Effect of ICT Integrated Constructivist Pedagogy in Transacting Class VIII CBSE Mathematics

A Research Project under ERIC

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NCERT

Submitted by

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Abstract

This pretest–posttest equivalent groups experimental study compared a procedure that is the ICT integrated constructivist approach for helping a section of eighth class students to be better able to improve the achievement in non-standardized summative assessment conducted by school than a control group of eighth class students. We predicted ICT mediated learning would improve the achievement and facilitate both the gender equally. The mean posttest score of the experimental group was significantly higher than the mean posttest score of the control group; the mean post test score of experimental group was significantly higher than the mean pretest score of experimental group and the means of pretest scores of experimental and control groups were comparable; moreover there was no significant difference between the pretest and posttest scores of control group. These four observations indicated that the ICT mediated constructivist approach had significant effect on improving the achievement score, which is consistent with the recent research on the effects of constructivist approach. There was no significant difference on the mean test scores of girls and boys in any of the pretest and posttest; which indicated gender had no effect on achievement in mathematics at class VIII level and ICT mediated constructivist approach facilitated both the gender equally for improvement in achievement.

Acknowledgement

Apart from the efforts of myself and my co-investigators, the success of any project depends largely on the encouragement and guidelines of many others. I take this opportunity to express my gratitude to the people who have been instrumental in the successful completion of this project. I would like to show my greatest appreciation to Prof. H. K. Senapaty. I can't say thank you enough for his tremendous support and help. I feel motivated and encouraged every time I attend his meeting. Without his encouragement and guidance this project would not have materialized. I am highly indebted to Prof. R. Raizada, Prof. J. Mandal, Dr. K.A.S.S.V Kameswararao and Mr. Harish Prasad for their guidance and constant supervision as well as for providing necessary information regarding the project & also for their support in completing the project. I would like to extend my sincere thanks to Dr. P.K. Tripathy, Dr. N. Rohen Meitei and Mr. L.S. Chouhan for their immense support in successful completion of the project. My thanks and appreciations also go to my colleague in developing the project and people who have willingly helped me out with their abilities. I am highly indebted to the staff of D.M.S, Bhopal for their sincere and timely support.

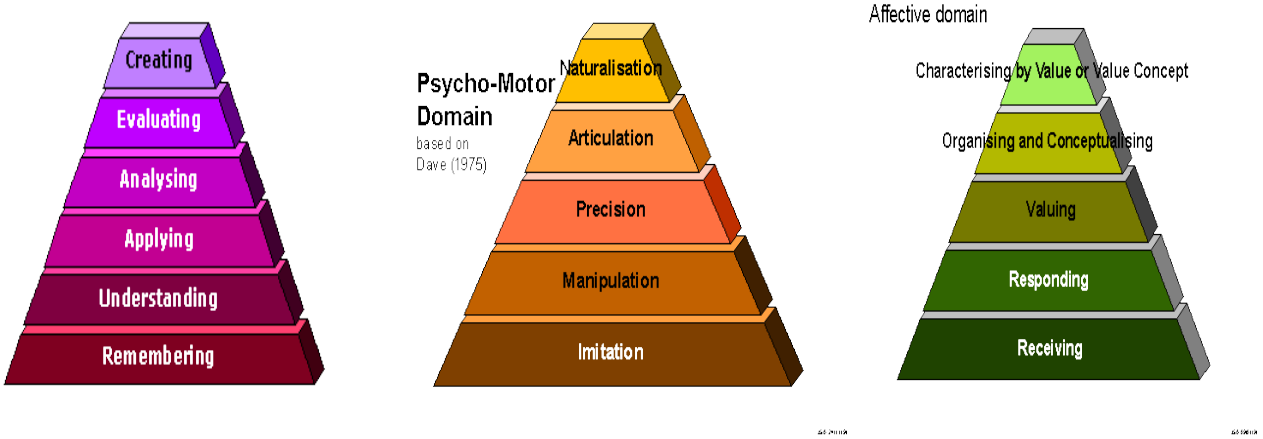
The guidance and support received from all the members who contributed and who are contributing to this project, was vital for the success of the project. I am grateful for their constant support and help. After all I am highly indebted to ERIC, NCERT for funding this project.

Content

Introduction

2.1. Need and Justification of the study in the contemporary societal context

The present assessment practice is based on behaviorist pedagogy. The immediate need is to put in place an assessment practice compatible with the constructivist pedagogy which gives importance to process skills instead of product. The present summative assessment practice contains items mostly from knowledge and understanding level of cognitive domain. Comparatively less number of questions on application, analysis, and synthesis and evaluation level are found in summative assessment. The affective domain (receiving, responding, valuing, organizing and conceptualizing, characterizing by value or value concept) and psycho-motor domain (imitation, manipulation, precision, articulation and naturalization) find unrepresented in present assessment system.



NCF 2005 advocates constructivist pedagogy. Constructivist pedagogy is in developmental stage in India. It is the backbone of CCE in India. Since the extension of CCE up to 10th doubt has arose at different levels about the effectiveness of this approach. There is a common belief that the academic standard has deteriorated with its introduction. There is chaos about CCE pattern in CBSE affiliated school. There is growing dissatisfaction among parents, teachers and students about the unnecessary pressure it has brought into in the form of comparatively more number of assessments, projects etc. People are not able to accept alternative assessment strategies (formative assessment and summative assessment) advocated in CCE pattern based on constructivist pedagogy. Rather than helping in the construction of knowledge most of the present strategies practiced under CCE are mere

repetition of traditional lecture method based pedagogy. The present practices are more ritualistic in nature than constructivist.

One of the remarks of education experts is that CCE pattern is ineffective without integrating constructivist pedagogy. Teachers practicing in school are either unaware of the practice or view this practice as too ideal.

This is researcher's belief that this is happening due to lack of integration of constructivist pedagogy in its true sense in CCE pattern. Here the researcher finds different ways to intervene and integrate constructivist pedagogical strategies into a regular format Indian secondary school classroom setting of CBSE Board for a period of six months. For this the researcher proposes to integrate ICT with constructivist pedagogy to teach mathematics to class 8^{th} students of DMS, Bhopal. The use of ICT will expedite the process of curriculum transactions in limited available time in regular school.

2.2. Theoretical perspective

Constructivism has become an important aspect of educational reform. "Constructivism as a philosophy is not new, but its application to modern education is still in the formative stages" (Ward 2001). Schools that are using constructivist methods have met with some success, but those schools are rare. Constructivism is a theory of learning rather than a theory of teaching; therefore, it does not prescribe a particular set of teaching practices. This means that the teachers can use a number of methods of teaching and assessment that will fit in the rubric of constructivism – even certain, more didactic practices, such as lecturing, note taking, and textbooks (Colburn, 2000).

Recent Research Works

Ali et al.(2011) attempted to check the impact of motivation on problem based learning environment on the academic achievement of High achievers and Low achievers in the subject of mathematics. The study was experimental in nature and pre-test- post-test design was used the study. Students were distributed into two groups. An experimental group comprising 19 participants received problem based learning practice including students motivational techniques, e.g. (well-structured problems, quiz, projects, self-learning in groups, discussion in groups, representation, self-assessment, peer assessment). A control group comprising 19 participants received treatment of traditional teaching in shape of lecture/demonstration method for four weeks. At the end, post-test was administered and the scores of pre-test and post-test were served as data of the study. It indicated the significant impact of motivation on the academic achievement of students in problem based learning environment. The result further indicated that motivation in problem based learning plays more effective role than traditional method of teaching.

Rachmawati and Johancynthia(2010)conducted an ICT based learning schools to assess the challenges on implementation. Results indicated that in ICT based learning the role of teachers were significantly changed from transferring of knowledge into facilitating of learning, from a main source person to be a manager of learning. Other challenge is also addressed to head teachers in encouraging teachers to implement ICT based learning in order to improve students capability and skills.

Husain(2010) in his study "Teacher competencies for the Use of Information Communication Technology" found that all the teacher educators were agreed for the following ICT competencies that teachers need to develop are: 1. Use of ICT Skills in developing and presenting information. 2. Prepare ICT based learning environments designing effective learning experiences and creating rich learning environments.

Ponraj and Sivakumar(2010) in their study "Computer-Assisted Instruction in Zoology in Relation to Learner's Personality" found that experimental method of teaching is more effective than the traditional method. The sample consisted of 40 students in control group and 40 students in experimental group. The data was collected by using Myers-Briggs Types Indicator (MBTI) personality test and two syllabus based computer software packages. Collected data was analysed by using "t- test" and "F-test". The major findings of the study are that CAI provides greater opportunities for the students to learn and it is better than the traditional method of leaning. It brings a new kind of experience for the students.

Nimavathi & Gnanadevair(2009) in their study "Developing Study Habits through Multimedia Program" found that the students learning with the help of multimedia fared better in their study habits than the students learning through conventional method. During this study, the sample consisted of 180 secondary school students (9th class). The Pre-Test and Post-Test Equivalent group design was followed for the study. Study habits inventory by B C Patel was used to assess the study habits of secondary schools students and data was analyzed by using t-test.

Wood & Ashfield(2008) in their study "The use of Interactive Whiteboard for Creative Teaching and Learning in Literacy and Mathematics: A case study" found the ways in which the interactive whiteboard may support and enhance pedagogic practice. Data collected from observations of whole class lessons, alongside individual interviews and focus group discussion with class teacher and initial teacher education students has provided opportunities to consider the potential of such technology to facilitate a more creative approach to whole class teaching. The data suggest that, in the first instance, the special features of information and communication technology such as interactivities, provisionally, speed, capacity, and range enhance the delivery and pace of the session. This research seems to indicate that it is the skill and the professional knowledge of the teacher that mediates the interaction and facilitates the development of pupils creative responses at the interface of the technology, which is critical to enhancement of the whole class teaching and learning methods.

