Issue No. 9: August, 2022

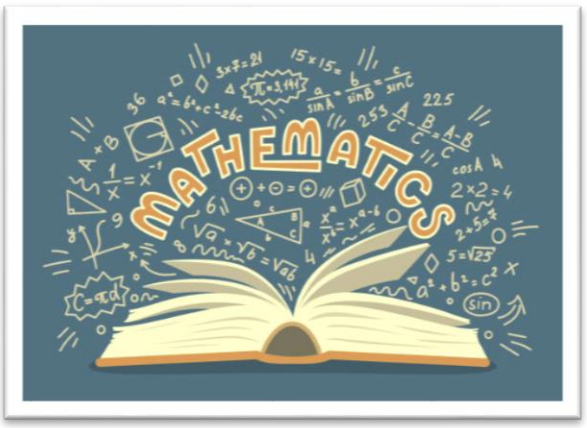
WORLD EDUCATION FELLOWSHIP

INDIAN SECTION - NEWSLETTER

In this Issue

- **Message from WEF Global**
- **Contributed articles**
- **Random Thoughts on Maths teaching/Learning**
- **Shared Articles**
- **Two Book reviews**
- **Several Useful resources for teachers of mathematics**
- **WEF news**
- **Invitation to join the WEF-IS family**
- **And many opportunities for reflection and sharing**

This issue is dedicated to all those wonderful teachers who make it their business to see that our children begin to love mathematics as they grasp the concepts and go through the required drill and practice



The Editor's Voice

Dr. Priti Sachdev
Hon. Secretary
World Education Fellowship – Indian Section

Dear Readers,

Welcome to the ninth issue of the WEF-Indian Section Newsletter!

It is a widely accepted reality that mathematics brings out fear and anxiety in most school children. The early years of a child's cognitive development focuses on the three R's – Reading (W)riting and 'Rithmetic. An early understanding of the concept of numbers and what we can do with them is considered the basis of the good cognitive development – and there are several reasons for this thinking.

While many children can easily adapt to the 'abstract' involved in understanding mathematical concepts, there are an equally large number who struggle with it. Much of the training of teachers of mathematics at all levels consists of strategies to make the 'abstract' more 'concrete' so that children can relate to the subject and comprehend its intricacies. This clearly requires a very thorough and deep understanding of the concepts by the teachers themselves along with the ability to communicate this in simple understandable ways to the children.

Much has been written and said about teaching and learning of mathematics. Clearly the anxiety and fear of the subject can be and is bypassed by the creative and understanding teacher. In this August newsletter which focuses on the subject, we are happy to have received several points of view of practicing teachers with ideas on how to approach the subject! And we have resourced several online sites that focus on making the teaching and learning of mathematics a pleasurable pursuit for both teachers and students.

Three shared articles on the teaching and learning of mathematics give us a perspective on the experiences of teachers in other parts of the world. Some random thoughts on the subject by teachers of mathematics round off the subject.

You will definitely enjoy Dr.Turner's (WEF-Global) take on the teaching of Mathematics.

I trust you will find these interesting reading and do feel free to give your feedback and short comments for the next issue.

Apart from this we have, as usual, an article from WEF global, news from WEF, a book review and a list of online resources for mathematics teachers.

Happy reading!

Contributors to Ninth Newsletter

We are happy to have inputs and contributions from a wide variety of educators, parents and others interested in the education of young minds, To all the contributors to this fourth Issue of the WEF IS newsletter, a big 'thank you'

Dr. Shrima Banerjee

Dr. Banerjee, M A, M Sc, Ph D (Edu) , has been a Teacher Educator for the last 17 years. Currently she is an associate professor at the Hansraj Jivandas College of Education, Khar. Passionate about teaching she sees herself as a lifelong learner. For the last over a decade she has been appointed a Field Coordinator at the Department of Life Long Learning and Extension (University of Mumbai).

Dr. Tripti Bej

Dr. Tripti Bej has been working as an Assistant Teacher, Department of Science Education, Maniklal Singha Smriti Madhyamik Vidyalaya (H.S.), West Bengal, India for last fifteen years. She has received a M.Sc. & Ph. D. in Applied Mathematics from Vidyasagar University and M.A. in Education from Indira Gandhi National Open University (IGNOU). Her research interest includes fuzzy algebra, artificial intelligence, and educational technology. She is the lead author of the presented case study.

Ms Preeti Goel

Ms Preeti Goel (M.Sc., M.Ed.) is an International Vedic Math Trainer, CEO and Founder of 'Edutainment Study Point' at Karnal, in Haryana. The institute mission is to develop excellence in Maths and Science through entertainment.

Dr. Arnab Kundu

Dr. Arnab Kundu is an independent researcher. He has received a Masters in English & Education, PGDEMA, PGDET, and Ph.D. (Education) from Bankura University. He has authored about 40 research articles in national and international journals. His research focuses on several issues regarding teachers' work specially to promote literacies in online/digital environments. He is the corresponding co-author in the presented caselet.

Dr. Smita Patil

Dr. Smita Patil, is a passionate Maths teacher. Who has been teaching Math for the past 10 years. She specially enjoys teaching mental math, calculations and constructions to all age groups. Currently at the Bombay Cambridge International School she teaches students from class 6 to 10.

Dr. Priti Sachdev

Priti Sachdev, the honorary secretary of the Indian section of the World, Education fellowship and a member of the guiding committee at the WEF headquarters, has been in education space for the last about five decades. She has an academic background in Biophysics, Education and Management with certificates and diplomas in various areas of learning/teaching/administration. Starting off as a secondary school science/maths teacher she went on to become a teacher trainer, a university reader, a research guide, a school principal, a trainer, a facilitator and an independent consultant. She currently contributes to the cause of education through her involvement in the World Education Fellowship and the International Literacy Association and its activities in India.

Ms Shehnaz Saronwal

Ms Saronwal is an assistant professor at the Department of mathematics at the Manav Rachna University. He is a blog writer and contributes her thoughts to the internet from where her thoughts have been gleaned.

Ms Sanah Sayed

Starting in 2008 at the Bombay Cambridge group of schools I have grown as a teacher and become ever more creative and innovative. I attribute this to my work environment which has always encouraged me. I hope to make a positive difference in every student's learning experience. As a Maths and Science teacher in the primary section for the last 14 years I have found that being with children has made me even more positive and I enjoy the challenges that teaching brings. I look forward to creating independent 21st century learners.

Professor Dr. David Turner

David Turner, is Professor Emeritus of Education at the University of South Wales, and Professor at the Institute for International and Comparative Education, Beijing Normal University. He is a Fellow of the Academy for Social Science and Honorary Member of the British Association for International and Comparative Education. After graduating in engineering, Professor Turner became a science teacher in secondary schools for nine years, before moving into teaching in higher education. His book, **Theory of Education**, presented a novel approach to viewing education as a complex system, which is shaped by the choices that individuals within the system make. His second book, **Theory and Practice of Education**, was published in 2007.His latest book, **Comparative Education:**A field in Discussion, published in 2022 is a excellent text in Comparative Education.He is critical of much current policy in education, including the desire to see institutions ranked in league tables. He is committed to the view that the education system needs to accommodate diversity in all its expressions.

Ms Ishita Verma

Ms Verma started within the corporate corridors and later moving into the passionate area of school education. Through her 30 years of experience, she brings an interesting spread of insights and ideas to the QEDRAK team of which she is a founder member. A graduate in Sociology, with ranking in PGDCA and a Gold Medal in Educational Management, she found her true passion in being with children, animals & nature – the perfect blend for designing and implementing innovative, sensitive, sustainability-driven, fun-filled and inquiry-soaked curriculum for students of the schools she has headed, She writes for the Indian Express, blogs for webpages and lends her voice for audiobooks & podcasts. She likes to remain connected with the latest in educational trends worldwide and has conducted several in-service training workshops for teachers, parenting sessions.

Dr.Shalini Verma

Dr. Shalini Verma has a Ph.D in mathematics with seven papers published in different journals. She has over 15 years of teaching experience in different schools, Colleges and University and has been a HOD Math in renowned Gurgaon school. Currently, she is attached to HDFC School, Gurgaon.
Dr Verma has been a regular research paper presenter at conferences related to her subject. Her areas of expertise lie in mathematics and she has, over the years, developed effective and efficient teaching strategies in Mathematics learning.

Dr Steve Warner

Dr. Steve Carlise Warner, B. Sc., Dip. Ed., M. Sc., and Ph.D. has been a secondary school teacher and administrator for the last 30 years at San Juan Government Secondary School and Waterloo Secondary School as well as a part-time / guest lecturer at UWI ROYTEC, The University of the Southern Caribbean, Open University Malaysia and UWI Open Campus. His areas of study and specialization have been in Mathematics and Computer Science Student Facilitation, Teacher Education, 21st Century skills acquisition, and Distance Education.

Dr. Warner is a regular at international conferences and an editor and author of books as well as journal articles related to the teaching and learning of mathematics and to distance education. He also facilitates professional development workshops for teachers.

Dr. Warner's interest lies in infusing 21st century thinking and skills simultaneously while content is being facilitated in any institution. He believes that this present century requires a different type of learner and facilitator and endeavours to be at the forefront of this educational revolution.
Dr. Warner has been appointed to a team responsible for infusing technology in the teaching and learning process for primary and secondary school teachers, organized by the Ministry of Education, Trinidad and Tobago (2017-2019)

The best teacher is not the one who knows most but the one who is most capable of reducing knowledge to that simple compound of the obvious and wonderful.

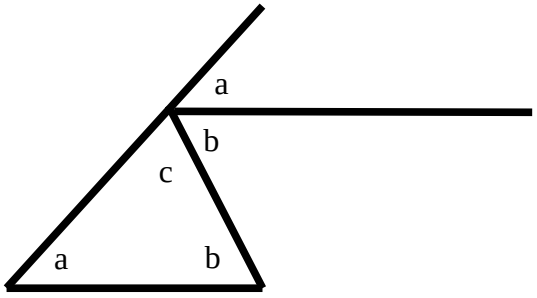
H. L. Mencken

THE WORLD EDUCATION FELLOWSHIP

Dr.David A. Turner

Teaching and Learning Mathematics

Sixty one years ago, I fell in love with mathematics. I know it was sixty one years ago, because I was in the first year of secondary school. In school, we had been cutting triangles out of cardboard, measuring the three angles of each triangle, and then adding them up. We got answers ranging from 175^o to 185^o depending on our dexterity. I remember asking a friend of my older brother why we were doing that. And he did what I suppose Euclid would have done; he took a stick and drew a rough diagram of a triangle in the dirt. Then he extended the sides beyond the corners of the triangle. Finally, he drew in the construction, a line parallel to the base of the triangle, to produce this figure:



From which it is obvious that a + b + c = 180^o in the one case, and
a + b + c = the sum of the angles of a triangle in the other.
So the sum of the angles of a triangle is equal to two right angles, and case proven.

And that was a revelation to me, and I found it full of promise for the future. Now it was not a revelation to me that the sum of the angles of a triangle is one hundred and eighty degrees. I think that I could have guessed that from the work we were doing at school. The revelation was that, although measuring real triangles could never do more than suggest the answer, there was a way, a mathematical way, of arriving at a truth that was certain, and at the end of which one could write with confidence 'Q.E.D' (quod erat demonstrandum, or that which was to be proved). There was a world of mathematics, where you could know things with certainty, and then there was the real world, where we depend on imperfect measurements, and uncertain conclusions. And, although various people have asserted that mathematics is the language of nature, or something similar, the world of mathematics is not exactly the same as the world we live in, especially when it comes to that sense of certainty. (Actually, it took me many more years to learn that second lesson, that mathematics is in a way separate from the real world, and to come to terms with it, but that is another story.)

But, for the moment, let me concentrate on that scene on a street corner, with a diagram scratched in the earth, and a theorem proved. It was certainly the start of a long journey for me. It was the beginning of an interest in how we know things, and with what certainty we know them. What we know of the world is in some way a combination of the abstract ideas we have in our heads, and the experiences we have of the world through our senses. And that way leads into the philosophy of Plate, Aristotle, Hume, Kant and Popper. But that is not what I want to concentrate on in this short essay.

I want to think for a moment about what Robert had taught, and what I had learned. Clearly, he had taught me that the angles of a triangle add up to one hundred and eighty degrees. I may have learned that, although I suspect that I knew it before, in the way that one may know a disconnected fact, like somebody's telephone number. But I also learned that there was a major distinction in how we know things, based on either logic or experiment, and that the things that we know on the basis of logic are more certain. Now I have no doubt that Robert wanted me to learn that second lesson. After all, he was responding to my question as to why we were doing experiments with triangles, and by offering an alternative approach he effectively told me that the experiments were irrelevant, and there was a more direct route to the truth. What I want to focus on here is that there were two

pieces of teaching and learning going on here. Robert taught me the content of a specific proof, in the hope that I would learn a bigger lesson about mathematics and truth. He knew he was doing that, and he was successful. (He may have been teaching a third lesson, perhaps about the design of the universe, but if he was I did not notice, and he was unsuccessful.)

The point here is that, in teaching mathematics, we very often teach one thing in the hope that our students will learn

something different. We teach the multiplication tables in the hope that our pupils will learn the nature of numbers, and see patterns in numbers. We teach long division, in the hope that our pupils will master the position theory of value. And we teach geometry in the hope that our pupils will learn how to apply logical deduction. In general, we teach some content of mathematics, in the hope that our pupils will learn something about mathematics and its place in our thinking.

I do not think that this is an observation that is restricted entirely to mathematics. We teach poetry in the hope that our pupils will reflect upon their own emotional life and personal responses. We teach geography in the hope that our pupils will form a healthy relationship with their environment. We teach history in the hope that our pupils will develop a broader perspective on their place in the world. But the danger is perhaps strongest in mathematics that we become so focused on the specific content that is to be taught that we forget the larger idea that we were hoping would be learned. And in failing to explain to our pupils what that larger purpose is, we ensure that what they learn is that mathematics is a collection of routine procedures, I think we would say today of routine algorithms, which do not make any particular sense.

I do not think this is anybody's fault in particular. I think it is one of the paradoxes of education, that we teach subjects, as it were, from the inside. And we expect that at the end of the process our pupils will climb out of that context, and look back on mathematics, history or geography from the outside, and understand their place in our intellectual life. Not all of our pupils reach the end, and not all look back on what they have learned from that new perspective.

I was lucky. I found Robert in a moment of need, and he was able to explain my frustration with the mathematics that I encountered in the classroom. Who knows what might have happened if he had not been there? And no one answer will be right for everybody. Somebody else might have needed to be given a more empirical answer to their question. But as teachers we need to remember, every now and then, that the content of what we are teaching is not the only thing that we hope will be learned. Shakespeare's Sonnet 116 is a wonderful poem, but it is less important to me that the pupil learns it by heart, than that they love poetry and can use poetry to enrich their emotional life, even if the poems they love do not move me. In much the same way, I am less concerned that every pupil should be able to recite the five times table than that they can see that there are some patterns in the numbers that we use, and that those numbers have some practical value.

And perhaps occasionally, very occasionally, we should let our pupils into the secret that there is something beyond the content of their education that we are hoping they will learn.

Rose Manor International School
(Cambridge Preschool to A levels)

OUR PHILOSOPHY

We believe in creating and nurturing a truly holistic educational environment which respects our cultural diversity. This assists our students to soar high in their professional and personal lives.

Our Curriculum is designed and Assessments are in line with the Cambridge learner attributes. We strive towards cultivating and encouraging creative learning methodology for imparting education and skills which are mandatory to excel in a rapidly changing world. We are committed to the philosophy that every student must get the opportunity to realize her or his maximum potential by exploring dimensions of excellence which encompasses emotional, social, physical and intellectual development. We will work towards bringing out the best value in every child.

MISSION

Rose Manor International School is committed to providing excellence in education that meets each student's interest, abilities and needs within a common curricular framework. We reflect and promote an understanding of, and appreciation for, diversity in our community as an integral part of school life.

Each student is challenged to develop intellectual independence, creativity, curiosity and a sense of responsibility towards others, both within the school and in the community at large.

Rose Manor is guided by its principles **"Learning Today…Leading Tomorrow".**

OUR IGCSE SECTION

Established in the year 1948, we evolved and inaugurated Rose Manor International School – IGCSE in 2016. It has come to be known as one of the leading schools in the suburbs. With performing and visual arts, sports activities forming part of the curriculum we have all it takes in the making of an International School.
Our faculty has over 3 decades of experience that effectively implement the motto and vision of the school, **I can and I w**

Mrs. MaryRose Nazareth.
The Managing Director

Rose Manor International School. It all began with a dream. A dream of providing a Stellar education to the children of this city. It was our Foundress Ms. Eula D'Cunha, who acted upon fulfilling her dreams with the guidance of her father, my grandfather the Late Mr. Marcel D'Cunha. In the year 1948, Rose Manor School began, in a quite little by lane of Santacruz. From her humble beginnings, Rose Manor has risen to becoming a name to reckon with, in the field of Education. What began as a dream has become a wonderful reality today.

When I took over as Managing Director from my father in the year 1995, I vowed to continue to peruse not just Ms. Eula's dreams but my own as well. Rose Manor should be a symbol of progressive and quality education in the ever-changing education scenario in our country. With determination and purpose, I adopted the IGCSE curriculum. That's where Rose Manor International School took root. Today we have classes from the pre- primary right up to the A levels.

Teamwork is the ability to drive individual dreams and accomplishments toward organisational objectives. Indeed, it is the fuel that allows dreams to come true. Over the years, the successive Principals and teachers have worked steadfastly taking Rose Manor to new heights. Our students have stepped out of the portals of our school, well equipped to make a global statement, contributing to a better world for all.

