: such as personal development; reinforcement of active citizenship; abatement of unemployability, and; formation of more human societies.



The effective teaching of mathematics includes the use of various teaching methods. There is a consensus that certain methods such as problem-based learning, investigation and contextualization are particularly effective in achieving results and improving students' attitudes towards mathematics. Although most central authorities in Europe say they provide some guidance on how to teach mathematics, there is a need to strengthen support for methods that encourage active student participation and critical thinking.

At present, many studies reaffirm the idea that non-formal mathematics can provide a basis on which learners can rely to build more sophisticated mathematical knowledge; the classroom activities should allow the learner to experiment with a plurality of mathematical situations, tools and concepts that make explicit the links between the mathematics of everyday life and those developed in school.



With non-formal mathematics, the learner is at the heart of learning: he discovers, manipulates and models. They can be based on individual and group learning as part of an overall collective approach, they are participatory and learner-based, they are action and experience-based. Non-formal mathematics can therefore demystify math in order to give it a taste from an early age and, therefore, encourage STEM (Science, Technology, Engineering and Mathematics) to contribute to the economic development of our countries.

LEARN MORE

If you are a math/science educator or student and you would like to learn more about various ramifications of non-formal mathematics, stay tuned with “Math Reality” website, as well as with the official communication channels; we will very soon launch the finalised version of our Pedagogical Guide “VR for Mathematics”. The guide, specifically customized for math/stem educators, but also easily readable for anyone who is interested in such topics, will be elaborating on the following:

- **The Non-Formal Approach of teaching Mathematics**

What's the non-formal approach of teaching mathematics; tools for learning in non-formal education; successful examples of non-formal tools related to mathematics which could be incorporated to the official math curricula; how to DIY Non-Formal Math.

- **Integrating VR Technology into the Non-Formal Approach of Teaching Mathematics**

-Modern technological innovations that are currently being used; new perspectives and possibilities that VR Technology could bring to mathematical non-formal scenarios.

- **Pedagogical aspects of VR technology**

-What makes a VR Math tool pedagogical; properties and criteria; the most powerful VR Math tools/games that are currently being used within different educational contexts.

- **Practicalities of using combined non-formal approach and VR technological innovations for mathematics in the classroom**

A practical guide on how to create lesson scenarios:

-How to select the topic along with the mathematical concept(s)?
-Which topics-concepts are suitable and why?
-How to embed the topic along with the math concept into a non-formal scenario?
-How to introduce innovative technologies and already existing VR Math applications into the non-formal scenario you have created?
-Media and Techniques which could reinforce the educational process.

A practical guide on how to create a progress timeline:

-Possibilities that the educator has as regards the structure of the lesson (lesson plan) that includes VR technologies and the order of presenting all the material which contains VR applications

Being someone else: VR as an “empathy machine”

Virtual Reality can surely change how we see the world around us: the experience of being deeply immersed in a totally different environment, deciding what to do and where to go, talking and feeling other people as though they are real, can stimulate empathy.
In fact, one of VR's key strengths is the chance to be in someone else's shoes: starting from this idea, some researchers have studied if VR experience could be more impactful than simple imagination.

Becoming Homeless

One of the most interesting studies about this subject was led by Stanford’s Virtual Human Interaction Lab, and it is called “Becoming Homeless”. In this experiment there are many interactive VR scenarios, simulating what would happen if someone had lost their job, such as selecting which items should be sold in order to pay the rent, finding a shelter on a public bus and protecting their belongings from a thief.
This study found that people who underwent this experiment were more likely to be empathetic towards homeless than people who just read a narrative or interacted with a 2D version of the scenario on a PC.
This would suggest that taking someone else's point of view produces more empathy than reading or imagining what it would be like to be someone else.

The first step of “Becoming Homeless” - an eviction notice.
(https://vhil.stanford.edu/becominghomeless/)

What if I were a toddler...

Have you ever thought about why a toddler cries? Passig, Klein and Neuman tried to simulate a toddler's experience during the very first days in daycare, developing a virtual world by toddler's point of view, in order to test caregivers' awareness of the cognitive experiences that the toddler lives. Results says that "being a toddler" for at least 10 minutes significantly improved caregivers' awareness.

... a dsyelctic pupil...

In 2005, Shavit led a study about the use of Virtual Reality in order to improve teachers' awareness of the cognitive experiences dyslectic pupils encounters while trying to read. Some teachers were immersed in ten different worlds, each one simulating different grades of dyslexia, while another group of teachers watched a film on the same subject.
At the end of the experiment, the former group had great improvement in understanding dyslectic pupils' cognitive experiences than the latter.

... or a refugee?

Charities and government agencies uses Virtual Reality for their campaigns: one of the most successful examples is VR film Clouds over Sidra, the story of a 12 year old girl who has lived in the Za'atari Refugee Camp in Jordan since the summer of 2013. It is the first film shot in VR for the United Nations, in order to generate empathy and to show everyone about the conditions of great vulnerability of people who live there.
Thanks to VR experience, everyone can feel on their skin how life in a refugee camp is: by thanks to this film, translated into 15 languages and screened by UNICEF face-to-face fundraisers in different countries, donations were doubled.

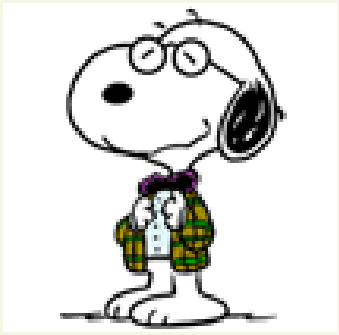
(courtesy of unvr.sdgactioncampaign.org/cloudsoversidra/#.XSy8kfZuJPY)

VR and empathy: conclusions

Much more research needs to be done before anyone can say for certain if VR is the best media at inspiring empathy: anyway, if we are open-hearted and open-minded while using VR, then we can recognize someone else's feelings in a deeper way, compared to other media. The biggest (and most important) result, however, is how people will act after taking the VR googles off: early research suggests that VR produces long-lasting effects, such as motivating positive social behaviors (donating, volunteering, or cooperating with others). If confirmed, this would mean that VR could be really be the “empathy machine” someone speaks about.

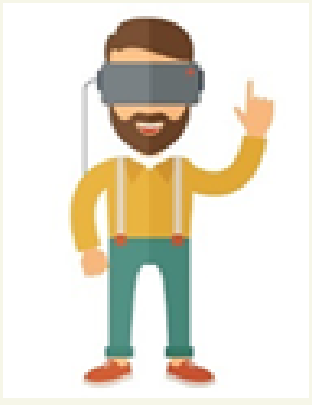
“Good teaching is 1/4 preparation and 3/4 theater.” - Gail Godwin

Teachers are no longer surprised when they see how the students can easily focus their attention on their smartphones or other gadgets instead of keeping tabs on the lesson. And it must be pretty challenging to compete with such new technology whilst teaching through methods that have been around for hundreds of years... but things are beginning to change. Even for maths teachers.



Extraordinary teachers do it all: they will educate, teach, create, model and change. Teaching has far exceeded its classical definition, as it has now become a form of art, one that requires teachers to be widely skilled, with an enormous capability to adapt to all kinds of learners. The world we live in is constantly changing and we have to adjust at a very fast pace. The way we teach will have great influence on the way our students perceive all the important things in life.

During a regular lesson, the teacher will often be the controller, the prompter, the resource, the assessor, the organizer, the participant and the tutor. During a lesson that contains virtual reality, the teacher will also need to be all those, but more of a perfect organizer and an observer. Once you choose virtual reality to be part of your lesson, you should be able to put teaching aside somehow and allow the students to learn on their own, to discover information through the alternative reality they have access to.

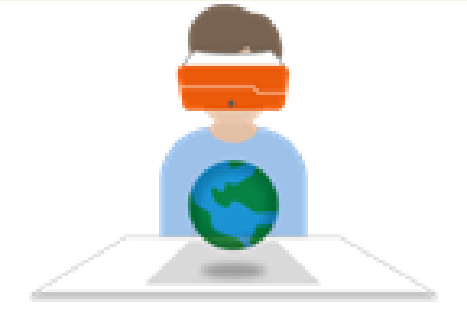


As organizers, the teachers that include virtual reality in their classes will need to prepare everything to the smallest detail, as their goal is to introduce students to a completely new classroom environment. First of all, the room used for these lessons must comply with all the standards required by the manufacturers of the devices, making sure that using them will not have any harmful consequences on the students or the teachers. . The first lessons may be a bit less rewarding because students will need time to understand the devices they are working with and the rules they have to follow in order to use them in complete safety.

Therefore, the teacher should make sure that students are aware of the risks resulted from using such devices. Also, the teacher should try to channel his/her attention to every move the students make, anticipate what could happen and always be prepared to react to it.

As observers, the teachers using VR should pay attention to the students' needs and the pace they learn through this method. For example, if some students find it easier to acquire information or to understand how the device and the software work, they should be provided with extra material. Opposite to those will be the ones finding it difficult to deal with the new methods and the teacher should try to identify them too and find alternative tasks for them to do until they are able to keep up with the others.