Goulding(2008) in his paper "A Systematic Review of the Use of ICTs in Developing Pupil's Understandings of Algebraic Ideas" found

- Peoples achieve general games of understanding when using one type of ICT.
- Students successfully use visualization with graphing software to fit graphs to Data sets, to solve equations and to transform functions.
- Pupils working in a computer environment reach higher level of thinking and are able to think better than pupils working in a traditional paper and pencil medium.
- Lower attaining students prefer to work arithmetically the tables of value and only later move to integrate the tables of values with computer-generated graphs.
- Pupils have difficulty moving between symbolic, tabular and graphical sums when solving equations.
- Students do not always know how to use the technology, interpret ambiguities in the output or exercise critical judgment when using some of the advanced calculators.

On the other hand, the findings of the study indicate limitations, at least in the British context, of conceptualising the use of ICT in mathematics teaching and learning in terms of an opposition between 'constructivist' and 'didactic'(or 'transmission') pedagogies, and of classifying software in similar terms. First, for the teachers in this study, investigation and consolidation appeared to be complementary aspects of teaching and learning; the former concerned with opening up new ideas, the latter with securing them. Second, certain types of software, and even certain types of task, were claimed to be of value for both purposes; what changed their functioning was the prior knowledge and learning expectations that teacher and students brought to them.

Biswas & Kumar(2006) in their study “Effectiveness of educational television program: invention of television” found that education through technological devices place a pivotal role in the overall development of the students. Under educational technological de vices, the reach of the television is quite wide because of its effective utilization for giving the benefit to the target viewers. In this opinion, the potential of educational television programmes produced by CIET was field tested among the students and teachers of two central schools. The study also focuses that the students of experimental group observing education television programme achieved higher score as compared to the control group taught through traditional method.

Baskaran and Sadatcharavel(2006) conducted a study on relationship between scientific attitude and achievement. It was conducted on a sample of 114 students of 8th standard (56 boys and 58 girls of Panchayat union aided and municipal schools). It was found that there was no significant difference between the mean attitude scores of the pupils in terms of gender, locality, panchayat and aided schools. There existed a higher positive relationship between scientific attitude and achievement in science. There is a higher positive correlation between achievement in science and that of Mathematics.

The main objective of the study of Sharma, Narayan and Subramanium(2006) was to find out the relationship between self-concept, achievement motivation and achievement in

mathematics among boys and girls. The sample of the study constituted 80 students of sixth class of Government and Old Champion Middle Schools of Madhya Pradesh. No relationship between self-concept and achievement motivation among boys was found while a significant positive relationship was found between self-concept and achievement motivation among girls. Boys and girls have shown a significant relationship between achievement motivation and achievement in mathematics. More positive the self-concept and achievement motivation of boys greater will be their achievement in mathematics.

Harlen & Deakin (2003) in his study "A Systematic Review of the Impact on Students and Teachers of the Use of ICT for Assessment of Creative and Critical Thinking Skills" found that (i) Computer-based concept-mapping with automated scoring can be used for summative assessment of critical and creative thinking about complex relationship (ii) The use of ICT can help teachers by storing and recording information about how students are developing understanding of new material, and by taking over some of the role of assessing and providing feedback to students so that teachers can focus on other aspects of supporting learning. (iii) Feedback from the computer during the use of test material improves student performance in later use of the same test material.

i. There are several studies which show the positive effect of constructivism. The studies by (Lord, 1997; Guthrie et al., 2004; Bijas, 2007; Cook, 2007; Kim,2009; Julie, 2010; York, 2010) showed significant increase in the achievement of student when they were taught through the constructivist approach.

ii. Kirschner et al. (2006) argue that the constructivist teaching technique 'learning by doing' is useful for more knowledgeable learners, and is not useful for novices.

iii. Dogru & Kalender (2007) found no significant difference between traditional and constructivist methods. However, in the follow-up assessment fifteen days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods.

iv. Gonen et al. (2006) & Cook (2007) concentrated their studies at the high school level. The study by Gonen et al. (2006) provides a comparative effect study of the Computer Assisted Teaching and the 7E model of the Constructivist Learning methods on attitudes and achievements of the students in physics classes. Statistical analysis of achievement tests showed a significant difference between the students' achievements at the knowledge and comprehension levels of cognitive domain with no difference noted between their achievements at the application level. To determine the effect of the instruction methods on the student's attitudes towards the physics course, a physics

attitude scale was applied to both groups. The results have indicated that the student's attitudes towards physics learning were not affected by different instruction methods.

Objectives of the Study:

Objectives of the Study/ Project:

1. To compare the effect of ICT mediated performance-based learning materials(PBLM) on achievement in mathematics
2. To know the effectiveness of performance-based learning materials(PBLM) in integrating learning and assessment process in mathematics

Rationale for the hypothesis

ICT mediation will help in the practice of constructivist pedagogy. It compensates for the shortcomings of the classroom practice of the constructivist approach. ICT mediation can be used to motivate students and make the mathematics classroom environment student centred. It may facilitate scaffolding and multiple representations. It provides multiple chances to repeat the activity and learn from successful practice. It would improve the academic engagement of students. All of these positive contributions from ICT mediation may possibly help students improve on their academic achievement in mathematics. Moreover, less number of experimental studies has been conducted to see the effect of ICT mediated pedagogy on achievement in mathematics. At least to the researcher's knowledge, no study was found to integrate ICT mediation with constructivist pedagogy for learning mathematics in elementary school. Similarly, the researcher could not find any study finding the effect of ICT mediated constructivist approach on gender of students. Here the researcher finds different ways to intervene and integrate constructivist pedagogical strategies into a regular

format Indian elementary school classroom setting of CBSE Board for a period of six months. For this the researcher proposes to integrate ICT with constructivist pedagogy to teach mathematics to class 8th students of DMS, Bhopal. The use of ICT will expedite the process of curriculum transactions in limited available time in regular schoo

Hypotheses of the study

Hypotheses of the study were as follows:

H01. The mean academic achievement score of the students in experimental group will not be significantly different from that of controlled group.

H02. There will be no significant difference in the mean academic achievement scores of the girls and boys in both the groups.

Operational Definition

Variables: - Performance based learning materials (PBLM) in mathematics (treatment)

Constructs:- academic achievement, attitude towards mathematics, level of student(bottom line, below average, average, above average), achievement in mathematics

Traditional classroom setting: It contains writing board (blackboard or white board), textbook which each student is supposed to bring to classroom, students, teacher (experience of teacher), notebooks possessed by students, chart papers and models related to mathematics. Teacher mostly uses chalk and talk method to explain the concepts in mathematics. Occasionally students use boards to demonstrate their understanding or help others understand important concepts.

ICT mediated constructivist pedagogy: In the present context the ICT mediation was limited to the use of one LCD projector, laptop, smart phone, multimedia CDs, pen drive and loud speakers as hardware supplement to the existing traditional classroom setting. Among other additions were e-textbook, freely available readymade videos over internet on different mathematical concepts related to class 8th mathematics curriculum, videos created during ongoing class to demonstrate both good and bad examples of doing the assigned job,

exposure to motivational videos at the beginning of each class, encouraging students to create e-materials in the form of power point presentations to facilitate their as well as other students learning in classroom and to take control of their own studies by resorting to best available source and learning at their own pace through access to repeat the multimedia material.

Achievement in mathematics: It was the score obtained in the summative assessments conducted by school, which were teacher made tests at the beginning and end of session.

Method

Design and Plan of the Study:

Two sections of students each containing 34 students (already randomly allotted) of class 8^{th} of DMS, Regional Institute of Education, Shyamla Hills, Bhopal affiliated to CBSE, India was selected for the purpose of study. One of the sections was randomly selected for receiving the treatment and the other group served as control group. It is purposeful sampling. It was a true experimental design i.e. The Pretest-Posttest Equivalent-Groups design. To bring additional information into picture mixed method research technique was also be applied to the whole study. The researcher and his team developed sample material on the ICT integrated learning material of 8^{th} standard mathematics and introduced the same as treatment. The activities of the students during the process were put on multimedia platforms. The effectiveness of ICT integrated learning material and its usefulness in assessing the process aspects of learning was established through both formal and informal interview of students on the clarity of concepts and performance in achievement tests conducted by school at the end of semesters.

Subjects

Eighth class students were chosen as the population of interest for two reasons. First, because of a large variety of concepts in mathematics is introduced at this level as compared to other classes; the eighth class student is likely to have many misconceptions about basic mathematical skills needed to carry out complex calculations. Second, the eighth class students are matured enough to make use of developmentally appropriate practices, and the treatment used in this study was designed in accordance with such practices.

All of the eighth class students in one secondary school in Bhopal participated as subjects in the study. Thirty-four students (21 boys and 13girls) made one sample and 36 students (21 boys and 15girls) the other sample. None of the student had received ICT mediated instruction earlier to the treatment.

Randomization

School had already assigned students randomly to either section at the time of their admission in the first standard. In addition to the random selection of students to either section, the Ravines Progressive Matrices IQ Test was introduced at the beginning and IQ scores of students of both the sections were compared to assure the equivalence between the groups. As the groups were found equivalent reshuffling was not necessary.