I am indebted too, to our stakeholders, parents, students and alumni who have provided assistance and inspiration along the way...Helping me to continue to dream great things for Rose Manor School.

The Rose Manor dream unfolds for me first as a student, then a teacher and now the Managing Director. Five years ago, I trusted the magic of a new dream. I ventured into making it a reality. Rose Manor International School is a testimony to that.

My dear students as we embark on this milestone 75th year, I want to encourage all of you to harness the fearlessness that comes so easily to you, as children. That's the key to bringing grownup dreams to life! Teach yourself to dream without limits and you will achieve without limits. Talk about your goals. Envision them. Schedule them. Make them real!

Let us celebrate this institution's past with great respect and look forward to its future with great enthusiasm but most importantly let us embrace the present, believing success is no accident. Persevere, learn, study, sacrifice and love what you do. That my dear children is the recipe for making dreams come true!

Priya Fernandes.
Head Of School.

As we reopen physical school this year, we look forward to putting into practice the precious mass of knowledge and learnings we gathered during the pandemic years into action. Pandemic has been the mother of all teachers. We unlearnt and learnt new things, created and improvised our learnings, changed the way we thought and the way we acted. We have moved to a completely digitalised world today.

RMIS is also going through a transition, with new pedagogies and technology. As we shift our focus from Gen Z to Gen alpha, we are trying our best to involve more technology into teaching - learning Process. Gen alpha being born with technology in their hands we are looking forward to integrate AI tools in the day-to-day interaction with our stakeholders.

We at RMIS believe in Holistic development of our students. How can we refrain them from being in the Metaverse? It's our constant endeavour to keep abreast with the latest technology and connect our students learning in the metaverse.

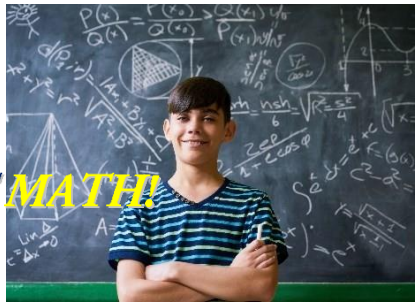
As we step into this Academic Year 2022 - 23, we share with all our stakeholder's dual pride, 75 th Year of Rose Manor and a successful completion of 5 years of the IGCSE Section (Pre-Primary to A – Levels). The theme for this year being, 'Dare to Dream!', We want to dream of the school self-sufficient to prepare Gen alpha for the future. As stakeholders we should all seek the opportunity and get involved , learn and understand the Metaverse quickly – It's barely born but the journey is long.

As we begin the new academic session we welcome one and all with open arms to new learnings. A dream doesn't become reality through magic; it takes determination, constructive planning and hard work. We shall together dream to achieve our goals in reality.

Visit us on:

http://www.rosemanorinternational.com/

MADDENED BY MATH to MAD ABOUT MATH!



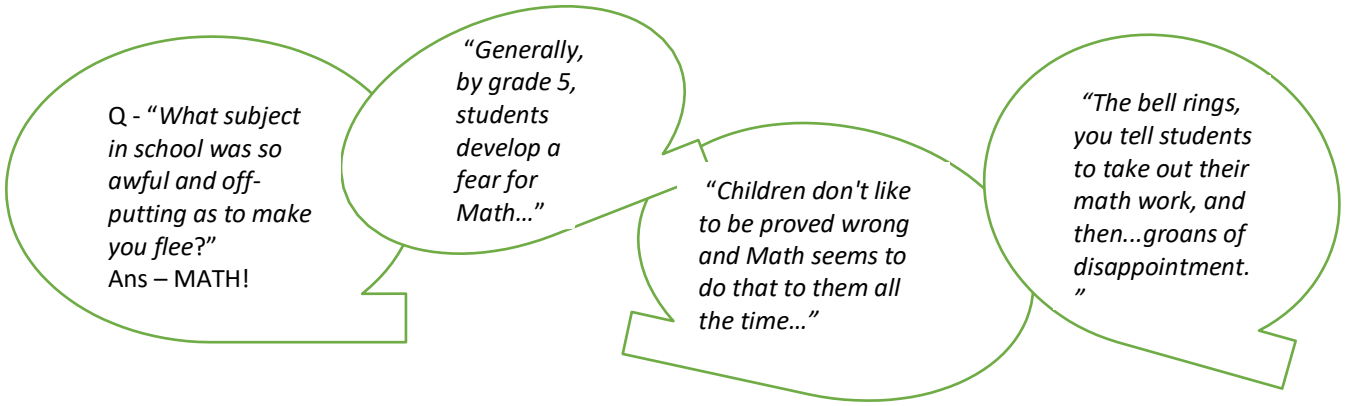
By : Ishita S. Verma, Team QEDRAK, www.qedrak.com, info@qedrak.com

concrete and abstract mathematics is to Scaffold or provide slightly more challenging material and prompting questions that guide a student towards the desired learning objectives.

Concrete activities have enormous emotional benefits too like increased self-confidence, satisfaction, self - efficacy as all understanding begins at the concrete level.

The journey of **Mathematics** can either be a cake-walk, or hang like a Damocles' sword over the heads of students, parents and educators alike. The seemingly easy confidence and stellar performance in pre-school numeracy through primary school arithmetic, progressively dissipates for many by the middle

school - when concepts become more complex, varied and require more than 4 step calculations, a lotof patience and of course the time old adage – *practice, practice, practice*!



Familiar statements? When and why does the FUN with numbers turn into a FEAR of Mathematics! Let's
familiarise ourselves a little more about the basics of this subject – **M A T H E MA T I C S.**
Reality check - Mathematics is omnipresent and required by everyone! The word **'mathematics'** comes from the Greek word *'mathema'*, which means learning, study, science and additionally came to have thenarrower and more technical meaning *'mathematical study'* even in classical time (Roy, 2011).

The earliest evidence of written mathematics dates back to the ancient Sumerians, who developed a complex system of metrology (3000 BC, Mesopotamia). Much later, Aristotle defined mathematics as"*the science of quantity*", and this definition prevailed until the 18th century. In his classification of thesciences, Aristotle further distinguished between arithmetic, which studies discrete quantities, and geometry that studies continuous quantities.

As an integral part of school curriculum worldwide today, Mathematics is one of the core fundamentals in formal educational system. It is an important subject with broad applicability to

everyday life and yet, mathematics is often considered as a ***difficult*** subject in schools (Kaur, 2017). One's attitude towards thesubject plays a very important role in getting **MADdened by Math** OR **Being MAD About Math**! As early as Grade 1, students can start demonstrating *negative attitudes* towards learning mathematics andthis gradually develops into a form of *mathematics anxiety* (Hornigold, 2015). Students find mathematics a *boring* and *disengaging* subject (Colgan, 2014); they hate mathematics, and try to avoid it because of the **stress** associated with remembering the formulae, steps and being accurate with the answer. Even teachers and

parents have negative attitudes towards mathematics; it is expressed as a ***hard*** subject relegated to the *elitist* lot - inaccessible, uninteresting, not for cool nor engaging for *normal* people, and certainly *not* for girls (Boaler, 2016

Mathematics phobia or *Mathophobia* is a feeling of **anxiety** that appears due to the fears of solving different mathematical problems – a feeling of tension, panic, helplessness, and mental disorganization This phobia in the long term can have a negative impact on the health and desire to learn the subjectfurther. Hence it should be addressed at the elementary stages and eliminated.

Mathophobia has many **causes** :

- Weak conceptual base from previous grades
- Weak teaching method – lecture-based teaching as opposed to hands-on experiential learning
- Lack of understanding at the classroom pace
- Inability to solve mathematics problems correctly and in time
- Teachers' aggression, stress and impatience, at times physically or through punishment
- Lack of motivation and use of abusive words by teacher and peers
- Inability to solve voluminous home assignments deemed as 'practice makes perfect'
- Lack of real-life application analogies
- Mathematics learning difficulty (dyscalculia)
- Community Influence (negative perception)
- Lack of a child friendly learner centred environment

Although not comprehensive, this list indicates some of the more **commonly viewed symptoms** of

Mathophobia:

- Trying to avoid numbers
- Getting confused and disorganized
- Apparent choking sensation, problems with breathing, depression, panic, running a fever, sweating, trembling
- Fear of doing anything else,
- General low self esteem
- Becoming disinterested and engaging in disruptive classroom behaviour, even bunking class orschool

The key to making Mathematics a FUN subject lies in the ***approach taken***. The San Francisco State University has developed a programme we can all learn from – ***Math Without Fear***. The course seeks tomove students from rigid reliance on *rules without understanding* (rule orientation - which tends to shift learning into a rote-based journey), to an *understanding of mathematical concepts and flexibility in problem solving* (concept orientation – a more successful journey with contentment of achievement of learning outcomes).

The QEDRAK team has experienced Math in the classroom and has researched extensively on how to shift the attitude from **MADdened By MATH** to **MAD About MATH**! We've put together a list of someof the ways we had explored and we hope they will help students in your class also love Math.

Math games

Online or in-class Math games are tried-and-tested methods for bringing excitement and healthy competition while learning Math. These games can align your lesson plan and robustly engage yourstudents:

- **Card games** like **War**, where two students use multiplication, subtraction or even exponentrules to build cards with a higher value than their opponent's.

- **Math stations** filled with number blocks and other manipulatives during play-based learning activities for younger students.
- **Math board games** that help students learn basic math facts, while also building socio-emotionalskills like turn-taking and collaboration. Try filling a tic-tac-toe board with math facts, or hosting a math bingo game for the whole class
- **Prodigy Math Game** is a video game-inspired learning platform that transforms math into an epic adventure. Created for first to eighth grade, students can complete quests, earn rewards and collect pets as they learn.
- "**Number Scrabble**" (or "**Math Scrabble**") is a game based on normal Scrabble rules, but students need to make equations instead of words.

Visual aids and picture books

Charts, picture books and other visual aids can help **Visual Learners** unravel the mysteries behind newconcepts and offer quick look-up tips as they work. Students can be encouraged to make their own visual aids to reinforce the key terms and concepts! Picture books are also a great way to engage students that prefer *seeing* and *reading* to written math work. Whether it's reading or drawing, there's something to help every student learn new math skills – here are some ideas:

- **G is for Googol: A Math Alphabet Book by David M. Schwartz** — Best for students in 4th to 8th grade, this math book explores interesting math concepts for every letter of the alphabet.
- **Bean Thirteen by Matt McElligot** — Ralph and Flora are trying to get rid of the unlucky thirteenth bean, but it keeps coming back! This story is a goofy exploration of remainders and division.
- **Uno's Garden by Graeme Base —** Search for different plants and animals in the forest where Unolives. Students have to complete skills, puzzles and multiplication questions to finish the adventure.

Using Digital Technology

When it comes to teaching math, ICT & digital technology like smartphones, tablets, laptops (which havevastly impacted student learning in the last 2 years), can broaden horizons and offer students differentways to engage with math on their own terms and at their own pace.

- **Math is Fun** offers student games and math puzzles that balance fun with skills-building

challenges.

- **Prodigy Math Game** or **Educational Initiatives' MINDSPARK**, are both adaptive math based educational games.
- **Dragon Box,** a colourful math app turns concepts like algebra and multiplication into a fun game.
- **Khan Academy** video tutorials**,** offer lessons for a variety of different topics and levels.

In the morning, as students enter the classroom and wait for their friends, you can have ready a set of quick solving **10 Number Crunch Questions** (covering different concepts) displayed on the smart board. Students attempt these Qs on a named response sheet and drop it into a box. Later in the Mathclass the response sheets can be reviewed through Peer-Checking.

Take a hands-on approach & encourage physical involvement

We all know that *worksheets* aren't always the most 'engaging' way to reinforce concepts. For the **kinesthetic learners**, you need to be really innovative about making math a DO and LEARN experience. This involves

finding real-life examples of formulas and concepts, or including student interests in relevant work problems. Strategies that encourage movement out of the seats or just engaging in hands-on learning activities can help a variety of different learners:
Try a **beach ball toss** with equations written on each section or bake with your students to learn about fractions!

- Math puzzles like **KenKen, Magic Squares** and **Tangram** puzzles can also help kinesthetic learners practice their skills.
- Writing and **acting out skits** about math concepts
- A **scavenger hunt** for geometric shapes or patterns
- **Brain breaks** to help students stay focused during long stretches of class
- **Interactive games** like flash cards, dice, manipulatives or "Around the World" with relevant math
  problems
- **Think-pair-share** activities and flipped classrooms can also help students get hands-on experience and talk through new ideas with peers in real time.

Stick to fixed routines

Building a *familiar tested math class routine* can comfort students into feeling settled and confident whenmath class starts, especially the ones with fear about Math. At the onset, **outline expectations** and what students need to bring to class, whether that's a sharp pencil and paper, or just a sharp mind!

a) To **start your lesson**, pick something interesting and unfamiliar, whether it's introducing a new concept or reviewing an old one:

- Spring a discussion question and ask how they would solve it
- Put some vocab words on the board and ask students to define them
- Challenge smart students to analyse a mathematical concept / theorem

b) Spend the **middle of your lesson** teaching or giving your class hands-on experience with new concepts:

- Set up station-rotation activities and small-group instruction

- Use blended learning techniques to promote hands-on activities and group work
- Give a mini-lesson and then hands-on practice with worksheets or other tactile activities

c) **End the class** on a high note with quick activities that reinforce learning:

- Ask students to summarize what they learned, in writing or out loud
- Have students work individually or in pairs to answer a quick wrap-up question
- Set up exit slips so students can indicate what their confidence is level in what they learned, either by submitting a piece of paper or simply answering a question before they leave

Use real objects & apply lessons to life

To help students **picture abstract math concepts** in the **real world**, you can try some Math tools thatcan be incorporated into problem-solving activities for varied ways to learn. For example,

- Play money
- Abacus for counting and number sense
- Spheres, prisms and other shapes for geometry
- Manipulatives like base ten blocks, number lines and clocks
- Small objects like gummy bears, buttons or rocks for pattern making
- Flashcards for subtraction, addition, multiplication and division facts, or other math vocabulary terms

A common phrase heard in many math classrooms is, "*Are we really ever going to this in real life*?" To help students understand the benefits and wonder of math, **relate** what they're learning **to the real world**! Have students research different career paths that use the concepts they're learning, or invite members of the community to speak about how they use math in their jobs. You never know where itcould lead them!

Use interesting and engaging questions + humour too!

Students love stories, so **word problems** are a great way to connect student interests in Math. If you're not sure what students like, send out a quick survey or ask them about theirfavourite books, TV shows or video games. The excitement to find their favourite literary or TV show character or their own names on your next handout will energise the class or and make them excite for HW. Don't forget to add humour!

Example : *Humour for the day…..* ***"I 8 sum pi."***

While you may be a master at framing word problems, try a flipped approach of **getting students to frame word problems** using their understanding of the concept. Students feel engaged and you get your answer on their level of conceptual clarity.

Integrate math into other subjects

Whether it's statistics in social studies or angles in art and sports fields, there are endless ways to connectmath topics and excite students into learning more. Ensure that some math talk happens in other subjects as part of **interdisciplinary teaching activities** to help students stay engaged — especially if thesecond subject is something they're more interested in. This provides a holistic real-life picture.

Focus on your students & Address learning issues promptly

Many educators get through the annual curriculum by teaching in a time-bound flow, with a *one-*

size-fits-all approach. Particularly in the Math class, a shift to **Student-Centred Learning techniques** can help a teacher support the needs of **every** student. The SCL technique involves *kids in decisions about their studies*, which helps them to build a *growth mindset* and encourages them to *make connections between concepts*. Some common SCL techniques include:

- **Interdisciplinary learning** that mixes math with other subjects
- **Service-learning projects** to combine academic goals with community service
- **Personalized learning** through regular formative assessments and pre-teaching
- **Student-Led Conferences** or SLCs that involve students in archiving, evaluating, feedback and decision-making about their learning

Learning issues can crop up at any time. If you notice students falling behind (or racing ahead), **addressit early** to avoid any long-term engagement problems.

- **One-on-one instruction** or in small groups offers *pastoral care* that can help focus attention to individual learning needs (to slow down the pace for those struggling OR step up the challenge for the super smart ones).
- A **mix of individual and group work** can help different learners absorb information in the way they learn best.
- **Response To Intervention (RTI) methods** to address small and large learning issues also help. (RTI focuses on early and continuous identification, assessment and assistance of students who have learning and behavioural needs)
- An **Individualised Educational Plan** (**IEP)** can be set up if the learning needs are serious, in
- consultation with parents and the administration. The IEP ensures that students get access to support that helps them achieve and stay engaged

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Encourage communication with students and parents

Knowing your students well as well as connecting regularly with parents are both equally important, for different reasons. PTMs and *Post-It-notes home* are ways for you to share positive notes and get meaningful insights from parents about how students feel about math. **Math journaling** as well **Entry Slips** & **Exit Slips** after each class, allow students to reflect on what they're struggling with, what they enjoy doing and where they think they need more practice. These can make you aware of the specific needs, confirm your insights, or find something new about the level of understanding and how you needto tweak your lesson plan!

Finally, it would be fair to say that mathematics is NOT everyone's favourite subject, since we are all gifted differently. However, with a POSTIVE approach and support of Parents & Teachers, any studentcan be made to understand basic everyday mathematics. There's NO *one-size-fits-all solution* for engaging a Math class, because it's a process that looks and feels different for every student. We discussed many techniques - don't be afraid to mix it up and try several different techniques to make math fun in your classroom! See which ones students respond to best, then use them to keep your students loving math class.

The **Success Mantra** is – *Keep your Math Class* **FUN** *and* **INTERACTIVE**, *with* **SURPRISE** *elements andconnected with* **REAL-LIFE**.

