EFFECT OF ICT MEDIATED RECIPROCAL TEACHING ON ACHIEVEMENT IN MATHEMATICS

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This pretest–post test equivalent groups experimental study compared a procedure that is the ICT Mediated Reciprocal Teaching (IMRT) for helping a section of Class IX students to be better able to improve the achievement in summative assessment conducted by school than a control group of Class IX students. It was predicted that IMRT would improve the achievement and facilitate both the gender equally. Comprehending mathematics word problems related to mensuration, algebra and Euclid geometry of Class IX was delivered using IMRT to two groups of Class IX students. The achievement of students in their last school conducted test was taken as pretest scores of both the groups. Comparing the estimated marginal means using ANCOVA showed that students in the experimental ICT mediated group (M = 39.7, SD = 24.4) scored better in post test than did the students in the control group (M = 40, SD = 28.6). These results suggest IMRT has significant impact on improving the achievement in mathematics. There was no significant difference on the mean test scores of girls and boys in any of the pretest and post test; which indicated gender had no effect on achievement in mathematics at Class IX level.

Keywords: ICT mediated learning, IMRT, Reciprocal teaching.

Introduction

Can you tell me what needs to be done when most of the time students want somebody else to read the problem for them; and also students expect somebody to direct them about the required operations and steps; for next time they can remember the steps and carry out similar problems. Sometimes even after manual reading of the problem, the students do not try to comprehend the meaning. In the context of universalisation of education, the first question to ask is, what mathematics can be offered in eight years of schooling that will stand every child in good stead rather than be a preparation for higher secondary education alone (NCF 2005, p. 43)? NCF 2005 advocates constructivist pedagogy. Developing children's abilities for mathematisation is the main goal of mathematics education (NCF 2005, p. 41). In addition, field studies of problem solving in real situations show that people often fail to apply the mathematical problem-solving approaches they learn in school to actual problems encountered in the grocery store or home (Woolfolk, 2004, p. 371). The higher aim is to develop the child's resources to think and reason mathematically, to pursue assumptions to their logical conclusion and to handle abstraction. It includes a way of doing things, and the ability and the attitude to formulate and solve problems (NCF 2005, p. 61). Several attempts have been done among experts and educators to make connections between abstract mathematical ideas and the everyday material world. Almost all sorts of simple everyday materials offer great scope for a variety of interesting and mathematically rich activities. Connecting mathematical concepts includes linking

new ideas to relate ideas learned previously, helping students to see mathematics as a unified body of knowledge whose concepts build upon each other.

NCERT came up with its vision document 'Learning Outcomes at Elementary Stage-2017' to translate the ideals of constructivist pedagogy into the reality of our classrooms. Learning outcomes are assessment standards indicating the expected levels of learning that children should achieve for that class. The learning outcomes mark the switching over to constructivist pedagogy from the behaviourist. Here, IMRT is described as a constructivist strategy of learning using projector, laptop and smart phone with access to internet. The researchers have taken up a variety of topics from Class IX mathematics textbook of CBSE and delivered these concepts over a period of four months using IMRT. In fact, this research is one semester long intervention designed to test the effectiveness of this model.

Need and Justification of Problem

Making space for good conversation as part of the educational process provides the opportunity for reflection and meaning making about experiences that improves the effectiveness of experiential learning (Kolb, 2016). Reciprocal teaching is one of the most successfully implemented instructional practices (Tarchi and Pinto, 2016; Palinscar and Brown, 1984). In this cooperative learning methodology, a group of students read together a text and co-construct its meaning. In mathematics, students face problem in comprehending the meaning of text used in the problem; most of the time they expect others to comprehend the meaning for themselves so that they can carry out the related operations. To make students comprehend the meaning is a great challenge for teachers, comprehending and meaning making can be a social process with reciprocal teaching methodology. ICT mediation in the form of projector, laptop, smart phone and access to internet would facilitate in different ways (playing motivating videos, presenting on screen the problems for collective dialogue facilitating in comprehension and meaning making, placing solution before the whole class) the whole process. Reciprocal teaching (Palinscar and Brown, 1984) is a reading comprehension methodology, in which a group of students is collaboratively applying four reading strategies (questioning, clarifying, summarizing, and predicting) to co-construct the meaning of a written text (Tarchi and Pinto, 2016). Reciprocal teaching is a specific application of the cooperative learning interventions, as it is an interaction pattern where the goals of separate individuals are linked together so that there is positive correlation among attainments.