In the end, teachers will be teachers, no matter the method and the devices they use while teaching, as their job will always be about catering to every student's needs, trying to get the best out of a multitude of learner types and skills. But we have to agree on one thing: if done properly, the Virtual Reality will revolutionize teaching and learning at the same time

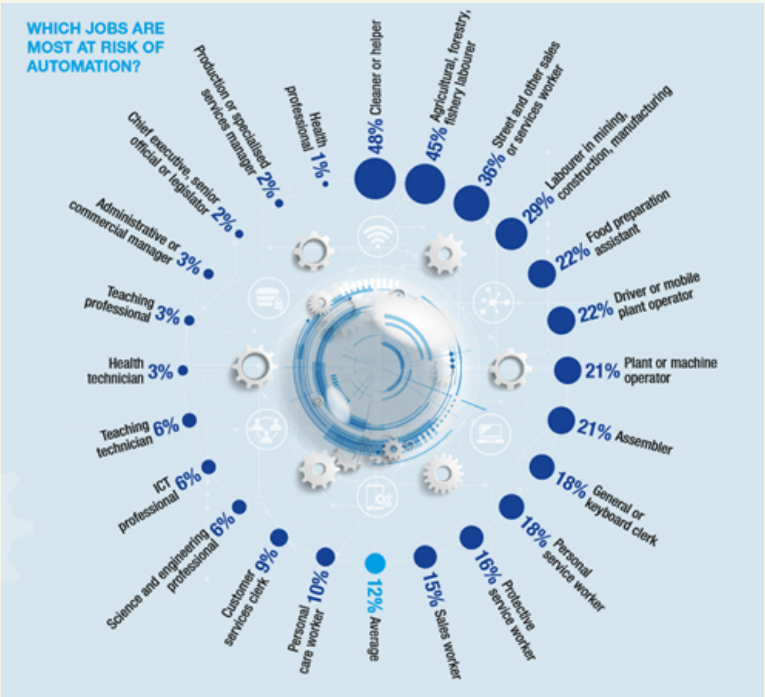


How virtual reality affects education

We are aware of the speed of ICT development and its impact on development of our society. Technology is integrated in a great number of everyday activities. New technologies enable us to communicate faster and more easily, they open doors to millions of pieces of information and make our lives easier. Today`s students use technology that changes their habits on a daily basis. It changes the way of life and actions of the whole society, and so it does for the new generations of students. Therefore it needs to be integrated in education.

Today, students can reach information anytime, anywhere; it is just „a click away". Teachers are no longer the main source of information. But the question that arises is whether the studens can find the relevant information and if they know how to use it? What is the right way to teach new generations of students and how to train them in skills needed in the 21st century? What are the jobs they will actually do in the future?

Research shows that 60% of students who are just starting their education will perform jobs in the future which don`t even exist today. The world they will live in will surely be much different than today`s world, the existing jobs will change. As advances in technology create new job opportunities, on the other hand some jobs are disappearing as a consequence of development of technology and automatization of the process.



Source: https://www.cedefop.europa.eu/files/9129_en.pdf

Technology and social trends have influence on education. It has to adapt to the needs and interests of the 21st century students, which means: using ICT and new ways of learning – communication and collaboration, and influencing the 21st century skills development – creativity and ability to adapt to changes quickly.

Integration of VR technology into education brings new and wide possibilities, but also changes the role of the teacher, who becomes the organizer of the learning process with multimedia as a tool that enables the him/her to create interactive learning environment focused on the students. VR technology can be included in everyday teaching and can be used sa a tool to enhance teaching of almost all subjects. They become more lifelike and lessons are better and more interesting. VR makes learning from experience possible.

Why should students read about something in books, without being able to visualize and understand the main point, when VR makes it possible for them to see, experience and immediately understand and remember how things work in real life, which is the best way of learning because human brain can remember only 10% of what we read, 20% of what we hear, and 90% of what we experience. This enables the students to try different things and thus find out what they are really interested in.

By using VR technology in teaching and by new styles of learning, students develop creativity, independence and critical thinking. VR simulations enable the students to understand the subject more deeply and use the knowledge later in life, while VR technology in teaching motivates students to learn. However, it is clear that students should not only be entertained, but also actively included in learning which produces long term results and prepares students for fast changes and jobs of the 21st century.

Mathematics and learning disorders

Math is a very concrete and exact subject. If you ask a child to tell you how much is 7 plus 3, the answer can't be approximated, it has to be very precise to give the right answer. You are either right, or either wrong. And usually, children don't get point for being almost right. So, more than any other object, math is causing anxiety because of the fear to be wrong, the fear of negative evaluation.

Because it is a "cumulative subject" (Brian Butterworth) knowledge is constructed so the new information is based and linked to the previous one. If you skip some content, the following one is less accessible. Making sustained progress in learning math is a very challenging process for people with Specific Learning Disorders.

The SLD are named Specific Learning Disorders because they are not the consequence of visual, hearing, or motor disabilities, nor mental retardation, emotional disturbance, or environmental, cultural, or economic disadvantage. They can affect cognitive development of one or more ability such as speaking, reading, writing, doing mathematic, plan and coordinate motor task.

The SLD do not have a cause determined by:

- Physical disabilities
- Mental disability or developmental delays
- Psychological or sensory problems
- Socio-cultural factors

Here is a list of the SLD :

- Dyslexia - Difficulty with reading and spelling
- Dysgraphia - Difficulty with handwriting and some fine motor skills
- Dyscalculia - Difficulty with arithmetic and mathematics
- Dysphasia - Difficulty to produce and understand spoken language

Additionally:

- Dyspraxia - difficulty with gross and fine motor coordination which is classified as Developmental Coordination Disorder and not as specific learning disorder but has an influence on students learning process

Even though many learners are affected by SLD, the estimation of their quantity differs. The European Dyslexia Association estimates that between 5 to 12 percent of the population have at least one SLD.

We already mentioned that for most people (including teachers, educators and decision-makers), mathematics is somewhat a complicated subject that can only be taught in a formal way. Many of us struggled with the queen of science and reasoning of the many abstract concepts but for students with SLD some of the tasks are very hard to overcome.

The biggest challenges in mathematics for students with SLD:

- making sense of numbers and how they work
- understanding the symbols and remembering the vocabulary
- understanding shapes: symmetry, relative size, their quantity and how to manipulate them
- weak long term and short-term memory which is necessary to automatize math procedures in calculus
- using drawing tools due to poor fine motor skills
- reading and organizational difficulties make it harder to solve multistep problems and tasks
- remembering multiplication tables that requires trying several approaches to find the most suitable

Making mathematics more “dys-friendly” starts by communicating with the student: getting to know what they like, how they approach the tasks and what discourage them during the process.

Here are some tips for teachers that could be beneficial for all students with SLD:

- using real objects that can be manipulated to explain geometry
- advise students to read problems aloud and help them to break the tasks in the smaller steps
- start a lesson with the outline of what is going to be learnt today and finish with a small recap of most important information’s
- increase comprehension by explaining recalling vocabulary and symbols in a form of math dictionary
- minimizing as much as possible the abstract aspect of mathematics by linking tasks with real life examples and applicability

- use books and photocopies with large print and big spaces between lines and paragraphs (line spacing of 1.5 is preferable). Font size should be 12-14 point. It is recommended to use a plain, evenly spaced sans serif font such as Arial and Comic Sans. Others: Verdana, Tahoma, Century Gothic and Trebuchet Remember that one size does not fit all and you should test it with your students to see what works best for them.

Using VR technology offers great opportunity to strengthen visualizing skills that are essential to learning mathematics. Algebra relies on a compressed system of written symbols with specific vocabulary, and it requires to automatize calculation tasks; whereas geometry relies on understanding shape, symmetry, relative sizes and quantities, how to manipulate them and how on trace them precisely on paper.

Non-formal approach to teaching mathematics

In recent years, the issue of mathematical skills has become increasingly important. They are classified as key competences necessary for personal fulfilment, active citizenship, social inclusion and employability in a knowledge-based society.

Children's first experiences are crucial, but students too often fear mathematics and some change their schooling to avoid them. Different approaches can improve attitudes, restore the taste for discovery, so raise the levels achieved and open up new learning opportunities to satisfy children's need to learn.

We have seen in recent years a movement in the way of teaching mathematics: **a non-formal approach to learning mathematics with more research activities and less computational exercises**.

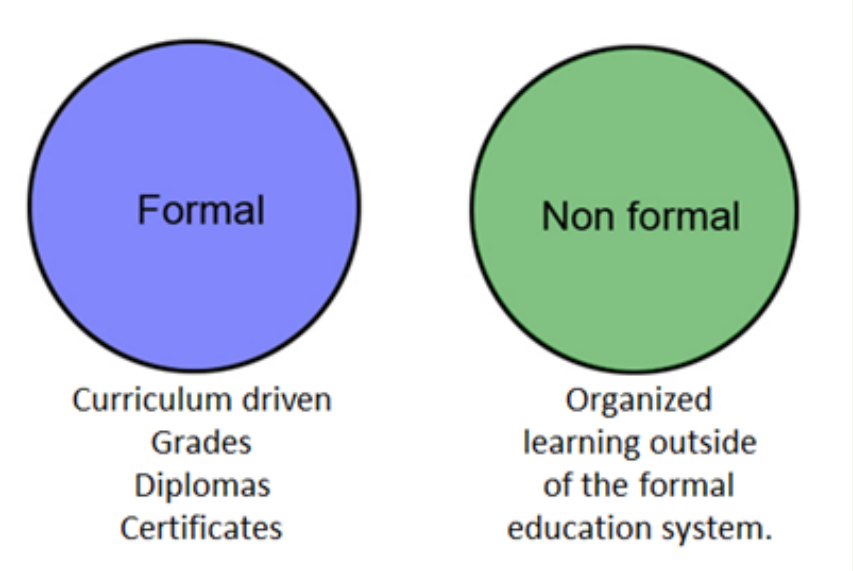
The approaches and methods used to discover mathematics can have a significant impact on how students learn in the classroom, as well as on the quality of their learning. If appropriate, they can improve students' level of understanding and help them master mathematical rules and procedures. The methods used also influence the enjoyment that students take of learning, which in turn has an indirect impact on what they learn, both in quantitative and qualitative terms.