PLACE OF MATH IN LIFE

Soorya Nair

Bombay Cambridge International School

We usually come across people comparing life with playing tricky games, moving ahead like chess pieces with utmost care, but I would say Life is like Math where we need to make each situation simpler. I like those simplified looks on life because it's already complicated enough. When I felt stuck, I initially blamed the universe, my own bad luck, the economy, and a handful of other things and people who had nothing to do with my lack of success and happiness, but I soon realized that strategy was not helpful. So, in need of answers, I started reading more books about business, productivity, psychology, entrepreneurship, history, biology, you name it. To proceed further extra ordinarily we just need to know pattern and follow it wisely i.e., we need to relate it to Math. You must find the patterns in whatever you're trying to achieve and take happiness.

Scott Adams, creator of the Dilbert comic, and author of How to Fail at Almost Everything and Still Win Big, put it best:

"If you find yourself in a state of continual failure in your personal or business life, you might be blaming it on fate or karma or animal spirits or some other form of magic when the answer is simple math." Mathematics has become an inseparable part of our lives, makes our lives orderly and prevent confusion. We cannot do a single moment without math; it has made our everyday life goes easy and comfortable. Math includes numbers, letters, and equations, but it is also so much more than that, it is certain qualities that are nurtured by mathematics are power of reasoning, creativity, abstract or spatial thinking, critical thinking, problem-solving ability and even effective communication skills"

Practice of Math helps us develop our brain by being very calculative and spontaneous. It also helps us achieve huge success in our own kitchen where we can easily judge how much time for baking, cooking, boiling etc by making our food super delicious. It also helps us know time better and value it since we can easily relate to how much time are we wasting and how things are getting procrastinated. It also helps us a lot when we have to quickly say how much each person has to contribute over the restaurant bill. Math gives us a universal voice because it a language understood by all.

I remember sitting in my school math class and asking, "Why is math important in life?" Where in life are we going to apply these equations and trigonometric values? I also contemplated when I would ever need to know how to solve an algebraic equation. Clearly, I was not the only one! If you are a math professional then you have probably tried to find a way to motivate your students.

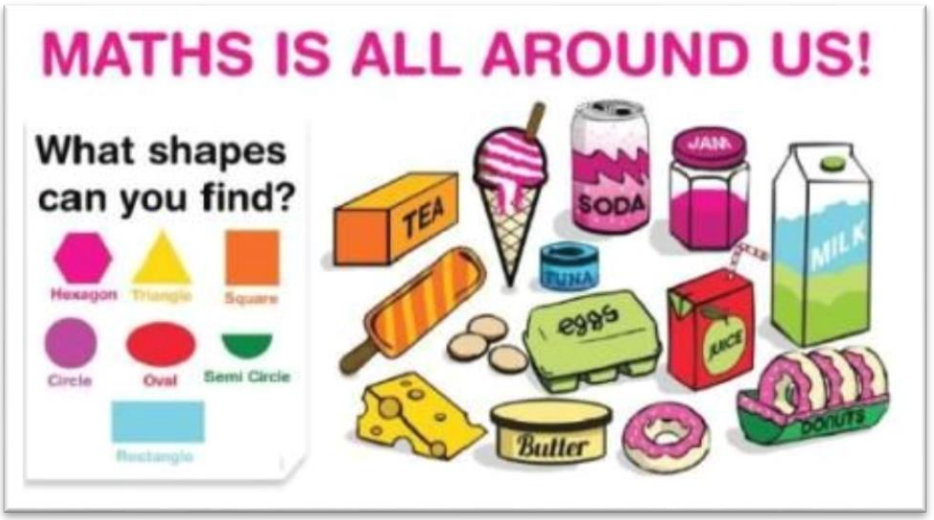
When it is about loving math, I just can't ignore a famous quote by the great **Richard Courant,**

"Mathematics as an expression of the human mind reflects the active will, the contemplative reason, and the desire for aesthetic perfection. Its basic elements are logic and intuition, analysis and construction, generality and individuality."

Life is a math equation, in order to gain the most, you have to know how to covert negatives into positives. The real-life applications of Mathematics are endless. We are surrounded by numbers, equations and algorithms – especially in this age of data science, with huge data sets that can only be understood through statistical models and analysis. Maths gives us the ability to view the world in a way nothing else can!

I conclude with the most heard and accepted mathematical rule of life:

"LIFE + LAUGHTER x LOVE – HATE = HAPPINESS"



The essence of math is not to make simple things complicated, but to make complicated things simple.
— Stan Gudder, American mathematician

Making Mathematics concepts concrete

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If a picture is worth a thousand words,
a hand-held object is worth a million.

For many students, grasping concrete mathematics is the easiest part of learning math. Some students suddenly face obstacles and frustration in their math education when content moves from concrete to abstract. An eager and disciplined student who understands everything that the teacher presents might find very difficult to connect to the new math, no matter how he/she tries because the content is too abstract to understand. Teachers who can properly facilitate this transition can make huge differences in their student's math-confidence and long-term academic success.

Concrete mathematics is mathematics that has a tangible aspect that allows the students to learn the content through direct demonstration or example. Concrete learning opportunities like hands-on activities are essential for every child's mathematical development. When students develop their number sense with concrete math learning tools, a deeper sense of understanding occurs. Concrete materials allow students to visualise and understand maths which allows them to make sense of what is actually happening. It also helps students learn new concepts and relate them to what they have already learnt.

Counting objects, combining them, moving them apart, forming groups are all processes that children can do with their hands. These activities work more areas of the brain than if the same problem were done abstractly. Things always get exciting when the props come out in a classroom and just about anything can be used. Coins, flashcards, beads, dice, cube, seashells, geoboards, tangrams are just some objects that allows students to make mathematics more concrete. Other concrete materials such as playdough can be a fantastic tool for making 3D shapes and helping children visualise what these shapes look like. It is very convenient to show edges, vertices and faces of a particular playdough 3D shape. Using ear buds or match sticks to draw different types of angles can enrich and deepen understanding.

To bridge the gap between concrete and abstract mathematics, a teacher must be aware of the prior content students have been exposed to and the future math content that students will be learning. For example, Let's consider the example of multiplying fractions to dividing fractions. The prior knowledge in this example would be adding and subtracting fractions and the future math content around this concept would be applying order of operation to fractions.

Once the prior knowledge is established, the teacher's best tool to bridge the gap between concrete and abstract mathematics is to Scaffold or provide slightly more challenging material and prompting questions that guide a student towards the desired learning objectives.

Concrete activities have enormous emotional benefits too like increased self-confidence, satisfaction, self - efficacy as all understanding begins at the concrete level.

'Cooperative Learning as a Teaching Strategy in Teaching of Mathematics'.

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Cooperative learning is a teaching strategy that encourages students to assist each other in a small group to achieve a common goal. Through cooperative learning methods, each student in the group responsible to share opinion and work together to solve the mathematical problem. In considering how best to prepare students for the challenges of the next century, educators are changing the content of the mathematics curriculum and the ways we teach it. We are moving from a focus on arithmetic and computational skills toward a curriculum that develops students' abilities to think, reason, and communicate mathematically. The goal is to help students construct their conceptual understanding of mathematics, not just memorize facts and rules.The teaching of mathematics is likewise changing in order to meet these new goals. Instead of teaching by telling or by demonstration, a blend of instructional methodologies is recommended that includes individual and group work and direct instruction. The focus is to provide frequent opportunities for students to explore and solve problems, individually and with others; and to develop their mathematical skills in the context of this exploration.

The teacher is a facilitator of learning, guiding students' explorations, asking questions that extend their thinking, and encouraging students to communicate their thinking. Direct instruction is provided as the need emerges during this process.

SMALL GROUPS

- Small groups provide a social support mechanism for the learning of mathematics." Small groups provide a forum in which students ask questions, discuss ideas, make mistakes, learn to listen to others' ideas, offer constructive criticism, and summarize their discoveries in writing" Students learn by talking, listening, explaining, and thinking with others.

- Small-group cooperative learning offers opportunities for success for all students' in mathematics (and in general). The group interaction is designed to help all members learn the concepts and problem-solving strategies.

- Mathematics problems are ideally suited for cooperative group discussion because they have solutions that can be objectively demonstrated. Students can persuade one another by the logic of their arguments. Mathematics problems can often be solved by several different approaches, and students in groups can discuss the merits of different proposed solutions.

- The field of mathematics is filled with exciting and challenging ideas that invite discussion. Mathematics offers many opportunities for creative thinking, for exploring open-ended situations, for making conjectures and testing them with data, for posing intriguing problems, and for solving non-routine problems. Students in groups can often handle challenging situations that are well beyond the capabilities of individuals at that developmental stage.

THE TEACHER'S ROLE:

A cooperative mathematics lesson might begin with a meeting of the entire class to provide an overall perspective. This may include a teacher presentation of new material, class discussion, posing problems or questions for investigation, and clarifying directions for the group activities. The class then works in small groups, often in pairs in the elementary grades and groups of four in upper grades. Each group has its own working space, which in the upper grades might include a flip chart or section of the chalkboard. In their groups, students might work togetherto discuss mathematical ideas, solve problems, look for patterns and relationships in sets of data, and make and test conjectures. Students actively exchange ideas with one another and help each other understand their work. The teacher circulates from group to group, providing assistance and encouragement and asking thought-provoking questions.

PLANNING:

As the teacher plans, several questions specific to cooperative mathematics lessons need to be addressed,including the following:

- What are the important mathematical concepts of this lesson? How will I helpstudents link these goals with previous work and with long-term goals?
- Does the problem or exploration allow for multiple strategies, perspectives, and solutions?
- What opportunities for direct instruction or class discussion of a mathematics concept or skill mightarise from students' exploration?
- What are some possible opportunities for supporting social, as well as mathematical, learning?
- How can I make this lesson interesting, accessible, and challenging for students at all levels ofmathematical understanding and proficiency?
- How will this lesson provide opportunities for students to make decisions about such things as questionsto explore and strategies and tools to use for problem solving?
- What open-ended questions might extend students' thinking? What questions might be asked tointroduce the lesson?
- What questions might help students during group work? What questions might help students reflect ontheir experience?
- How can I link assessment with instruction?
- What are appropriate extension activities for groups that finish early or for the next day?

INTRODUCING LEARNING:

Cooperative mathematics lessons might begin with a problem statement or a question for exploration. Setting a context for the mathematical investigation serves as a motivator and helps students link the exploration to their own lives. It is also important to help students understand the mathematical goals of the lesson and how these goals connect to prior lessons and learning; what is expected of them; and how they will be held accountable. In addition, the teacher might facilitate a discussion about the group work by asking questions, such as "What do you want to find out?" "What aresome possible strategies you might try?" "What has helped your group work well in the past?" "How will you share the work?" and "How will you agree on decisions?"

FACILITATING GROUP WORK:

During group work, the teacher's role is to encourage students to define the problems they are investigating, to solve interpersonal problems, and to take responsibility for their learning and behavior. The teacher may intervene to refocus a group, to help its members see a problem from another perspective, to ask questions that extend mathematical and social learning, or to assess understanding. The teacher should try not to interrupt the flow of the group work and, instead, should wait for a natural pause in the action. The teacher might ask open-ended questions that require progressively more thought or understanding and avoid giving the impression that there is a "right" answer. It is important to allow groups time to solve a problem themselves before intervention. Asking key questions to help them resolve the difficulty is more beneficial thansolving the problem for them or giving lengthy explanations.

HELPING STUDENTS REFLECT:

Reflection on the mathematical and social aspects of group work helps students develop their conceptual understanding as they discuss their experience and hear about the strategies, problems, and successes of others. Asking open-ended questions helps students consider such important issues as the following:

- What strategies did you try? Were they effective? Why?
- What solution do you think is reasonable? Why do you think that? Is there another solution that mightwork?
- What problems did you have? How did they affect the group? Were you able tosolve them? If so, how?
- What are some ways to work that you would recommend to other groups?
- What was something someone in your group did that was particularly helpful toyou or the group?

The reflection time should be kept relatively short and include use of a variety of methods such as group reflection, whole-class reflection, and reflection through writing or drawing pictures. If appropriate, the teacher might wish to give feedback regarding both successes and problems he or she observed as groups worked.

Individual Activities That Lead to Cooperative Discussion

Graphing

After students have individually responded to a class graph, chart, or table such as Figure 15.1 (Freeman, 1986), several simple cooperativestrategies can encourage students to analyze and discuss the data.

Simple Cooperative Strategies

Turn to Your Partner*:* Students turn to a person sitting next to them to discuss an issue or question, such as "What do you notice about the data?"

Heads Together*:* Similar to Turn to Your Partner, but for groups of four. Students might put their heads together, discuss the data, and agree on at least two factual mathematical statements, such as "More than half the students chose honesty and dependability," or "The same number of students chose honesty as good listener." These statements can then be discussed as a class.

Think-Pair-Share: Students individually take a short period of time to think about a question such as "What inferences can you make from the data?" and discuss their thoughts with a partner. (An example of an inference statement might be "Intelligence is not an important quality in a friend.") Pairs then share their thinking with another pair ***(Think-Pair Share)*** or report their thinking to the class.

Think-Pair-Write*:* This structure is like Think-Pair-Share, except that pairs write about their thinkingafter they have discussed their thoughts with each other. Pairs can exchange their written statementsand decide whether or not they agree with the other pair's statement. The teacher might also collect the statements and place them near the graph for students to read, discuss, and decide whether ornot they agree with the statement

Mental Math

One way to encourage student discussion of mental strategies is to ask them to individually think for a short time about a question, such as "How many ways can you double 38mentally?" Groups of four can then discuss and list as many strategies as they can and make sure each member can explain oneof the strategies. The teacher then asks the class to stand and has one student explain a strategy. After checking with the class for understanding and agreement, the teacher asks all students with a similar strategy to sit down. The activity continues until all students are sitting.

Group Problem Solving

Short- and long-term group explorations, investigations, and problem solving activities provide opportunities for students to cooperatively tackle problems that are not easily solved, to define questions to be studied, to determine the information required, to decide on methods for obtaining this information, and to determine the limits of acceptable solutions. These experiences might include real-world investigations that involve students in solving actual problems that relate to their lives, for example, studying food waste at lunchtime and making recommendations to the principal based on their research. These experiences might be projects that engage students in mathematical exploration and thinking as they develop a product, such as designing and making a quilt. These experiences might also involve students in investigating mathematical ideas and
relationships, such as generating their own algorithms and developing ways to compare the capacity of several containers or the areas of various shapes.

Whole-Class Activities

Whole-class activities provide opportunities for class building as well as for mathematical development.

The following are just two of many possibilities:

Line-up Activities

Students line up based on a specific characteristic, such as their birth- dates. Many options for mathematical activities can follow. For example, the class can form a human birthday graph with allstudents born in January standing in a line, all born in February forming a second line, and so on. This produces a bar graph that can be transferred to paper. Students can also find the median birth date and the percentage or fraction of the students born in each month.

Four Corners

Students with a common characteristic meet in a corner of a room. In a primary classroom, for example, corners might be labeled with numbers such as 0, 10, 20, and 30. Students go to the corner with the number closest to the day of the month they were born. The teacher asks questions that help students explore the relative magnitude of numbers. The numbers might then be changed to *5, 15, 25,* and *35.* Students move to the corner now labeled with the number closest to the day of themonth they were born. Students discuss how their position and the groups have changed, as well as issues of relative magnitude.

COOPERATIVE LEARNING FOR SECONDARY MATHEMATICS INSTRUCTION

To get started using cooperative learning in the secondary mathematics classroom, the teacher might begin with some simple cooperative structures that encourage student interaction. The following describes several useful structures and sample applications for use in general mathematics, algebraI, and geometry classes.

Simple Cooperative Structures

The Three-Step Interview

The Three-Step Interview is conducted in a group that consists of fourmembers subdivided into pairs: A and B, C and D.

Step one*:* A interviews B while C interviews D. The interviewer listens,asks questions, and paraphrases, but does not elaborate or share personaldata.

Step two*:* Reverse roles: B interviews A, while D interviews C.

Step three*:* Share-around: Each person shares information about his orher partner in the group of four.

Math Class Applications of Three-Step Interview

General math: How can you use fractions? What examples of fractions did you find in the newspaper? Algebra I: What are some variable attributes of people in our class or of our classroom (for example,
height or age)?

Geometry: Give examples of geometric shapes that occur in your home.

Thoughtful responses to interview questions are more likely to occur with advance preparation by thestudents. It is useful to give these interview questions to the students a day or two in advance.

Roundtable

The teacher poses a question having multiple answers or gives each group a worksheet. The group has only one piece of paper or worksheet and perhaps only one pencil. One student in thegroup writes down one response, says it aloud, and then passes the paper or worksheet to the personon his or her left. The process continues in this way. A student may choose to pass on one roundand give an answer the next time.

Math Class Applications of Roundtable

General math: Find combinations of three numbers whose sum is 60.Algebra I: Give specific examples of the rule *(a")" = a"'*.

Geometry: State a variety of terms in geometry (for example, "point"). Roundtable can be used for creative brainstorming, simple applications,or review. It fosters cooperative skills such as taking turns and listeningwith out interrupting.

Numbered Heads Together

Each student in the group is given a number from one to four. The teacher poses a question, issue, or problem. Students talk this over within the group and prepare to respond. The teacher then calls upon students by number to represent the group.

Math Class: Applications of Numbered Heads Together General math: Find all factor pairs for a given whole number.Algebra I: State examples of perfect square binomials.

Geometry: State possible values for the base and height of a set ofrectangles that all have the same given area.

Because Numbered Heads Together allows discussion and interaction, it is more appropriate than Roundtable for more difficult mathematical questions. ***Numbered Heads***
Together gives all students equal opportunities to respond successfully in the whole class after small-group discussion.