Statement of the Problem

ICT-mediated reciprocal teaching strategy can help students to improve their comprehension abilities in mathematics.

Improvement in comprehension abilities of students can lead to better achievement in mathematics.

Hypothesis

The mean learning achievement score in mathematics of secondary school students taught through ICT mediated approach will be significantly higher than that of their counterparts taught through traditional approach.

Research Design

It was pretest-post test non-equivalent groups design. Previous achievements in school conducted assessments were taken as pre-test score so as to statistically control pre-existing variations. Two intact sections of Class IX were selected randomly to serve as control and experimental group. There were 34 students in one group and 33 students in other group.

Treatment

The following paragraph, excerpt from Class IX NCERT mathematics textbook, which was learnt using reciprocal teaching strategy in Experimental Group.

"In geometry, we take a point, a line and a plane (in Euclid's words a plane surface) as undefined terms. The only thing is that we can represent them intuitively, or explain them with the help of 'physical models'. Starting with his definitions, Euclid assumed certain properties, which were not to be proved. These assumptions are actually 'obvious universal truths'. He divided them into two types: axioms and postulates. He used the term 'postulate' for the assumptions that were specific to geometry. Common notions (often called axioms), on the other hand, were assumptions used throughout mathematics and not specifically linked to geometry.

Postulate 1: A straight line may be drawn from any one point to any other point.

Postulate 2: A terminated line can be produced indefinitely.

Postulate 3: A circle can be drawn with any centre and any radius.

Postulate 4: All right angles are equal to one another.

Postulate 5: If a straight line falling on two straight lines makes the interior angles on the same side of it taken together less than two right angles, then the two straight lines, if produced indefinitely, meet on that side on which the sum of angles is less than two right angles.

Some of Euclid's axioms, not in his order, are given below :

1. Things which are equal to the same thing are equal to one another.
2. If equals are added to equals, the wholes are equal.
3. If equals are subtracted from equals, the remainders are equal.
4. Things which coincide with one another are equal to one another.
5. The whole is greater than the part.
6. Things which are double of the same things are equal to one another.
7. Things which are halves of the same things are equal to one another.

Nowadays, 'postulates' and 'axioms' are terms that are used interchangeably and in the same sense. 'Postulate' is actually a verb. When we say "let us postulate", we mean, "let us make some statements based on the observed phenomenon in the Universe". Its truth/validity is checked afterwards. If it is true, then it is accepted as a 'Postulate'. The statements that were proved are called propositions or theorems. Euclid deduced 465 propositions in a logical chain using his axioms, postulates, definitions and theorems proved earlier in the chain.

These materials were displayed on screen; students pre-recorded their reading and

played it during class; they kept on explaining the concept. They tried to respond to the queries raised by their friends. Teacher also raised critical questions to highlight the meaning of core concepts.

Results

Table 1

Means and Standard Deviations on the Achievement in Mathematics

Group	Pretest		Posttest	
	M	SD	M	SD
Control	55.5	22.1	40	28.6
Experimental	33.2	21.9	39.7	24.4

Table 1 contains means and standard deviations of the pretest-post test achievement for the ICT-mediated PBLM group and traditional pedagogy group on the selected mathematics concepts of Class IX. The pretest mean score was 33.2 for the ICT-mediated PBLM pedagogy group and 55.5 for the traditional pedagogy group, whereas the posttest mean was 39.7 for the ICT-mediated PBLM pedagogy group and 40 for the traditional pedagogy group. In order to test the initial preexisting variance between the randomly selected groups, the pretest scores of the experimental and control groups were subjected to independent samples t-test. A two-tailed t-test for independent samples showed statistically significant difference between group means at pretest, *t* observed = -4.07, *t* critical = 2.0, *df* = 66, *p* <.001, indicating that the two groups were not comparable prior to instruction. The achievement of experimental group was significantly lower than that of control group.