Treatment

One of the sections was randomly selected to receive treatment and the other acted as control group at the beginning of the study. At the end of the first summative assessment and beginning of the second half of academic session we assigned the treatment conditions to the randomly selected experimental group. During the treatment phase the students were shown introductory motivating video at the beginning of the class for 4 to 5 minutes. The purpose of showing interesting motivating videos was to help students stop gossiping and motivate them for active learning. We collected a large number of motivating videos available over internet and encouraged students to share similar motivating videos with their friends. As we would see in the result section, we were quite successful towards our objective of getting the students ready to learn. The students were asked to share their experience. The table 1 shows some of the sample introductory videos shown to them.

The main source of video content was internet. Now a days free videos are available on youtube on a wide range of topics. We collected many videos related to our topics in mathematics as per the 8^{th} standard syllabus of second summative assessment of the school. The challenge was selecting the right sort of video and it was done by by a team of experts. The videos related to topic were presented for about 7 to 10 minutes with pause as per the demand of students. After the display of the content questions related to the concept were put on screen to check their understanding. Students were sitting in groups of 3 or 4 to help each other in understanding the concept and completing the task. After that they used to pictures of their work on a smart phone given by teacher for displaying on screen their work and group evaluation.

When most of the students understood the matter to an appreciable extent then the videos of their work were collected and displayed on screen for the benefit of other students. The representation styles of different students were displayed on screen for critical examination and acceptance of best features before the whole class. This helped transfer of good culture of note preparation, calculation skills and representation on note books among the students without highlighting their weaknesses in a friendly way. This encouraged multiple representation and diversity in our work style while encouraging efficient ways of carrying the work.

Digital folders of their best works related to content were maintained on the laptop during ongoing activity after taking snaps of their mathematics note books. Snaps of chalk board work were also taken for later use.

The snaps of best work style, model procedures and chalk board works were shared using social network site Whats App among the group members. Students also shared their best work online among the group members. The students used to put questions and queries and other students started responding to their concerns online. This created scope for using the social networking sites for a good educational cause.

Evaluation was always carried on by exchanging the notebooks among the group members. The model copy scoring 100% was displayed on screen and students were explained the feasible multiple representation styles of the task. After thorough counseling the students were found quite honest and strict in their evaluation. They used to rectify the note books of their friends after critical examination. At places of doubt they refer the copy to teacher or more knowledgeable friend of theirs.

Before the students exit from the class some motivating messages or pictures were displayed on screen to help them receive correct values and create a topic for discussion on their way back to their classroom.

Testing

We used the pretest-posttest equivalent group design. Pretest scores could be used in analysis of covariance to statistically control for any differences between the groups at the beginning of the study. Subjects were pretested and posttested on their knowledge, understanding and

application of concepts using routine first and second summative assessments conducted by school in the middle and end of the session. No separate timetable and test booklet was introduced. The summative assessments were routine half yearly assessments generally carried over in the month of mid September and mid February in school to assess their performance. It is group administered paper-pencil test containing about thirty items of objective, very short answer, short answer and long answer type questions from the relevant 50% syllabus taught to them during four months preceding to their assessment.

TABLE 1 Introductory videos shown to students at the beginning of each class

1.	Arunima Sinha on the top of the world #INKtalks by Google Down loaded from You Tube
2.	Cool math mental multiplication trick - become a genius solving math instantly! - YouTube
3.	Fast Math Tricks - multiplication of two and three digit numbers. - YouTube
4.	Fast Mental Multiplication Trick - multiply in your head using base 10 - YouTube
5.	Key Skills - Numeracy (6, 7, 8 and 9 times tables) - YouTube
6.	Multiplication Trick _ Full-Time Kid _ PBS Parents - YouTube
7.	Chinese Method of Multiplication (Lettuce Multiplication) - YouTube
8.	Brain Teasers - Find the Missing Number Series - YouTube
9.	How to square any numbers in your head - fast mental math trick - YouTube
10.	Vedic math tricks find square of number in 5 sec. -Hindi Math Magic EP6 - YouTube

11.	Surface Area Song - YouTube
12.	Proportions - Basic examples and word problems - YouTube
13.	Number pattern and Puzzle - 7, 20, 47, 94, 167, ___ Tricks and Solutions (HARD) - YouTube
14.	Laugh at Yourself by Sandeep Maheshwari in Hindi - YouTube
15.	Anand Kumar_ Real life Superman #INKtalks - YouTube

TABLE 2 Videos related to concepts YouTube

	Topics in Algebraic Expressions and Identities YouTube
2.	Review of basic concepts in algebra YouTube
3.	1.
4.	Addition of algebraic expressions YouTube
5.	Subtracting algebraic expressions YouTube
6.	Multipyling one monomial with another monomial YouTube
7.	Multiply monomial by a binomial YouTube
8.	What is an Identity YouTube
9.	Standard Algebraic Identities YouTube
10.	Application of Standard Algebraic Identities YouTube
11.	Application of Algebraic Identities Part 2 YouTube
12.	Proportions - Basic examples and word problems - YouTube
13.	Negative exponents - YouTube
14.	Solving Proportions The Easy Z Way_ - YouTube

15.	Direct and Inverse Proportion - YouTube
16.	Best Method to Calculate Compound Interest - YouTube
17.	Ratios and proportions movie A series of collection different sources YouTube
18.	Real Life Math Ratios Proportions and Basketball Algebra YouTube
19.	History of Mathematics YouTube
20.	Prime Factorization - MathHelp.com - Math Help YouTube
21.	Surface Area of Three Dimensional Figures, Composite Solids, and Missing Dimensions YouTube
22.	Mensuration YouTube
23.	Area of a Quadrilateral You Tube

TABLE 3 ICT Mediation as Evaluation Strategies

1.	Problems from e-text book (NCERT Class VIII)	Motivates to remain focused and time bound with onscreen clock and group of questions
2.	Evaluation questions related to concept in e-form	The video can be paused at any moment to help students cope up and complete steps in advance(whenever feasible)
3.	Pictures of students class work copy displayed on screen for group evaluation	The big screen and high magnification helps in appreciating good points of the work and award score. Others try to imbibe the good aspects related to handwriting, flow of writing, calculation tricks.
4.	Short Video capture of ongoing work and displaying	Helping students appreciate different ways to perform the same task. Helps students patch up gaps in their learning and scaffolding.
5.	Individual folder as portfolio	Best works of students in the form of snap shots of their class work and videos

		of their complete task
6.	Students taking charge of the ICT mediated learning	Handles LCD projector and laptop. Decides which video best describes the concept. Captured snap shots and videos of their work.
7.	Students prepare e-materials for whole class	They took responsibility to prepare e-material on selected topic and presented in class.
8.	Students created social group on What App platform	Some students voluntarily took the lead to form the group. Posted challenging problems and interesting facts.

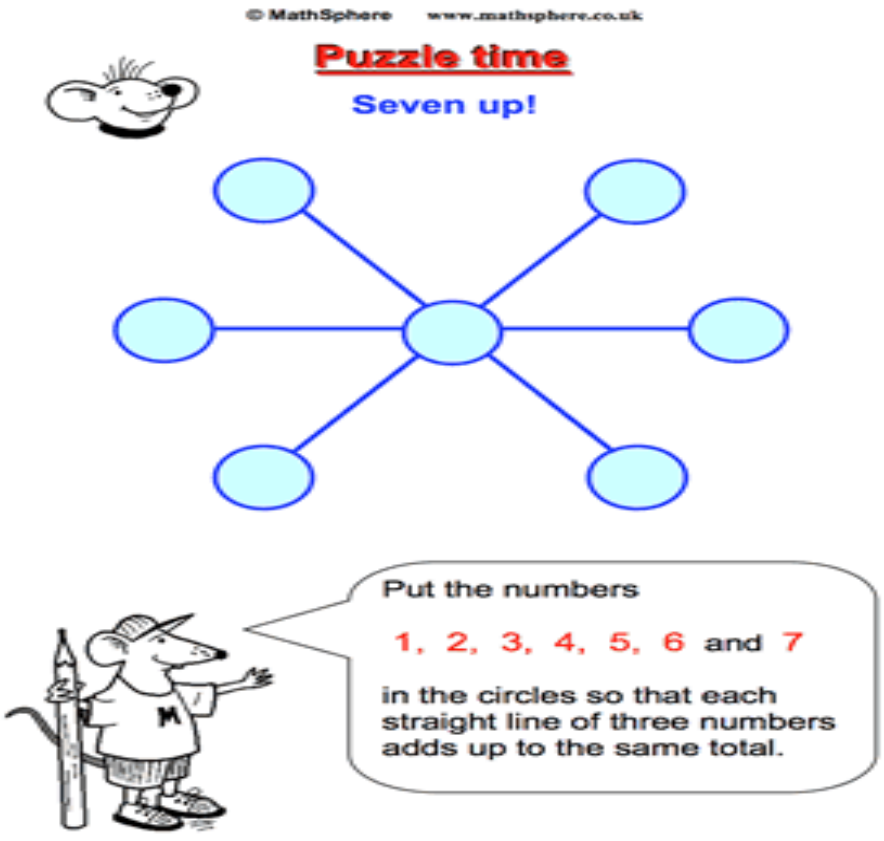


Figure 1 One of the introductory motivating puzzles displayed when the students entered class

Figure 2 One of the selected humor creating situation presented in classroom when the students enter

Figure 3 Students during watching one introductory motivating videos at the beginning of each class.