Think-Pair-Share

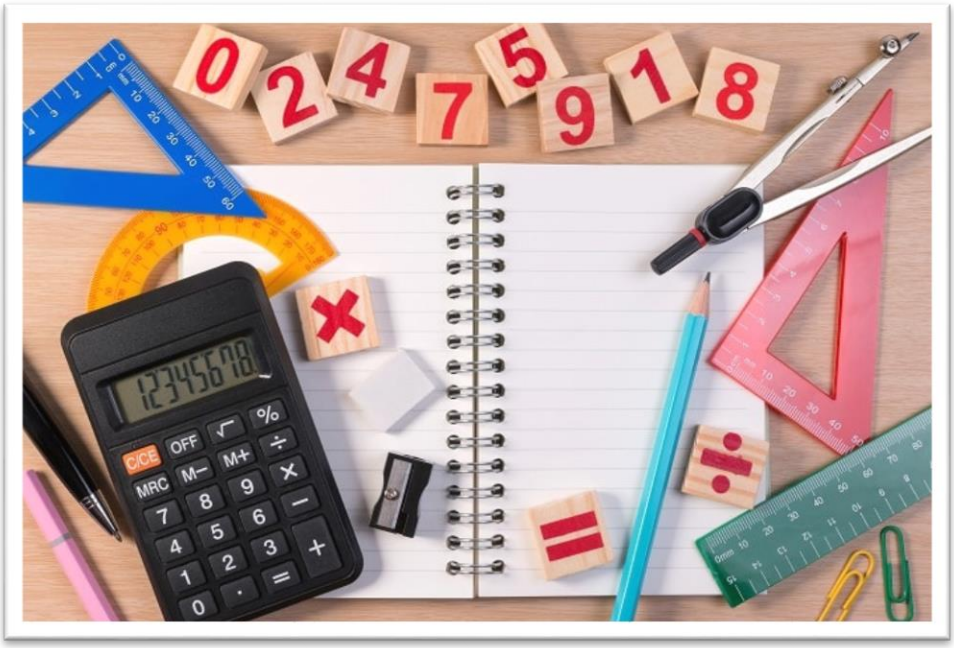
As mentioned earlier in this chapter, this strategy allows the teacher to pose questions to the students sitting in pairs. Students silently think of a response individually for a given period of time, thenpair with their partners to discuss the question and reach consensus.
The teacher then asks students to share their agreed-upon answers with the rest of the class.

Math Class Applications of Think-Pair-Share

General math: Describe the meaning of the terms area and perimeter and show how to10compute themfor a rectangle.
Algebra I: Is the slope computed for a given line always the same, no matter which two points on that lineare used to calculate that slope? Illustrate with examples.
Geometry: Clarify the relationships among these figures: rectangle, square, rhombus parallelogram.
Think-Pair-Share can be used for discussion of concepts or procedures, for problem solving, or for practice. It can also be used spontaneously to clear up ideas given during a presentation. The teacherasks the students to think about what has been presented, and then, in discussion with a partner, students either clarify it or pose a question. Clarifications or questions are then stated to the whole class.

CONCLUSION:

Cooperative learning is a viable and effective instructional methodology for teaching and learning mathematics and helps make mathematics exciting and enjoyable for both students and teachers. Cooperative strategies can be integrated at any grade level and for any mathematical topic. Students "learn to cooperate with others and to communicate in the language ofmathematics. The classroom atmosphere tends to be relaxed and informal, help is readily available, questions are freely asked and answered, and even the shy student finds it easy to be involved. Students tend to become friends with their group members, and the teacher- student relationship tends to be more relaxed." In addition, "Many students maintain a high level of interest in the mathematical activities" and "have an opportunity to pursue the more challenging and creative aspects of mathematics while they achieve at least as much information and skill as in more traditional approaches."



Teach Mathematics as Human Language for Enhanced Understanding:A Caselet

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Abstract

A surprising statistics unfolded in the ASER-2018 that only 20.8 percent of elementary students in Indian government-run schools at Std. III who can do at least a simple subtraction. This is alarming for an aspiring nation targeting an ambitious crewed mission to the moon by 2022. It's high time to take care of mathematics performance on which the superstructure of science rests. Why are kids confused with maths? Where lie the loopholes? What could be the possible solution? This mini-case study was spurred by these basic questions where the authors aimed at adding pedagogical effectiveness in teaching mathematics like a language. Findings revealed that students' mathematics understanding was enhanced when taught through this humanized language pedagogy instead of dehumanized abstractions.

Introduction

Galileo Galilei. (n.d.), the great mathematician and the father of modern science once told *'the laws of nature are written in the language of mathematics.*' Galileo's philosophic assertion may be taken as a proclamation that he forethought long ago. He was immensely correct wrote ***Helmenstine (2020)*** that mathematics is a language just like any other language- English or Spanish. Language is a system of communication using symbols or sounds (***Hauser, Chomsky, & Fitch, 2002).*** Linguist Noam Chomsky defined language as a set of sentences constructed using a finite set of elements (Chomsky, 1991). Some linguists believe language should be able to represent events and abstract concepts. Mathematics meets all of these requirements. ***Helmenstine (2020) further wrote that t***he vocabulary of math draws from many different alphabets and includes symbols unique to it. She illustrated a mathematical equation may be stated in words to form a sentence that has a noun and a verb, just like a sentence in a spoken language. For example: [3 + 5 = 8] could be stated as "three added to five equals eight." People can communicate with each other using mathematics and this mode of communication has been there since days unknown. Thus, math is a language overture that is nothing new.

But what is the vantage of math is treated as a language? *"Understand a fraction 1/b as the quantity formed by 1 part when a whole is partitioned into b equal parts; understand a fraction a/b as the quantity formed by a parts of size 1/b."* If we give it to an eighth-grade student, he will naturally feel embarrassed and perplexed. He may find himself crippled in mathematics forever. But to a math expert, it certainly makes sense but to a kid it's torture. Kids need to have a clear idea of the fractions because these are fundamental for algebras, trigonometry, or calculus. If kids don't get a clear hold on fractions, they are going to have a tough road in higher classes. But are there ways to make fractions simple and easy for kids to understand?

Here the language aspect of mathematics may help students and the focus to this paradigm shift should be given from the elementary levels. A few examples are placed in Fig. 1 for easy understanding of this deep sense of language lying inside mathematics.

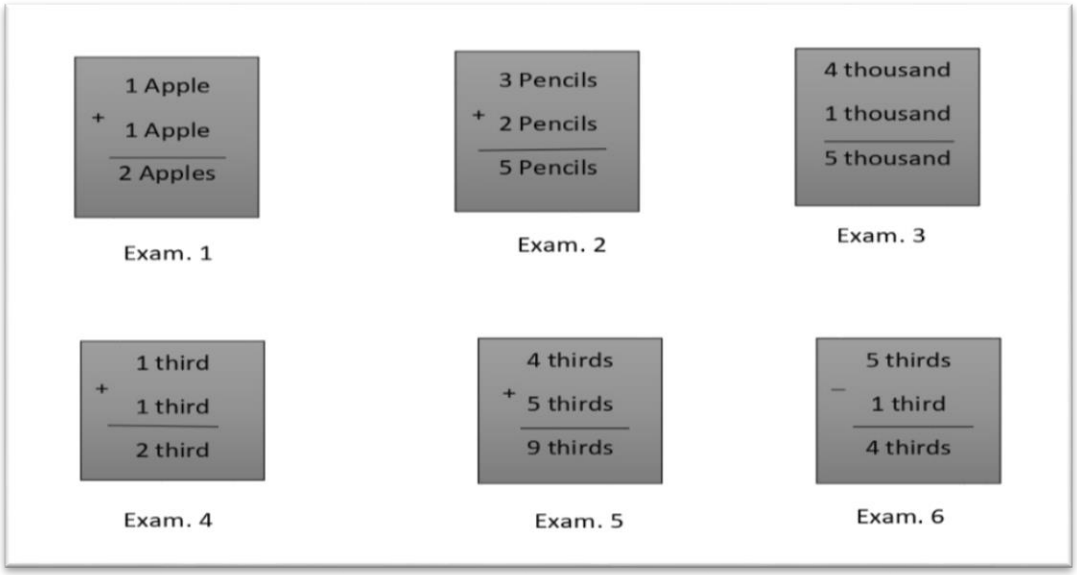

Figure 1: Language sense latent in mathematics

Starting with the 1st example kids will easily solve the problem. In the next two examples, the problems get more complex but kids will reply, based on their language sense common in all three problems. Especially the correct addition of 5 thousand is most difficult not even expected from an elementary student when the kid doesn't have a basic math skill of how to do additions. But his/her inherent language sense here helping them to seek out the problem. Coming to the fractions when an elementary kid does know nothing about the numerator and the denominator or why they are separated by a line. But out of his/her language sense solve all three problems in Examples- 4, 5, & 6. He probably doesn't think it in that way as well, rather he thought in a simple language repetition. Naturally, if an elementary student can do this and master this lying language sense he will surely do better in mathematics the next levels.

Objective and Design

The basic proposition gets further consolidation as a hypothesis that mathematics may be taught to elementary students as a language for enhanced understanding. But the authors went out to add further assurance through empirical evidence. To this end, a mini case study or 'caselet' was conducted in a government-run Indian elementary school in the state of West Bengal having classes from grades 1-5 with 95 students. A caselet is a shorter version of a case study, generally two to three pages in length (ICMR). This particular method has been gaining traction as a pedagogical tool in management teaching and executive education. The basic objective of a caselet is to allow the learner to apply ideas and insights from theory to the real-life issues and problems contained in the caselet. This helps the learner obtain a deeper understanding of all the relevant factors in a particular problem situation as well as gain insights into the finer nuances of a topic in a particular field of management (ICMR). This is a casual approach to solve a problem without methodological rigor. All 21 students in the 5th grade participated in the study conducted by the two researchers in front of three teachers having a design approach.

Project Outcome

During the survey the students were asked an algebra question: [7 X^2 + 2 X^2 =?]. They suddenly became puzzled and nobody could answer rather felt uneasy, conveying the impression they were poor in mathematics. However, researchers pass a little more time with them explaining the problem simple in the above stated manner (in Fig. 1) and students could easily understand the answer is: [9 X^2]. Then they blushed with shyness probably because such an easy answer they didn't know! Deep observation found their confidence reflecting around her faces and activities.

The next question asked was a simple multiplication but majority of kids didn't realize the problem: [7 × 3 =?]. Then they were illustrated in the language teaching method they could easily get it. Multiplication has also language embedded in it. Here we need to change our dehumanized approach to the humanized way, the one having underlying language sense. We should read the problem as *"Seven times 3"* and this will appear simple to the kids. They will make it as: [3+3+3+3+3+3+3 = 21]. Thus, when they feel that such a repetition gets easier with a multiplication then they get a full overview of the problem and will never forget.

Another interaction raised during the project needs a mention here. One 5th grade girl once asked *"Sir what is the price of a laptop?"* This was the first time she had been viewing a laptop (belong to the researchers) so closely that is why the question came to her mind. We simply told her that it costs thirty thousand and asked her what could be the price of such five laptops? She replied all five made one lakh fifty thousand. Then the girl looked at us disapprovingly said *"sir, it's too expensive and you have spent a lot of money."* The point is that at that moment math was no longer difficult for her. She could easily comprehend how much (one lakh fifty thousand) we have to spend. It gets easier to her since she has been using mathematics in solving a problem.

Conclusion

The authors conclude that students didn't understand because we didn't soundly teach them. We are teaching mathematics as a dehumanized subject. But if we teach math as a human subject, it will work better on the kids. It also concludes that mathematics is a human language and we have to understand it in this way. The simple truth is that if take something by heart it will appear easier to us and we need to accept this language approach to teaching as soon as possible. In elementary classes, too many kids are anxious about their mathematics. It is even more anxious for their guardians as well. A rudimental change in the orthodox mindset of teaching is fundamental for grafting new policies into practices. As an educator we have to make learning problematic, involving learners cordially in problem-solving. Mathematical thinking not only builds our minds but is also a basic necessity for the complex world the future generations going to have. We need to change our approach to teaching mathematics, especially in multitudes of substandard government schools in India and we need to get that sooner rather than later. We can't continue with 20.8 percent further. Among alternative approaches, we can try to '*teach mathematics as a language'* that the current study comes up with apposite rubrics to teach math like a language with proven efficacy.

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The 2T2C Instructional Model for Teaching Mathematics in the 21st Century

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Abstract

This paper is an excerpt from a larger study whose main objective was to develop an instructional model to infuse 21st century thinking and skills in the teaching of secondary school mathematics. The study also determined the effectiveness of the instructional model in improving 21st century thinking and skills and mathematics performance amongst secondary school mathematics students and determined students' and teachers' views on the effects of the instructional model to facilitate learning of mathematics and 21st century thinking and skills. The study applied a quasi-experimental pre-posttest control group research design to explore and measure significant differences in the infusion of elements of 21st century skills among groups of students, facilitated by teachers using a new student-centered teaching model based on the 2T2C Model, when compared with students taught by teachers using conventional and traditional methods. The population of the study consisted of 4 classes comprising 117 Form Four students in a typical government secondary school in the central region of Trinidad. Teachers were trained to implement the instructional strategies using the 2T2C Model over a period of four months. Qualitative and quantitative approaches to data collection were used. A paired sample *t-test* was used to measure whether there was a significant difference in the test scores of the experiment and control groups. With $p < 0.05$, there was statistically significant difference in the scores of the experiment group when compared to the control group. A one-way ANOVA between groups was conducted and there was a significant effect on the implementation of 2T2C - [$F(7, 226) = 50.96$, $p = 0.00$]. When the 2T2C Model was employed on the experimental group, test scores improved significantly; students and teachers gained a better perspective from the teaching and learning classroom environment; high-order questioning and thinking were accomplished; the relationship between mathematics through real-world questions was realized by students; communication improved through planned cooperative and collaboration sessions; the use of technology as a resource both in and out of class provided a framework for communication and thinking; and student's confidence and self-efficacy improved as they took responsibility for their learning. The results demonstrated clearly that 21st century thinking and skills were infused simultaneously while the teaching of mathematics were employed using the model 2T2C and there was an improvement in mathematics academic performance and teacher satisfaction.

Background

Facilitating students to become effective twenty-first century knowledge creators, inventors and innovative workers is increasingly recognized as a primary objective of education.
Today, the rapid expansion and availability of knowledge indicates the importance of curriculum and classroom instructions that will empower learners to process knowledge using learner centered strategies rather than merely memorizing facts infused by the teacher. Rotherham & Willington (2010) suggests that this present era mandates that students attain the kinds of skills that are required to use the communication devices and technological tools and resources, capitalize on team efforts and use the correct interaction and communiqué skills daily in our everyday living and which will become essential in all entry-level jobs. This means that graduates at every level of the educational system be equipped with the thinking and skills to interpret, analyze or manipulate information, critically think about information, ideas and opinions, and draw conclusions, inferences or generalizations, communicate their ideas and provide constructive feedback to peers. Students also need to be able to produce original thought, make predictions, propose solutions, create new tools, solve real-world problems, judge ideas, express opinions and make choices and decisions (Trilling & Fadel, 2009).

The real question however, is, whether the education systems of today have been receptive or will make the necessary changes to prepare their learners with the capabilities of performing the various tasks mentioned above. In this respect, it gives the impression, as Rajendran (2002) suggests, that despite numerous vigorous attempts by various reformers to make such twenty-first century thinking and skills a primary focus of education and to effect whatever changes in educational practice, there has been remarkable resistant to these efforts.

Twenty-first century thinking and skills include teamwork, communication, innovation, and creativity and have as corollaries, creating, evaluating and analyzing, challenging the learner, promoting active participation, argumentation, problem solving, conducting investigations and tackling subject matter that is complex (ATCS, 2010). It involves a new classroom culture that caters for students being at the center of learning and being fully involved in active and participatory learning.

The following 21st century skills, from The Framework for 21st century Learning (Partnership for 21st Century Skills, 2009), are seen as ideal for mathematics classroom instruction: critical thinking and problem-solving, communication and collaboration, and information communication technology literacy and application. The solution to making 21st century skills have an important effect on students is to transmute them into classroom applications connected to curriculum content and assessment (Jacobs, 2010). Reagan (2008) corroborates that the infusion of 21st century skills must be a primary element of teaching and learning and not placed as add-ons to the curriculum.

It is easy to articulate a commitment to the development of twenty-first century skills but more demanding to translate this commitment into action. How do we develop curriculum, such as mathematics, with teaching and learning strategies that both addresses subject matter content and emphasizes twenty-first century skills? Such a curriculum will encompass students taking responsibility for their learning and having confidence in their abilities to perform the assigned tasks.

As Savery & Duffy (1996) remarked, appropriate teaching strategies and learning environments facilitate growth in acquiring such thinking and skills. Similarly, students' and teachers' persistence, self-monitoring, open-mindedness and flexible attitudes, also contribute to achieving twenty-first century skills. In addition to students acquiring content in any subject area, it is important to know and be concerned with students thinking skills and mental processes in learning (Treffinger & Feldhusen, 1999), as well as cooperative and collaborative and communication skills.

Educational systems which demonstrate academic excellence solely depending on summative examination results will propel rote learning and regurgitation of facts. Academic achievements based solely on summative examinations results may not depict whether classroom learning really did take place in terms of achieving certain skills, such as, problem solving and critical thinking skills, cooperative and collaborative and communication skills (McKay & Kamber, 1997).

The 2T2C Model

It is a truism that the 21st century learner and graduate should possess skills which are necessary for the knowledge-based society we now reside and function. The instruction model, 2T2C, typifies and ensure that elements of 21st century thinking and skills are infused simultaneously, while content is being delivered during mathematics instructions. These skills are thinking creatively and critically; use of technology as a resource to solve problems; being able to communicate collaboratively and cooperatively; and having the confidence to be able to solve new problems. Thus 2T2C – Thinking Technology Communication Confidence.