Table 1 contains the means and standard deviations of pretest and post test scores of experimental and control groups. The means of the experimental (IMRT) group was 33.2 on the pretest to 39.7 for the post test. A two-tailed *t*-test for paired samples showed statistically significant difference between group means at posttest and pretest, *t* observed = 2.88, *t* critical = 2.04, *df* = 33, *p* <.01, indicating that the pretest and posttest mean scores were not comparable; that is there was significant improvement in the performance of the students exposed to IMRT.

The means of the conventional pedagogy group was 55.5 on the pretest and 40 on the posttest. A two-tailed *t*-test for paired samples showed statistically significant difference between group means at post

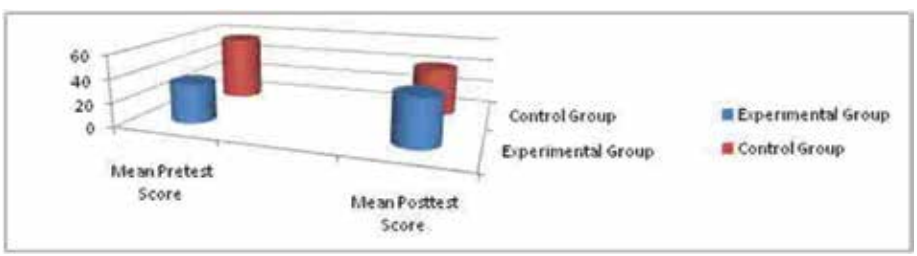

Fig. 1: Bar graph representing pretest-post test percentage scores of experimental and control groups

test and pretest, *t* observed = -5.32, *t* critical = 2.04, *df* = 33, *p* <.001, indicating that the pretest and post test mean scores were not comparable; that is there was significant deterioration in the performance of the students exposed to conventional (traditional) pedagogy.

Table 2

Analysis of the Variance Summary Table for the Achievement in Pertest

Source of variation	SS	df	MS	F
Between groups	8456.9	1	8456.9	16.2*
Within groups	34420	66	521	
Total	42877	67		

*p <.05; F critical: 4.00.

Table 3

Analysis of the Variance Summary for the Achievement in Post test

Source of variation	SS	df	MS	F
Between groups(n=34)	1.8	1	1.8	.006**
Within groups	20600	66	312	
Total	20601.8	67		

Table 2 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 not comparable at pretest in terms of students' achievement.

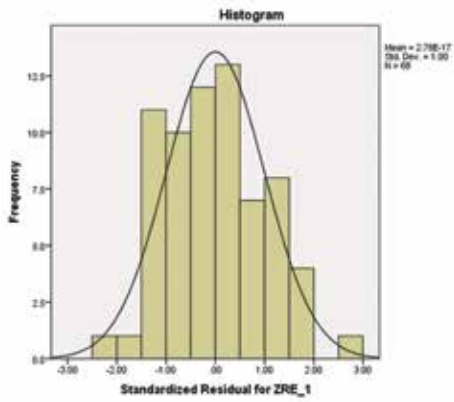

Fig. 2: Histogram with Normal Curve representing Standardised Residuals

Numerical value of skewness = .43, standard error of skewness = .291. As numerical value of skewness (.43) falls within the range of twice standard error of skewness (-.588 to .588), the distribution of Standardized Residuals can be considered to be normal. So, the second assumption before applying ANCOVA was met.

Table 4

Levene's Test of Equality of Error Variances

F	df1	df2	Significance
2.42	1	66	.125

Table 4 Levene's test of equality of error variances tests the null hypothesis that the error variances of the post test scores of experimental and control group is equal across groups. The results F(1, 66) = 2.42, p = .125 indicate that the error variance of the post test scores of the experimental group is no different from that of control group. So, the third assumption before applying ANCOVA was also satisfied.