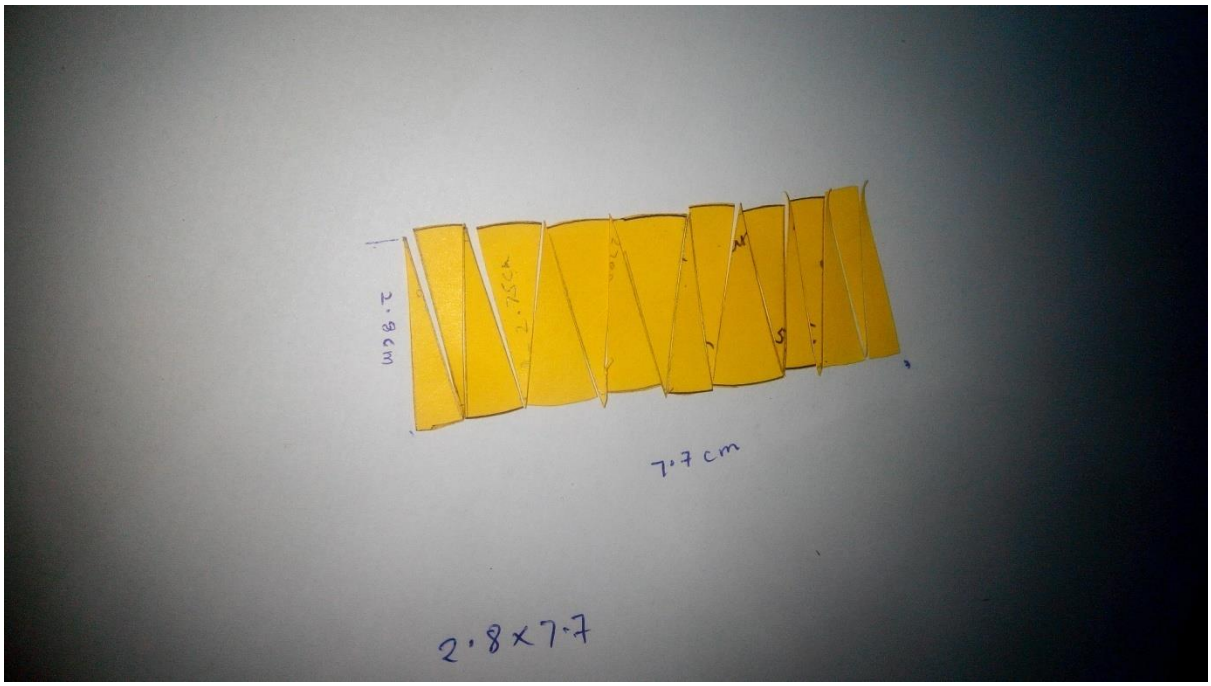


Figure 4 Model item prepared by student by following e-demonstration

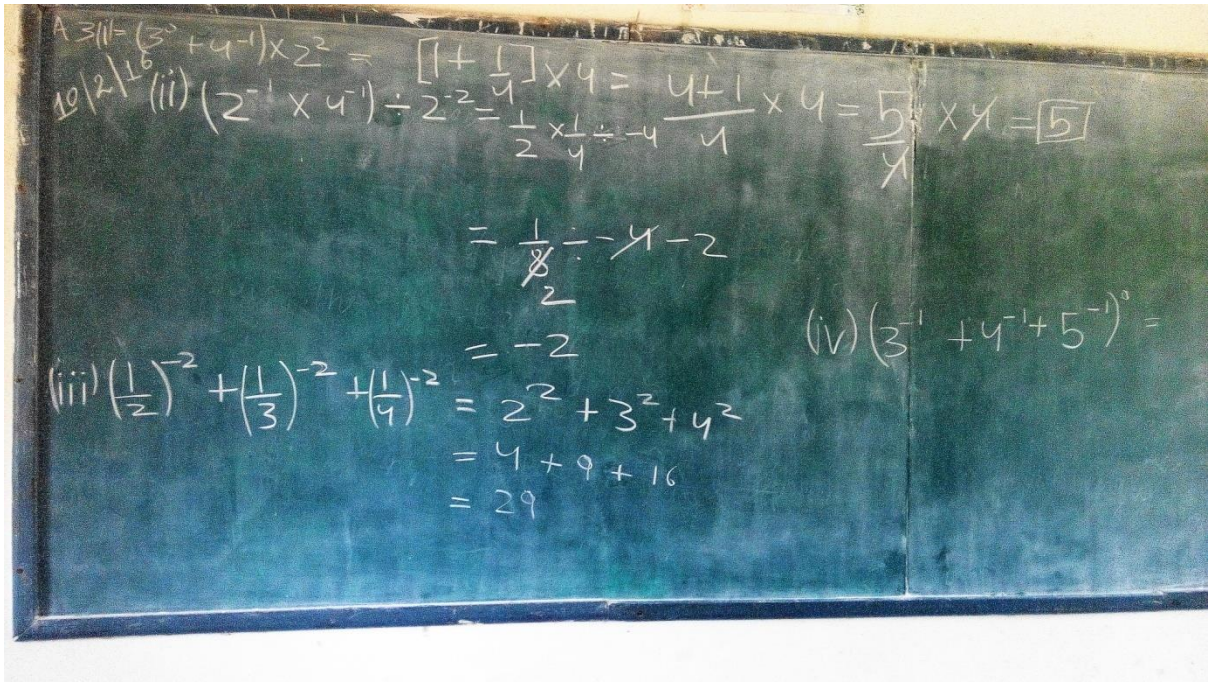


Figure 5 Work done by student on chalkboard in class later shown on demand to recall