The 2T2C model firstly provide teachers with the necessary and relevant training, to ensure that they understand the need and relevance to transform their thinking and then be equipped with the competencies and skills, as well as understanding of the need to infuse these skills, in their teaching and learning. The training also prepares teachers with the confidence and resources that is critical for them to perform their teaching duties expertly. Support is also provided when and where necessary during the implementation of the model.

The purpose of 2T2C is to facilitate the infusion of elements of 21st century skills and competencies, simultaneously, while teaching mathematics content. As students respond to classroom instructional strategies and the intervention, teachers will implement 2T2C adeptly. Thus, in the end, both teacher and students, via 2T2C, will possess 21st century thinking and skills which are synonymous with 21st century learning (Warner, 2015).

The Figure below depicts 2T2C. The model has both a conceptual and theoretical framework as its foundation. The training of teachers and equipping them with the thinking, skills and competencies are crucial. The four pillars of the model are the elements of 21st century skills being used in this study, namely, Thinking, Technology, Communication and Confidence.

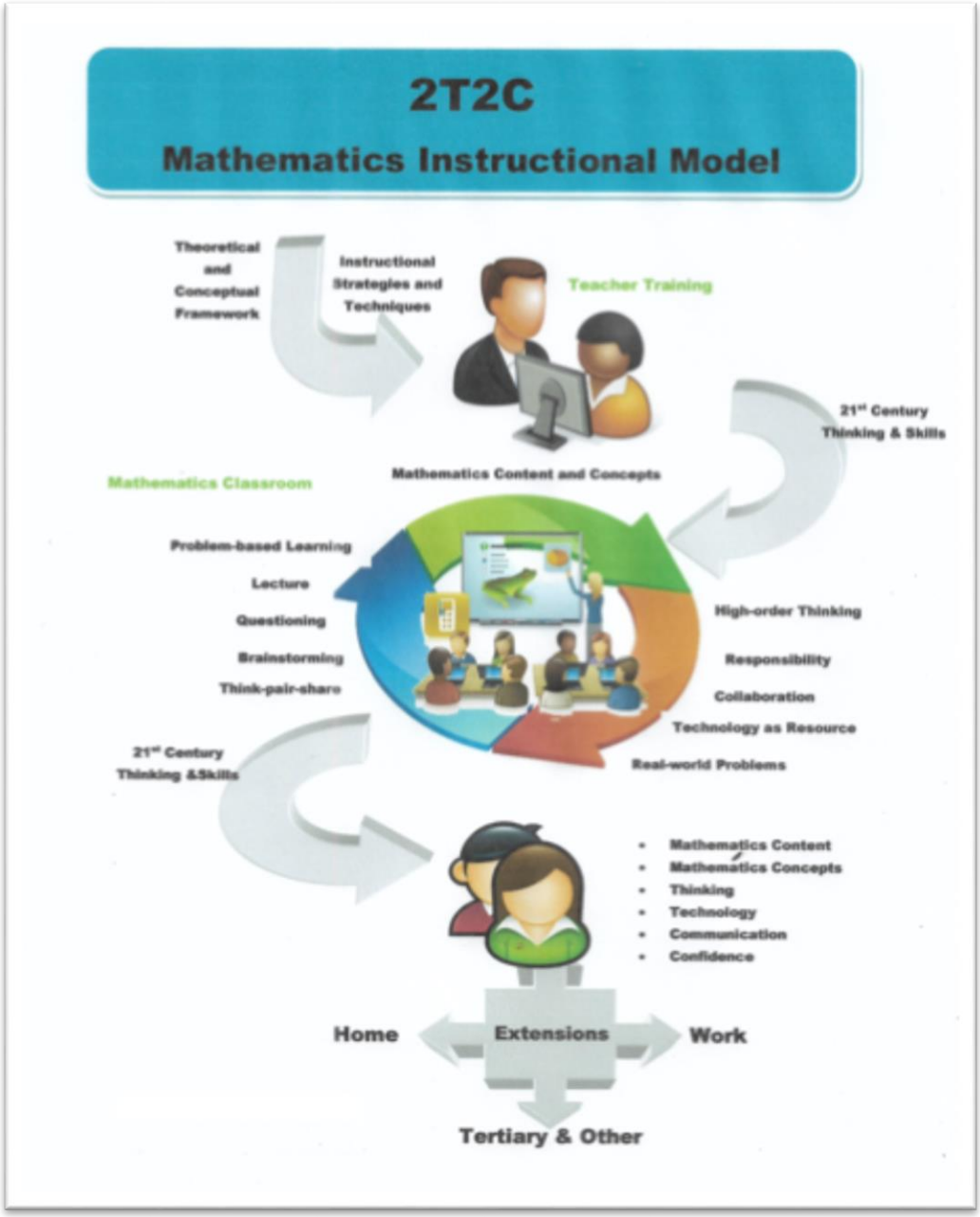

Figure 1: The 2T2C Model

> Why do children dread mathematics? Because of the wrong approach. Because it is looked at as a subject.
> — Shakuntala Devi

The Conceptual Model

The figure below demonstrates the conceptual model for the 2T2C instructional model

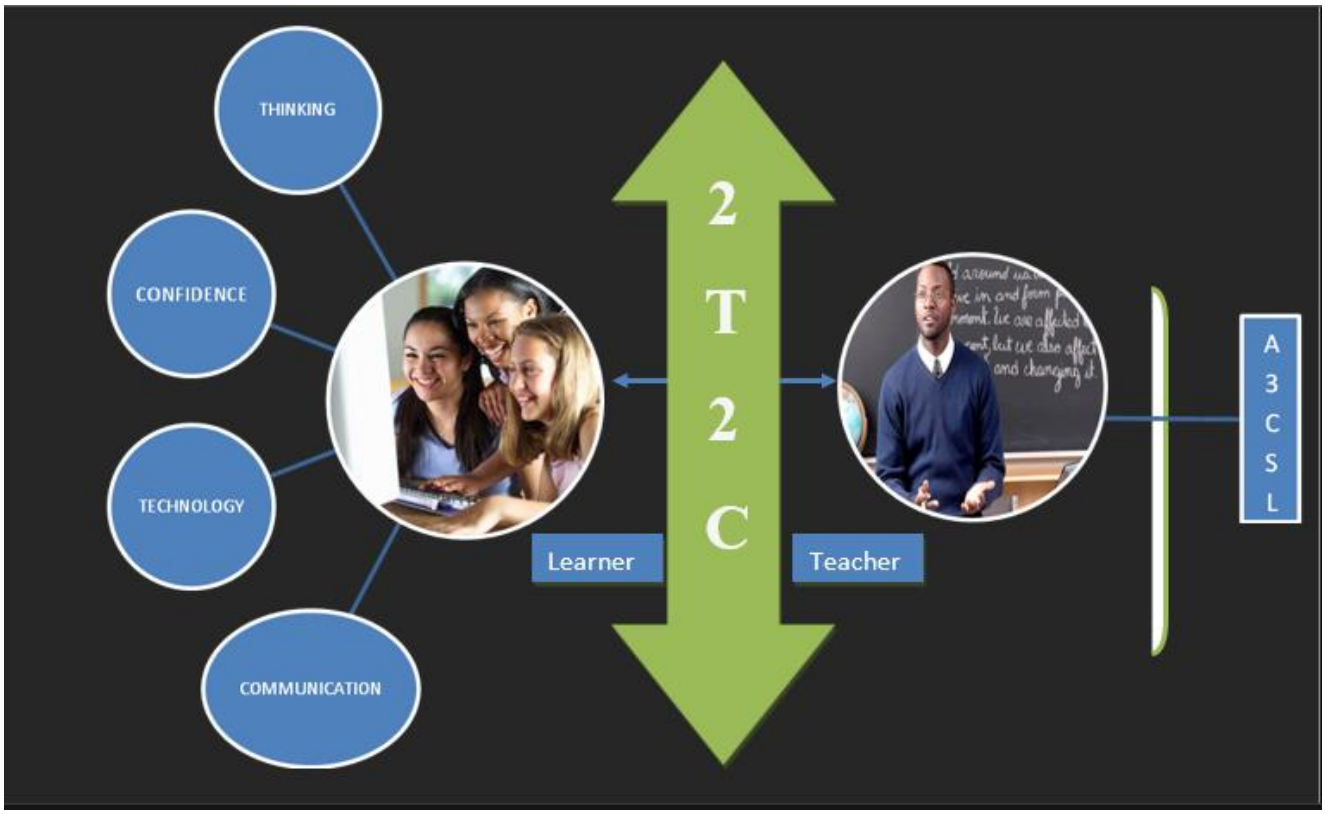

Figure 2: The Conceptual Model

The Theoretical Framework

The Theoretical Framework is based on the figure below:

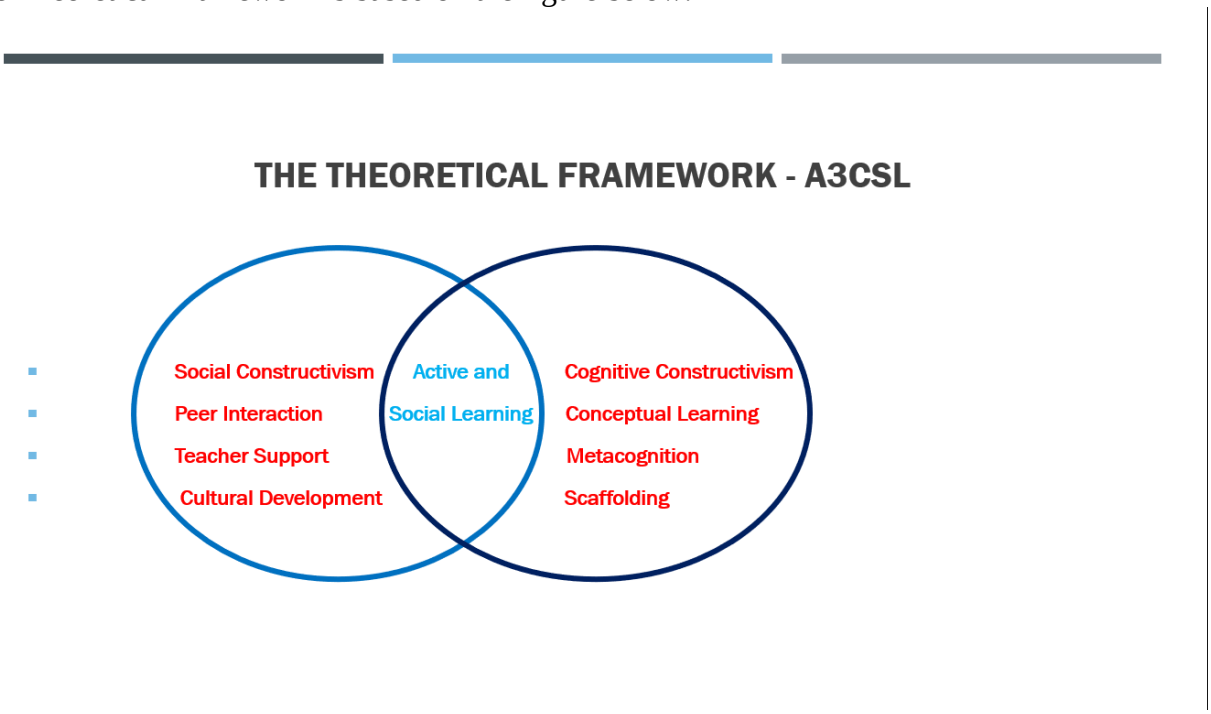

Figure 3: The Theoretical Framework: A3CSL – Active, Collaborative, Cooperative, Cognitive and Social Learning

Teacher Training

It is imperative in the 2T2C model that teachers are trained and supported to ensure that they are equipped with the necessary skills and competencies in facilitating the elements of 21st century skills simultaneously with the scheduled content schemes of work. Teachers will be made aware of the various learning and teaching strategies they can use to guarantee that not only learning of content takes place, but that the 21st century skills are attained. It should be noted that the instructional strategies used by teachers may depend upon their judgment and pedagogical content knowledge.

There are several approaches which can be implemented to make certain that classrooms are active and where thinking, communication and confidence are stressed and engaged. The training of teachers will therefore cater for the use of these schemes and tactics can assist teachers in creating the required active classroom environment. For example, the Think-Pair-Share method used in collaborative classrooms is one such strategy which can be employed. Questioning skills can also be employed expertly to allow students to think critically and creatively to solve real-world and non-algorithmic problems. Thus, in the training of teachers, they will be given such information, examples, practice and support to assist them with their teaching/learning experiences.

The training of teachers to use the model, 2T2C, has the advantage of being easily transformed to be implemented using blended approaches. Online learning sessions in the form of professional development, via Web 2.0 tools and other Open Educational Resources (OERs), can be arranged. Blended learning can be applied as it may not be possible for teachers to be given the required time during the school hours for the training. Thus, the training of teachers for 2T2C can be accomplished using many approaches, for example, face-to-face, blended or via professional development using online support and the use of OERs.

The duration of the training should take 75 hours over a period of 10 to 12 weeks. Ideally there should be some face-to-face contact between the facilitators and the teachers during the training programme. However, if this is not possible, as in the case of the training being performed fully online, then a learning management system will be utilized. Teachers will have to spend time reading given materials and practicing infusing the skills from the examples provided the facilitators. Videos will be provided as resources to enhance the reading material.

Teachers will be trained in instructional approaches, as to how to get their students to be confident – student's self-efficacy will be defined and ways given to improve same. Communication will take the form of three parts, namely, collaborative, cooperative and social/communication skills. The difference between high and low order thinking will be defined and discussed in detail; and their corollaries explained – critical and creative thinking. The infusion of ICT will be given and the Technology Integration Model employed.

There will be a session for discussion, practice and reporting. Teachers are expected to have a portfolio where entries are made about their experiences during the training period. Teachers will be asked during the training to participate with each other how they expect their students to interact and share. Thus, teachers will gain from the training experience threefold. Firstly, they will receive the literature on the elements of 2T2C; secondly, the use of ICT tools will be done and practiced with the teachers with each other; and finally, teachers will have experience of integrating all the theory into practice with their colleagues. In this way, teachers will have the theory, practice and experience in using the resources they may then want their students to interact and have discussion with and use as a resource.

At the beginning of the training and throughout, the facilitator will emphasize the need for 21st century thinking and skills. Teachers need to understand and be convinced of the need of infusing these skills and competencies as relevant and necessary and to believe that students need them to exist in a world that requires them continuously, to solve new problems. teachers will be given information about our knowledge-based economy. Demonstrations will be given, articulating how fundamental these skills and competencies are in the 21st century. Examples will be given of numerous situations where new thinking has been crucial.

In summarizing, the teachers, facilitators of the pillars of 2T2C, Thinking, Technology, Communication and Confidence, will be trained to ensure that they not only possess the thinking and skills and competencies, but they understand and are convinced that these skills are important and crucial for every student to acquire. Also, the mode of training can either be face-to-face or blended, depending on the availability of time and for teachers to undergo the necessary training.

Student Involvement

2T2C involvement guarantees the infusion of elements of 21st century skills. In the process, teachers will be transformed to facilitators, and classrooms will be active. The teaching/learning experience will be full of interaction and technology resources will be used to enhance learning. The teacher's questioning skills, for example, will be used to entice student's response to think at higher levels and the real-world questions and projects will be a valuable experience for the future.

Instructions to students will comprise of the following:

- Whole-class conceptual development of CSEC mathematics ideas and skills
- Use of a variety number of instructional approaches for conceptual development, skill acquisition, and application, including re-teaching, enrichment, and/or additional practice
- Guided practice
- Use of physical, visual, and abstract representations
- Manipulative and technology as instructional tools and for individual skill practice

The following is a list of resources to be used in the model to ensure student participation and engagement while 2T2C is being implemented:

- Instructional materials aligned to the syllabus
- Content materials that support the Intended Learning Outcomes
- Pacing guides
- Manipulatives and technology

Students are expected to be instructed for the most part in an active and interactive classroom experience whereby teachers will not be only interested in subject matter content, but in the acquisition of the elements of 21st century skills as depicted in this study. Thus, the numerous teaching strategies will include the use of contrast – voice and tone; creating and using emotion storytelling and debate; where knowledge is built on previous knowledge via concept lesson through project simulations (Harkirat, 2010; Banikowski, 1999). The use of portfolio writing, projects and technology will also be a part of student involvement.

Example of Implementing 2T2C

It must be noted that each session should see the teacher planning and interfacing with the theoretical framework and conceptual model. Too often, teachers return to what work for them in the past and what the educational system demands which is rote and teaching the curriculum for competitive testing. Most times learning is sidelined and overlooked.

The role of a teacher as facilitator in the 2T2C model is not to cajole students into a certain perspective or way to think about mathematical concepts, but instead to give students the confidence and skills to analyze and think for oneself and to be ready for the ever-changing 21st century information and knowledge era. To accomplish the teachers' role to implement 2T2C, training was provided for the teachers of the experiment group, to prepare them to open new windows of understanding students, teaching, learning, purpose, community, and most importantly themselves. The training of teachers is therefore very crucial for the implementation of 2T2C.

Teachers have preconceived beliefs about how to teach mathematics, formed from their experiences as students, their pre-service education, past and present experiences in teaching, and professional development throughout their careers. Many of these beliefs about mathematics instruction may not align with current reform standards; change is, therefore, both necessary and extremely difficult. Thus, the need to provide some training to equip teachers with the skills and competencies to implement 2T2C.

