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EFFECTIVENESS OF BAR MODEL IN TEACHING ALGEBRA AT SECONDARY LEVEL

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ABSTRACT

The paper presents an experimental study on the effectiveness of Bar Model in enhancing the learning of Mathematics at Secondary level. The Pre-test Post-test Equivalent Group Experimental Design was adopted and the sample to form the groups for treatment was drawn through Cluster Sampling. The VII std students who form the Control and Experimental Groups were taught the unit 'Algebra' in mathematics through 'chalk and talk' and Bar Model respectively. The experiment proved that Bar Model of teaching mathematics is more effective than the Conventional Method in enhancing the learning of mathematics at the Secondary level.

Keywords: Teaching of Mathematics, Bar Model, Singapore Maths.

INTRODUCTION

Indian Math History dates back as far as 1200 BCE. During this time, all the way up until 1200 BCE, several important mathematicians lived and worked in India, making important discoveries and paving the way for modern mathematics. The decimal number system, the binary number system, the concepts of zero and infinity, the concept of negative numbers, basic algebra, and trigonometry all got their starts with the Indians.

Mathematical knowledge becomes meaningful and powerful in application. This curriculum embeds the learning of mathematics in the solving of problems based on real-life situations. Other disciplines are a ready source of effective contexts for the study of mathematics. Rich problem-solving situations can be drawn from closely related disciplines, such as computer science, business, recreation, tourism, biology,

physics, or technology, as well as from subjects historically thought of as distant from mathematics, such as geography or art. It is important that these links between disciplines be carefully explored, analyzed, and discussed to emphasize for students the pervasiveness of mathematical knowledge and mathematical thinking in all subject areas.

The contemplation of the various steps by which mankind has come into possession of the vast stock of mathematical knowledge can hardly fail to interest the mathematician. He takes pride in the fact that his science, more than any other, is an exact science, and that hardly anything ever done in mathematics has proved to be useless. The chemist smiles at the childish efforts of alchemists, but the mathematician finds the geometry of the Greeks and the arithmetic of the Hindus as useful and admirable as any research of today. He is pleased to notice that though, in course of its development, mathematics has had periods of slow growth, yet in the main it has been pre-eminently a progressive science.

SINGAPORE MATH AND BAR MODEL

Using the Singapore Math Bar Model for solving word problems is a terrific way for students to organize their thinking, concretely show the students what the elements of the word problem are, and help them understand word problems on a more fundamental level. Further, having them really investigate the questions and the relationship between information in the problem helps them think critically about the problem and think of a logical solution. As students use this method, they are thinking algebraically, identifying the missing variable and solving for it. However, this ingenious method of representing numerical values and relationships with a symbolic bar helps to simplify even the most complex of problems.

Students are introduced to the Singapore Math method of using the Bar Model to solve word problems. Students learn the steps of the Bar Model method, and are walked through three problems. At the end of the presentation, there is an opportunity to work collaboratively to try out this new strategy as they guess what might be behind boxes, fill in the blanks, and work as a class to solve six additional word problems.

In Singapore, where 4th and 8th grade students consistently come in first on international math exams, students learn how to solve both problems using the same *bar model* technique. Students first encounter the technique in 3rd grade, where they apply it to very simple problems like the first one. In grades 4 and 5, they apply the same versatile technique to more difficult, multistep problems. By grade 6, they are

ready to solve really hard problems like the second one. With that solid foundation, students easily step into algebra. The bar modeling tool has taught them not only to solve math problems but also to represent them symbolically- the mainstay of algebraic reasoning. Bar modeling is a specific variant of the common Draw a Picture mathematics problem-solving strategy. Because Singapore Math uses this one variant consistently, students know what kind of picture to draw. That's an advantage if the bar model is versatile enough to apply to many complex problems-- and it is. It is especially useful for problems that involve comparisons, part-whole calculations, ratios, proportions, and rates of change. It communicates graphically and instantly the information that the learner already knows, and it shows the student how to use that information to solve the problem. Singapore's textbooks are used in more than 600 schools in the United States and also by many homeschoolers. The books were discovered and drew high praise when mathematicians and teachers investigated why Singapore students scored so high on international math exams. Homeschoolers and teachers like it for its simple and effective approach. Mathematicians like it for their logical structure, coherent curriculum, and focus on the skills necessary for success in algebra.

REVIEW OF RELATED STUDIES

Kevin Mahoney (2012) conducted a study on effects of Singapore's Model Method, also known as "model drawing" or "bar modeling" on the word problem-solving performance of thrid and fourth grade students. Employing a single-case design, the researcher-designed teaching intervention was delivered to a child in third grade over the course of 8 teaching sessions. Using researcher-designed assessment probes, repeated measures of the dependent variable (percentage of problems solved correctly) were taken throughout the experiment through three different phases: baseline, intervention, and maintenance. The design was repeated across four different third and fourth grade participants. The results demonstrated the existence of a positive functional relationship between the independent variable (the model drawing intervention) and the participant's problem-solving performance. The percentage of problems solved correctly rose significantly as soon as the intervention phase began and the child employed Singapore's Model Method in solving complex word problems. The pattern was repeated across two different problem types, multiplicative comparison word problems and fraction word problems. The validity of the findings was strengthened considerably when the results showed a very similar functional relationship across four different subjects in grades 3 and 4.

