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Beauty and Essence of Mathematics: Students' Vision

Research Article

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Abstract: Mathematics as a subject is indispensable in the development of any nation with respect to science and technology since mathematics itself is the language of science. The importance of Mathematics has never been greater than now and for the foreseeable future. Mathematical skills are crucial for a wide array of analytical, technological, scientific, economic and soft skill applications. Training students to become adept users of mathematics and to appreciate its usefulness is of paramount importance for the future. With mathematical resilience, students are motivated, confident, and persevere through negative situations. We seek to measure and track attitudes to mathematics, improve positivity and confidence, and ultimately, transform numeracy for all. It is, however, need of the hour for students' to develop interests and do well in mathematics, being the basic for all subjects and a tool for their future career. Teachers are the single most important resource for developing students mathematical identities. By catering to the differing needs of students that derive from home environments, languages, capabilities, and perspectives, teachers allow them to develop a positive attitude to mathematics. A positive attitude raises comfort levels and gives students greater confidence in their capacity to learn and to make sense of mathematics. In recognition of the important role that mathematics plays, at all levels of the education system, the challenges in mathematics teaching is to attract young and adventures students into the field of a mathematics when at this time they may involve/fascinated by technology. Our main focus is to motivate the students, so that they must have fun and enjoyment while doing mathematical problems and the best chance at becoming excited about learning mathematics and they can enjoy the beauty & essence of mathematics.

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1. Introduction

Mathematics has **Universality**, the mathematics we know is the only mathematics that can be; **Unity**, there is only one mathematics indivisible now and forever; **Certainty**, mathematics has a method, rigorous proof which yields absolutely certain conclusions; **Objectivity**, mathematical truth is the same for everyone. Mathematics as a subject is indispensable in the development of any nation with respect to science and technology since mathematics itself is the language of science. The importance of Mathematics has never been greater than now and for the foreseeable future. Mathematics is a model for thinking & analyzing, for developing scientific structure, for drawing conclusions and for solving problems. Mathematics is not a close world but open to other fields, in fact it is basic for all the subjects & is essentially a subject of everyday needs. It helps us to think logically, we carefully state the problem, plan out our solution, execute steps in an appropriate order, and evaluate the solution with proper reasoning.

Doing mathematics can be fun, just as we play games, do crossword puzzles, and read mysteries for fun, mathematics shares characteristics with all of these. The knowledge of mathematics helps us to identify patterns and relationships, two things

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that may at first glance appear very different may turn out to be mathematically very similar. Students like its challenge, its clarity, and the fact that he knows when he is right. The solution of a problem is a challenge, has an excitement while working it out and a satisfaction when solved. Success in mathematics is seen as a ticket for the future prospects. The weight lifter might exercise daily for no other purpose than to have a well-muscled body that to him and his fellows seems beautiful. But there's another reason for such exercise: to develop strength, endurance and health to do productive work. The pure mathematician might seek only the beauty in his work and have little thought for how his abstractions might benefit the world, but such exercise of the mind does in fact prove useful.

Mathematics acquires the unique position as the art of pure thought and at the same time as a universally applicable science. From daily chores to profession in each sector, from compact discs to the stock exchange, from computer tomography to traffic routing, from electronic transfer of money to climate change, they make the "math inside" understandable, interesting and enjoyable. In fact, our daily life is a constant succession of additions and subtractions. Whether we like it or not, our daily routine compels us to become expert mathematician, but it is true fact that the modern world runs on mathematics. It provides a way to make things work better and more efficiently, which is one of the ways that economies can emerge from a recession. This necessary fervor is fueled by knowledge of the latest applications of mathematics. To get the essence of mathematics, we have to take an up-to-date trip into the fascinating world of the mathematics all around us. We have to make students familiar with beauty & essence part of mathematics by involving them in mathematical activities & applications so that they themselves get associated with mathematics mentally. In spite of avoiding mathematics, they love mathematics and have fun while doing mathematics and they just try to correlate each & everything with mathematics. It is, however, need of the hour for students' to develop interests and do well in mathematics, being the basic for all subjects and a tool for their future career. This paper is the fruit of years of dreams and the author's fascination for mathematics, its essence, beauty & elegance.

