



# INNOVATIVE PRACTICES ADOPTED IN MATHEMATICS BY MUKTANGAN TO ACHIEVE 21ST CENTURY SKILLS

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## ABSTRACT

One of the effective methodologies in teaching learning process is “**LEARNING BY DOING**”. Ideally, mathematics should be taught in an easy way such that student can relate it even after the school is over. This helps the student to perform better and develop positive attitude towards the subject, which leads to avoid mathematics phobia.

Teaching mathematics realizes that more focus should be laid in the classroom. The focus of teaching mathematics is to achieve objectives such as critical thinking, logical reasoning, decision making and problem solving for students. Such objectives are difficult to be achieved only through verbal and mechanical methods which are usually used in the mathematics classroom.

In Muktangan, math is taught using the constructivist approach. Objective of this paper is to highlight math innovative practices followed in the Muktangan which are applied in the pre-school and primary level such as **Bell work, role play, storytelling, picture talk, puzzles, games** . These innovative practices help to create a conducive environment for learning through exploring concrete materials and also engage all learners to visualize and make connections in mathematical concepts. Being an inclusive school, such practices assist teachers into creating lesson plans according to the different need of students. Tracking tool for each student is developed to record their progress in learning each concept.

Key Words: Muktangan, Mathematics, Innovative practices, Mathematic phobia, Tracking, Connection, Inclusive, Visualization.

## **1. About Muktangan**

India is a developing country; our education system follows different boards. Here many schools follow the traditional method of teaching. The children from urban low-income families have access to schools with high student-teacher ratios that enforce rote-learning methods. Such practices lead to non-conducive environment in the classroom affecting logical thinking in the children. RTE (Right to Education Act, 2009) report states that all children six to fourteen years of age have the right to education without any discrimination. Hence Muktangan comes into picture.

Muktangan was established in 2003, with the help of the Paragon Charitable Trust now the Mukhtangan Education Trust and in partnership with the Municipal Corporation of Greater Mumbai (MCGM). Mukhtangan emerged from the founder Elizabeth Mehta's vision to bring about a change in mainstream education.

Muktangan works with an integrated model of inclusive teacher and school education. In the starting years it ran a pre-primary centre at Worli, Mumbai. With growing recognition of its integrated model and active-constructivist approach, it now runs 7 schools from Pre-primary to Standard 10. In the 16 years of service, Mukhtangan has impacted over 3000 students and generated employment for over 800 teachers via training through its teacher education training programme.

A typical Mukhtangan classroom has a stimulating environment where learning happens through integration of various art forms. With a student teacher ratio of 14:1, teachers and students sit at the same level, allowing for collaborative approach in the learning process. Moreover, the classroom infrastructure consists of light-weight, portable furniture which makes room for multiple activities, whereby children learn by doing.

## **2. Mathematics phobia**

Phobia is an unreasonable sort of fear that can cause avoidance and panic, in simple terms phobia means "fear". A Phobia is a type of Anxiety Disorder indicating a fear of a specific object or situation. Using exposure and fear reduction techniques, phobias can be treated with cognitive behavioural therapy. Some type of phobia includes Fear of water (hydrophobia), fear of closed space (claustrophobia), fear of height (acrophobia). Math anxiety is one such fear mathematics which involves the feeling of anxiety that emerges when an individual is required to manipulate number or perform mathematical operations.

A major factor in the development of mathematics phobia and dislike towards mathematics in students is the way the teachers feel about mathematics. It is well known that it is important that teachers love the subject they are teaching. On the other hand, if the teacher feels negatively towards mathematics, it probably shows up in his/her teaching and affects the teaching. Some significant reasons, why students fail in Mathematics are:

1. Attitude towards learning the Subject
2. Method of Teaching
3. Lack of Connection between the Subjects
4. Self - Doubt
5. Lack of Understanding of Signs and Symbols
6. Teacher Student Ratio

### **3. Mathematics in Muktangan**

In Muktangan, we define mathematics as the “Science of Patterns”. We encourage students to identify different patterns in each mathematical concept. This helps in constructing connections between different concepts and also establishing inter-relationships between different school subjects.

For example,

- a. In geography to locate the position of given cities on the basis of their latitude and longitude on a graph paper can be related to the coordinates in mathematics.
- b. In word problems, language (mathematical) is used.

#### **3.1 Making mathematics meaningful for students**

Mathematics is to be learnt by both teachers and students together through fun and exploration. Students bring many experiences to the mathematics classroom from their daily lives. Here the job of a teacher is not to ignore these experiences but to find ways for each child to actively build, on their own unique set of experiences. We as teachers often focus on set of procedures which hamper the student’s ability, to develop his own understanding by making connections between his experiences both within and outside the classroom.