Definitions of the terms

Formal education and non-formal education are two ways of looking at education. Let us first define these two approaches:

Formal learning is that which is provided in an organised and structured context (e. g. in an educational or training institution, or in the workplace), and is explicitly designated as learning (in terms of objectives, time or resources).

Non-formal learning is integrated into planned activities that are not explicitly designated as learning activities (in terms of objectives, time or resources), but which include an important learning element.



Organizational learning, source : .imranchohan.com

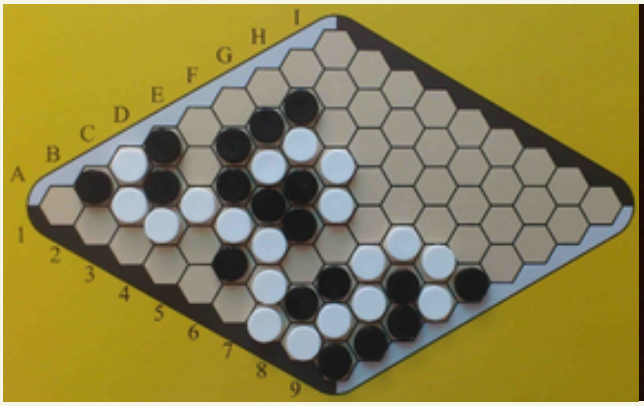
Non formal education and playful mathematics

Making math fun does not mean making it simpler and even less lowering the level. It is even surprising to see how complex notions can be conveyed through play.

Fun mathematics replaces obligation with instruction. The student is not obliged to do anything except follow a game instruction. He quickly realizes that a good understanding of the instructions allows him to succeed in the manipulation undertaken, as Stella Baruk, professor of mathematics and researcher in psychology, points out in her books on education.

It is then a question of the student placed in a playful learning situation to understand and not to apply rules imposed on him. This way of de-dramatizing mathematical learning makes it possible, once confidence is restored, to return painlessly to more formal teaching.

The notion of game is very broad, it can go from a traditional game with two or more players (Hex game), to a magic trick to understand, through origami, enigmas or the construction of strange objects (like hexaflexagons for example). Playing a game is a good way to approach a mathematical notion.



Jeu de Hex, source : images.math.cnrs.fr

Hexaflexagon, source : JustOrigami

An example of a fun workshop: the Tangram

Tangram can be used to develop children's observational skills and introduce them to geometry in an empirical and visual way.

The origins of this game go back to the 16th century in China: a legend tells us that an emperor, admiring a magnificent faience tile, inadvertently dropped it on the ground, where it broke into seven pieces. Trying to reconstruct the broken tile, he was never able to do so and recreated thousands of different figures instead. The Tangram game was recently imported into the West: the first known works describing it date back to the end of the 18th century.

The rule is simple: after having followed a construction program to create his Tangram pieces, the instruction is to make silhouettes representing characters, geometric figures, animals, letters... All the pieces must be used and they can only be juxtaposed and not superposed. There are a very large number of possibilities, there are about 2000 geometric or figurative models, more or less complicated.

Tangram, source : dhgate.com

Another playful approach: the history of mathematics

The history of mathematics makes it possible to understand certain mathematical concepts by placing them in their context. This approach makes it possible to give meaning to learning that, in the eyes of the students, ran the risk of being deprived of it. Instead of notions detached from life, it has the merit of restoring mathematics in the evolution of humanity, in culture. Using math history can also become a good way to create motivation by telling mathematical discoveries as part of the human adventure. This makes it possible to give the discoverer the desire to better understand, for example, with Thales and the measurement of the pyramid, Eratosthenes and the measurement of the circumference of the Earth or the extraordinary story of Pierre Fermat's Great Theorem.

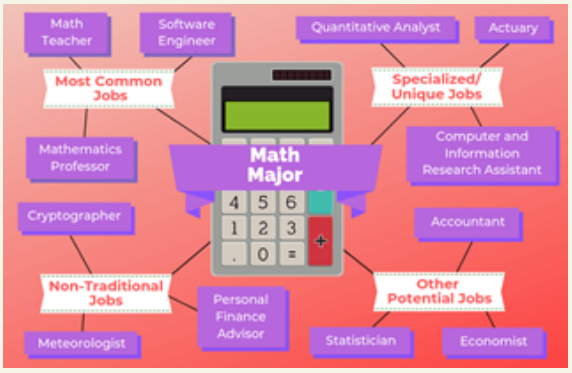
Conclusive results

The level of motivation to learn mathematics is an important determinant of students' academic performance. National strategies to increase student motivation are in place in almost half of European countries.

Eratosthenes research, source : gerard-verhoest.com

Improvement is not necessarily immediate, but when confidence is restored and tools are given to understand and succeed, the student's state of mind in relation to mathematics is changed.

According to Stella Baruk, children can be passionate about this subject as early as first grade. Mathematics is useful and necessary in more and more fields, in computer science of course but also in the whole economy: statistics, geometry, probability, etc... Promoting the scientific approach through appropriate means means means promoting creativity and innovation, thus revitalizing education and the economic fabric



Mathematics careers, source : tun.com

How to convince a teacher to use non-formal approach

In recent years we have been trying to find ways to motivate students and to convince them that math classes can be fun and pleasant. Also, we want them to become actively involved in the learning process, but we do not always find the right resources to achieve this.

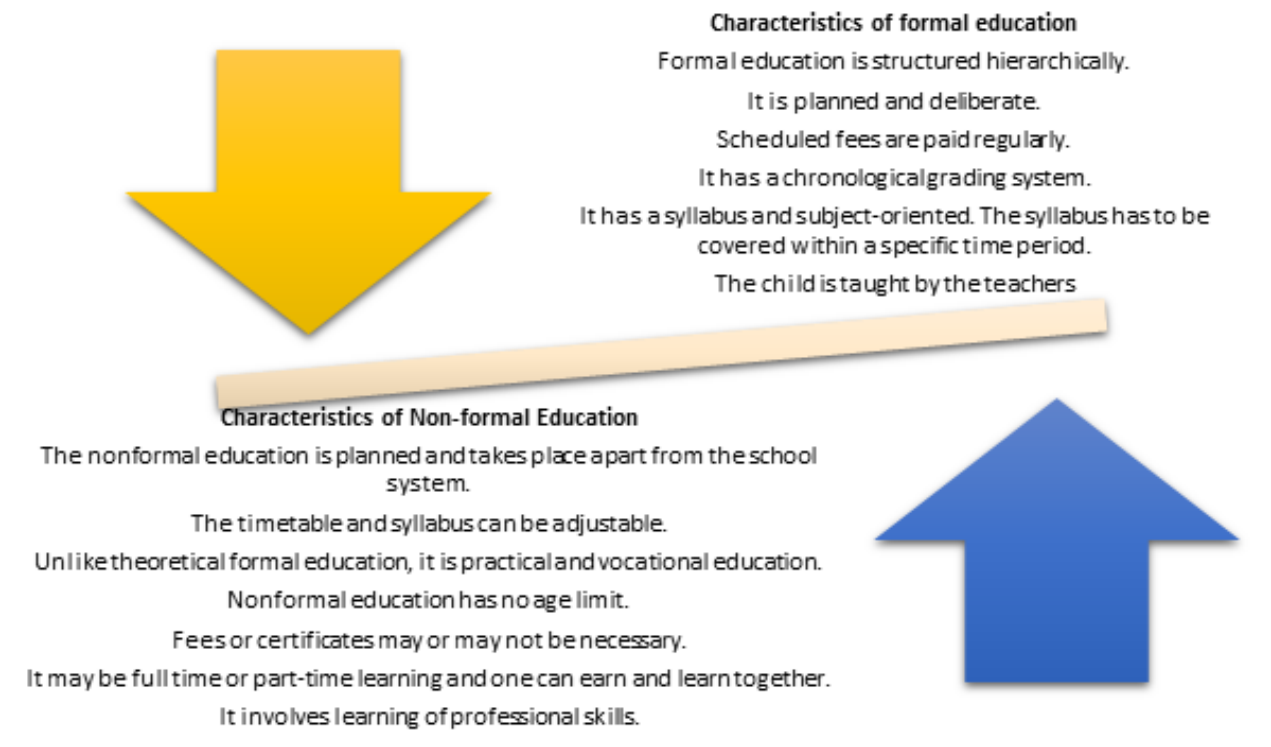
Formal teachers are often looking to discipline their students while providing information. Their classes are highly structured so that every student has the opportunity to learn without distraction. Formal teaching often takes place solely in the classroom where students work through prepared material over the course of an academic year. Once students complete the year, they move on to the next educational level.