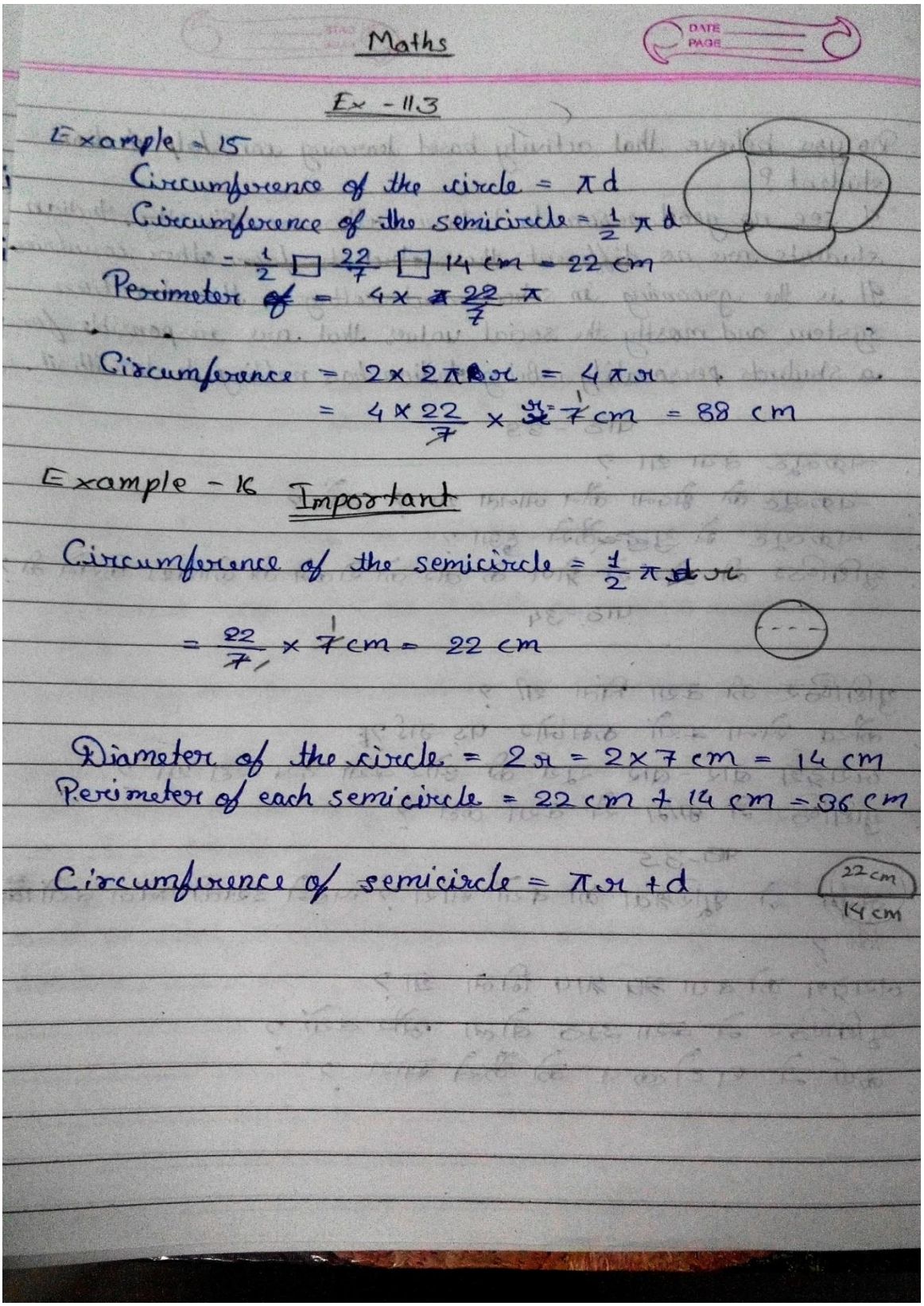


Figure 6 Snap of ongoing work of a student displayed for group evaluation

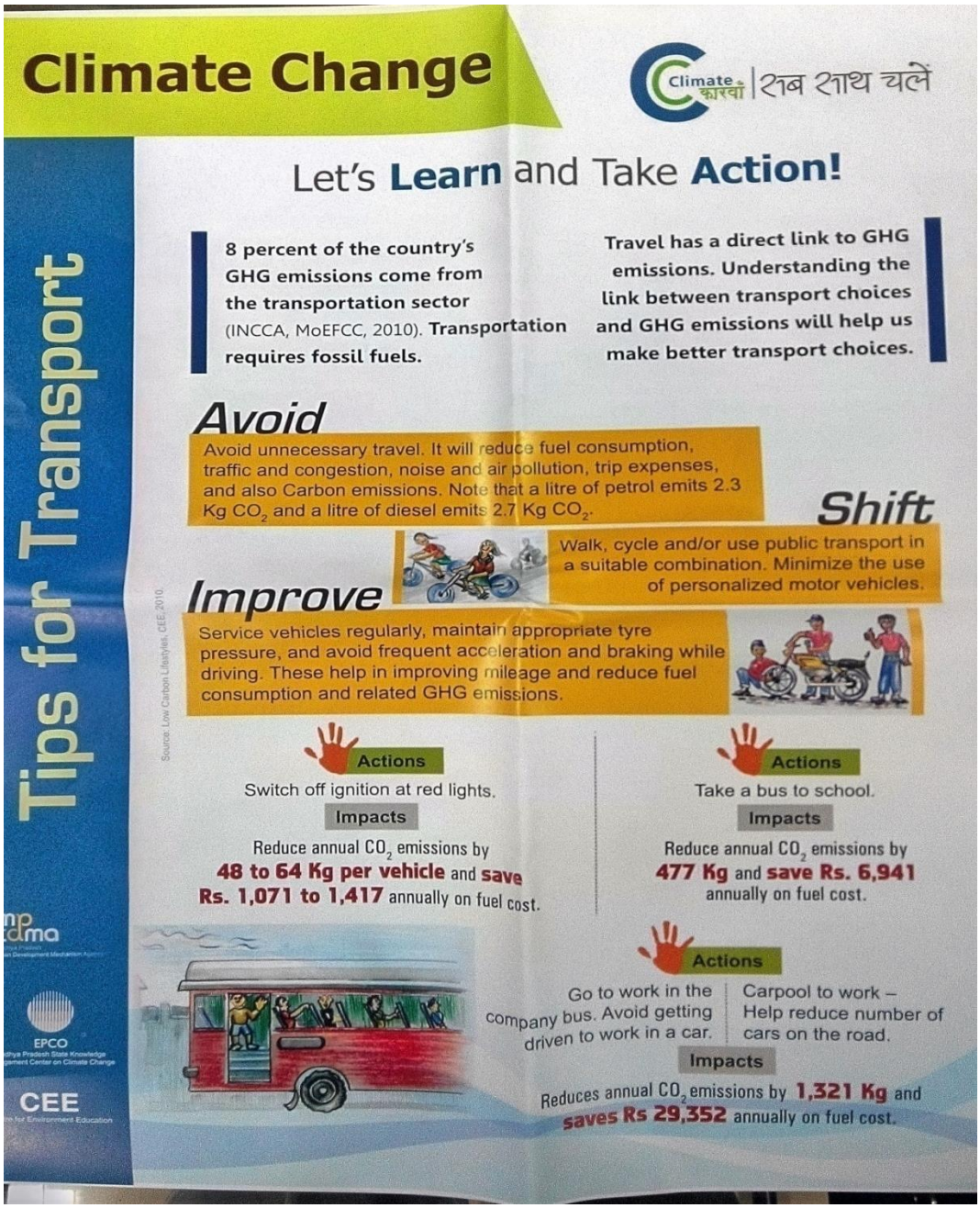


Figure 7 Snap of a poster in school compound displayed in class to create useful mathematics and awareness for checking pollution

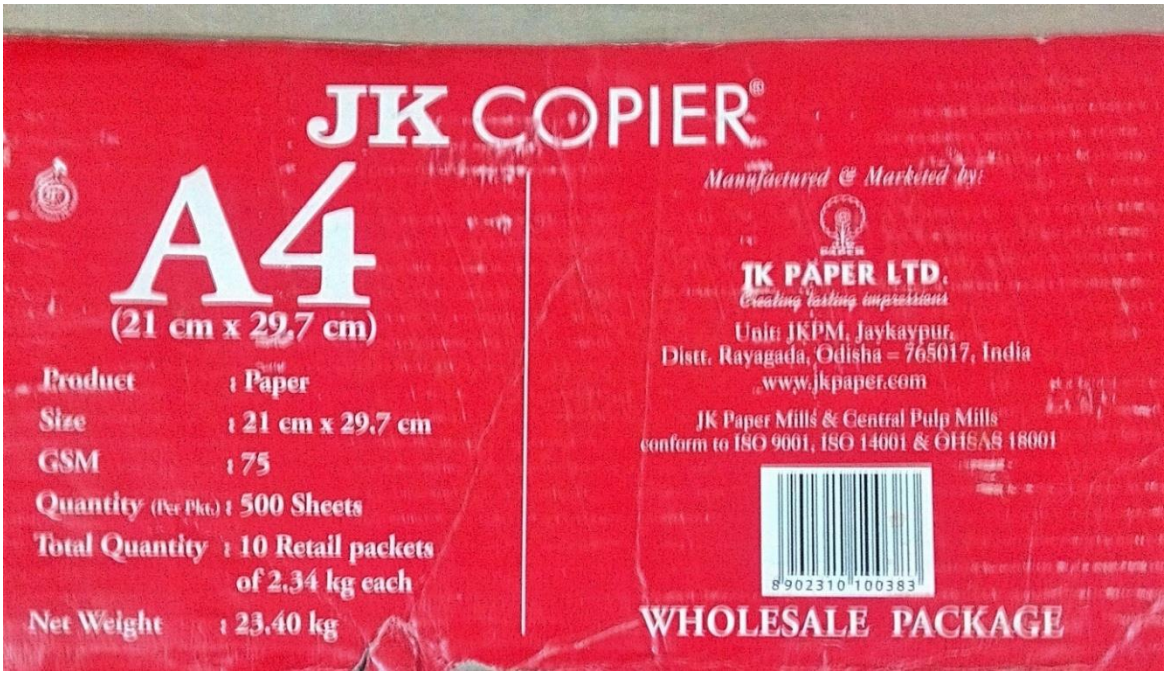


Figure 8 Snap of waste piece of packing wrapper used to generate problems and awarness

Figure 9 Snap of names of students putting up their doubts and those who came forward to clarify others doubts in class during exposure to ICT mediated learning

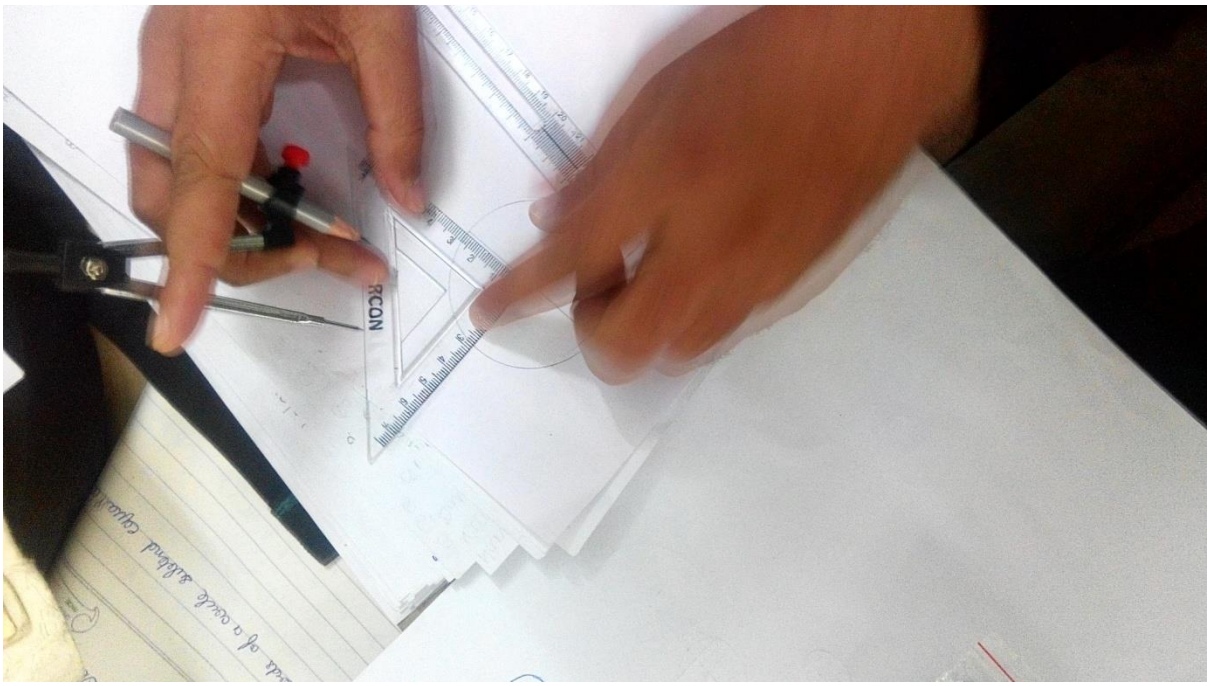


Figure 10 Creating videos of students engaged in scaffolding for repeated use in class