Teacher's beliefs are largely influenced by their experiences in learning mathematics, and teachers frequently teach mathematics as they were taught (often a traditional approach to mathematics instruction consisting of drill and practice (Metz, 2007). As a result, the teacher's traditional beliefs about mathematics instruction are passed on to their students. To have mathematics classrooms that encourages a more constructivist model of teaching (students actively participating in mathematical tasks that foster understanding), the teacher training aspect of the model was instituted.

The teacher ‘s pedagogical content knowledge is extremely important when considering changing teacher ‘s beliefs and, ultimately, their instructional practices (Ma & Xu, 2004). It was envisioned by the researcher that by using their new knowledge from the training, teachers developed more awareness of children ‘s abilities in learning mathematics. By viewing lessons taught by other teachers, reflecting on themselves as practitioners, and having many discussions (both face-to-face and online using Skype) with the researcher and their colleague, the teachers were able to generate appropriate questions to probe student’s thinking.

During a typical 2T2C problem-solving session, for example, students will be given specific mathematical problems and told to use their prior knowledge to solve them. These problems will be open-ended real-world worded problems requiring multiple steps to solve. The students will work in groups and spent time trying out different strategies that they came up with on their own to understand and solve each problem. Students overall understanding of mathematical concepts of the topics being covered as well as developed positive attitudes towards tackling more difficult mathematical problems should be the result of these sessions.

Conclusion

It must be noted that 2T2C can be used for any subject area or discipline in primary and secondary school. 2T2C has been experimented with and used extensively, and the results demonstrates that 21st century thinking and skills can be infused simultaneously while content is being delivered

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Vedic Mathematics: Power for Brain

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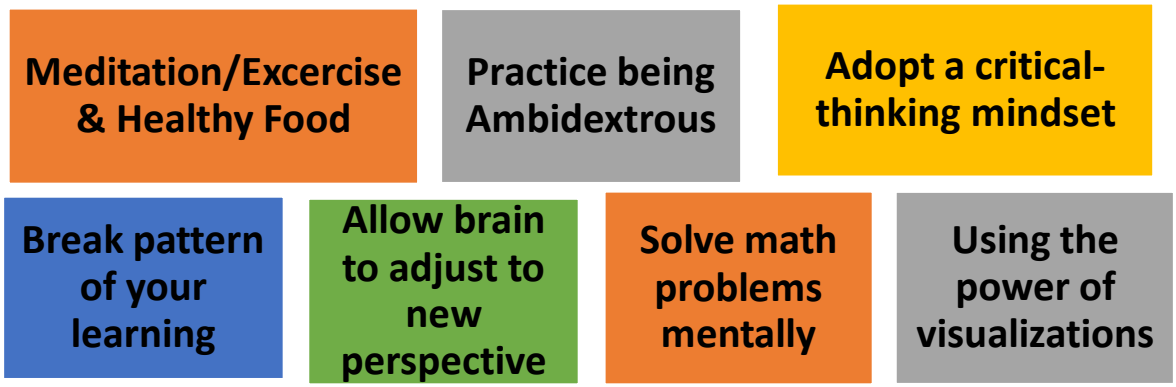
Today's word is technology, which is speeding quickly due to its immense power. With the growth of technology, a student now needs to be able to think quickly. But how do students with median ability adjust to this new technology? As a result, it is critical to increase the cognitive power of children. Increasing brain strength not only helps you keep up with the modern technology era, but it also aids in faster learning, greater memory, sharper thinking, problem-solving inventiveness, and efficiency. Researchers have been looking into a variety of methods for increasing a child's brain power.



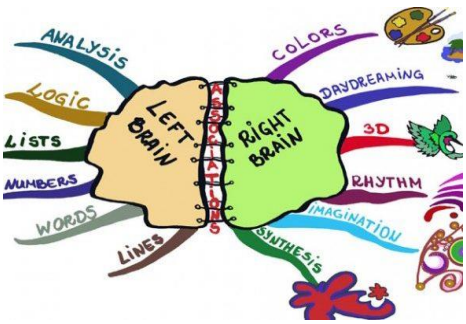
Methods for Increasing a Child's Brain Power

Math is a great approach to boost your brain strength. However, Modern Mathematics does not have the same ability to improve brain function as our Ancient Mathematics system named **Vedic Maths**.

Many mathematical operations, ranging from elementary addition, multiplication, subtraction, and division to more complex topics such as Algebra, Differentiation, Integration, Trigonometry, and Geometry, may be solved quickly as well as mentally by using Vedic Math's formulas (16 formulae and 13 sub-formulae) given by Swami Bharthi Krisna Tirtha ji. One unique ancient way of solving mathematics not only aids in the development of a child's mathematical ability, but also contributes in the improvement of the student's brain function. Vedic Maths-Power for Brain:

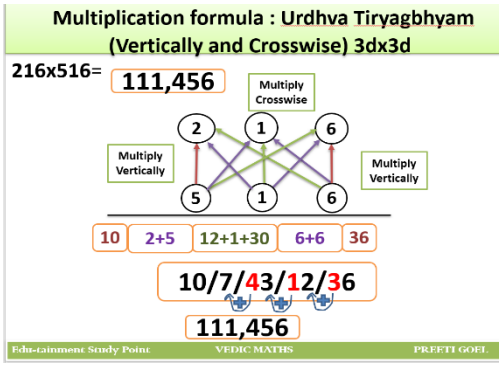
1.Vedic Math focuses on mental calculations, visualisation that keeps brain fit and sensitive. Medical research has proved that without any mental exercise, brain weight can grow and cannot be lowered any more. As an example, consider adding 198 to 247. A simple and natural method is to add 200 and take away 2, giving the answer 445. The sutra indicating this is Yavadunam meaning Deficiency. Taken in its widest context the sutra describes or indicates the mental process involved with solving any type of problem.

2. The most important advantage of learning Vedic Maths is that it allows a person to use both the left and right sides of their brain for logic and imagination, enhancing their ability to solve problems in the most creative manner. Our current math is only concerned with the left side of the brain. Unlike Vedic Math, there is no room for using the right half of the brain.

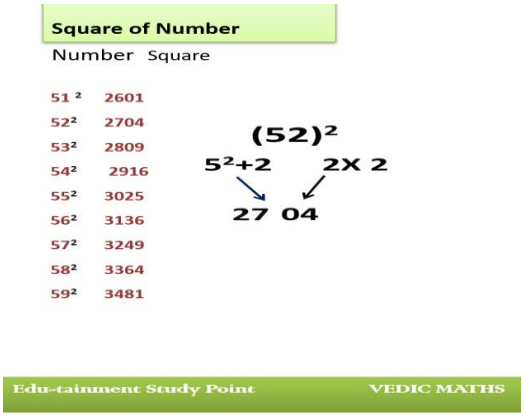


"Logic will get you from A to B. Imagination will take you everywhere." ~ Albert Einstein

3. It facilitates in breaking the traditional right-to-left pattern of solving mathematical problems. Multiplication, addition, and subtraction are always started from the right side in modern math, although they can be started from either side in Vedic Maths. This technique generates intermediate products in parallel, which not only speeds up multiplication but also helps to develop the brain.



4. Patterns are more important to the human brain. Like in Vedic Mathematics, the brain is trained to see things as patterns. For example, in square number from 51 to 59 there is a pattern. Every square number of (51 to 59), last two digit is square of last digit of number. And first two digit is sum of 25 and last digit. As a result, it allows for the exploration of alternative methods to the same problem. Vedic Math simply mentally plugs in the core factors and figures out what must be happening into the situation.



Sri Ken proposed that the formulas of Vedic Maths operate as the way the mind functions. As a result, any mathematical issues cannot be beyond the mind's ability to work or think. As a result, it covers everything. It has now become a must-have learning tool for students who want to execute calculations faster in a logical and creative manner in a fraction of a second. As a result, Vedic Maths is known as "Power for Brain."

"The intuitive mind is a sacred gift and the rational mind is a faithful servant. We have created a society that honours the servant and has forgotten the gift."- Albert Einstein

Visualization In Mathematics- A Skillful Art

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Source: https://manavrachna.edu.in/blog/mathematical-visualization-skillful-art/

Call it a myth or a belief- but many people presume the fact that they aren't good at Mathematics -that their brains aren't wired to think mathematically. But just as there are various paths to mastering Arts and Humanities, so there are also alternative approaches to understanding Mathematics. One of the most effective methods by far is **VISUALIZATION.**

'If a picture speaks a thousand words then in Mathematics a picture can spawn a thousand ideas'

Visuals help to engage students, to grab their attention and demonstrate how Mathematics is relevant in their lives. In today's scenario, a scholar needs a logical reasoning for everything they're taught. Visual models are important tools in explaining how Mathematical concepts work.

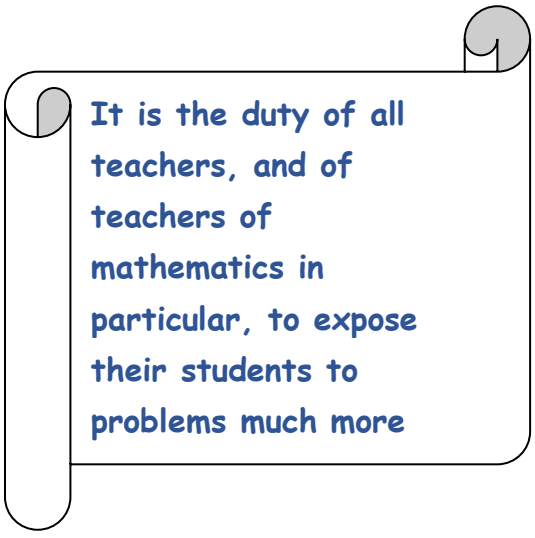
Our world is full of information that comes to us visually. The colour and shape of a red, octagonal sign says, 'STOP'. A pie chart tells us the percentage at a glance. Graphs demonstrate the ups and downs of financial markets. When it comes to expressing Mathematical concepts, visual language can be a noteworthy and powerful way to convey information. Imagine trying to explain what a parallelogram is to someone who has never seen one, using only words. Now imagine simply sketching the shape and watching the viewer's eyes light up with comprehension.

'Images express things in ways that words and numbers do not'.

Understanding abstract Mathematics concepts is reliant on the ability to 'see' how they work, and students naturally use visual models to solve mathematical problems. For example, how do you find the surface area of a pyramid? You envision a net of all its sides.

Strategies that support visual learning parallel in the teaching of Mathematics can take any form but the best being displayed is in the form of charts, graphs, timelines, 3-D diagrams. This technique can make a profound difference in the student's depth of understanding about Mathematics.

I personally believe that Mathematical lab-component incorporated in every Mathematical course offered @MRU helps to build a sense of visual imagery and confidence with its application in students. In fact, by teaching visual mathematics WE CAN- and WE SHOULD- increase the learning potential of all students to develop their ability to communicate mathematical concepts in an increasingly visual world!



Place of Math in Life

Ms Sanah Sayed
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Just when I thought of putting down my thoughts on a paper for the article the first thing that came to my mind was my knowledge of Math - counting and estimation ,as I had to stick to the word limit. This reminds me of what the great mathematician Shakuntala Devi said, 'Without mathematics, there's nothing you can do. Everything around you is mathematics. Everything around you is numbers.' Mathematics plays an important role in our life.

Children start using Math at a very young age when they use blocks, or decide big-small , more-less etc. As adults it helps us deal with everyday matters such as time tracking, driving, cooking etc. Every task that we do involves some aspect of Math in it, right from the simplest things from the time we wake up ,sleep or do things , the quantity of things we use , the simplest calculations we do, to the permutation and combinations we make in life to solve bigger problems. Collecting and organizing data is Math too .

Every profession needs a basic understanding of Math . A doctor needs to know Math to decide on the dosage of medicines. An artist needs the knowledge of ratio, proportion , symmetry and shapes. A sports person uses Math to calculate his score, estimate the speed, monitor the time and strategize the win. Math is also an essential concept of fashion designing from taking measurements, estimating the quantity of clothes, calculating profit etc.

Math keeps both your body and mind healthy. With the knowledge of Math you can decide the time and quantity of food you eat. Studies have shown that daily practice of Math keeps your brain active. Math helps in developing logical reasoning, critical , creative and spatial thinking and the icing on the cake is problem-solving ability. All these are essential for living a happy and easy going life.

It helps an individual to be more organized, thoughtful and solution oriented. It would be right to conclude saying , ' Mathematics might not teach us how to add love or subtract hate but it gives us hope that every problem has a solution'.

"Millions saw the apple fall, but Newton asked why." – Bernard Baruch

Place of Math in Life

Dr. Shalini Verma
HDFC School, Gurugram

"Mathematics is the language with which God has written the universe".
Galileo Galilei

When one thinks of 'Mathematics', it is perceived as a vast mass of unimportant numbers, several of them conjoined to form bewildering formulae, analysis of chunks of information, data, data and more data. We tend to think of it as something that must be absorbed, mugged up, in order to be understood. But in reality, mathematics teaches us fundamental principles of life. It is a language of signs. The world was merely a gigantic mass of boiling rock and magma floating in a deep space of oblivion, until the path of understanding shone, the roadway of mathematics led us to answers. Mathematics is a deliberate utilization of issues. Moreover, the subject is one of the predominant subjects of our life. Regardless of which field you belong to, its utilization is all over. It tells us that we should add harmony, joy, happiness; multiply with love and positivity; subtract sadness, hate, and negativity. Math ensures us that every problem must have a solution. That is the reason it is essential to have a decent comprehension of the subject.

Math is all around us. Math depicts in nature from symmetrical petals of flowers to sequence chirping of the birds to blowing cool air at particular speed to rising and setting of the sun. From dialing numbers on the telephone, to giving cash for making instalments, to understanding the never ending vastness of space, our reality is encircled by mathematics, the foundation of all humanity has been laid down by it. While planning our meals, we generally measure the various fixings to cook the ideal amount as it were, along with the amount of ingredients we will add. This is conceivable only because of mathematics. So one can comment that our day starts with the idea of math. While going shopping, we set up a rundown of things we require, compute the necessary measure of cash for it, and so forth. This count depends on numbers which lead us back to mathematics. Without the numbers, you can't choose the amount you have to pay to the merchant and the amount you have spared. So on account of buying your daily items as well, you are encompassed in the universe of mathematics.

Subsequently, everyone loves to travel, yet there is much more to it than the delight. While arranging your excursion, one does not just choose where they wish to go, they must also book their inn, tickets, and so forth. This requires spending, arranging and a feeling of comprehension of mathematics with the goal that you can achieve the various assignments effectively. From preparing for a trip, to its cost, transport, tickets, employing taxis and more, all employ the skills of mathematics. Subsequently, from the above models, one may experience the reasonable thought that there is no such region where the idea of mathematics isn't utilized. An individual cannot manage without this subject, and that is why it is essential to keep one's rudiments to play out the regular exercises of life.

A PICTURE IS WORTH A 1000 WORDS – THE ROLE OFVISUALIZATION IN MATHEMATICS LEARNING

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University of Duisburg-Essen, Germany

This paper describes some important aspects concerning the role of visualization in mathematics learning. We consider an example from integral calculus which focuses on visual interpretations. The empirical study is based on four problems related tothe integral concept that highlight various facets of visualization. In particular, we are interested in the visual images that students use for working on specific problems and how they deal with given visualizations. The findings show the importance aswell as the difficulties of visualization for the students.

INTRODUCTION

The first part of the title is borrowed from a common proverb which highlights the importance of visualization in general. Likewise, visualization has a long tradition in mathematics and the list of famous mathematicians using or explicitly advocating visualization is large.

One prominent example is certainly the blind Euler whose restriction did not have an effect on his creative power. During the years of his blindness he was able to producemore than 355 papers – due to his visual imagination as well as his phenomenal memory (Draaisma, 2000). Hadamard (1954) pointed out the importance of visualization by referring to Einstein and Poincaré. They both emphasized using visual intuition. In Pólya's (1973) list of heuristic strategies for successful problem solving, one prominent suggestion is "draw-a-figure" which has become a classic pedagogical advice.

However, in this paper we discuss some findings which focus on the role of visualization ranging from being useful to being an impediment.

VISUALIZATION IN MATHEMATICS LEARNING

The role of visualization in mathematics learning has been the subject of muchresearch (e.g. Arcavi, 2003; Bishop, 1989; Eisenberg & Dreyfus, 1986; English,1997; Kadunz & Straesser, 2004; Presmeg, 1992; Stylianou & Silver, 2004). Inaccordance to Zimmermann and Cunningham (1991) as well as Hershkowitz et al. (1989), Arcavi (2003, p. 217) defines visualization as follows:

> Visualization is the ability, the process and the product of creation, interpretation, use of and reflection upon pictures, images, diagrams, in our minds, on paper or with technological tools, with the purpose of depicting and communicating information, thinking about and developing previously unknown ideas and advancing understandings.

2006. In Novotná, J., Moraová, H., Krátká, M. & Stehlíková, N. (Eds.). *Proceedings 30th Conference of the International Group for the Psychology of Mathematics Education*, Vol. 4, pp. 457-464. Prague: PME.4 - 457

This definition emphasizes that, in mathematics learning, visualization can be apowerful tool to explore mathematical problems and to give meaning to mathematicalconcepts and the relationship between them. Visualization allows for reducing complexity when dealing with a multitude of information.

However, the limitations and difficulties around visualization and even the reluctanceto visualize have also been largely discussed (Arcavi, 2003; Eisenberg, 1994; Stylianou & Silver, 2004). Visual techniques which rely on "not always procedurally 'safe' routines" (Arcavi, 2003, p. 235) are considered to be cognitively more demanding than analytical techniques.

In a different context, visualization is discussed as an important part of so-called "concept images" (Tall & Vinner, 1981). The concept image includes visual images, properties and experiences concerning a particular mathematical concept. To understand a formal mathematical concept requires of the learner to generate a concept image for it. Nevertheless, Vinner (1997, p. 67) points out that "in somecases the intuitive mode of thinking just misleads us." In this paper, we focus only on the visual aspects of the concept image.

