SAIIER Annual Report – Project

Reporting period: 2017-18

This form is for reporting on a **Project** (in contrast to a **SAIIER Sub-unit**) which was supported by SAIIER over the last financial year. Please use as much space as you need for the report.

Please submit this report to SAIIER by **May 14, 2018**. For any questions or clarifications, please send an email to saiier@auroville.org.in.

1. Title of project:
Deep learning of Mathematics through engaging with life and interdisciplinary work

2. Project holder:
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3. Report writer:
As above

4. Introduction:
We use Mathematics here as a language of science and the goal of learning it is to be able to interpret, analyze, abstract and model something in real life. The ability to do these builds critical skills (problem solving, logical thinking, etc) and competencies (perseverance) in children and broadens their mind and helps them Mathematize (or think Mathematically) (Pal Y, et al., 2005).

Our research questions are:

1. How does the use of physical material to understand abstract concepts help children in deep learning of Mathematics in terms of
    a) their ability to apply what they learn in different contexts
    b) retention of concepts they learn?
2. Do the results of the above measures change if the children themselves create these materials rather than using ready-made materials?
3. How effective are real life EBDs (Education By Design) that apply Mathematics to real life problems for the above measures. For real life EBDs the Mathematics required to understand, interpret and design is often concepts 'beyond their syllabus'. These projects are often inter-disciplinary (e.g. including EVS, Electronics) in nature. Does it help children feel that learning Mathematics has a purpose or does it intimidate them?
4. How does doing this research change my perceptions of how I engage with children with Mathematics.

Background Survey (more details in the attached draft paper)

High School Survey of Student Engagement (HSSSE) found that creation of learning materials could possibly engage children more filling the engagement gap (Yazzie-Mintz, 2009). Further research suggests that engaged students are better able to make an effort to comprehend complex ideas or master difficult skills throughout their education **(**Fredricks, et al., 2011).

Further, actual application through solving real life challenges e.g. in water, etc would help children use Mathematics to analyze, model and understand problems while attempting to solve them.

Example: There was a water shortage in Isai Ambalam school and we asked the children to gather more information and look for solutions for the problem.

We applied 8 EBDs(Education By Design) last year and felt that it creates an opportunity for the children to be challenged to learn through application of concepts in the environment around them. We believe that these approaches are in line with Sri Aurobindo's third principle of true education of learning from near to far (Aurobindo S, 1910). The children even addressed concepts that would have been termed beyond their curriculum because they were interested in what they were learning and in line with the second principle of true education "the mind must be consulted in its own growth".

The national context NCF (National curriculum framework) 2005 states that "Learning should be made enjoyable and should relate to real life experiences. Learning should involve concepts and deeper understanding."

5. Description of project:

We have a variety of teaching learning materials in STEM land. Following is a description of 3 of them.

Vaughn Cube

We identified multiplication tables as one of the stumbling blocks in children's ability to do calculations. Difficulty with the multiplication tables made children feel they were not good at Mathematics. We used the Vaughn Cube with children from 3rd grade onwards who had difficulty with learning multiplication tables (up to some in 8th grade).

The Vaughn Cube for Multiplication is a complete program that includes 2-1/2-hour of DVD video with accompanying skill development and testing materials, and an Instructor's Guide. The goal is that in approximately 6 hours (including video and practice) a child can answer the 100 multiplication facts. Students do not have to memorize the multiplication table by continuous repetition. Instead, they use their natural ability to remember what they see and where they see it.

Observations

We attempted to use Vaughn Cube methodology including the videos and soon found that it was exhausting for children. We adapted the Vaughn Cube methodology by creating laminated sheets for the objects that need to be mastered so children could touch feel and work with the sheets instead of watching videos. We also identified specific tables that children needed to master and focussed on those objects thereby reducing the length of time required to learn

these objects. We also used group activities rather than only individual learning that opened the possibility of peer-learning.

Many children who struggled with the tables have been able to master them now. As the Vaughn cube method has lots of pictures, children were more interested and were also able to work in groups. Once they understood it they didn't need a teacher's help and became independent.

Ganit Rack

We used the Ganit Rack for addition and subtraction with the 1st grade, 2nd grade and 3rd grade children as they had some difficulty in seeing patterns in numbers.