However according to Carpenter and Lehrer (1999) the teacher is key to many students’ ability to learn mathematics. Research supports the importance of teachers’ development of

pedagogical content knowledge, built upon a deep understanding of how students think and develop mathematically. Muktangana, a Hindi word ('Mukt'–'angan') has literal meaning 'free courtyard'. It provides children the freedom to think act individually. Students are encouraged to discover their own processes to reach answers. It is not the answer which is important but rather the process of mathematical thinking. Games and puzzles lead to joint discussion and group thinking.

### **3.2 Making connections and forming relationships**

What happens to a student's brain in a primary mathematics classroom? Leonard (2000) highlighted that lectures guarantee that a particular amount of material is covered but does not guarantee that the students have fully understood the material. The student's brain is often overloaded with information which he is unable to process and in turn the information gets wasted. Mathematical knowledge is cumulative. Later concepts cannot be understood without an understanding of the earlier ones in the learning sequence. The curriculum is to be delivered in a spiral manner with the earlier concepts being revised and retaught whenever necessary giving students a second chance to understand the foundational concepts. In Muktangana teachers as facilitators create an environment for the students to build their own understanding of concepts (active-constructivism) through questioning and using concrete objects.

According to Piaget, between the ages of 7/8 to 11/12 years children need concrete experiences in order to form the mental images required for performing operations in mathematics. Jodi B. Prideaux, 2007, shows that active learning strategies would motivate and engage students in the learning process, thus resulting in an enhanced understanding of the material.

## **4. Distribution of syllabus**

We, in maths department at Muktangana, follow the books prescribed by the state board. Although the syllabus is given by the state board, the textbook sequences are changed or re-order that students can discover the interrelationships and connection between topics. From std 1 to std 8 all the subsections such as Number, Measurement, Geometry, Patterns, Algebra, and Data handling are taken up simultaneously across standards enabling faculty and teachers to readily create activities suitable according to the level of students.

#### **4.1 Preschool:**

Pre Primary Education can be defined as “a set of knowledge along with skills and experience as well as behavioural rules which prove essential for coping successfully in everyday life and at school.”

The kids count with variability in maturity, knowledge, emotion, excitement, mental, ethical, fine motor, gross motor, verbal, education, admiring responses. With other individual traits building up at this phase.

#### **Mathematics in Pre – primary**

Teachers at Mukangan implement activities right from pre-primary. Activities conducted in the pre-primary are based on the daily classroom observation. Where, the teacher develops the pre - number concept in mathematics. Such as seriation, sorting, matching, ordering, classification according to attributes (shape, colour, size, thickness and texture), subitising, one to one correspondences, more / less and equal.

#### **4.2 Primary**

The students at Mukangan, move from one classroom to another during transition from one subject to the other. To bring the students to the world of mathematics, sessions start with **bell work** which consists of 5 mins. Here, the teacher provides problems related to previous knowledge as well as previous concepts taught. Bell work evolves mental mathematics, solving problems, puzzles, games, riddles, peer work according to the concept. This 5 mins exercise enables teacher to get know the level of each and every individual in his/her group.

Every topic is introduced in a unique way. It is either a storytelling, picture talk, role play or hands on activity for introduction to a concept For eg. 1. Profit and loss, Discount and commission is introduced through role play where actually students guess the topics which teacher is going to conduct. 2. All basic four operations i.e addition, subtraction, multiplication and division are introduced by picture talk and storytelling. These innovative practices enhance the students to visualize and make connections, also to develop their communication skills in terms of mathematical language.



### 4.3 Practices used to achieve 21<sup>st</sup> century skill

In Muktangnan the lessons are planned using CREDA to help students visualize mathematical concepts from simple to complex, concrete to abstract and known to unknown

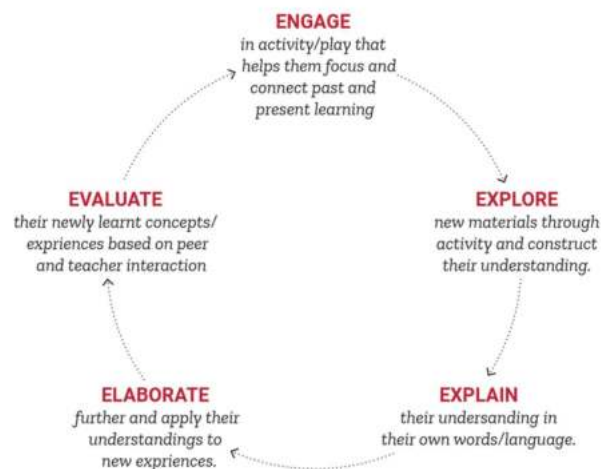
#### Connecting CREDA to 5E's

In Muktangnan math teachers follow CREDA as a process ( 5 E's ref. to Figure 1. ) to evolve innovative practices in teaching mathematics.