TREATMENT OF INTEGRAL CALCULUS IN SCHOOL

Many topics in mathematics have visual interpretations and the integral calculus is certainly one of those. This paper is not the place to go into detail on teaching and learning integral calculus in Germany; for this general discussion we refer to Blum and Törner (1983) and Kirsch (1976).

For the sake of brevity we limit ourselves in the following to the presentation of the major aspect relevant to our study. A classical approach to the integral in school isthe area calculation problem. This problem allows for using the geometric reference for visualization. Thus, the most basic way of introducing integrals is using the close connection between the idea of an integral and the idea of an area, initially for functions with positive areas in the first quadrant. Later on, this idea is expanded by identifying the integral as sum of the oriented areas.

RESEARCH QUESTIONS

Much of the research into mathematics students' knowledge of the integral has been oriented by assumptions about what students should know. Instead, we report onsome ongoing research into what students do know with a special focus on visual aspects of the integral. This paper presents some results gained within the scope of a larger study to investigate students' mental representations concerning the integral (Rösken, 2004). Our research questions in this study were:

- What visual images do students have concerning the integral?
- How do students deal with a given visualization?
- To what extent are visual images used by the students?

METHODOLOGY

The study employed qualitative methods to capture the importance of visualization in the learning of integral calculus. The observation of the lessons in question and the analysis of the teaching material led to constructing a questionnaire containing several problems related to the integral. The students worked on this questionnaire in the classroom under supervision and were allowed to use a calculator. For the purposes of this paper we focused on four problems revealing diverse aspects of the integral.

The subjects in this study were students in grade 12 of two German high-schools. Thefirst class consisted of 24 students, 14 female and 10 male students. The second class consisted of 28 students, 6 female and 22 male students. The two classes together form a total of 52 students. For the analysis, we do not distinguish between these two classes.

EMPIRICAL RESULTS

This is not the place to give a detailed analysis of the observed lessons. The main approach to the integral discussed above emerged in both classes. In this section, we restrict ourselves to the presentation of the problems, the underlying mathematical aspects and the students' answers.

Problem 1:

Draw a figure to illustrate the geometric definition of the integral.

The geometric definition refers to the area concept as already mentioned. We were interested in the visual representations that students associate with this aspect of the integral. The following table shows the distribution of the students' solutions:

Table 1: Students' answers to problem 1

Positive area	Positive and negative areas	No answer
77%	13%	10%

90% of the students were able to illustrate the geometric definition of the integral. However, it is remarkable that 77% of the students disposed of an image that is limited to a positive area. Figure 1 shows an example of such visualization which represents merely one aspect of the integral concept. This restricted visualization will turn out to be an obstacle for working on the other problems.

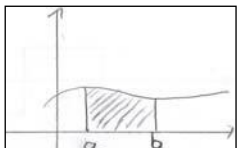


Figure 1

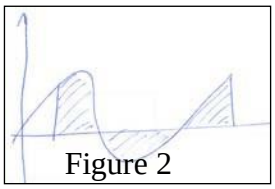


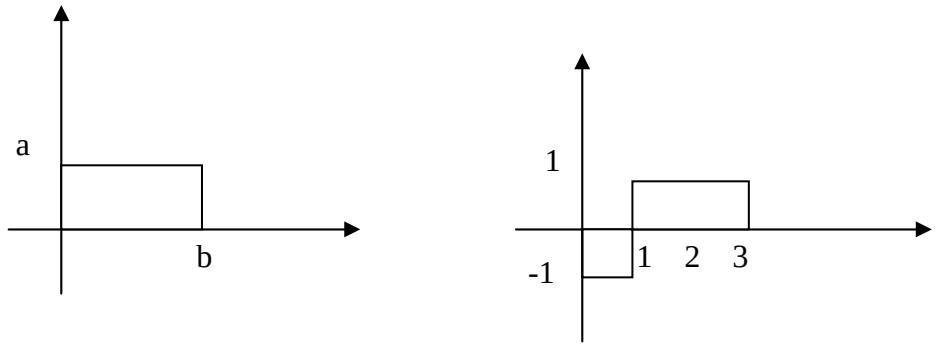
Figure 2

Figure 2 shows an example for a more adequate visualization which was only used by 13% of thestudents.

Problem 2:

Find a formula for the area by using integration.

a) b)



In contrast to problem 1, the students were given a concrete visualization and were asked to find the integrand as well as the limits of integration. In problem 2b, the students additionally had to consider the orientation of the area.

Table 2 shows the distribution of the students' answers to problem 2a:

Table 2: Students' answers to problem 2a

Correct answer	Incorrect answer	No answer
50%	40%	10%

It is notable that the given visualization of this problem differed only slightly fromthe visualization the students chose in problem 1. However, half of the students were not able to give a correct answer. Among the incorrect answers, the following terms can be found:

$$\int_a^b k\,dx \quad \int_a^b a\,dx \quad \int_a^b a(x)\,dx \quad \int_a^b a\,da \quad \int_a^b f(a)\,dx$$

One difficulty for the students was to name the limits of integration. It is evident that finding the integral for the given image conflicts with the standard notation: $\int_a^b f(x)\,dx$

Furthermore, the students had major problems to recognize the given constant function as a possible integrand. Obviously, they were missing an x-term. One student gave the correct answer but stated the following:

$\int_0^b f(x)\,dx$

Not possible, because this is a constant function and there is no x in it andthat's why it is not possible to put in the limits

Two students solved this conflict by drawing a supporting straight line asshown in figure 3. They obtained the answer to this problem in a creative though complicated way.

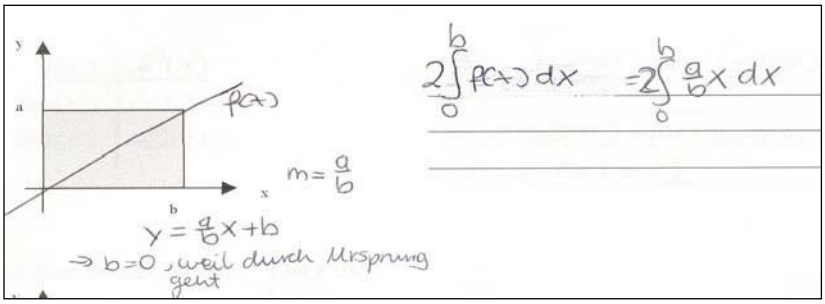


Table 3 shows the distribution of the students' answers to problem 2b:

Table 3: Students' answers to problem 2b

Correct answer	Incorrect answer	No answer
40%	54%	6%

While the difficulties to find the integrand remained, the problem to name the limitsof integration minimized due to the concrete numbers provided in the illustration. However, a new obstacle emerged because of the orientation of the area. Instead of the area, the students calculated the integral. This was found in more than half of the incorrect answers. Some students solved this conflict by shifting the square above thex-axis.

Problem 3:

a) Find the area bounded between the function f(x)=sinx and x-axis over [π,2π].

b) Calculate the integral: $\int_{-\pi}^{2\pi} \sin x dx$

For the answer to problem 3a the students had to calculate an area of negative orientation while in problem 3b the same function was given but this time they were asked to calculate the integral. Even though the limits of integration changed, the answer to problem 3b could be immediately given by visualizing the graph of the function and considering problem 3a. This problem demanded that students distinguish clearly between the area and the integral concept.

Table 4 shows the distribution of the students' answers to problem 3a:

Table 4: Students' answers to problem 3a

Correct answer	Incorrect answer	No answer
27%	67%	6%

Some of the students had difficulties to put in the limits or to give the correctantiderivative. More interestingly, 77% of the incorrect answers resulted in giving a negative value as area of the function. On the one hand, these students did not use

visualization to approach the problem. On the other hand, they did not scrutinize thenegative value of their result. Only 8% of all students sketched the graph.

Table 5 shows the distribution of the students' answers to problem 3b:

Table 5: Students' answers to problem 3b

Correct answer	Incorrect answer	No answer
23%	73%	4%

The distribution of the answers to problem 3b is similar to 3a and the same mistakes emerged. Remarkably, in 47% of the incorrect answers a positive value was given. The students continued calculating the area as required in 3a instead of the integral, some of them even mentioned explicitly "A=2". Only 8% of all students visualized the graph, 6% referred to their solution of problem 3a.

Problem 4

How would you proceed to calculate $\int_{-1}^{1} \sin(2x^3)dx$ *?*

This problem can be easily solved by visualization. The function is odd so that on the given interval [-1,1] the integral equals zero. Only 4% of all students took into account these considerations. 8% of the students did not answer at all while the other students proposed to work out the integral by substitution (42%), by finding the antiderivative (29%) or by integration by parts (17%). To summarize, the solutions tothis task showed an explicit bias towards an algorithmic approach even though the visual one would have been significantly easier.

DISCUSSION AND CONCLUSIONS

The selected problems emphasize convincingly some important aspects inherent to visualization. On the one hand, visualization proves to be a useful tool for working onthe problems and the common proverb mentioned in the title seems to be appropriate.For example, some students use visualization in a creative way by modifying the given task (problem 2; figure 3). This approach enables them to avoid the difficulties with the given visualization and thereby sheds light on the underlying obstacles concerning this task. Another interesting point is that even students that do not show visualization on their paper were able to solve problem 3 correctly. This highlights once again the importance of pictures in the mind (Presmeg, 1986).

On the other hand, visualization raises some difficulties which lead us to modify the common proverb mentioned in the title. A picture is worth a 1000 words – only if oneis aware of its scope: The students in this study largely demonstrated their ability in visualizing the geometric definition of the integral (problem 1; figure 1). Nevertheless, their chosen visualization only reflects one particular aspect of the integral concept. This entails some important consequences for working on the other

problems. For example, the restricted visualization proves to be a hindrance for the solution of problem 3. The connection of the integral with the area misleads the students not to distinguish clearly between the two concepts. Basically, both conceptsare different from each other, but at the same time, they have a certain though marginal intersection which predominates the students' thinking.

Another interesting aspect leads us to change the proverb as follows. A picture is worth a 1000 words – only if one is able to use it flexibly: First, even if students use visualization to solve the problems 2 and 3, this does not mean that they are able to solve the problems correctly. They do not dispose of the cognitive flexibility to use both visual and algorithmic techniques (Arcavi, 2003). Second, the students usually did not choose to visualize in problem 4 but proposed an algorithmic approach instead. They are cognitively fixed on algorithms and procedures instead of recognizing the advantages of visualizing this problem – a phenomenon which Eisenberg (1994) describes as reluctance to visualize. Third, the visualization givenin problem 2 differs only slightly from the visualizations the students gave in problem 1. However, most of the students were not able to deal with this given visualization and to adequately interpret the information given in this problem.

These aspects highlight the ambivalence of visualization as Tall (1994, p. 37) points out: "It is this quality of using images *without being enslaved by them* which givesthe professional mathematician an advantage but can cause so much difficulty for the learner." Hence, the importance of visualization for mathematics learning and teaching is constituted in being aware of the fact that visualization never represents an isomorphism of mathematical concepts and their relationships. Therefore, visualization should be accompanied by reflective thinking to avoid being enslavedby it.

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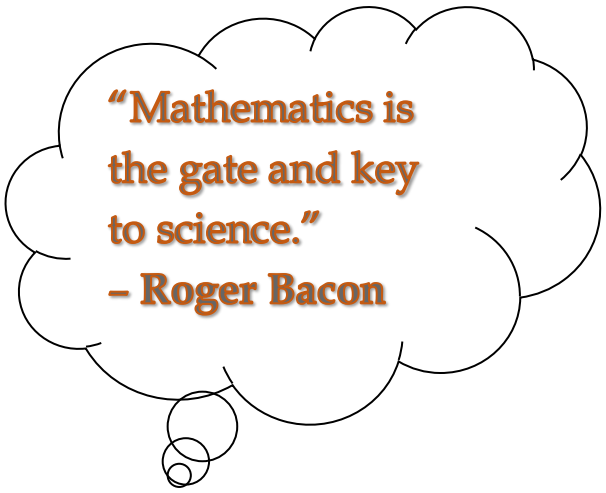
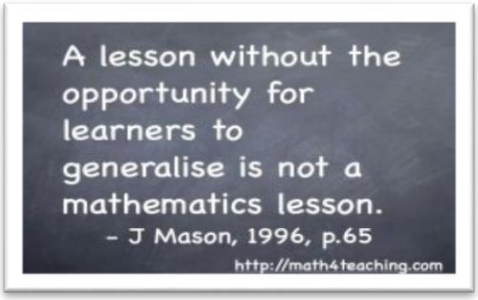


Making generalizations in mathematics



Making generalizations is fundamental to mathematics. Developing the skill of making generalizations and making it part of the students' mental disposition or habits of mind in learning and dealing with mathematics is one of the important goals of mathematics education. Making generalizations is a skill, vital in the functioning of society. It is one of the reasons why mathematics is in the curriculum. Learning mathematics (if taught properly) is the best context for developing the skill of making generalizations.

WHAT IS GENERALIZATION?

There are three meanings attached to generalization from the literature. The first is as a synonym for abstraction. That is, the process of generalization is the process of "finding and singling out [of properties] in a whole class of similar objects. In this sense it is a synonym for abstraction (click here to read my post about abstraction). The second meaning includes extension (empirical or mathematical) of existing concept or a mathematical invention. Perhaps the most famous example of the latter is the invention of non-euclidean geometry. The third meaning defines generalization in terms of its product. If the product of abstraction is a concept, the product of generalization is a statement relating the concepts, that is, *a theorem*.

For further discussion on these meanings, read Michael Mitchelmore paper *The role of abstraction and generalization in the development of mathematical knowledge*. For discussion about the importance of generalization and some example of giving emphasis to it in teaching algebra, the book Approaches to Algebra – Perspectives for Research and Teaching is highly recommended. There is a chapter about making generalizations and with sample tasks that help promote this attitude.

SAMPLE LESSONS

Mathematical investigations and open-ended problem solving tasks are ways of engaging students in making generalizations. The following posts describes lessons of this type:Sorting number expressions

1. Lesson study: Teaching subtraction of integers
2. Math investigation lesson: polygons and algebraic expressions
3. Polygons and teaching operations on algebraic expressions

Of course it is not just the type of tasks or the design of the lesson but also the classroom environment that will help promote making generalization and make it part of classroom culture. Students will need a classroom environment that allows them time for exploration and reinvention. They will need an environment where a questioning attitude is promoted: "Does that always work?" ,"How do I know it works"? They will need an environment that accords respect for their ideas, simple or differing they may be.

SHARED ARTICLE

How to help your child with math

Sourced from 'Children's Education Services' , Florida

At a glance

- Some kids need extra help and encouragement to get better at math.
- There are lots of ways you can help your child improve math skills at home.
- Having trouble with math doesn't mean a child isn't smart.

Many kids (and adults) have trouble with math. And for some people, math causes a lot of anxiety. When math is a struggle, how can you help your child get better at it?

Helping with math isn't always easy, especially since the way they teach math is different than it used to be. But even if you're not the best at math, there are many ways you and the school can help your child improve. Here are tips.

How to help with math at home

If you feel lost or frustrated trying to help your child with math, you're not alone. Most parents and caregivers haven't taken math classes in a while. And schools use new methods to teach it now. The more familiar you are with the new ways, the easier it becomes to help.

Here are some examples of "new" math problems to help you get your bearings. You can also use tips to help with tricky math homework.

Even if kids struggle with math, it doesn't mean they're "bad" at it. Even good math students can have a hard time with certain parts of math. Kids need different skills for different subjects, so they may need support in one or more of these skills.Even different types of math problems within a subject can require different skills. For instance, some kids may be great with math facts but struggle with word problems.

For some kids, the biggest challenge is math anxiety. Whether or not they have trouble with math itself, they feel anxious about doing the work or taking math tests. They may doubt they're good at math even when they are. And their fear of failure can actually get in the way of doing well.

There are lots of stress-free and fun ways to help with math at home. Here are just a few:

- Use sports, like football, to reinforce math concepts.
- Read books that build math skills in young kids.
- Play board games that help young kids build math skills.
- Cook and bake together.

There are also inexpensive tools you can use to help make math easier for your child.

- Discover items around the house that can be used as math tools.
- Try graphic organizers for math.

Teachers have great strategies for helping kids learn math. Here are a few teacher tips to try:

- Use an anchor chart to help with multiplication.
- Use number lines to help your child compare fractions.
- Play a warm-up game to get your child ready for math homework.

A popular way to help kids learn math is by engaging various senses. Teachers use sight, hearing, touch, and movement to help kids understand what numbers and symbols mean. (Teachers use this approach with reading and writing, too.)

It can be hard for kids who struggle with math to use abstract thinking to do math problems. For example, they might have trouble understanding amounts, like the fact that 10 cents is more than five cents.

Technology can also be a great tool to help with math. There are inexpensive or even free tech tools for math, like apps, Chrome tools, and software. These programs not only help build skills. They can also reduce the challenges and frustration kids feel.

Frustration is a common problem for kids who struggle in school, whether it's in math or another area. One of the best things you can do is talk about what that feels like, and share times when you've also felt frustrated by your own challenges. Tell your child that everyone struggles with something, and there are ways to get better at math.

How the school can help kids get better at math

When kids have trouble with math, there are lots of things schools can do to help. There are specific ways of teaching math that can help kids build skills. And schools can use supports called that make it easier for kids who are struggling.

To get this type of help from the school, you'd need to have your child evaluated. A free school evaluation can tell you exactly what your child is struggling with, so you can get and give the right type of help.

- Use this checklist of questions to ask the school about math instruction.
- Learn terms to know if your child has trouble with math.

