

PEDAGOGY OF MATHEMATICS - HIGH SCHOOL LEVEL

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The Subject “Mathematics” is considered as, “The Queen of all sciences”. Mathematics is the root of all studies which depicts many concepts for science, technology, engineering, auditing, commerce etc. We can say, the thought of calculation in human being’s mind was born before the birth of the thought of expression in language. As Base is important for every field, it is given more importance on the subject Mathematics. Because of its more abstract ideas rather than concrete ideas, students perceive Mathematics as difficult and so leave the disciplines involving Mathematics, which leads to the blocking hurdles to the careers of engineering, auditing, commerce etc.

In Indian history, mathematics education has been special and attractive. Indian predecessors showed extraordinary attitudes towards mathematics calculation in making almanacs, making horoscope, constellation of stars, distance between the planets, time taken by them in their orbit etc which were accepted as conscious and sub-conscious mind calculations as magic and later results got from instinct, talent were to be proved by logical thinking as proving it. The link between the past and the present in the field of Mathematics in India were found to be difficult because most of it were in Sanskrit. Scholars also differ in actual meaning of writings of mathematical concepts. If the development of mathematics in the past of India, was pursued continuously, Indian contribution to the field of Mathematics would have been to the topmost position.

INTRODUCTION:

Indian mathematician, Brahmgupta is renowned for his ingenious contribution to the field of geometry and number system. He invented the number zero and worked out many theorems for cyclic quadrilaterals. Aryabhata was the first to give the approximate value of π and the founder of the number system. Bhaskara was a famous mathematician and also an astronomer. Srinivasa Ramanujan was one of the geniuses of India who contributed in the number system, the analytical theory of elliptic functions.

As Mathematics plays important role in day to day life and it is a compulsory subject from first standard to tenth standard, studying Mathematics is needed one for all students.

But many people opine that it creates fear, phobia and stress on children. Many observations point towards the way of teaching Mathematics create stress.

To make stress free class room environment, The given methods and activities can be followed in teaching Mathematics, which gives the pavement of success in this coarse field.

ABSTRACT : The recent assessment in the field of Education like National Achievement Survey (NAS) reveals that the students even in high school level lack in the expected standard of Reading, Writing, Arithmetic. As the need of change in the ways of teaching is severely wanted in all subjects, in this paper, it is discussed what are the different ways, in teaching of Mathematics to the high school level students. Benefits are as under:-

- ❖ How to motivate the students,
- ❖ How to attract them towards Mathematics,
- ❖ How to keep away the fear from the students’ mind,
- ❖ How to change the Mathematics class room joyful,
- ❖ What are the ways to make all the students to engage in this learning
- ❖ To enrich the teachers with the variety of mathematical teaching ways.

The stress in the process is “understanding the concepts” rather than “the calculation”. Calculations through different formulae can be learnt after the stage of understanding the concept. Because when it is clear that ‘what we have to do’, ‘what we are going to find out’, the further step of calculation – ‘which formula we have to use’, comes.

DIFFERENCE BETWEEN CONVENTIONAL TEACHER CENTRED LEARNING AND LEARNER CENTRED LEARNING

CONVENTIONAL METHOD:

- The teacher is the information giver
- Learner starts from unknown to known
- It is an instructive process
- The teacher helps learners to acquire skills and knowledge

LEARNER CENTRED METHOD:

- The teacher is the facilitator
- Learners start from previous knowledge
- It is a constructive process
- Learners apply skills and construct their own knowledge.

METHODS

MATHEMATICS EXHIBITION:

Here Mathematics exhibition at school level is an act of or instance of exhibiting, a public showing the exhibits or toys depicting the mathematical concepts. It refers to the projects, presentations or the products through which students exhibit what they have learned, usually as a way of demonstrating whether and to what degree they have achieved expected Learning standards or learning objectives. Visualization of the mathematical concepts takes peculiar innovative role in this method.

Exhibitions are typically designed to encourage students to think critically, solve challenging problems and develop skills such as oral communication, public speaking, research, teamwork, planning, self-sufficiency, developing etc.