2. Beauty of Mathematics

"Numbers and letters are two eyes given by god to man"-Avayyar (poetess).

"Mathematics is music for the mind; music is mathematics for the soul"-Anonymous.

In the immortal words of Russel that "Mathematics, rightly viewed, possesses not only truth, but supreme beauty, a beauty cold and austere, like that of sculpture" and matched in equal measure by the remarkable words of Penrose when he says that "The more we understand about the physical world and the deeper we probe into the laws of nature, the more it seems as though the physical world almost evaporates and we are left only with mathematics".

Oddities, Curiosities and Recreational Mathematics discuss the beauty of mathematics. Tricks, puzzles and stunts with numbers provide mathematics for entertainment. Fibonacci numbers (series) occur in nature, music, geography and geometry. They can be found in the spiral arrangements of seeds in sunflowers, the scale patterns of pine cones, the number of petals in flowers and the pattern of leaves on trees. The abilities to use logical thought, to formulate a problem in a way which allows for computation and decision, to make deductions from assumption and to use advanced concepts are all enhanced by learning of mathematics. If we take an example of football player, he didn't become superstar by reading about game and its rules or watching other play. Besides knowing the rules and the objectives needed to play, he needed countless hours of practice, hard work and determination to achieve this goal. Likewise, one cannot learn mathematics by simply watching his/her teacher do it in class or by reading about it. One has to do it itself every day just as skill is acquired in sport. Only then one can learn & enjoy beauty of mathematics in small progressive steps by building on skills he/she already has developed. Mathematics should remain with the rigorous logic and its supreme beauty.

3. Essence of Mathematics

The essence of mathematics is the study of patterns and abstraction. It is best practiced by observing the world to find patterns that hold across varying circumstances, then using those patterns to find new patterns which were too complex to discover directly. For some people, and not only professional mathematicians, the essence of mathematics lies in its beauty and its intellectual challenge. For others, including many scientists and engineers, the chief value of mathematics is how it applies to their own work. Because mathematics plays such a central role in modern culture, some basic understanding of the nature of mathematics is requisite for scientific literacy. To achieve this, students need to perceive mathematics as part of the scientific endeavor, comprehend the nature of mathematical thinking, and become familiar with key mathematical ideas and skills. It encourages accurate and logical thinking, allows for cooperation with others to achieve common goals, allows for character building; patience, persistent and perseverance and remarkably, it makes one to be happy. The creativity is the essence of mathematics. Hence, mathematical skills are crucial for a wide array of analytical, technological, scientific, economic and soft skill applications. Training students to become adept users of mathematics and to appreciate its usefulness is of paramount importance for the future. With mathematical resilience, students are motivated, confident, and persevere through negative situations.

4. Initiatives in Mathematics Education

The development of mathematics through the centuries might be compared to a seed of a tree that starts its growth near the surface of the earth. From this point it grows in two opposite directions: up and down. Mathematics can be thought of as the art of concise symbolized abstraction. We start from the ground level of concrete experience and then develop upwards into practical developments and extensions and downwards towards logic, towards ever more fundamental bases on which all above it is built. As one ancient stated, teaching is not a matter of pouring knowledge from one mind into another as one pours water from one glass into another. It is more like one candle igniting another. Each candle burns with its own fuel. The true teacher awakens a love for truth and beauty in the heart–not the mind–of a student after which the student moves forward with powerful interest under the gentle guidance of the teacher. These kinds of teachers will inspire love of math, while so many at present diffuse distaste for it through their own ignorance and clear lack of delight in a very delightful subject. Teaching involves – cultivating student's interest in mathematics, teachers need to be people who themselves curious and interested in mathematics and who are fascinated by student's mathematical curiosities and interest. We have to encourage a favorable attitude and a readiness to consider more. The effects of any one experience are often slight and diffuse, but popular activities are repeatable. One can revisit a museum, watch a film again, read a novel again and again, follow a television series.