Your child's teacher is a great source of information and help, too. Ask the teacher if there are strategies that help in the classroom that you can try at home.

Working with the school can help your child develop what's known as a growth mindset. That means kids believe their skills can improve with work and support. And learn how setting a "competence anchor" can help your child feel more confident about math.

SHARED ARTICLE

Tackling Math Anxiety

By Wayne D'Orio
May 12, 2022,

Many children start feeling apprehensive about math in elementary school, but lowering the pressure can help.

Math anxiety can impair students' abilities and persist into adulthood. But experts say teachers and parents can help children develop a more positive math identity.

You don't have to dig deep to uncover the negative feelings many people have about math. In one survey of U.S. adults, 93% reported they felt some apprehensiveness about the subject.

In fact, "math anxiety" is so common that it has been studied for seven decades, says Jalisha Jenifer, the lead author of a new study that shows how the problem affects even top students.

Math anxiety is defined as "a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in … ordinary life and academic situations," according to the Mathematics Anxiety Rating Scale, an instrument commonly used to measure math anxiety.

Research has found varying levels of math anxiety depending on the population studied and how it is measured. One oft-cited study from 2009 estimates that 17 percent of the general U.S. population has "high levels of mathematics anxiety." Some research shows girls report more math anxiety than boys, although there is no difference in actual math performance between genders.

Math anxiety can impair students' abilities and persist into adulthood. But experts say teachers and parents can help children develop a more positive math identity.

What to Know About STEM Public High Schools.

What Causes Math Anxiety

When children begin school, they are typically excited to learn about math, says Trena Wilkerson, the president of the National Council of Teachers of Mathematics. A number of factors, including the pressure of doing math quickly, can cause anxiety to begin.

Students as young as 7 show signs of math anxiety, "depending on how much testing is taking place," says Ann Dowker, a lecturer at the University of Oxford and the lead researcher on a 2016 meta-study on the subject.

Experts say that in math, unlike most other subjects, speed plays a big role in how competent students feel. Being slower than peers at solving problems can trigger anxiety.

"When people say they aren't good at math, often they mean they aren't fast at math," says Dowker. Students who don't keep up with their classmates may start avoiding math, leading to a "vicious circle" of less practice and declining skills.

Attention is another factor, Dowker says. Because math is much more dependent on working memory than some other subjects, students can become lost if their minds wander during a lesson.

And because both parents and teachers may remember their own math anxieties, they have to be particularly careful about transferring those feelings to children, Wilkerson says.

When left unaddressed, math anxiety can snowball and continue into college and beyond.

Jenifer, a postdoctoral research fellow at Barnard College, found that even some college students who had chosen to take Advanced Placement calculus suffered from math anxiety. Her study showed that these students avoided study strategies that were harder and concentrated instead on reading their textbook or solving easier problems.

Although Jenifer's' work is the first to study high-achievers, she says the results didn't surprise her. She surmises that these students' anxiety probably began in elementary school and compounded over time.

Rethinking Math Instruction to Reduce Anxiety

Despite a lot of studies proving math anxiety exists, there's less research on how to prevent or reverse this issue. Some studies show that having students discuss or write about their anxiety before a test can reduce the negative effects and break a cycle where anxiety leads to worsening results.

For students with high anxiety, one-on-one tutoring was also shown to have helped.

In the classroom, some teachers are using strategies to take the pressure off and make math more relevant to students.

When Desiree Harrison moved from teaching middle school math to third grade, students' reactions to math caused her to rethink how she presented the subject. The first thing she did was eliminate timed tests.

As she got to know her students, Harrison, who is now an instructional coach at Forest Elementary School in Farmington Hills, Michigan, showed them how math played a role in their interests, from sports to cooking to fashion design. "Instead of focusing on the subject first, I focused on the child," she says.

Lorie Huff, the director of K-12 mathematics for Fayetteville Public Schools in Arkansas, says when she taught, she de-emphasized the importance of getting the right answer for a problem and instead asked students to prove their answer in three different ways. And she, too, worked to connect the learning to students' lives.

"If you can't explain how students will use (math) in real life, you probably shouldn't be teaching it," she says.

How Parents Can Help

Helping children overcome math anxiety can be challenging for parents who don't feel comfortable with math themselves. Huff remembers an after-school program she ran where parents were required to attend with their children. After five weeks, one father admitted to her that this was the first time math made sense to him.

But even parents who have math anxiety can help their kids.

The Maths Anxiety Trust, a British nonprofit that seeks to address the problem, suggests parents let their children know they don't have to be perfect in math.

It's fine to acknowledge that some math problems are difficult and don't lend themselves to easy answers, Jenifer says. Parents can tell their children, "It's OK to find math challenging." Teach your children to welcome new challenges, and show them how they can learn from their mistakes.

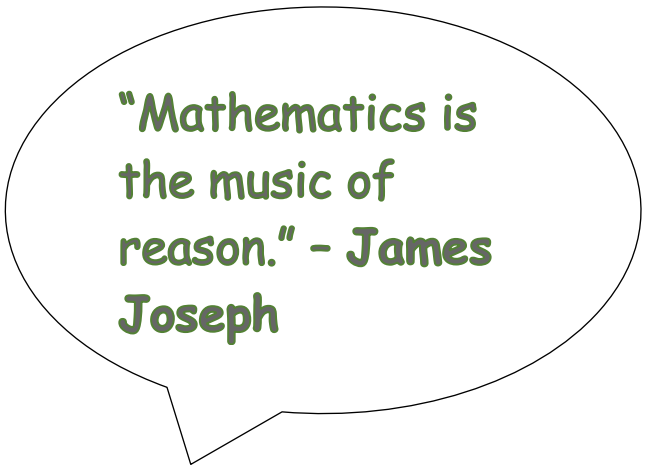
Let your child know that there is more than one way to answer a particular problem, says Harrison, and encourage them to explore different solutions.

Experts say parents can also encourage children by showing them how math is used in many everyday interactions, from shopping to planning a garden, and allowing them to count and add figures themselves.

Harrison, who had math anxiety growing up, says avoiding negativity (like declaring that you or your child are "not math people") is important. She hosts the podcast, Kids Math Talk, to promote positive conversation among parents and educators around math.

Even if parents can't help their children with a particular topic, they can encourage them to persevere and access other people or online sites, says Wilkerson. You want to help students develop a positive math identity, she says, because "we know everybody can do math."

Source: **https://www.usnews.com/education/k12/articles/tackling-math-anxiety**



ONLINE RESOURCES FOR MATHS TEACHERS

Teachers may find many useful ideas in these online sites to enhance the learning experience in their classrooms *(This is merely a suggested list)**:***

1 https://in.ixl.com/maths Experiencing mathematics with practical everyday examples
2 https://www.adaptedmind.com/Math-Worksheets.html Free kids maths games
3 https://www.teachthought.com/pedagogy/teaching-math-online/ suggests 15 apps which can be used to teach maths online
4 https://cdn.sanity.io/files/nosafynr/leo-production/178c73c4ac0ed306c55adff5ff113f17f5a7e455.pdf Ebook on blended learning and why this is the way forward.
5 FAQ: Champion's Club – Prodigy Education (zendesk.com) A teachers community of those using the Prodigy Maths game with their students
6 https://www.educatorstechnology.com/2014/01/20-great-math-websites-for-teachers-and.html provides a list of useful websites for math students and teachers
7 https://www.edarabia.com/best-math-websites-teachers/ 20 best math websites for teachers
8 https://www.mathteaching.org/math-teacher-resources-lesson-plans-games-more/ Lesson plans, games and more for the math teacher.
9 https://www.teachervision.com/subjects/mathematics math resources for teachers including lesson plans and printables.
10 https://www.slideshare.net/jiannacconi/teaching-mathematics-77375622 A ppt illustrating issues that maths teachers experience while teaching math
11 https://www.slideshare.net/vidyaj7/resources-of-teaching-mathematics a ppt suggesting ways in which maths teaching can be made more interesting

> "Without mathematics, there's nothing you can do. Everything around you is mathematics. Everything around you is numbers."
> **– Shakuntala Devi**

Engagement By Design

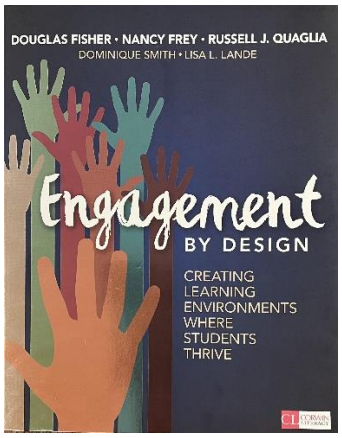
Creating Learning Environments Where Students Thrive

Douglas Fisher et al
Corwin/Sage; California;2018

Reviewed by
Dr Priti Sachdev

Every teacher wants engaged students. No student wants to be bored. The reality may however be quite different. Normal classrooms everywhere do not usually see active lively discussions among teachers and students or even activities focusing on the learning expectations of the day! There could be many reasons for this.

The authors contend that finding a way that student's progress through relevant and challenging content, though not easy, can be possible and effortless when teachers have the right design for genuinely engaging students.



Each student is unique and different in the way s/he approaches the academic and social challenges they face in the classroom. This is the big challenge for the teacher.

This book gives teachers a framework they can use on a daily basis that will bring about efficient and effective changes in the classroom dynamic. The book talks about

- The inviting classroom,
- Relationships
- Clarity
- Challenge and
- Engagement

The issues addressed include ideas on what constitutes 'engagement', the intentionally inviting teacher, the importance of relationships, wait time and praise; the importance of success criteria and feedback, meaningful challenges and fostering self-worth. It suggests self-reflection by students and how teachers can facilitate that. The five authors of this book are, each one, personally committed to the improvement of classroom climate and a satisfactory experience for teachers through effective learning experiences for students .
Understanding 'engagement' and actively pursuing it can make all the difference! This book puts you the teacher in active control of what happens in the classroom to ensure that students remain motivated and learn well.

The authors provide video and web content throughout the book which are available to readers through QR codes.

What's Maths Got To Do With It

How Teachers and Parents can Transform Mathematics Learning and Inspire Success

Jo Boaler (Penguin, 2015)

The book begins with a belief that all children are capable of learning maths to a high level. It is only a matter of how we go about it. And, to our advantage, there has been much research on the brain and on how people learn. It has now become possible to provide environments where children are excited to learn mathematics, because teachers can be prepared with the tools and the knowledge of how to go about this!

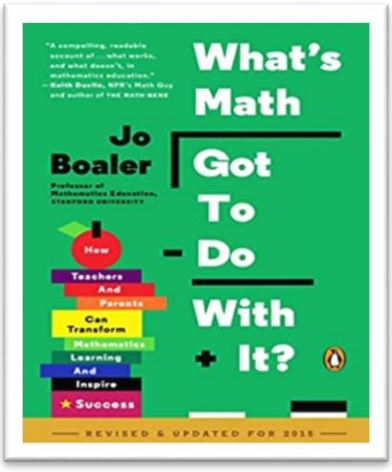
The beginnings of this book arose from a combination of her and Carol Dweck's idea of the 'growth mindset'. They negate the long-held belief by many, that, "math is a gift". Scientific evidence has shown that brain has an incredible capacity to change, rewire and grow. While traditional math teachers believed that some students do not have the brain to deal with complex mathematics, research now shows that it is working on complex mathematics that enables the brain connections to develop.

The trouble is that as teachers we give students the impression that math is a 'performance' subject rather than a 'learning' one. For students to view math as a learning subject, they need tasks and questions in math class that allows for learning. The book provides some interesting productive ways in which teachers can assess, grade and group students and the important role that parents can play to get students to move from a fixed to a growth mindset.

The author propagates the importance of providing an environment where children can make mistakes in math. This stimulates the formation of even more connections in the brain, and so for the brain to develop. Through mathematics it is possible to develop in children habits of problem solving, sense making, persevering and reasoning and skills that are needed to develop life skills such as flexibility, teamwork, communication and persistence. "If young people are to become powerful citizens with full control over their lives, then they need to be able to reason mathematically – to think logically, compare numbers, analyse evidence and reason with numbers."

The author shares many new practical ways math can be taught and math can be learned, These are based on longitudinal studies on students and the problems they encounter. Parents and teachers can change everything for children by providing them with positive messages and the strategies described in the book.
Running through about 200 pages it starts with identifying the problem to finding good solutions and developing a positive attitude to math learning.

An easy and useful read for any teacher, not only the math teacher!



NEWS from WEF

WORKSHOP - IMPLEMENTATION OF NEP2020

NEP 2020 is being implemented from 2022 on account of the COVID pandemic and there is still so much ambiguity about the logistics of its implementation. Keeping this in mind, WEF Indian Section organised a workshop for principals focused on the actual issues and problems which they were facing. It provided an opportunity for principals to discuss the issues and learn from each other, A number of new issues came up and principals could help each other through their own solutions. The resource team from QEDRAK, Vadodara, facilitated the workshop beautifully, so that it was interactive and participatory. Feedback from the twenty-seven participating principals indicated their satisfaction with the half day they had spent in the workshop. Thank you Ms Bhavna Tandon, Ms Ishita Verma and Ms Rutu Jaisingh!

A photo-diary of the NEP2020 workshop conducted by QEDRAK, Vafdodara

MEETING OF WEF GUIDING COMMITTEE

Members of the international guiding committee of WEF met with the secretary, WEF Indian Section, in Barnet, UK on the 21st of July to chalk out the way forward particularly with regard to the next International Conference. The last international conference which was an online conference had a mixed response. We look forward to a possible off-line conference. Various possible venues were mooted but it was decided to wait and see the situation with respect to the restrictions on different countries due to the COVID pandemic.

Dr. Priti Sachdev, Ms Annie Morley-Slinn, Ms. Guadalupe Turner (General Secretary) & Dr. David Turner (International committee treasurer)

WEF CENTENARY LECTURE 2022

The WEF centenary lecture

"The School Systems, the Pedagogical Practice and Approaches to Teaching and Learning"

Was delivered online by

Dr Sebastian Engelmann, PhD, Assistant Professor of History and Theory of Pedagogical Action and Thought ; University of Education; Karlsruhe; Germany / WEF Germany

NEWSLETTER 10

The next issue of the WEF Indian Section Newsletter will be focusing on the **Role of Social Sciences in the curriculum and the teaching and learning of the social sciences.** You are invited to contribute and enrich understanding of the issues in content, theory, or any other issues you experience through articles (about 2000 words) and short comments / thoughts (up to 500 words).

Do look out for the invitation to contribute which should be in your inbox around mid October. Your writing/thoughts may be submitted earlier, but not later than 15th November 2022

NEWS FROM MEMBERS

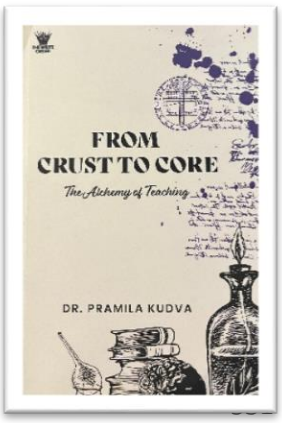
Congratulations!

Congratulations to Ms. Revati Wali for taking over the reins of the Pawar Public School, Kandivali. Ms Wali, with a post-graduate in Physics, a Masters in Education, a Diploma in Human Resource and almost 30 years of experience, has taken on the challenge of managing the large upcoming school situated in the Northern suburbs of Mumbai. We wish every success to Ms Wali. May you and your school grow from strength to strength in the years ahead!

Congratulations!

Congratulations Ms Priya Fernandes, Principal, Rose Manor International School on receiving the **SCLRRC Top Educator's Award 2022.**
And Congratulations to Rose Manor School for its own Amrut Mahotsav having completed 75 years since its foundation.

Congratulations!



Congratulations **Dr Pramila Kudva** on your second book – **'From Crust to Core'**. The book looks at connecting the NEP2020 with the four pillars of Education. An excellent, detailed insight into the new policy with many suggestions on how it's ethos can be implemented in the existing classrooms. A complete review will be available in the next newsletter.

Congratulations also to all our members (individuals and institutions) who's students I am sure have all done well in the examinations in the results declared in June/July this year

We invite members to share their own achievements and news with us and we would be happy to add this to our section on 'News from Members'

WELCOME TO OUR NEW MEMBERS

Dr Arnavaz Bhagat : Principal, Parle Tilak Vidyalaya; Mumbai
Ms Monica Fernandes; Bombay Cambridge International School; Mumbai
Greenlawns High School: Mumbai
St. Kabir International School: Vadodara
Arya Vidya Mandir, Bandra W: Mumbai

MEMBERSHIP FORM

WORLD EDUCATION FELLOWSHIP
(INDIAN SECTION)

Membership Form No_____

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World Education Fellowship, Indian Section
Gujarat Research Society
Dr. Madhuri Shah Campus, R. K. Mission Marg
Khar (W), Mumbai – 400 052

Please enroll me as a member of the World Education Fellowship, Indian Section.

Membership compensation with effect from January 2020

Please tick as applicable.

INDIVIDUAL ☐ 1 Year – Rs.800/- ☐ 3 Years – Rs.2100/- ☐ Life – Rs.5000/-

INSTITUTIONAL ☐ 1 Year – Rs.1600/- ☐ 3 Years – Rs.4,200/- ☐ Life – Rs.10,000/- (2 nominees per program. Nominees can be changed per program)

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Name (block letters)

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Postal Address: _____

_____

_____

Tel No: _____

Cell No.: _____

Email : _____

Designation & Institution:

_____

_____

Current areas of Interest:

_____

_____

Research Interest: _____

_____

Date: _____ Signature:_____

INSTITUTIONAL

Name of the Institution

_____

Postal Address: _____

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Name of the Principal / Trustee_____

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Institutional Stamp _____

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