Non-formal learning, on the other hand, is characterized by a deliberate choice of the person, which takes place in any organization pursuing educational and training purposes, even volunteering, the national civil service, private social service and in enterprises. Thus, non – formal education is any type of structured and organized learning which is institutionalized, intentional and planned by an educational provider, **but which does not lead to formal level of qualification recognized by the relevant national education authorities.** People of all age groups can participate in non - formal education which can be offered through courses, workshops, seminars.

The majority of teachers find it a lot easier to teach in a formal way, given the fact that there is a great range of teaching materials that will help them achieve their objectives. What is more, they are the product of the formal kind of training and some of them have never seen or experienced the non-formal approach. Through teacher refreshment courses, the European Union is trying to convince teachers to use innovative teaching methods and up to a point it works. Enthusiastic, the teachers, as it happened to me, go back to their schools and for a few weeks they try to introduce the new non-formal methods in their everyday teaching. Things go south when they realize that the teaching materials are scarce and that the fellow teachers will see the methods they use more or less suspicious.

1. https://classroom.synonym.com/
2. http://www.young-adulllt.eu/glossary/detail.php?we_objectID=193

It gets even more difficult when they have to correlate the non-formal teaching methods with the all-so-formal exam items. And this leaves them wondering: is the non-formal approach approachable? Can I teach without using it? Yes, this can be done, but aren't students' knowledge and wellbeing the ultimate goal of teaching? There are ups and downs when it comes to formal and non-formal educational processes, and we, as human beings, will always tend to choose the easy way. Teachers who will not easily give up the classical methods have to be well-informed about the non-formal approach in teaching, as opposed to the formal one:



Formal education does work; we are all its visible results. But experts around the world have been trying to give people a wakeup call: education is the key to everything and it has to be oriented towards the students, as they will be the creators of the world we would live in at an old age. The famous Ken Robinson said: `Human resources are like natural resources; they're often buried deep. You have to go looking for them; they're not just lying around on the surface. You have to create the circumstances where they show themselves.` Standing in front of a group of children or teenagers, telling them about sciences, literature or any subject is not really an image of an explorer, is it? The circumstances Ken Robinson is mentioning can be created by using non-formal methods, such as immersive activities using Virtual Reality gadgets, which will help students visualize and explore notions that maybe seemed extremely abstract for them.

From a psychological point of view, learning math can be a real struggle. There is a condition called dyscalculia, which makes it hard for people to do math or tasks that involve math. It is estimated that 5 to 10 % of people might have dyscalculia. This condition does not only affect children, but it will continue through adulthood and it may interfere with the quality of people's lives. By finding alternative, non-formal ways of teaching and learning math, we, as teachers, would improve our students' self-confidence and we would definitely manage to reduce the number of drop-outs.

So, how do you convince math teachers to use non-formal approach? The process is long and sometimes tiring. First off, make sure they know what the non-formal approach is. Then you should teach them the same things in a formal way and then in a non-formal way. This is where they will see the real difference. The next step involves the teaching material available, most of which could be found online (try https://www.ixl.com/).Teachers also love a bit of a challenge and maybe they will be willing to teach two groups of the same age range using the different approaches, the informal one and the non-formal one. This way they will realize that the non-formal approach is rewarding and entertaining not only for the students, but also for them. Last but not least, although reports are not what we love doing, ask them to write one after performing this experiment. If things are done the right way, the advantages of using the non-formal approach will outweigh the ones of the formal one.

So teachers, be brave,
be the real explorers of the new and modern world,
you will love it!

3.https://examplanning.com/types-education-formal-informal-non-formal/
4.https://www.understood.org/en/learning-thinking-differences/child-learning-disabilities/dyscalculia/what-is-dyscalculia#Snapshot:_What_Dyscalculia_Is

Different worlds in Virtual Reality

The great potential of Virtual Reality technology can be fully unleashed when we create realistic simulation of our world. But there is an even more interesting use of VR, that can not be matched by anything else: simulation of mathematical spaces, such as hyperbolic spaces, four dimensional worlds, or Einstein's space-time.

So, put your VR headset on and let's take a closer look to something you've never seen before!

1) Hyperbolic VR

If you are studying, or if you have just heard something about non-Euclidean geometry and you want to see it, you can't miss Hyperbolic VR, an alternative world created by Hart, Hawksely, Matsumoto and Segerman. Visiting h3.hypernom.com you will be able to move through this alternative world, where the basic rules of geometry we know do not apply: you can experience, for instance, how parallel lines can intersect or veer apart.

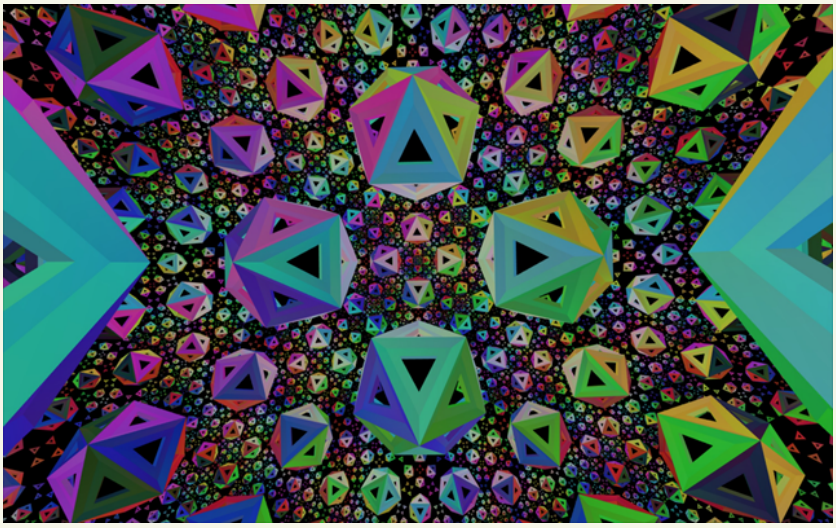


Figure 1: Non-Euclidean virtual reality I: explorations of H3
(retrieved on March 26th, 2020, from: https://arxiv.org/pdf/1702.04004.pdf)

By entering this world, you can understand non-Euclidean geometry easier than analyzing it via abstract mathematical models or formulas... and if you think this is just a weird stuff, with no connection to reality, just remember that Universe itself is a non-Euclidean space!

2) 4D Toys

Are you bored of your conventional 3D toys? Looking for something new? The fourth dimension is here to entertain you! 4D Toys is an extremely interactive immersion into a 4D world: you must move objects through the fourth dimension by picking them up, then sliding a finger on a touch surface to move back and forth in 4D space. Instructional text appears and reacts to your every grab of objects and swipe through four-dimensional space.

Figure 2: 4D Toys
(Image courtesy mtb design works, inc.)

In this strange world, we, as 3D beings, can just see a section of a 4D object: for this reason, 4D toys "change their shapes" as they move, but only because we can not see through the fourth dimension. Still too complicated? Do you feel like living in Flatland and talking to the Sphere? Maybe experiencing the fourth dimension could be easier than trying to imagine it!

3) Captain Einstein

Could you imagine a world where the light speed is 20km/h? And, if you can, could you imagine how the world around you would look like, as soon as you approach gradually to the speed of light? Well, Ghent University created Captain Einstein, a VR movie that allows the visualization of the effects of Einstein's Theory of Relativity during a boat trip in the city: rainbows in the sky, due to the infrared radiation, and space-time distortion.

Figure 3: Captain Einstein – Original Boat tour since 1905
(image retrieved from http://captaineinstein.org/)

The VR viewing experience gives you the chance to feel the Theory of Relativity by seeing its effects on the surroundings. And, after that, if you really want to understand what stands behind the creation of such a movie, you can always take another trip (this time, at your own speed!) on http://captaineinstein.org/.

What 21st century dream classroom could look like

21st century education should provide students the skills they need to succeed in new, rapidly changing world, and helping them grow the confidence to practice those skills. Therefore, education is affected by social and cultural trends, advances in ICT and more and more schools are redesigning classrooms according to the needs of the 21st century students. Learning environment has got a big impact on teaching and learning, so classrooms have to be adapted to foster students' development in critical thinking, creativity, communication and collaboration they will need in work and life. New concept of 21st century classroom must be focused on creating personalized, student-centred, flexible, encouraging and motivating learning environment integrating digital technologies in order to build skills for future success. Schools making even a simple change can make a big difference in creating a positive school culture and it can have an important impact on teaching and learning.

When thinking of redesigning and adapting learning spaces in order to create interactive and creative learning environment and to enable the introduction of innovative pedagogy using technology, schools often look up to the European Schoolnet Future Classroom Lab, which is an inspirational learning environment in Brussels. By the FCL model, the way to ensure development of the 21st century skills in students is to design six learning zones in the classroom: investigate, create, present, interact, exchange and develop.

http://fcl.eun.org/blog

Six learning zones reflect what a good teaching should be about: being connected, being involved and being challenged. A dream classroom should have various learning zones where students are active and they facilitate different types of learning using technology, so the furniture should be flexible and easily rearranged.