The rack consists of two rods of 10 beads each with 5 beads in red and 5 in white colour. This helps children to automatize additions and subtractions up to 20 and number facts.

For example, to add 6 and 7 the children quickly remember that 6 is 5+1 on the first rack and for 5 + 2 on the second rack. The two 5's together is recognized as 10 and the result 13 is read out easily with the remaining 3 white beads.

Observations

As Ganit rack is a hands-on material, they were engaged and were able to count beads and observe patterns. Even the children who don't usually engage in class were very engaged when they were doing additions with the Ganit Rack. They also became independent as they practiced more and asked for teacher's help less often.

8 out of 12 children from the 3rd grade class wanted more problems from the teacher at the beginning and later solved their own problems.

They were able to see patterns of 5.

Algebraic Identities

We used materials to make algebraic identities concrete with 8th and 9th grade children.

The materials for $(a+b)^2$ and $(a-b)^2$ are made of cardboard sheets and different colours to represent the squares and rectangles representing product of 'a's and 'b's.

The $(a+b+c)^3$ Montessori material consists of wooden cubes with different shapes and colours.

Observations

The children were able to understand and visualize the identities instead of memorizing the formulas. Using the materials, they were able to feel squares and cubes physically. This gave them a better sense of squares and cubes.

Education By Design (EBD)

Following the concept of EBD, the children from Isai Ambalam School were given real life challenges and an opportunity to collaborate in teams to work towards the solution.

For example, the school was running out of water for 3 months. Children were struggling to go to the rest room and to find drinking water. We decided to take a real life problem for their EBD. Then the children started to discuss in groups what were the real reasons behind the shortage of water. They had lots of hypotheses and they tested them.

Through the experience of solving this problem children learned Mathematics, English, Tamil and science.

For Math they measured length of pipes, built a pond in school where they measured the diameter, depth, area etc. For English they wrote everything they learned in their note book in English. The younger children who were not able to write in English wrote in Tamil first and then translated it back to English. A few children discussed the project in English and presented it to the whole group in English. As part of science children learned the water cycle. They learned what ground water is and the process of settling down in the aquifers. They watched a video to learn few concepts like, ground water, water cycle etc. They also saw the process of drilling a bore well near their school. The water problem was fixed by lowering the bore well pipe by 150 feet. Now the total depth of the bore well is 350 feet.

We work on EBDs with the age group of 8 to 13. There were other EBDs, including creating a herbarium of plants found in the school and studying and creating models for the honey bee. We also took on real life challenges which included creating a pond, refurbishing a clay room, making a garden and kitchen water recycling. The children gave ideas to solve problems and did field work such as painting, digging, masonry, plumbing, planting. They also contributed in measuring the depth of a bore well, automating the process of pumping water.

Thanjavur EBD

Students from 3^{rd} grade to 7^{th} graders went to Thanjavur, an educational trip. Their EBD was about studying the angles and shadows of the temple. The students came to know that the shadow will fall on the ground. The shadow differs based on time. So they learnt angles from this. After coming back from the trip, students built a structure of the temple and made a project about the shadows. Through this they learnt measurements, angles and teamwork. The 4^{th} graders and 5^{th} graders worked together as a team

Materials created by children

1m scale and $1m^2$

12 children from 5^{th} and 6^{th} grade combined together to make a 1m wooden scale. A 6^{th} grade girl said that she was thrilled to use and cut the wood for the first time. With that 1m scale, they cut out a $1m^2$ in a chart paper. They were able to figure out that 10000 cm^2 can be placed on a $1m^2$. Then, they shared their learning with the younger children. The older children asked a question to the younger ones, “how many $1cm^2$ can be placed on a $1m^2$?”. Many of them were stuck with the number 1000 and were not able to go further. Using Dienes blocks, the older children demonstrated that there are 10000 cm^2 in a $1m^2$.

Sets game

One of the volunteers had an interesting game that helped children learn some of the fundamental ideas about sets. The setup of the game required a couple of hidden rules about

two sets (e.g. one set of blue shapes and the other set of rectangles). Then 3 9th graders drew the Venn Diagram and the children guessed a shape and its color in each section till they were able to figure out the secret rules. Within two or three days most children had mastered it and were then able to link it to concepts of intersection, complement within set theory.