Conducting exhibition separately for the subject Mathematics attracts the students to participate in that. Mere Participation gives indirect education to the students for understanding the mathematical concepts. In this method exhibits, models (working-non working) depicting mathematics concepts are prepared and made by the students themselves and during the exhibition students repeat the explanation to the coming spectators. It indirectly helps to analyze the fact after facing many questions from the spectators. The participation in the exhibition gives more confidence to the students and the FEARLESS learning is happening through this.



(STUDENTS EAGERLY EXPLAINING THE MATHEMATICS CONCEPTS TO THE SPECTATORS)

MATHEMATICS DRAMA:

Drama is a written work that tells a story through action and speech and is acted out.

Though it serves the function of entertainment for the audience, in this method drama is used to express many mathematical facts involved in life.

Dramatizing the mathematics concepts is nothing but making drama involving the students on the basis of depicting basic concepts like area, volume, measurements, cost, profit and loss which are the day to day life activities. Students in the age group 11 to 15 usually needs others' attention on them. Drama helps them to stand on the stage and gives them to express their talents before all. Doing calculation to the students is somewhat fearful of wrong answer, but, participating in drama by doing characters of seller, contractor, helps them to do the mental mathematics unknowingly.

Mathematics Drama enhances verbal and non-verbal expression of ideas. It develops skills and abilities such as speaking, critical thinking, self-confidence, time management, self-discipline and team work. Mind calculations are the main part of it as these type of dramas contain mathematical operations like addition, subtraction, multiplication, division, area, volume, weighing measurements, etc. Drama characterization, acting the role, script of the play, making up with cosmetics according to the character are the extra learning in this. These are brought out of the young students to identify the talent hidden in them.



(STUDENT'S ACTIVE PARTICIPATION IN DRAMA EXPLAINING MATHS CONCEPTS)

MATHEMATICS GAME:

A game is any mental or physical activity with rules that is done for fun. Playing lets students practice what they know, and also what they don't. It allows them to experiment through trial and error, find solutions to problems, work out the best strategies with team spirit and build new confidence and skills.

Games nurture optimism and create positive emotions. Gaming teaches players how to deal with frustration and anxiety. Gaming promotes social skills; more than 70 per cent of gamers play, either competitively or co-operatively, with a friend. Games are being used to treat certain medical and mental health conditions

Teachers play main role in designing the game which has the concept of the subject Mathematics like multiples, divisors, squares, square-roots, multiplication table, etc. Students play it joyfully, with happiness and physical activity. Game certainly attracts the students since they are in childhood which has attraction towards playing. In this method, students give importance to the game but without knowing that they are learning mathematical concepts.

In this Game method, critical thinking, team work, management of the team, taking decision in depressed situation, creativity, focus, visual memory, strategy, leadership are special characters development.



(STUDENTS LEARNING MULTIPLICATION AND SQUARES BY PLAYING GAME)

MATHEMATICS WORKSHOP:

It is a workshop to the students of high school level, it is not like the workshop of small group doing conferencing or presentation. Here workshop means work place, where students themselves learns to produce or make the exhibits. During this process, they learn the actual meaning of angle, diagonal, length, cubic measurement, etc and work skills,

Working themselves gives the thinking of creator to them, which is a great way to teach hands-on skills as it gives learners an opportunity to try out new methods and fail in a safe environment. It is usually a brief intensive educational program for a relatively small group of students that focuses especially on techniques and skills in doing aimed material.

In this method, students try to make the models expressing the Mathematics concepts by their special skills. Workshop teaches them to think the abstract ideas of Mathematics in their mind like rotation, revolution of an object in a specified angle, three dimensional space, angle of rotational symmetry, order of rotational symmetry, what is pi (π), circumference of circle, how to measure the circumference, practical doing of measurements of volume, understanding the concept of area by laying the one by one tiles themselves, finding the height of the mountain or pole with trigonometric ideas, etc.

When the students are asked to measure angles in notebook, some lack the knowledge of measuring and because of that they are afraid of the subject. But during workshop, they work with others and they learn to measure though they are like substitutes in the game, but learning happens when they work with others pragmatically.

Skills of cutting the shape, measuring the distance, using the tools carefully, mechanical skills are learnt during the workshop practice. Friendliness, sensitivity, empathy, integrity, sincerity, flexibility, adaptability are the facilitation skills in this method.