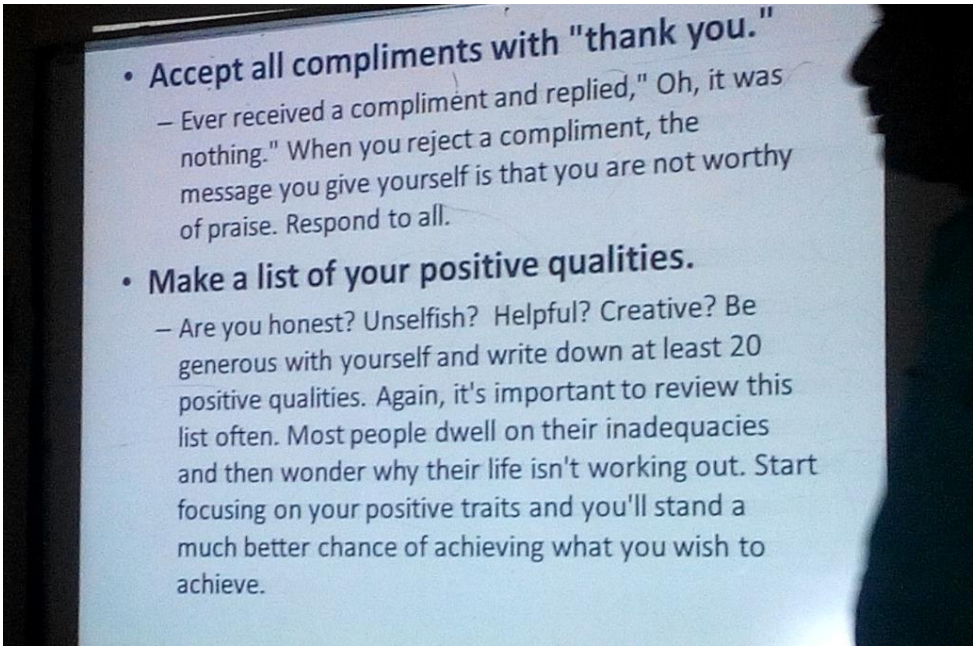


Figure 11 Snap of an endnote to let the students brood over after the class

Figure 12 Picture shown at the end of class to keep the students motivated: why do we need to learn mathematics?

Figure 13 One of the snaps used at the time of departure of students from class

Figure 14 Students undertaking an invigilator free full length test

Results

Table 4 Score Means and Standard Deviations on the Achievement in Mathematics

	Pretest		Post test	
Treatment group	M	SD	M	SD
ICT mediated pedagogy group(n=34)	22.8	5.4	33.3	13.4
Traditional pedagogy group(n=34)	18.7	12.5	19.4	13.1

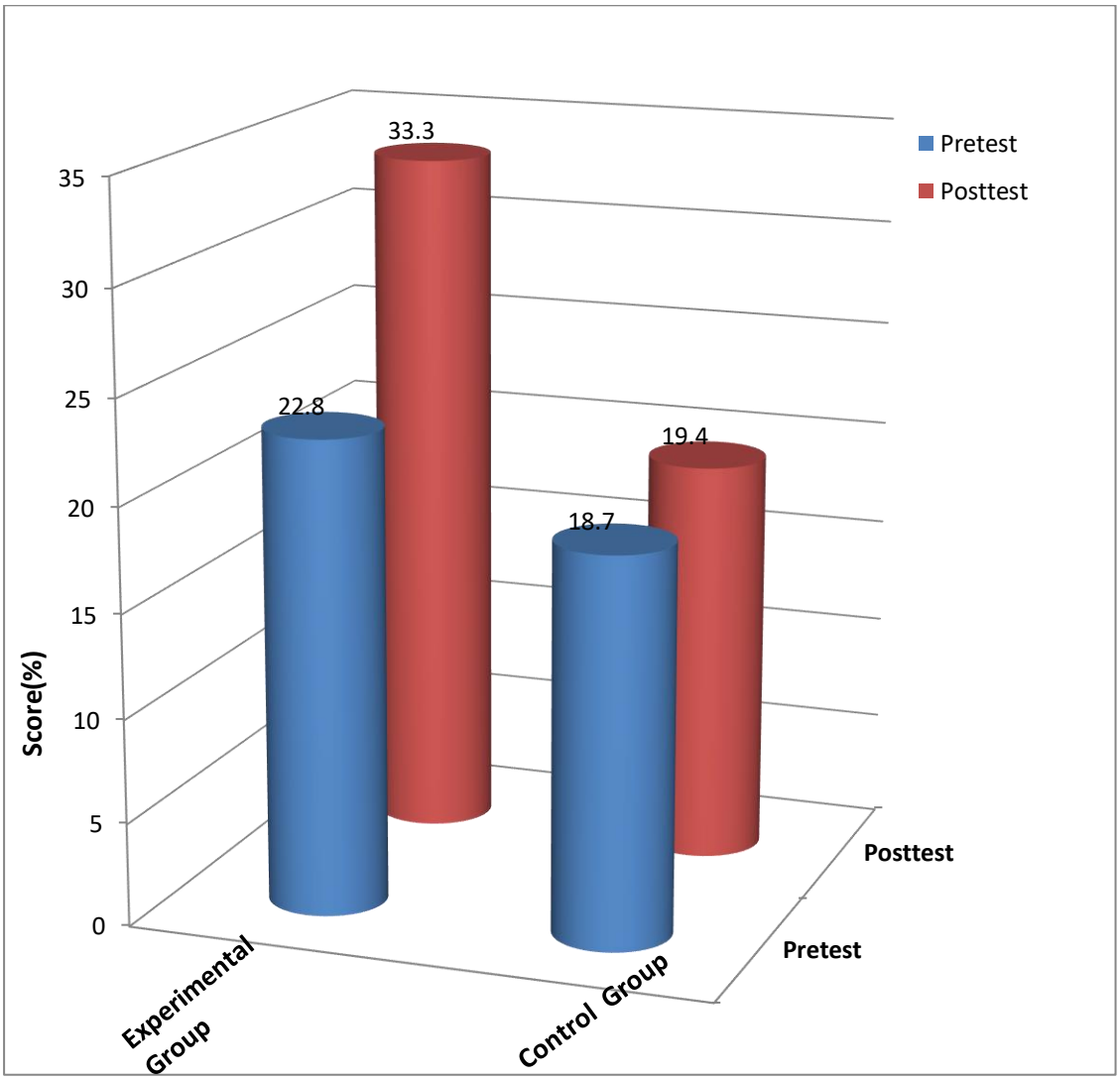


Figure 15 Bar graph representing Pretest-Posttest percentage scores of experimental and control group

Table 4 contains the pretest-posttest achievement score means and standard deviations for the ICT mediated pedagogy and traditional pedagogy groups on the selected mathematics concepts of class VIII. The pretest mean score ranged from 18.7 for the traditional pedagogy group to 22.8 for the ICT mediated pedagogy group, whereas the posttest means ranged from 19.4 for the traditional pedagogy group to 33.3 for the ICT mediated pedagogy group. In order to test the efficacy of the ICT mediated classroom interaction in comparison to the traditional method of instruction, the pretest and post test scores of the experimental and control groups were subjected to two separate independent samples t-test. A two-tailed t-test for independent samples showed no statistically significant difference between group means at pretest, t observed = -1.75, t critical = 2.0, df = 66, $p < .05$, indicating that the two groups were comparable prior to instruction. A second one-tailed t- test for independent samples at posttest indicated that the mean of the ICT mediated pedagogy group was statistically greater than the mean of the traditional pedagogy group, t observed = -4.3, t critical = 1.67, df = 66, $p < .05$.

Table 4 contains the means and standard deviations of pretest and posttest scores of control group. The means of the traditional pedagogy group ranged from 18.7 for the pretest to 19.4 for the posttest. A two-tailed t-test for independent samples showed no statistically significant difference between group means at pretest and posttest, t observed = -.25, t critical = 2.0, df = 66, $p < .05$, indicating that the pretest and posttest mean scores were comparable; that is there was no significant improvement in the performance of the students exposed to traditional pedagogy.

Table 4 contains the means and standard deviations of pretest and posttest scores of treatment group. A one-tailed t- test for independent samples at pretest and posttest means of treatment group indicated that for the ICT mediated pedagogy group the posttest mean was statistically greater than the pretest mean, t observed = - 4.2, t critical = 1.67, df = 66, $p < .05$; that is there was significant increase in the performance of students exposed to ICT mediated pedagogy.

TABLE 5 Analysis of the Variance Summary Table for the Achievement in Pretest

Source of variation	SS	df	MS	F
Between groups	284.13	1	284.13	3.07*
Within groups	6106.62	66	92.53	
Total	6390.75	67		

**$p < .05$; F critical: 4.00.

Table 5 contains the results of one-way analyses of variance used to compare the pretest means of the ICT mediated pedagogy and traditional pedagogy groups. The one way ANOVA indicated that the two groups were comparable at pretest in terms of students' achievement in mathematics summative assessment.

TABLE 6 Analysis of the Variance Summary Table for the Achievement in Posttest

Source of variation	SS	df	MS	F
Between groups(n=34)	3262.37	1	3262.37	18.5**
Within groups	11629.91	66	176.21	
Total	14892.28	67		

**$p < .05$; F critical: 4.00.

Table 6 contains the results of another one-way analyses of variance used to compare the posttest achievements of the ICT mediated pedagogy and traditional pedagogy groups. The one-way ANOVA indicated that the posttest variances between the groups were significant.

T**ABLE 7 ANCOVA results for the posttest of experimental and control groups**

Source	Type III Sum of Squares	df	Mean Square	F	Sign.	Partial Eta Squared
Group	1748.09	1	1748.09	15.77	.000	.195
Error	7207.09	65	110.88			

R squared = .516 (Adjusted R Squared = .501).

Table 7 contains the results from analysis of covariance of posttest scores of experimental and control groups by taking into account the preexisting differences between the groups at the time of pretest. The results showed F=15.77 (p=0.00) that indicated there was significant difference between the variance of the two groups which could not be accounted to error variance.