In this country of great diversity, we also have a very promising group of students spread across the country and across grade levels. The present trend has resulted in an increased need for workers with greater mathematical skills. Teachers are the single most important resource for developing students' mathematical identities. By catering to the differing needs of students that derive from home environments, languages, capabilities, and perspectives, teachers allow them to develop a positive attitude to mathematics. Initiatives have been taken to retain their Interest in mathematics and motivate them to pursue a career in mathematics. Some such programmes are the Mathematics Training and Talent Search (MTTS), Rural Mathematics Talent Search (RMTS), Mathematical Sciences Foundation (MSF) and the Mathematics Olympiad. These aim to promote independent thinking among students, make challenging mathematics accessible to them, show applications of mathematics in various walks of life and interact with experts in the field. The MTTS programme is meant for students pursuing undergraduate and postgraduate degrees. The main aim of these programmes is to expose and attract young minds to the excitement of doing mathematics and choosing mathematics as a career, to train them to discover mathematics by query, observation, experimentation and finally proving the results.

The National Council of Educational Research and Training (NCERT) contribute towards popularizing mathematics among students, teachers and the community at large. Ganit Mela and Metric Mela (mathematics fairs held in villages where adults are involved in answering questions raised by children based on estimation) organized in different parts of the country are some attempts to take mathematics to the community. Mathematical competitions involving math quiz, mathematics symposia, poster competition, math fest, celebration of national mathematics day will accelerate student's mathematical skills, nurture a spirit of enquiry and creativity among students, generate love for mathematics, create curiosity, excitement and exploration among students in mathematics. The nurture programmes help to train students to build capacities to think mathematically and solve problems of various complexities, and popularization of mathematics, largely to attract students to take up higher mathematics.

5. Students' Attitude Towards Mathematics

Researchers concluded that positive attitude towards mathematics leads students towards success in mathematics. A lot of work has been done on student's attitude towards mathematics by many researchers, ([3, 4, 6, 9]). Attempt to improve attitude towards mathematics at lower level provides base for higher studies in mathematics. It also causes effect in achievement of mathematics at secondary school level [5]. Maths makes some people feel anxious, leading them to avoid situations where they may have to use mathematics [2]. Academics in school/college has been considered as important predictor of future succeeds in education, profession & life [1]. Infact mathematics achievement has been considered as significant factor in deciding future progress in students' life [8]. Researchers have been exploring the factors hindering students' mathematical performance and it is identified that affective and motivational factors are the key factors for it [7]. The attitude towards mathematics is closely associated with achievements in mathematics. The high achievers have favourable attitude while low achievers have unfavorable attitude.

The students with favourable attitude can understand the beauty and essence of mathematics. [10] defines the attitude towards mathematics as positive or negative emotional disposition towards mathematics. Gender difference in attitude towards mathematics has also been researched widely. With these things in mind, a questionnaire was framed and 200 students (male and female) from Colleges of Jammu were requested to respond to 50 statements. These 50 statements were further subdivided into 8 subheading regarding attitude towards mathematics. The response of students is shown by the graph below:

Attitude	Rating Female	Rating Male
Love for Mathematics	8.00	9.00
Interest in Mathematics	8.26	8.50
Ignorance about Mathematics	3.47	2.00
Reasoning & Analytical Approach towards Mathematics	7.96	8.00
Understanding of Mathematics	7.67	8.50
Power of Mathematics	7.65	7.00
Necessity of Mathematics	7.73	8.40
Access to Mathematics	8.26	8.60

Table 1. Presenting Arithmetic Mean for each entry of Male & Female



Figure 1.

It is pleasing to find out that most of the students have positive attitude towards mathematics. Very few of them who don't perform well in mathematics have negative attitude towards mathematics. So, to change their attitude towards mathematics we have to generate their interest in mathematics by explaining them beauty, power and essence of mathematics. We have to engage those teachers for mathematics who have enthusiasm in teaching mathematics and they can themselves feel essence of mathematics. One can change the opinion about mathematics by discussing daily life situations and examples where mathematics is applicable.