(STUDENTS LEARN CONCEPTS BY DOING - HOW TO MEASURE LENGTH AND ANGLE IN WORKSHOP)



MATHEMATICS FIELD TRIP:

A field trip allows students and teachers to get out of the formal context of the classroom and cultivate shared experiences. Shared experiences lead to better rapport between teachers and students, as well as a deeper bond among classmates. It is a visit (as to a factory, farm, or museum) made (as by students and a teacher) for purposes of first hand observation.

Mathematics field trip is a visit to carpenter shop, welder's shop, place of building construction, etc for the purpose of first hand observation on mathematical calculation or concept where they are used in that work.

Field trip attracts the students as it is an outdoor experience. Field trips provide relaxation to the child's mind after having the burden of study and exam. It also refresh the child's mind for doing other activities. Field trips provide huge practical experience and theoretical knowledge in different circumstances. It helps in making good bonding with the classmates. It also helps in improving the skills, growth, development, and communication process. The field trip providing an opportunity to explore child ability, talent, and skills on different experiences. The field trip involves different students of different caste, religious, and community. Hence, it also helps to dispute the religious issue and unites the child for better facts.

MATHEMATICS DRAWING :

Drawing is essentially a technique in which images are depicted on a surface by making lines, though drawings can also contain tonal areas, washes and other non-linear marks. There are many purposes of drawing such as describe or record something, document some evidence or history, explore different objects or nature, remember the past or past moments, change people understanding or thinking, express feelings and emotions and many more. Usually all our drawings come from our memory.

During the mathematics class, when the construction of geometry is taught teachers face problems such as not bringing geometry box, or necessary items like pencil, eraser, compass, divider, scale. As students have no proper tools to draw, learning process of construction is disturbed. But when you proclaim there will be a drawing class and the students are motivated as they think something new and different happening will be there.

Here the students are directed to draw the same construction of triangle, cyclic quadrilateral, Incentre, Circumcentre, Orthocentre, tangent etc. And they are directed to draw any shape, drawing of building, machinery, material with the use of any two dimensional geometrical shape, etc. As it is different, they are focused to the drawing, they learn the same construction with joy.

Benefits of Mathematics Drawing:

- Develops Fine Motor Skills. Fine motor skills include any specialized movement of the hands, wrists, and fingers.
- Encourages Visual Analysis with front & back views, angle of figures.
- Helps Establish Concentration on isometry, solidarity, etc.
- Improves Hand-Eye Coordination with different figures .
- Increases Individual Confidence in learning Mathematics .
- Teaches Creative Problem Solving.



STUDENTS PARTICIPATING IN MATHEMATICS DRAWING

MATHEMATICS SONGS:

Songs are used for many purposes- **to tell stories, express emotions, or convey a belief in faith.** Sometimes they give instructions or help make difficult, repetitive work a little less tiresome.

Here Songs are used to make the students remember the formulae and some mathematics concepts. Teachers who teach in high school level find difficult to make them understand the concepts of “Addition & Subtraction of Integers” “Formula for finding the area of geometrical shapes”

As songs reduce stress and elevates mood, students are focused towards what the teacher tells through these songs. When the songs are prepared on the concept and the words are formed to memorize the formula, students are relieved from symptoms of depression in learning Mathematics and they have the stimulated memories.

Music ignites all areas of child development and skills for school readiness, including intellectual, social-emotional, motor, language, and overall literacy. It helps the body and the mind work together. Exposing children to music during early development helps them learn the mathematics abstract concepts and meanings of the formulae.

Teachers should select the songs from latest film songs, famous lullabies, musicians so that those songs are already heard by them. But teachers change the words according to the concept which he/she likes to teach them, there should be some important points to be followed. The songs should contain simple, easily understood lyrics.

- Link with a topic or vocabulary that you are studying in class
- Words are repetitive
- Children can easily do actions.



(STUDENTS SINGING SONGS HAVING NAMES OF SHAPES AND BASED ON FORMULAE)

MULTIPLICATION TABLE RECITATION :

It is the act of enumerating a recitation of relevant details. Usually language teachers use this technique to make the students well versed in poetry, prose written by the famous authors.