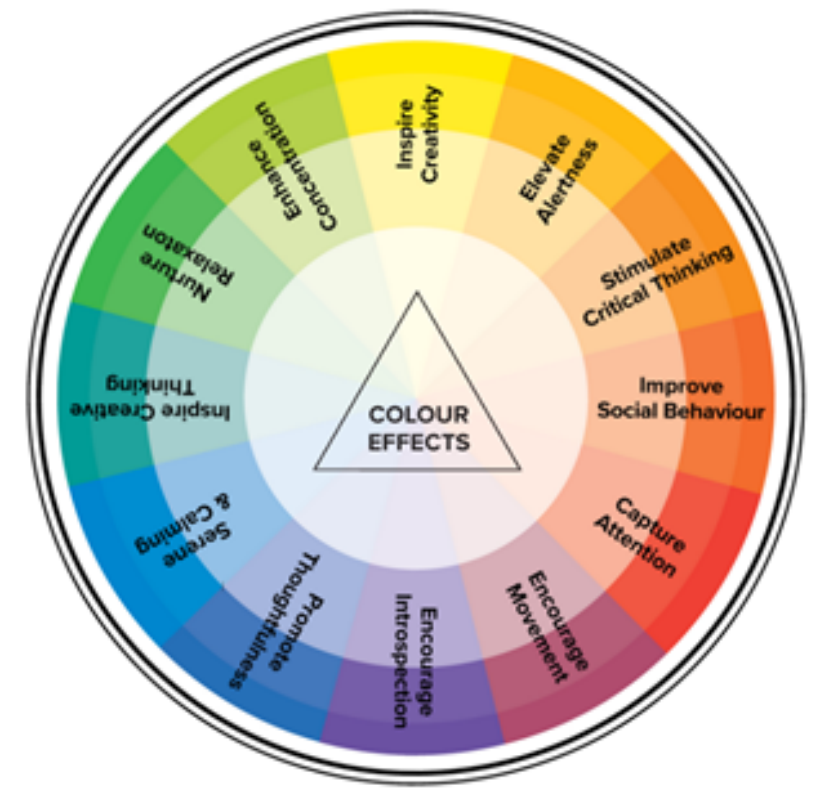
http://www.eun.org/professional-development/future-classroom-lab

Open and colourful spaces, flexible furniture and modern technology should ensure interactive teaching and learning. Different learning zones ensure mobility of students, modularity and flexibility of furniture and safe and invisible use of technology. The role of teachers is therefore changing to a facilitator, providing support and being creative in designing activities for students with maximizing the resources in the classroom. The teacher can organize different activities for students which encourages students to be active participants in learning. Activities can be implemented at the same time because of modular classroom equipment and students can easily collaborate and communicate using different technologies.

Integration of technology in education opens new and wide possibilities to achieve goals in a different way than was possible before. It enables the teacher to perform interactive teaching focused on the student. It can be easily implemented in everyday classes and it offers a number of opportunities to enhance teaching and learning spaces. Subjects become closer to students, and teaching and learning more interesting and purposeful.

High school Ivanec

Design of the classroom should provide pleasant and stimulating atmosphere, so the colours in the classroom are also important. Colours in the classroom can make an important influence on learning outcomes, brain development, students` attention, motivation and engagement. Choosing the right colours can change the environment and make it modern and stimulating, but choosing different colours will have different effects on students.



More and more schools recognize the need to create innovative learning spaces so students can learn in new ways, that engage, inspire and motivate them. Therefore, it is clear that in those spaces students shouldn't be entertained but actively engaged, in order to ensure the foundation for long-life learning and prepare students for rapid changes and skills for the 21st century.

Adapting the classroom to students with learning disorders

How to adapt the classroom so all students feel good and perform at their best.

In recent years we have become aware that no two students learn in the same way or at the same pace. Today, if a student is having difficulties in learning, we fortunately no longer categorize him or her as a student who is failing academically. Indeed, before such a sentence is overturned, it is strongly advised to refer the student to a specialist (speech therapist or psychologist).

The role of the specialist is to identify what learning disorders the learner may have and how to help him/her overcome them. Some children have attention disorders, others have specific learning disorders like dyslexia, dyscalculia, dyspraxia... The learner may have only one disorder or several at the same time. Again, there is no rule or standard.

In order for each student to develop and learn in good conditions, it is recommended that teachers adapt their teaching as well as the classroom environment. Of course, it is not up to the teacher alone to take these steps. These should be discussed beforehand with the specialists who follow the children, the children's parents and other children in the class. Indeed, in order for an adapted education to be well received, understood and effective, it must be implemented as harmoniously as possible and without anyone feeling aggrieved, privileged or neglected.

For students with learning disorders, these accommodations are essential. Just like a student who needs glasses to read, children with learning disorders need special materials and structures. Additionally, it is worth to add that some of the adaptations are very beneficial for all the classroom so non-DYS student would also have a more positive learning experience. It is also very important that other students are informed and understand what one of their classmates is going through. This is a mandatory step so that they can accept the help he or she will receive, without the other students experiencing it as cheating or injustice.
To facilitate this awareness, the teacher should accompany the class and address the notion of empathy. To be able to develop empathy, you have to start by understanding. The short reading exercise below is a simple and effective way to show and understand what a dyslexic person sees when reading text:

Inclusion is thc conscious and purboscful uoıʇɐɔnʇ of an intcrscctional environment in which cvcry pcrson is valucd, connccted and cngagcd. Pcoplc havc eontrol of thcir own subbort and making thcir own dccisions. That mcans cvcrypody gcts thc suppcrt thcy nccd in thc way thcy want it. Whcn pcoplc choosc to participatc, thcy do so without cxpcricncing rcstrictions or suoıʇɐʇıɯıl of any kind, including prcjudicc and qiscriminaticn.

This is what a dyslexic person sees when reading a text. The letters are inverted, confused, mixed up.

With this kind of exercise on empathy, the teacher can easily get to the heart of the matter and engage discussions where everyone can express their questions, doubts, or fears.

Among the technological tools to help develop empathy, VR can also be effective “Being someone else – you can check more on that in our previous article “VR as an "empathy machine".”

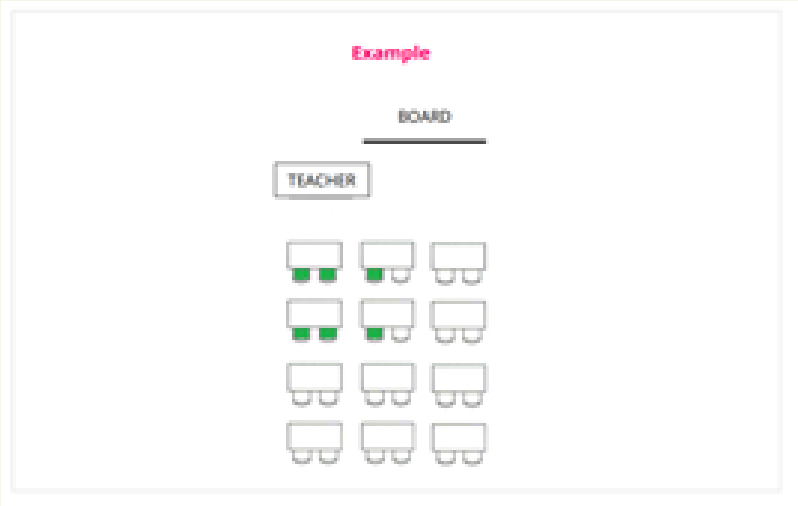
Source: https://www.freepik.com/free-vector/boy-girls-school-classroom_4770653.htm#page=1&query=classroom&position=34
School vector created by stockgiu - www.freepik.com

Beyond simple empathy and understanding, there is a range of classroom accommodations that are possible, simple and beneficial for students with learning disorders and the others.

A couple of examples:

To organize the class:

Make a class plan and place students with attention disorders or reading difficulties in the front rows. This prevents them from being exposed to the distractions of doors, windows and the rest of the class and allows them to see the board better. Proximity to the teacher can also reassure them or encourage them to participate.



For the lessons:

Students with DYS disorders may have difficulty organizing themselves in time, space, and ideas.
Establishing a structured plan at the beginning of the lesson can prevent them from getting lost along the way. The plan is also very useful for students without learning disorders.
To stimulate their short- and long-term memory, the teacher can provide the students with the headlines with a short summary of each part and the key points before the lesson.

During evaluations:

The accommodations that have been provided for DYS students must also be provided for the assessments.
If DYS students are accustomed to having appropriate materials (airy, sharp written materials of sufficient font size) or to using specific tools in the classroom in general, these accommodations should also be maintained during the assessments.

The use of technology:

There are some innocuous tools that can be very helpful for students with learning disorders. However, it should always be kept in mind that before allowing the use of these tools, it is very important to present them to the whole class and explain the situation. To reassure students who may feel aggrieved or encourage the student who may feel too differentiated, dialogue is the best weapon.

Among the tools:

- A recorder (simple phone recording function) so the learner doesn't miss anything from the lesson and can complete the note taking at home if needed.

- Use reading aid software (such as Kurtzweil 3000 or Medialexie)

- The use of a computer with word processing software if the handwriting is problematic for reasons of coordination or fine motor skills.