Testing of first hypothesis

The following observations were summed up from the above results:

First, there was no significant difference on the mean pretest scores of the experimental and control group.

Second, there was no significant difference on the mean pretest and posttest scores of the control group.

Third, there was significant difference on the mean pretest and posttest scores of the experimental group.

Fourth, there was significant difference on the mean posttest scores of the control and experimental group.

These results indicated students in the experimental ICT mediated group (M = 33.3, SD = 13.4) scored better in posttest than did the students in the control group (M = 19.4, SD = 13.1). These results suggest ICT mediated interaction has significant impact on improving the achievement in mathematics

The effect of ICT mediated constructivist approach on gender was studied through conducting 4 separate two-tailed *t*- test for independent samples of the pretest and posttest scores of boys and girls of ICT mediated pedagogy and traditional pedagogy groups. Tables 7 contains the pretest – posttest score means and standard deviations for the girls and boys of the control and experimental group. Pretest means ranged from 17.4 for boys to 20.8 for girls in traditional pedagogy group. A two-tailed *t* test for independent samples showed no statistically significant difference between gender means for traditional pedagogy group at pretest, *t* observed = .75, *t* critical = 2.04, df = 32 , $p < .05$, indicating that the gender groups were comparable at pretest. Posttest means ranged from 18.1 for boys to 21.7 for girls in traditional pedagogy group. A two-tailed *t* test for independent samples showed no statistically significant difference between gender means for traditional pedagogy group at

posttest, *t* observed = .77, *t* critical = 2.04, *df* = 32 , *p* < .05, indicating that the gender groups were comparable at posttest for traditional pedagogy group.

Table 8 Gender wise Score Means and Standard Deviations on the Achievement in Mathematics

		Pretest		Post test	
Treatment group	**Gender**	M	SD	M	SD
ICT mediated pedagogy group(n=34)	Girl(n=13)	22.1	4.8	36.0	13.3
	Boy(n=21)	23.3	5.8	31.5	13.6
Traditional pedagogy group(n=34)	Girl(n=13)	20.8	10.9	21.7	13.6
	Boy(n=21)	17.4	13.5	18.1	12.9

Result from table 8 was analyzed to see the effect of gender on achievement and effect of ICT mediation on gender. Pretest means ranged from 22.1 for girls to 23.3 for boys in ICT mediated pedagogy group. A two-tailed *t* test for independent samples showed no statistically significant difference between gender means for ICT mediated pedagogy group at pretest, *t* observed = - .65, *t* critical = 2.04, *df* = 32 , *p* < .05, indicating that the gender groups were comparable at pretest. Posttest means ranged from 31.5 for boys to 36.0 for girls in ICT mediated pedagogy group. A two-tailed *t* test for independent samples showed no statistically significant difference between gender means for ICT mediated pedagogy group at posttest, *t* observed = .97, *t* critical = 2.04, *df* = 32 , *p* < .05, indicating that both the genders in ICT mediated group were comparable at posttest.

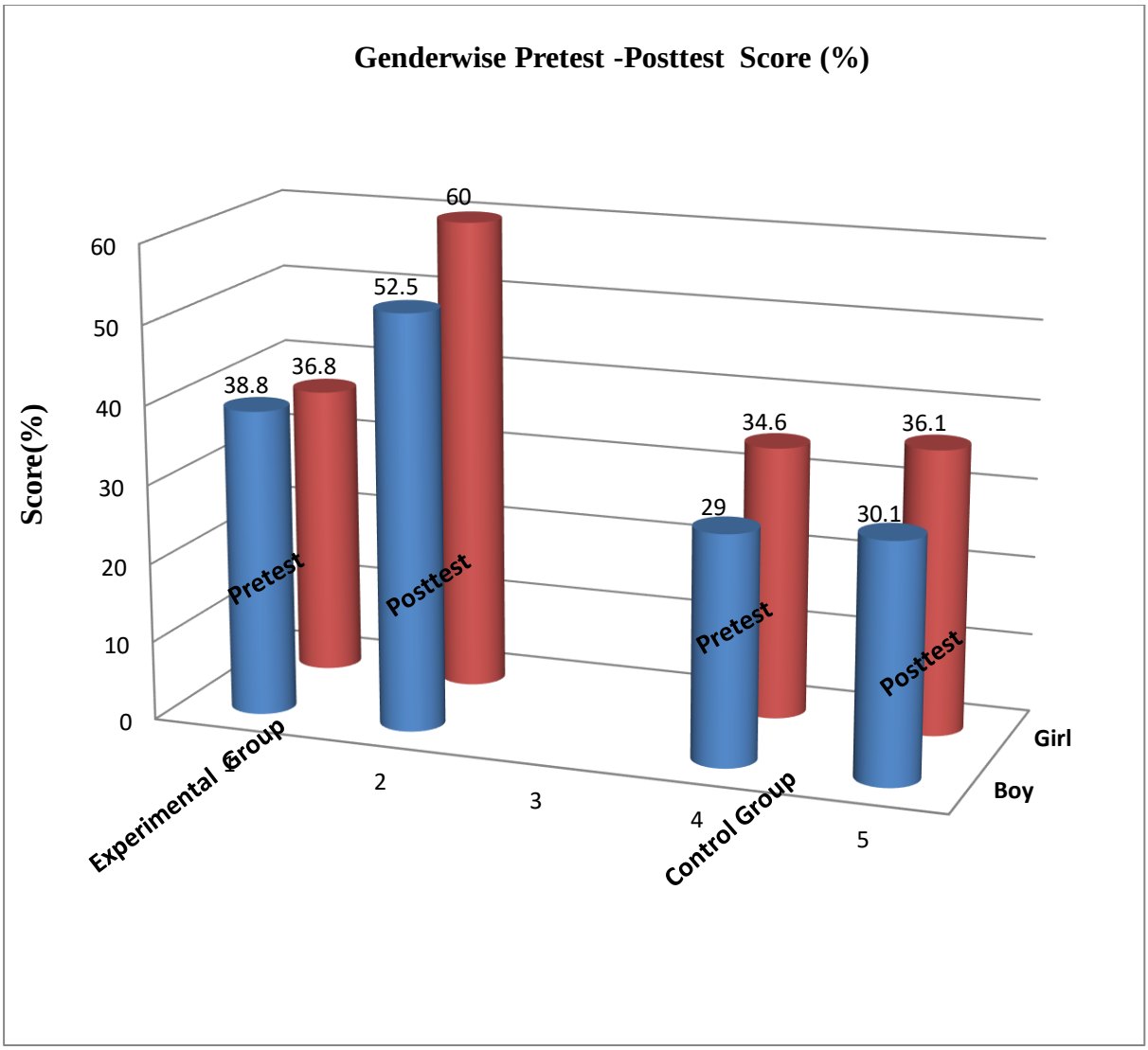


Figure 16 Bar graph representing gender wise percentage score in Pretest-Posttest

The heights of the columns in figure 16 clearly demonstrated that at pretest there was significant difference between the mean percentage scores of boys and girls for both experimental and control groups. Mean test scores of girls and boys of both the groups were quite comparable at pretest; whereas after receiving the treatment the girls and boys of experimental group showed significant improvement in their mean test score.

Testing of second hypothesis

The analysis of all the four *t*-tests indicated that gender had no significant effect on the mean test score. Moreover, ICT mediation seemed to facilitate significantly both the genders to improve their scores in comparison to control group.

Qualitative Observation

The introductory motivating videos helped the class to come to a standstill. Silence prevailed over the class. Students seemed to touched by the videos. Figures 3, 10 and 14 are examples of the situation prevailing in classroom.

Textbook in the e-form was displayed on screen and there was no need on the part of students to carry the textbook to classroom. Students with good reading ability read the textbook and their voices were recorded and played simultaneously to help other students read the textbook. It helped cover each corner of textbook. The examples, figures and introductory texts to concepts given before examples were read and discussed aloud among the group members and class as a whole. Students henceforth shying away from participation were seen to ask their fellow group members about their observations and clarify any mismatch. As we started recording the voices of the students while reading the students turned not only more cautious but also it helped them improve their reading by providing the best. Even they were seen requesting for a next time better recording their voice. Students were asked to record their reading the textbook using a smart phone and put the same in their e-portfolio. It was decided to play their voices to the class to ensure correct reading style. Students grew smarter in meaning making; probably the critical examination of each word and line of their mathematics text book on big screen in a group helped everybody in class. It was never seen before experience for me as a teacher. Earlier in spite of putting a lot of effort I was never able to do such thorough analysis of text book in class; the main reason being not able to catch hold of their attention for a longer duration. In traditional setting sometimes some gaps used to arise between me and students while analyzing the texts from a book. This gap seemed to melt away with group analysis and reading using a big screen to display the textbook.

Discussion

The ANCOVA results show that the teaching methods count for a total variation in learning effect of 51.6% in the eighth grade. The F values equal to 15.77 (p = 0.00) show that there is significant difference between the experimental and control group. The *t*-test results for the experimental group show that there exists a significant difference between pretest and posttest, but there is no significant difference before and after instruction for the control group. The analysis of strategies used by these eighth graders also shows that there is more progress (46.0%) in the use of number sense strategy for the experimental group than for the students in the control group (3.7%). These results suggest that the integration of technology into the mathematics instruction has a positive effect on the learning of number sense for the students in the experimental class. In addition, the pictorial representation via technology-based environment is easy and convenient for teachers to manipulate and demonstrate the mathematical concepts. In the other hand, the technology assisted in allowing students in the experimental class to interact with the mathematical concepts in novel ways. It promoted the students in the experimental class to develop calculation abilities through manipulating the model shortcut live representation of calculation. Therefore, there are several benefits for teaching and learning mathematics concepts via a technology-based learning environment: explaining diagrams and figures from textbook by computer can be done more easily, visual representations could attract the students' attention, and overlapping and separating the graphs can be more efficiently and conveniently accomplished by the computer.