#### CREDA

The concept of CREDA is a learning sequence for helping young children in the Mathematics classroom.

1. Concrete Experiences- Students explore the given concrete objects
2. Representation- Students represent the results of their exploration through drawing or any means of representation
3. Explanation- Students talk about and explain their drawing/representation to their teacher and own group
4. Discussion- Students discuss the concept with their teacher.
5. Algorithm- Students record the problem in standard mathematical notation



*These five E's of active - constructivism help develop 21st Century skills.*

Figure 1.

Example:

Topic: Multiplication and division

1. *Concrete*: The facilitator gives a jar of counters to the children, asking them to work in pairs. She tells each pair to remove 24 counters and to arrange them in equal groups.
2. *Representation*: The facilitator asks them to draw what they have done.
3. *Explanation*: The facilitator moves around the class asking each pair to explain their drawings.
4. *Discussion*: The facilitator discusses with the children which operation they feel they have been demonstrating.
5. *Algorithm*: The facilitator gives them the written algorithm for multiplication as repeated addition and division as equal grouping and gives them further examples to solve.

#### **4.4 Teacher children ratio**

Muktangan classroom comprises of 3 (three) groups, Children sit in U-shape, which allows the teacher to monitor each and every child. The teacher to student ratio is maintained as 1:14. This small group teaching promotes one to one correspondence where the role of the teacher is more to facilitate and create thinking in individuals rather than rote learning as in conventional classrooms. The classes are equipped with various low cost easily available resource material used for activity-based learning. Stackable furniture is used which can be put aside whenever required. This gives more space in the class which helps teachers to utilise floor to perform activities with the children.

#### **4.5 Inclusive**

Being an inclusive school Muktangan also caters to differently abled children which is almost 12% of the total strength from standard 1 to 10. To cater such students Muktangan supports a set of teachers to facilitate these students. They are provided with the overall development including essential content knowledge. These teachers support the children with special needs in the class room.



## **5. Tracking**

The tracking system is a mathematics assessment tool for tracking the progress of each student from standard 1 to 8. It is also helpful for planning diversified learning experience in CUD meetings. The various competencies/ strands for different grades are in the form of rubric. The teacher checks the competencies achieved by the student throughout the year. The un-achieved competencies are rechecked in the following academic year to ensure the quality education provided and improved level of the students.

### **5.1 Assessments for Learning**

As Muktangan follows a state prescribed syllabus, students at Muktangan schools undergo annual summative grade level assessments such as, unit tests, mid and end of term written examinations. However, in keeping with Muktangan's constructivist curriculum, teachers supplement these summative assessments with continuous classroom dialogue, projects and Q&A to gauge students' conceptual understanding of the subject matter and application of learning. Teachers then use this information to adapt their teaching methods to fortify student knowledge and improve learning outcomes.

### **5.2 Student Tracking**

Muktangan is currently using subject determined competencies to track individual student progress across grades. This tracker effectively quantifies student understanding on each competency allowing teachers to effectively focus on specific learning gaps. The team has completed the tracker for English and Math and is currently working on adapting the tracking system to other subjects. This process is cumbersome due to the diverse competency levels present at each grade especially with regards to subjects like language and the social sciences.

## **6. Spreading Muktangan's innovative practices out in the world (outreach)**

Muktangan's child-friendly, integrated teacher and school pedagogy, supported by inclusive leadership processes, has been demonstrated in its 7 lab schools. NGOs and governments at the local, state and national levels have seen it as relevant to address the shortcomings in the country's educational system. This, in turn, has led to the strengthening of Muktangan's Outreach, Advocacy and Research programme. Over the years, the senior management team has made the conscious decision to not be strayed with the temptation of isolated interventions and concentrate on proving the effectiveness of a more systemic approach, followed by focused advocacy. In addition, it was felt that a more limited number of focused, strategic, government, non-government and university outreach partnerships, apart from impacting immediate beneficiaries, would enable us to spread our approach in differing contexts e.g. urban, rural, tribal, teacher education and research organizations, whilst making us more visible to policy makers as a grass roots, "centre of excellence"

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