6. How do We Develop Positive Attitudes Towards Mathematics and Learning Mathematics?

It's brain, not brawn, that are needed to survive in the information age and brains need more than basic training to function at their best; they need knowledge and understanding. Teaching of mathematics requires being able to represent ideas, more and more understanding of the insides of ideas, their roots and connect carefully across different representation-symbolic, graphical and geometrical. There are so many problems related to mathematics – fear of mathematics (math phobia) among students, curriculum, lack of teacher's preparation and awareness, lack of different approaches in teaching of mathematics. To solve these problems teacher has – to involve students in creative mathematics by using real life examples, time to time faculty learning and equip the teachers with mathematical knowledge and skill that will enable them to teach mathematics effectively. The teachers will be able to inject in their teaching the relevance of mathematics to day to day life. We have to keep in mind that instills positive and productive attitudes toward mathematics lies within our teaching. This research also indicates the necessity of tailoring the preparation of mathematics that is important but the ability to think critically, skills to develop and analyze an argument, to define and research a problem, to present a well-reasoned solution to the problem, and to apply basic knowledge and skills in new and unfamiliar contexts. In recognition of the important role that mathematics plays, at all levels of the education system, mathematics teaching should

- (1). Assist students to develop an understanding of the language and concepts of mathematics and to use their language comfortably and confidently.
- (2). Provide ample opportunity for the development of mathematical process such as conjecturing, generalizing, justifying and proving through the exploration of open ended problems and investigations.
- (3). Focus on understanding application and communication of mathematical ideas.
- (4). Develop mathematical thinking, i.e. think accurately, precisely and logically about the problems.
- (5). Facilitate the development of analytical reasoning and critical thinking skills.
- (6). Focus for students to develop an awareness of how mathematical concepts and relationships they encounter are relevant and useful in day-to-day life and other related areas.
- (7). Foster interactive learning through student writing, reading, speaking, and collaborative activities so that students can learn to work effectively in groups and communicate about mathematics both orally and in writing.
- (8). Identify the ways to engage students, promote independence and challenge learners.
- (9). Nurturing confident, resourceful and enthusiastic learners.

In this era of technology, technological tools are available for use in mathematics classrooms. These include calculator and computer applications, presentation technologies such as the interactive whiteboard, graphic calculator, mobile technologies such as clickers and data loggers, and the Internet. These dynamic graphical, numerical, and visual applications provide new opportunities for teachers and students to explore and represent mathematical concepts. With guidance from teachers, technology can support independent inquiry and shared knowledge building. When used for mathematical investigations and modeling activities, technological tools can link the student with the real world, making mathematics more accessible and relevant. Teachers need to make proper decisions about when and how they use technology to support learning. Teachers need ongoing professional development so that they can use new technologies in ways that advance the mathematical thinking of their students. Various recommendations are also released by various commissions about importance of mathematics (National Commission on Mathematics and Science 2000). NCTM provides comprehensive guidelines covering curricula, professional teaching standards, and assessment standards targeted toward K–12 mathematics curricula time-to-time (National Council of Teachers of Mathematics 1989, 1991, 1995, 2000).

7. Conclusion

The changing face of Mathematics is that, in which new insights are gained, new concepts emerge from the darkness, new questions are formulated. Everyone should develop taste for deeper mathematics. No doubt, Mathematics is one of the oldest subjects, it is constantly being rejuvenated and it is very much alive as it heads into the 21st century. We have to encounter challenges on teaching mathematics by attracting young and adventures students into the field of mathematics when at this time they may involve/fascinated by technology. We need to provide opportunities for our students to become excited about mathematics while acknowledging and applauding their successes. These are necessary conditions that must be in place before we can make any progress on improving mathematical achievement. We have to quench the thrust of

today's learner who is very inquisitive for information. They are www.hungry generation. The teachers has to describe every query as young students are perpetually in the process of finding out "what happens when" by using their mathematical knowledge. If students are to compete effectively in a global, technologically oriented society, they must be taught the mathematical skills needed to do so. Any decision is not a condemnation to a life without maths!.

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