Figure 1 demonstrates the nature of one of the videos shown to children when they enter the classroom. There was no need on the part of teacher to put extra efforts to silence the class. The students seemed to enter a state of trance while watching these videos. As listed in table 1 these motivating videos were collected from a wide variety of sources and duration was restricted to 4 to 5 minutes. On some days the students used to demand to repeat certain videos like The Top Ten Football Goals, certain mathematical puzzles, moral stories etc. Short moral stories encouraging sincerity, adherence to task, honesty, helping others, reward for hard work, power of determination etc. were played as introductory videos as soon as the students enter the classroom. These videos worked as boosters for attracting the students to the class. They seemed to rush to the classroom without wasting a single moment at their disposal. There was lighter moment inside the classroom. Teacher was not at all compelling; there was no talk related to whether they have done their homework. Once the videos was

getting over students used to discuss in groups of two or three for 2 to 3 minutes regarding the content of the video. The teacher used to act like a group member; swayed with the mood swings of the children. Sometimes a puzzle was placed on screen and students got themselves engaged on the task. When the class got quite immersed on the task, the teacher told them to finish the rest part of the puzzle at leisure time. They were encouraged to engage themselves with such solved or unresolved puzzles and riddles with students of other classes, neighbours, other siblings and friends for using the wasteful time e.g. while waiting for their school vans after school hours, some period going vacant due to absence of the concerned teacher or any other reason, sometimes they don't feel like studying textbook portions, a lazy afternoon etc. They used to report their success stories enthusiastically before the teacher in class and sometimes did stay even during the lunch breaks to express their success stories. It provided a good platform for those students who were not good at coursework related problems to express their smart jobs. It seemed to provide them self-esteem; as fellow students started admiring their quick responses to unusual situations. These interactions brought the whole class closer to each other. To an outsider the situation would seem to be chaos; but in reality a lot of active learning through over-enthusiastic engagement was taking place inside the classroom.

Areeba: Sir, how amazing the class is full of fun and enjoyment; let us have this type of class everyday(in a friendly voice).

Mariyam: Sir, we don't want to move to any other class. Sir, please take the next period; we want to study maths only(with a tone of demand full of affection).

Figure 2 shows one of the pictures presented to create humorous situation in classroom to make it free from any sort of anxiety. It was creating a lighter environment in class where

Figure 3 shows the calm and quiet classroom situation when the students watch the motivating video.

Figure 4 shows the work done by student by following the demonstration provided in the video.

Figures 5, 9 and 10 show the doubts of students are written on chalkboard alongside their name and the name of student clearing their doubts. The videos of students while explaining their friend were prepared for later use in scaffolding and encouraging. The students used to come forward to chalkboard and write their name and question number of their doubts; those students who felt confident enough to explain the doubts came forward and wrote their names against the respective doubts. Then the whole class went on with students getting engaged in

helping each other understand the difficult concepts. Videos of scaffolding were created by other students using smart phone. Pictures of chalkboard work were captured and posted in social group Whats App platform formed by the students for further reference. It proved useful for students who were absent or those who still had doubts even after the class.

Figure 6 shows the picture of class work notebook of student when the task was given in class. The snaps of their notebooks were taken and kept in their digital portfolio. Then the works were displayed on screen for group evaluation; the concerned students carried out the correction as per the suggestions received from their friends. Students put scores on their own copy as per suggestion of the group. Sometimes the students exchanged their copies in group of three or four students sitting on one desk for cross evaluation and critical comments for improving their work. The snaps of their works were taken for group viewing on screen After due correction in note books. The best components of each work were integrated in each copy; the best copies were appreciated and given group clapping. More and more students stared finishing their work early with the hope that their work would be displayed first on screen. So the feeling of scare for evaluation turned to be matter of pleasure. Students' tiny irregular writing looked very big on screen; this scaring experience motivated them to improve their presentation.

Figures 7 and 8 display the pictures from surroundings of the school used as problem situation to apply mathematics concepts learnt in class. This was viewed as a connection between the outside real world and classroom mathematics textbook. I saw a poster on the school notice board for creating awareness about pollution. I took a snap of it on my smart phone. I displayed it in my mathematics class. I asked students how many of you had seen this poster on our school notice board or any other place. Nobody responded; followed by a very good round of discussion and possible inherent mathematics questions.

Figures 11,12 and 13 display the sample materials played at the end of each class to induce a sense of self responsibility, use of knowledge of mathematics in beautification of our world and a sense of gratitude towards our elder.

Figure 14 displayed the snap from an invigilator free examination hall where there was no cheating; as they had started taking responsibility of their learning. The continuous exposure of students to different motivating situations had some sort of effect on their work style in classroom and beyond. This situation touched my heart; as I felt my efforts had not gone

waste. At least I could bring some sort of socially desirable behavioural modification in my students with ICT mediated learning.

During this whole event I found I have come much closer to the hearts of children; many dark sides of my own personality were visible to me. It helped me bring change in my teaching style. Traditional teaching methods used in the control group did not yield these benefits.

Conclusion

Although this experiment was carried for a short period for about 9 weeks and was limited to two sections of class VIII students of only one school, the improvement made by the students in the ICT mediated group was readily distinguishable. Though the generalisations of the study were limited due to small sample size and duration of treatment, the results do provide some important and interesting findings.

First, the major contribution of this study is to support the evidence that ICT mediated learning in mathematics class can promote students performance in summative assessments conducted by school at the end of academic session. Even though many research studies and reports(Dick, 2007; Isikal & Askar, 2005; Inamdar & Kulkarni, 2007; Lin, 2008; NCTM, 2000; Olkun et al., 2005; Ruthven,2007; Vulis & Small, 2007; Zbiek et al., 2007) suggest that technology has a positive effect on mathematics teaching and learning, few practical studies focus on examining the use of technology when teaching a major portion of syllabus(about 50%) to elementary school children. Many teachers were of belief that in short term that is for research purpose the ICT may seem helpful; but in real classroom situation the use of ICT for whole academic calendar may not be successful at completing the whole syllabus within the assigned timeframe. Therefore this study was designed for almost half a calendar year to see whether mathematics can successfully be mediated with ICT to help students to improve their score in annual summative assessment conducted by school. To start with one may need an LCD projector, a laptop, access to internet (not necessarily inside classroom), a digital camera or a smart phone. This was the basic ICT based learning environment that was used in this study. Another limitation of this study was students did not have access to individual computers during mathematics class due to limited resources; although they had basic knowledge of handling the computer, digital camera and smart phone.

The major contribution demonstrates that children's concepts related to algebraic expression, factorisation, mensuration and comparing quantities can be promoted by using ICT based learning envirionment. It significantly improved the performance of students in their annual summative assessment. It helped both the genders to equal extent to improve their performance.

Second, it definitely improved the clue grasping power (understanding the intent of question) of the students. As the questions were displayed on big screen and whole class debated on the

solution procedure, students most unlikely to participate could gather sufficient information and outlook about the question. Think aloud was the norm of the class. Students seemed to take benefit of reading the text loudly and explaining the intent of the problem or statement to the whole class. Multiple representation of thought or process was encouraged.

Third, it ensured 100% student participation in the process of classroom communication. Model procedures, tricks, spellings, standard hand written representation of the solution in notebooks and videos of correctly doing the task were made available at different times as per the requirement of individual student or group of students. Whenever anybody got struck up either the concept were replayed or somebody came to their help. Multiple ways to carry the multiplication using Vedic tricks, Chinese ways or any other anonymous trick motivated the children to get engaged in calculations involved in comparing quantities, as these situations provided them the challenge to demonstrate their freshly acquired tricks to prove themselves before others. They could better handle the tricky calculations.

Fourth, it improved their skills related to writing and representation of solution in their notebooks. As their copies were scanned and displayed on screen before others for group evaluation the students were found to be more diligent and particular in their task. Also with continuous exposure to best works of class and encouragement to add best features from different sources to our own work helped them imbibe many good points in their work.

Fifth, it helped the teacher in completing their half year's course well in advance; thereby leaving enough time for revision. The students having doubts noted it on the chalk board and students with correct understanding came forward to help them. They selected and replayed the multimedia document related to their difficult areas. It facilitated social construction of knowledge of mathematics in classroom.

To sum up ICT mediated learning environment proved to have positive effect on improving the student's performance on a range of elementary mathematics concepts in traditional annual summative assessments through social construction of knowledge in classroom.

Even though the application of technology in teaching and learning key concepts of eighth grade mathematics has several benefits, it also has a key limitation. Designing concept wise ICT mediated activities for every class was tedious, skilful and a lot of time consuming affair

on the part of teacher. Moreover, designing a complete pack of ICT material for 40 minutes duration consisting of a motivating video of 3 to 5 minute duration, content related well split up small videos each of 3 to 5 minutes duration, followed by activity based questions, real time monitoring the works of students through live shooting and displaying on screen, capturing students' responses and maintaining their digital portfolios can initially be done only with collaboration with computer professional and other colleagues. It took a lot of efforts on the part of this researcher to prepare the ICT mediated material; obviously the regular classroom teacher may not possess the required infrastructure and available time for this type of ICT mediated material preparation.

One department may be dedicated for this type of ICT mediated material preparation and teacher can directly use the readymade ICT mediated learning material.

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