Table 5

ANCOVA Results for the Post test of Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sign.	Partial Eta Squared
Group	6020	1	6020	25.7	.000	.285
Error	15130	65	95			

As, all the three assumptions before applying ANCOVA were found satisfied, it may be appropriate to use ANCOVA to compare the post test scores of both the groups with due consideration to the pre-existing difference between the pretest scores of both the groups.

R squared = .675 (Adjusted R Squared = .665).

Table 5 contains the results from analysis of covariance of post test scores of experimental and control groups. A one-way ANCOVA was applied to compare the effectiveness of treatment by taking into account the pre existing differences between the groups at the time of pretest. Levene's test and normality checks were carried out and the assumptions met. There was a significant difference in mean post test achievement scores [$F(1,68)=25.7$, $p < 0.001$] between the experimental and treatment groups. Comparing the estimated marginal means showed that the more score was gained on ICT mediated treatment given to experimental group (mean=50.4) compared to conventional treatment given to control group (mean=29.4). The results indicated there was significant difference between the variance of the two groups which could not be accounted to error variance.

Discussion

The problem was that reading the facts described in maths textbook is a boring task. Students just skip these and jump to solve the exercises given at the end of the book. Most of the questions what students ask are trivial; students usually do not go through the descriptions of concepts given in their textbook; examples given in textbook are not explored step by step. To be specific in one of the classes, the responsibility was given to student to explain the concept of lemma, axiom, theorem, postulate, etc., on the basis of facts provided in their textbook. They came prepared to the class; some of them had already highlighted the important points on textbook; every time about six to seven students used to take the responsibility to voluntarily record their reading of text and comprehending the meaning in Hindi using smart phone. They carry their recording using pen drive to school and they take the responsibility to explain the topic to other students; teacher initiates the discussion; students carry forward the concepts ahead; in case of any mismatch teacher interferes and resolves misconception. Teacher deliberately asked certain questions so that students were forced to read the text given in their textbook;

Table 6

Discourse moves

Code	Description	Example
Mov-TI	Expert initiations	Expert: This is about Euclid's Geometry...
Student #1: 'I don't know axiom.'		
Mov-TR Expert: 'Who can help her understand?'	Expert responses	Student #2: 'reads the related line from screen and explains in Hindi'
Mov-TF Student #1: 'What is the difference between axiom and postulate?' Expert: 'you know theorem..give an example..'	Expert follows up	Student #3: 'You know Euclid's classification. ok. cites few examples..no difference... page number reads aloud and explains.
Mov-SI	Student initiations	Student: 'The whole is greater than the part.' Expert: 'I don't understand this axiom. Please explain.'
Mov-SR Student #3: 'tries' Student #4: 'wrong. explains..'	Student responses	Expert: 'What is rational number?'
Mov-SF	Student follow-ups	Student #3: 'same thing I told.' Student #4: 'points out how her point was different'
Expert: 'who is correct or both are wrong'		

the student, who finds the related content earlier to others comes to laptop and displays the relevant content on screen for group reading with regard to students of control group, earlier achievement in pretest scores was comparatively more than their post test scores; probably this may be partly due to the difficult concepts of Class IX; secondly, the pretest scores represented their achievement in Class VIII.

Discourse moves provide the glimpses of communication established in the class. Teacher was regularly withdrawing himself from providing direct reply to any question; rather the question was referred to other students; students were asked to authenticate their statements from textbook. Other students were encouraged to read together the meaning of text.

Conclusion

Reciprocal teaching strategy facilitates interaction among students. It encourages self-learning among students; it strengthens the relationship between teacher and student. ICT mediation facilitates reciprocal teaching strategy; onscreen presentation of textbook engaged the students in reading and meaning making; together they were found to engage themselves in being receptive, and simultaneously being critical towards others' point. The main concern was how to engage the students in reading the descriptions related to concepts in an interesting way; we think ICT mediated reciprocal teaching strategy is a viable option that uses simple available gadgets like smart phone, projector and laptop to engage students in meaningful reading. It may help students to improve their achievement in mathematics.

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