And as surprising as it may seem, the use of VR can be beneficial for students with learning disorders. See the article: "How VR can be profitable for students with learning difficulties?"

In conclusion, it should be noted that this list of examples is non-exhaustive. There are many, more or less simple and affordable ways to make education relevant and beneficial to all. Here again, it must be remembered that teaching alone should not be the only way to meet the needs of one or more students with learning disorders. Communication and collaboration with parents, specialists and the child are crucial.

VR as a training tool - example of use

New technologies can offer a chance to rethink the world of education and improve it in ways that are still unimaginable.

While many people continue to debate the use of Virtual Reality (VR) and its future development, we can already see that it is still very present in education. In preparation for our Math Reality project, which consists in co-developing and implementing an innovative teaching methodology based on the use of VR, the partners discovered several examples of its use. This project is co-funded by the European Union's Erasmus+ program.

As a quick reminder, Virtual reality is a form of computer simulation, in which the participant is immersed in an artificial environment. It provides new forms and methods of visualization, based on the strengths of visual representations. VR can more accurately than by other means illustrate some features, processes, as it can provide greater experience in some ways indirect of « touching » concepts that were so far only theoretical.

Photo of a meeting - Mons (Belgique) –Math Reality Project ©Fermat Science

1/ Virtual Reality Science with zSpace

This school used **zSpace** workstations to teach different arguments, such as Newton's laws of motion or anatomy. Students can interact with the subject taught in a creative and engaging way, by stacking blocks, setting up ramps, dropping out balls; or they can literally turn around a 3D heart, to understand how it is made and how it works, and feel its beat going faster or slower. Students can explore subjects at their own pace, without feeling ashamed of their mistakes, that become, according to constructionist learning, an opportunity to enhance their skills and knowledge.

Photo of ZSpace workstations ©ZSpace

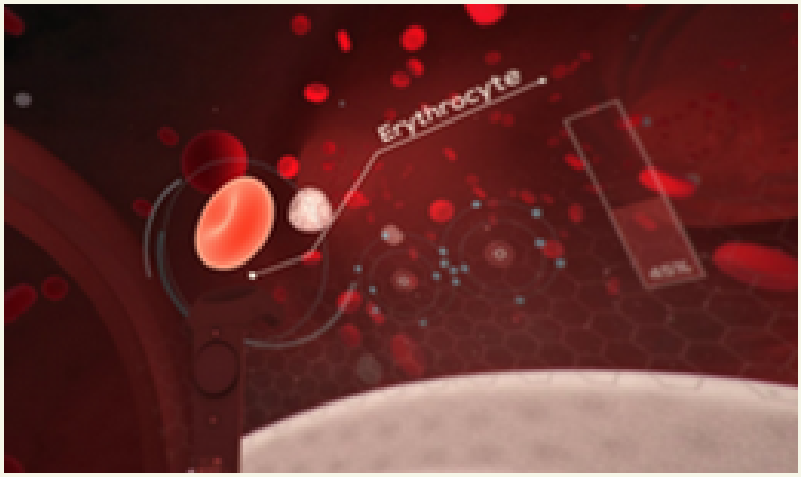
2/ A virtual laboratory with Google

The virtual-reality biology lab of the University of Arizona is one of the most interesting ways this University adopted to teach this subject. Through Daydream VR, a Google operating system. After logging in, students must “wear” a lab coat and gloves in order to proceed. In this lab, students must take two blood samples from basketball players to determine their blood glucose level. Then, they can view what is inside a glucose molecule, and they are asked to put the molecule in the right place to demonstrate the Kreb cycle (a basic biochemical process).

Virtual Laboratory – Google Project with the company Labster ©Google

3/ In the human body with a virtual reality application: The Body VR

A journey inside a Cell: thanks to this free VR experience, students can travel through bloodstream, discovering how blood cells work to spread oxygen throughout the body: students can also decide to “jump in” one living cell, in order to learn how it works (The Body VR).



The Body VR : Journey inside a Cell @ The Body VR

4/ Discover mathematical theorems with CalcFlow:

This application, aimed to high school students, gives the opportunity to explore mathematical theorems and scenarios in VR. Features included are: manipulating vectors with hands, explore vector addition and cross product, creating a parametrized function and vector field.

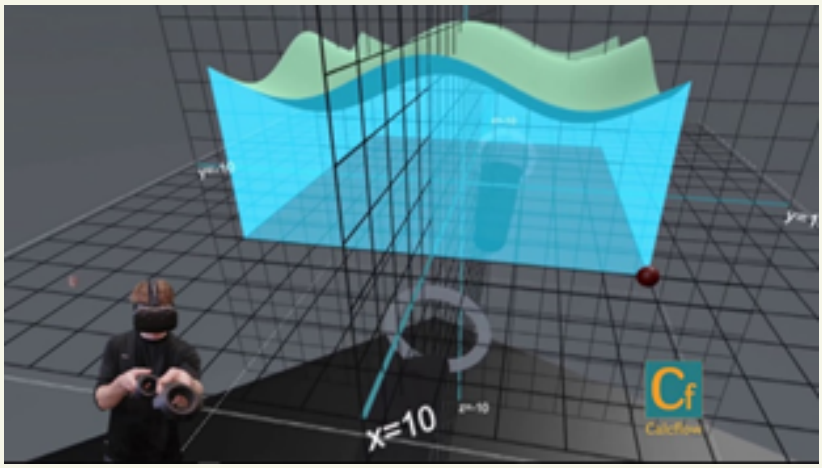


Image of the app @ CalcFLow

5/ A journey into the world of geometry with Neotrie VR :

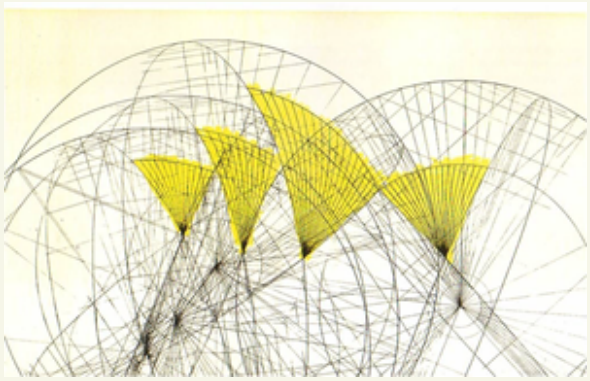
NeoTrie VR is a virtual reality software that offers the user the ability to create, manipulate and interact with geometric objects and 3D models in general. It allows total immersion. The Neotrie environment completely envelops the player, with the possibility to change the environment for with any 360° panoramic photo.
With the controls, which simulate virtual hands, the user can interact with 3D objects in the environment, create figures with vertices, edges, faces and easily modify elements.

@ Neotrie VR

The Language of Mathematics

Mathematics consist millions of distinct equations, infinite numbers and the whole Greek alphabet! Nonetheless, mathematics is written in the exact same way in all languages of the world. In other words, a mathematical equation or expression does not need to be translated in another language to be understood by someone living on the other side of the world. Mathematics do not discriminate, in terms of religion, gender, color or language. 2 + 2 = 4 in each and every single one of the countries of the whole world. (Why Math Is Important In Life, 2018)

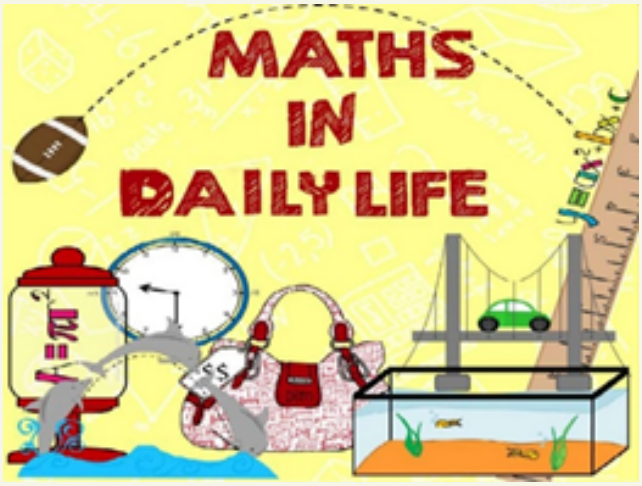
While usually children and teenagers complain of the difficultness and boredom caused by mathematics, a world without it, may mean that we experience a way different kind of world, a world on a much less interesting level. Imagine a world without math. An architect would not know how to calculate angles or lines, a doctor would not know how to count your heartbeat, a chemist would not be able to prepare medicines without accurately measuring the quantity, an engineer would not be able to build bridges etc. (Nautiya, 2012)



Source:http://stevekingonsustainability.blogspot.com/2013/02/mysterious-mathematics.html

"Math help us understand the world and we use the world to understand math" (Understanding the World Through Math, n.d.)

Several areas of mathematics originated by attempting to describe the real world and solve the real-world phenomena. Some examples are measuring farms (geometry), falling apples (calculus) or even gambling (probability). Mathematics has been extensively successful in helping us understand in more depth the universe – from its large scales (physical cosmology) to its smallest (quantum mechanics).