Areas and Ratios

The children from 7th grade created their own materials to understand areas and ratios. For ratios, they cut out sponge sheets to visualize ratios and connected it with fractions. For areas, they cut a rectangle and figured out that half the area of a rectangle is the same as that of an area of a triangle.

Findings

From our observations in 5th grade, 7 out of 9 children were able to retain previous term concepts like unit conversion (m to cm, km to m, minutes to seconds, days to hours etc...) , ratios. 5 out 7 children from 4th grade were able to remember life cycle of honeybees. After having a conversation with the children, 8 out of 12 children from 3rd grade were remember the process of creating a herbarium model book.

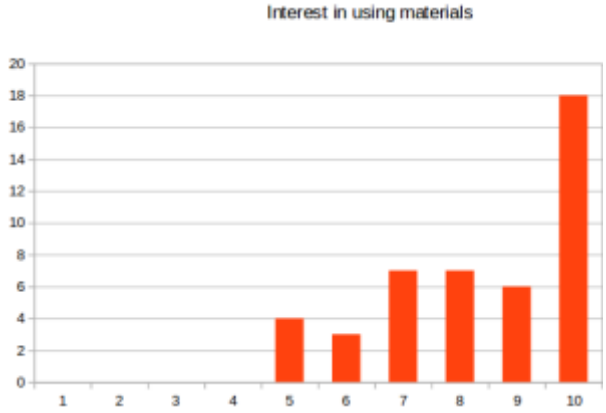
6. Outcomes:

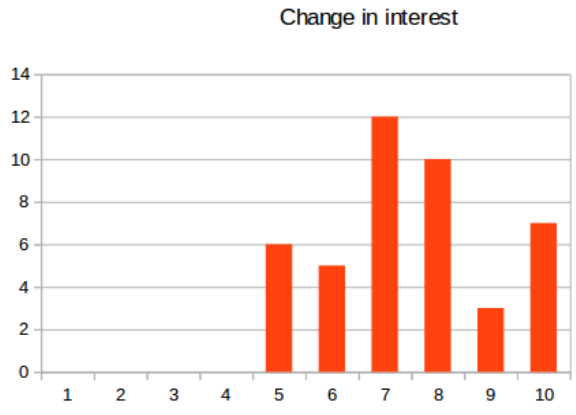
We studied the interest of children in learning Mathematics using materials. We conducted a survey for Udavi school children. Children were asked two types of questions.
1. Rate how interested you are in learning mathematical concepts using materials
2. Rate the increase/decrease of interest in mathematics from when you were in 5th grade

We used the Likert Emberling scale for rating(1- not interested, 5 - interested, 10-very interested).

According to this survey their interest increased when they used materials to understand mathematical concepts.

Below : x axis is the Likert Emberling scale, y axis is the number of children.





From surveying 22 children in Isai Ambalam school, more than 50% of the children said that they learn more during EBDs than in a normal class. 18 of the children said learning with materials helped them understand concepts better.
From the previous term EBDs, a child said he remembers 'names of materials in pond work, life cycle of honeybee, whether honeybee can create forest or not, process of painting in one direction, multiplication, division, addition, subtraction'
Another child said she 'how to make a raised bed for plants, how to grow plants without using chemicals'

7. Reflections:

What was most meaningful about this project? What was challenging and what was learned?
I learnt that children who were below average in their academics showed interest when they learnt through materials. They showed even more interest when they learn through Education by Design and built something. By doing EBD children improved their communication and showed team work. There were lot of peer learning happening with multi grade class rooms. It was enriching for me as a teacher and allowed me to learn a better approach to be effective as a teacher.

8. Conclusion:

In this research project we found that children tend to be more interested in learning when they use materials. The EBDs also help them to interact with the real world rather than just learning something abstract. It helps them apply their learning. When they learn with materials/projects, they have a deep learning and can retain the concepts going forward to the next grade/term.

9. Links and attachments:

Photos (please attach as separate files), links to videos and websites, any other supplementary material that you would like to share.