In the field of Mathematics education, memorizing is not advisable, because understanding the concept only can lead the students further calculation, creation and thinking in advanced situation. Sometimes memorizing with understanding is needed to develop their knowledge.

Since there are so many formulae which are to be recalled according to the situation while doing the calculation, multiplication table and square, cube table are necessary to do the calculations, memorizing the multiplication table and formulae are utterly needed. It helps the students in time management in the examination to do it in particular speed. It develops public speaking skills.

To be really enjoyable and fruitful, classroom recitations should be lively. A lively recitation provides opportunities for sharing and promoting feelings of recognition and sense of belongingness. It gives both teacher and pupils/students a sense of success and self-fulfillment, factors conducive to teaching- learning process.

FLOWER MATHEMATICS:

In this method, mathematical concepts are shown by arranging flowers as needed.

Different colours of flowers are used to differentiate the angles, the sides etc which attracts the students from the normal drawing of the geometrical figures. If the arrangement of flowers could not be done, the same may be done where it is possible and the photographs or videos may be taken and shown to the students by using small projectors.

If you divide circle into 360 parts, measurement of angle made in one part is called DEGREE

90° 180° 240° 300° 360° 0°

If you divide circle into 400 parts, measurement angle made in one part is called GRADIAN

300 200 0 400 100

The angle subtended by the arc having the length of radius at centre is RADIAN

r r r

One radian= 57.3°

ஒடிய = $8 \times (4/8) - 1 \times (4/8)$
 நீளத்தனை = $7 \times (4/8)$
 ஓரெட்டு = $28/8$
 சுறாக்கி = $28/8$
 சுற்றிலே ஒன்றை தள்ளி

குன்றத்தில்
 பாதியை = $(28/8) + (3/2)$
 சேர்த்தால் = $(7/2) + (3/2)$

வருவது
 கர்ணந்தானே = $(10/2) = 5$

OBSERVATIONS :

In conventional teacher method, mathematics class room is in controlled discipline and students learn Mathematics by listening, doing calculation and occasionally analyze critically. Learners have access to limited information, selected by the teacher or the school library. Topics of the study are typically isolated and disconnected from each other. Learners memorize the facts and there is little focus on applying facts or concepts to a variety of real world situations.

In Learners centered education, Learners have infinite access to unlimited information of varying degrees of quality. They study content in a way that shows connections between subjects. Learning takes place as high level analysis between the concepts and facts with evaluation and synthesis of a variety of kinds of material. There is an emphasis on showing how concepts apply to a variety of real world situations.

In conventional method, Learners learn passively in an often silent classroom. Learners usually work individually. But in learner centered method, Classroom environment resembles an active workplace with various activities and levels of sound depending on the kind of work being done. Since learners are given importance, they often collaborate with peers, experts, community members and teachers.

Teachers use various kinds of technology to explain, demonstrate and illustrate various topics in teacher centered method. In students centered method, Learners use various kinds of technology to conduct research, communicate and create knowledge. The differences shows that both approaches can be suitable depending on the situation. Good teachers recognize that there is more than one way to teach and that the different situations often require different teaching practices.

In a high school situation where learners are in the age group 11 – 15 years, they always like the situation where they are given focus and learning in work place is active circumstances.

CONCLUSION:

In India, National Curriculum Framework 2005 recommends that shifting the focus of Mathematics Education from achieving 'narrow' goals of mathematical content to 'higher' goals of creating mathematical learning environments; Engaging every student with a sense of success, while at the same time, offering conceptual challenges to the emerging mathematics field; changing the mode of assessment to examine the students abilities rather than procedural knowledge;

The above discussed methods are pragmatic methods where the students can learn Mathematics easily with all the expectations defined by the NCF-2005 and National Education Policy.

Mathematics Exhibition like Science Exhibition, if it is repeatedly conducted every year in school level, ensures the participation of the students, development of public speaking skills, understanding the mathematical abstract concepts. Mathematics Drama and Mathematics Game are the two fantastic methods where students work individually and also in group to learn the activities and the qualities of team work, flexibility, adjust with others, etc. As a high school teacher, the author, ascertains that these methods are learner centered and also produce the actual learning result of understanding the difficult mathematics concepts which leads to the expertise result of doing fast calculations as a consequent.