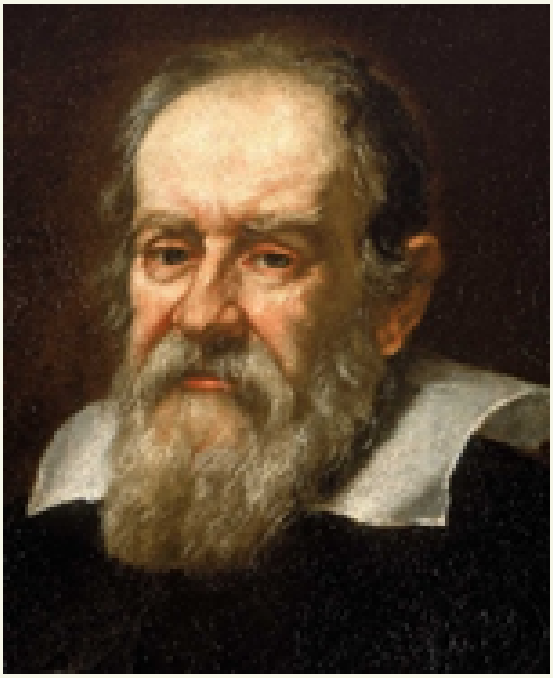


Source:https://www.slideshare.net/himanshukotnala99/maths-in-daily-life-54382866

In our days, mathematics can be found all around us, in every step of our lives. Have you ever thought how many things of our everyday life use mathematics and we take it for granted? From the watch and calendar to baking and sports, from electricity and technology (computers, television, mobile phones) to gardening and art. Because of mathematics, we know how everything around us works and can apply it in every field and profession. (Krishnan, 2016)

Considering all of the aforementioned, people all over the world understand these concepts without the need of translating them. So, should math be categorized as a language?

According to the Italian astronomer Galileo Galilei, "[The universe] cannot be read until we have learned the language and become familiar with the characters in which it is written. It is written in mathematical language." If mathematics is considered as a language, then as all other ordinary languages, mathematics is independent of the other and there is no need to rely on another language to be understood. (Silver, 2017)



Galileo Galilei
Source:
https://mg.wikipedia.org/wiki/Galileo_Galilei

Some key facts on why Mathematics can indeed be considered as a language:

- It is a system of communication, that has vocabulary, grammar, syntax
- The words and symbols have meaning
- Written rather than spoken form of communication
- An expression of thought in a specific way
- There is a group of people that use it and understand it (Helmenstine, 2019)

Therefore, mathematics can be viewed as a simpler, more consistent and more regular language than the English one. The numbers can represent the nouns and the operational signs can represent verbs. A mathematical equation such as '2 x 3 = 6' can be thought as a sentence. Just like the English language, Mathematics are based on grammar and correct syntax. For example, from a young age, children learn that a math sentence is written as 5 + 6 = 11 and not as 5 6 + = 11. The language of mathematics has an infinity number of nouns and just five verbs (operational signs) +, -, /, x, =. (Teaching Math as a Language, 2016)

Mathematics is a language that can be more carefully defined and more profoundly abstracted than the ordinary thought and expression we use daily. It might be considered as a language; however, mathematics differ from ordinary languages in an important way – by the rules of manipulation. Once a statement is changed in a mathematical form, it can be manipulated according to the rules. Every configuration of the symbols will represent facts in harmony depending on the ones of the original statement. ("Language of Mathematics," 2020)

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Teaching mathematics for students to learning difficulties

The great mathematician Grigore Moisil said that "it is the teacher who in a certain subject, knows more every day than yesterday, teaching another what he knows today, preparing him for what he will find tomorrow."

Specificity of the method of teaching mathematic

Teaching – learning mathematics is a real challenge for teachers, but also for students. Whether we encounter students with learning difficulties, or, on the contrary, students with higher capacities, the current trends in education are to adapt the knowledge, means and methods of teaching the individual and age peculiarities of the students, thus defending the concept of differentiated learning.

The student's attitude to learning mathematics must be active. He must be taught to think for himself, to address and to seek personal solutions to certain problems or demonstrations of theorems that he then confronts with others.Mathematical thinking involves the ability of reasoning in rigorously composed stages, each related to the previous ones, but also the ability to concentrate over a long period of time. Taking into account the influence of computational technique in current life, the mathematics teacher must emphasize the development of the students' algorithmic thinking. The formation of abstraction capacity is another desire in the work carried out in mathematics classes. However, only the superior scientific training of a teacher is not the guarantor of a good teacher. Crucial is also the ability to communicate knowledge to students, to present them in an accessible, comfortable, motivating form, leading to the best possible results. To do this, the teacher must know the psychology of the child, to perfect his teaching-learning-assessment method, holding notions of pedagogy, to have tact, to be open to the new.

In modern learning, the formative-educational side of the method is emphasized, the methods of search and identification of knowledge, self-training and permanent self-education are expanded. It is also recommended to use on a large scale the active-participatory methods and those that require the relational components of the teaching activity: teacher – student, student – student.

The efficiency and value of a method is conditioned by the quality, the correct choice, and the correlation of the processes of which it is composed.

For students with special educational requirements, there has been a well-organized educational system for an exceedingly long time, in the form of special education, but also in the form of classes integrated into mainstream education. There are differentiated programs that work based on Personalized Educational Plans through curricular adaptation.

More recently, the concern for excellence for gifted children, who are also children with special educational requirements, has also emerged in Romania.

Learning difficulties and teaching mathematics

Although learning difficulties have only been talked about since 1960, since they began to be studied, especially in children, it is very possible that there has always been what we call and conceptualize today as learning difficulties. Learning difficulties refer to a heterogeneous group of disorders that are expressed by significant difficulties in the acquisition and use of the reception and understanding of mathematical language.

Since the first grade of primary school the "arrhythmia" of the learning is present. It debuts in an area recognized as "arid", highly conceptualized, abstract, and symbolic, as conventional: the area or the world of numbers. Some children present, from the very beginning, difficulties in learning mathematics while others much later. This is because the field of mathematics is constantly and gradually complicated in the assimilation process, and the internal structure of this subject is particularly organized. For example, the cipher sign "0" is paradoxical for the child who, learning that it represents the empty crowd or "nothing", discovers that the same "0" next to a 1, becomes 10, that is, something more than 9 and not the nothing it expresses. The figure "6", for example, as a simple graphic sign is very close to the letter "G", but when pronounced the child must articulate an entire word composed of four distinct letters (S+I+X) and necessarily think about a lot of letters. Such examples could continue, which illustrates, once again, the many arithmetic (and mathematical in general) problems that the new student endures.

In classroom work some students tend to accept things as they are, without assessing the importance of logical coherence. They are indifferent to the illogicality of relationships or their own answers. This lack of logic does not come from a lack of intelligence, but rather is the cause of a deficient system, in which logic is not important. The initial and gradual learning of mathematics by children and later of current mathematical skills is part of everyday life. Therefore, the teacher has a decisive role in the formation of "small mathematicians". However, despite its importance, learning itself is insufficient. They must adapt, at any level, effective thinking methods. Understanding effective intellectual methods must apply all this both in school curricula and in areas outside them (generalization and transfer). It is an attempt to encourage students to understand the rules and principles, stimulating their desire to discover for themselves.

We therefore infer that the role of the teacher is now more important than ever, influencing the knowledge of each individual student. However, as important as it is, it competes every day with the negative influences in students' lives: television, the internet, friends and, why not, sex life far too early. Whatever the cause, learning difficulties in mathematics are a sad and common reality in schools. The phenomenon is usually observed from the beginning of schooling (6-7 years) and is amplified, in particular, in the 2nd and 3rd grades until the 4th grade, aiming for a constancy on the threshold of the secondary school cycle, when a genuine peak of manifestation (in the 6th and 7th grades) is reached, in frequency and gravity, statistically speaking.

Although it is difficult to produce significant statistics in the field of learning difficulties of mathematics, it is estimated that in the first grade about 8-10% of school children have, in one form or another, difficulties in learning mathematics. In grades IV and V this percentage rises to 20-25 %, so that in grades VII and VIII they approach the worrying 40% share. Children with learning difficulties in mathematics who have reached the 8th grade, most of them are either dropping out of school, or, at best, attending vocational education.

We ask ourselves the question: "Why did it come down to learning math?" Answer: due to repeated failures, frustrating experiences in math class, prolonged stress in the face of possible examinations; such anxiety states can stabilize at a constant and permanent anxious level. Unprecedented studies signal a higher degree of anxiety in girls than in boys, in older students than in small ones, in solving exercises and problems than in evaluating in mathematical theory.

It is difficult to say with certainty, to what extent mathematical anxiety influences the learning difficulties in mathematics. Significant remains only the fact that the two phenomena are frequently accompanied and that an anxious mathematical conduct greatly affects mathematical performance and "builds" slowly but surely, mathematical anxiety accompanied by its characteristic behavior. I have strung out the following:

Effects of learning difficulties in school

DIFICULTY ARIAS	TYPICAL EXAMPLES OF AFFECTED CONDUCT
Selective attention	he doesn't seem to care; is distracted by irrelevant stimuli; gets tired easily when trying to focus.
Impulsivity	fast pace of work; conceptualizes easily but does not participate in details; confuses and/or omits symbols.
Perseverance	difficulty moving from one operation to another.
Inconsistency	solves problems one day but forgets until the next day; is capable of great effort, if artificially motivated.
Language	difficulties in purchasing mathematical vocabulary; slow, cumbersome processing of oral/written messages with mathematical "mess"; difficulty in decoding some mathematical symbols.
Spatial organization	difficulties in organizing the work on the page; does not know which part of the problem to insist on; has difficulty presenting geometric figures and overlooks certain components of them; notebooks of themes and messy notes.
Graphomotor skills	incorrect copying; takes a long time to finally draft the theme; can't listen while writing; work more correctly on the board than on the notebook; the page worked is dirty (corrected, stained).
Memory	does not easily store the multiplication board; only partially and on jumping rules, steps of algorithm;
Self-esteem	believes that even the greatest effort does not ensure its success; denies the difficulty felt; is very sensitive to criticism; opposes, refuses help.

Mathematics is a subject acceptable to most students, but which presents learning difficulties precisely because of the negligence of the students. They no longer pay attention to classes and no longer discover the beauty of mathematics. In short, the new generation of students is no longer interested in learning mathematics by turning their attention and curiosity to other fields, especially extracurricular areas, such as computer and entertainment. Thus, the theoretical results of the researchers in the field proved to be correct, aiming to overcome them with the passage of time. That is why we are sounding the alarm and saying that urgent measures must be taken to prevent the difficulties of learning mathematics in school.

This cruel reality makes it difficult for the math teacher to do so, making it impossible in some cases to succeed. That is why I presented some ideas that should be taken into account:

It is recommended that, in front of the whole class, the teacher follow these rules:

- clearly present the structure of the problems taught, the resolution tasks and the essential requirements in relation to the students' requests.
- clearly and completely sequence each math lesson.
- stimulate the active participation and self-employment of students in the lesson.
- avoid loaded language.
- use colors and underlining to alert and assist the student in understanding, applying, and generalizing the notions taught.
- practice in the classroom the algorithmized approach, in small steps, of each theme presented.
- diversify the methods of presenting teaching activities of various mathematical problems and tasks.
- the teacher's attitude is flexible and facilitates the understanding and generalization on the part of the student because the mathematical rigidity itself, overloaded by that of the teacher, is strongly anxious.
- to use frequent, current assessment tests that avoid the accumulation of mistakes and remove the fear of assessment of students.

Parents are advised to supervise students especially in front of the computer and to prohibit its use before the homework is carried out, and then to restrict the time for each day, i.e. no more than 3 hours per day.

It is recommended to set up mathematical circles that include strictly mathematical games and not analytical problems, to attract students to a fun mathematics and to form and fix skills and abilities. However, this is not easy to do. It takes financial resources, teachers eager to keep such a mathematical circle once a week, patience, long time, and different rewards for students depending on the level at which they are and the evolution of each.

Under these rigorously respected conditions, the difficulties of learning mathematics will probably be fewer in the future.

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VR and COVID-19: A short guide to cleaning and sanitizing your VR headsets

Sanitization processes are one of the trend topics in the post-COVID-19 world, and one of the most urgent issue for every organization who is willing to use VR as an educational tool. Students are supposed to share the same equipment during a VR-based lesson: their safety must be obviously guaranteed, but how?
Here are some good practices that can be easily implemented.

1) Wash hands and face

- The first thing to do is to wash hands and face before and after using a VR headset, as this practice is proven to be the most effective in inactivating germs, bacteria and viruses;
- if there is no access to a sink or soap, it could be useful to have a hand sanitizer in the room where VR is going to be used. This will help keep headset and controllers safe and clean, and it will reduce the chance of spreading germs from people who enter and leave the room.

2) Disinfectant wipes: alcoholic or not?

- Both headsets and controllers must be wiped down before and after being used;
- lens must not be cleaned up with disinfectant wipes, as doing so can result in permanent damage. Lens can be cleaned up using microfiber cloths;
- ·Ethanol-based detergents appear to be most effective against viruses (including COVID-19) and are usually readily available (Gold & Avya, 2020), but their use can damage the material of the headset and controllers, dissolving certain plastics, making plastic less flexible or discoloring it;

- On the contrary, alcohol-free disinfectant wipes (with benzalkonium chloride) do not damage any part of VR headset, but it is not proven to be as effective as ethanol-based detergents: benzalkonium chloride products were ineffective in inactivating human coronavirus (Wood & Paine, 1998);
- In conclusion, a choice has to be made, when choosing wipes as a disinfection method: potentially damaging the headsets in the long term, or protecting them, without being 100% sure that headsets are sanitized.

3) UVC Disinfectant appliance

UVC (ultraviolet C) is a form of electromagnetic radiation in the range of 200-280 nm that can prevent bacteria, viruses, and other microbes to replicate, by penetrating their cells and disrupting the structure of the DNA molecules.
This technology has been used since many years to disinfect drinking water and food, but now it has become available for VR.

- UVC light seems like the safest (99.9% effectiveness) and easiest way of decontaminating headsets and controllers in a very short time (approx. 1 minute);
- UVC light do not cause any damage to VR headset, but it is very damaging to skin and eyes, so caution is needed during the decontamination process;
- The backlash is that a decontamination box can be a costly investment

4) Cleanable and disposable VR face masks

- VR headsets' face pads are not waterproof: it is better to replace them with waterproof ones, because they can be easily sanitized, thus being safer to use;
- using a cotton cover is not recommended, because moisture can seep through; the cover must be washed after each use with hot water and detergent;
- disposable face pads can be used as another layer of protection, but they are affected by the same problem as cotton covers (i.e. moisture), so they are effective against dirt, such as make-up;
- If cotton cover or disposable face pads are used, make sure to decontaminate underneath them after every use.

5) VR Hygiene Procedure Signs

- Write down an infographic to provide a step-by-step guide for VR hygiene procedure: by doing so, everyone will be informed about how to behave properly, in order to keep VR headsets clean and avoid the spread of Covid-19 (an example here: https://vrschoolresearch.files.wordpress.com/2020/08/be-vr-safe-2020-final-1.png).

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Taming Mathematics – How to create a fun lesson

Being a teacher, and especially being a math teacher, is a very challenging and demanding job. In fact, it could rather be said that it is a vocation, because a teacher does not cease to be a teacher by leaving a classroom or school.

Generations of today's students are surrounded by a multitude of easily accessible contents that they can access through a variety of digital media. Various information, and above all entertainment, comes in just a few mouse clicks or a touch of a screen. They are taught to process shorter information quickly and even more quickly move to new content. Everything must be fast, in a short time. Many do not have the ability to take long-term attention and lose concentration very easily. Due to these facts, the challenges of today's teaching and learning are high. The success of teaching largely depends of the achieved relationship between a teacher and a student. The power of connection between teachers and their students is huge. If they build a positive relationship, filled with empathy and mutual trust, if actions strengthen students' self-esteem, then the first step is taken to eliminate the fear of failure. And when there is no such fear, students are open to different scenarios and ready to show their creativity, which is very important in teaching and learning, both for students and for teachers.

When students' trust is gained, the question is how to make teaching interesting? How to attract and retain students' attention? How to interest them in certain contents and achieve the planned outcomes?

There are teachers who have an innate ability, like actors in a theatrical play, to attract students' attention and hold it until the goal is achieved. Not only with their voice, but also with their movements and facial expressions, they successfully keep srudents awake and ready to accept new insights, even if it's the matter of less attractive contents. But not all teachers have such abilities. However, anyone can go out of their way to find a way to present content in a fun way.

Source: High school Ivanec

So, how do you create a lesson that will lead students to achieve outcomes in a fun way?

Here are some ideas:

- **Talking through the teaching unit (storytelling)**

Present the unit with a story that may be current or may have a historical context (or a line from history, an anecdote related to the life of a mathematician relevant to a particular topic) or create a story with characters from some famous fairy tales or characters from current video games or movies. Mathematics is not a favorite subject for all students, but there are certainly those among them who are creative and can design a play on a certain topic. Such a different approach will surely refresh the work and interest the students.

- **Presentation of the problem with a picture** (because a picture speaks louder than words)

Instead of actualizing the problem with a text, a highlighted image can encourage students to discuss and independently identify and pose the problem, and thus easier to see the path to a possible solution.

- **Experiment**

There are areas in mathematics which contents and outcomes can very easily be presented by live experiment or video.

- **Game**

A game, which has the ultimate goal of winning, is certainly a motivating factor for students and a way to animate those students who are not too active in the teaching process. Achieving outcomes by connecting with the game, challenging students with the possibility of victory - Escape room, treasure hunt, discovering pairs in the memory game, are just few examples of such games.

- **Use of digital technologies**

Although the use of digital technologies is already present almost everyday in the teaching of mathematics because it allows us to present a problem more clearly and achieve faster conclusions (eg using the Geogebra dynamic geometry program), it gives us the opportunity for additional creativity and connecting mathematical content with the real world around us.

By updating the content, we make it more attractive to students and thus they are more willing to cooperate.

The latest innovation in digital technology today is certainly the application of VR glasses which gives students the opportunity to virtually enter the 3-D world of various examples of the application of mathematics.

These examples are just some of the ideas on how to strive to achieve outcomes to the mutual satisfaction of students and teachers, and this is a prerequisite for successful teaching. In addition, a class dynamic, which involves a combination and change of different modes of work (from individual, work in pairs or group work) can further contribute to the process.

Source: High school Ivanec

Erasmus+

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