Jonathan Hsu (2013) conducted a study on the strengths and limitations of applying Singapore math techniques with high school students in a private school geometry class. A qualitative method with a constructivism framework was used to collect the data from surveys and interviews. The students were then introduced to the Singapore math's bar modeling techniques through solving a word problem activity. The students were all visibly impressed and full of praise of Singapore math's bar modeling techniques. Singapore math has influenced my teaching style that appeals to all of the students visually. My visually inclined teaching style will be used continually to engage my students in math. Singapore math's bar modeling techniques should have a place in high schools because it can help increase students' confidence in math and improve students' level of critical thinking and problem solving skills. Teacher training in Singapore math and choosing an appropriate Singapore math textbook are challenges. More studies are still needed to implement Singapore math successfully at the secondary level in the U.S. However, it is not possible to completely transfer everything about Singapore math over to solve the problems of U.S. educational system.

Researchers from the School of Education and Department of Mathematics and Computer Science at North Georgia College and State University (NGCSU) conducted an empirical study that evaluated the implementation of Singapore Math in all 21 elementary schools in Hall County during the 2008-2009 and 2009-2010 school years. The results indicate that students who have not previously worked with Singapore Math have had a steeper learning curve as a group than is expected in subsequent years.

STATEMENT OF THE PROBLEM

Though the Bar Model of Teaching mathematics has been in practice in Singapore and a few other countries of the best for more than, the potential of this method same to have escaped the notice of Indian academics and educational researchers. As an attempt to fill the research gap in this vital area, the present study has been undertaken to find out the effectiveness of the Bar Model of teaching in enhancing the leaning of mathematics at the Secondary level. Hence the problem of the study is stared as "Effectiveness of Bar Model in teaching algebra at Secondary level**".**

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OBJECTIVES OF THE STUDY

The main objective of the study is to find out the effectiveness of Bar Model of Teaching Mathematics at Secondary Level in terms of the students performance in the achievements tests in mathematics with specific reference to certain selected variables. The specific objectives of the study are:

- to measure the level of increase in the Secondary level students performance in the achievement test in mathematics, after teaching them Mathematics through Bar Model.
- to find out whether there exists any significant difference in the achievement of mathematics with regard to the demographic variables.

METHODOLOGY OF THE STUDY

For the present Experimental study, the Pre-test, Post-test Equivalent Group Design was adopted as the research design. The sample chosen for the study consists of 45 students of VII standard for the Conventional Method of teaching and 45 students of VII standard for the Bar Model of teaching. The two groups of students were chosen through Cluster Sampling technique. The Conventional Method Group (CMG) was taught the unit 'Algebra' in mathematics through the chalk and talk method and the Bar Model Group (BMG) was taught the same unit of mathematics through the Bar Model. An Achievement Test in Mathematics was employed for the purpose of data collection. The collected data were analysed using descriptive and differential analyses.

ANALYSIS OF DATA AND FINDINGS

The following integrated table presents the deferential analysis of data and the findings are also presented after the table:

	Groups	N	Mean	SD	't' value
Pre-test	Conventional Method Group	45	6.27	6.13	0.36
	Bar Model Group	45	5.91	6.61	
Experimental Group	Pre-test	45	5.91	6.61	10.39
	Post-test	45	19.31	5.61	
Control Group	Pre-test	45	6.27	6.13	4.37

	Post-test	45	12.87	8.06	
Post-test	Experimental Group	45	19.31	5.61	1.86
	Control Group	45	12.87	8.06	
Special Training	Tuition Takers	21	19	6.17	0.98
	Non-Tuition Takers	24	20.7	5.32	
Favorite Subject	Mathematics	9	19.8	4.16	0.70
	Other subjects	36	19.2	5.93	

- The means of the pre-test achievement scores of the conventional and experimental group students are 6.27 and 5.91 respectively which indicates that both the group students equal in terms of their achievement in mathematics is specially In the which particular unit 'percentage calculation' chosen for the purpose of treatments. The 't' value i.e., 0.36 is less than the table value 2.69 at 0.01 level of significance. Hence, the null hypothesis is not rejected and it is concluded that the control and experimental group students do not differ significantly in their pre-test achievement scores in Mathematics.
- The means of the pre-test and post-test achievement scores of the experimental group students are 5.91 and 19.31 respectively. The above table further reveals that the calculated 't' value i.e., 10.39 is greater than the table value 2.69 at 0.01 level which indicates that there exists significant difference between the pre-test and post-test performances of the eighth standard students in mathematics, taught through Bar Model of Teaching. Hence, the null hypothesis is rejected and it is concluded that the experimental group students differ significantly in their post-test achievement scores in mathematics, when compared with their pre-test achievement scores.

- The means of the conventional group students' pre and post test achievement scores are 6.27 and 12.87 respectively. This indicates that the treatment given to the control group students i.e., conventional method of teaching mathematics has led to their higher achievement. The above table further reveals that the calculated 't' value i.e., 4.37 is greater than the table value 2.69 at 0.01 level which indicates that there exists significant difference between the means of the pre and post test achievement scores of the control group students Hence, the null hypothesis is rejected and it is concluded that the control group students, who were taught through the conventional method of teaching differs significantly in their post test achievement scores, when compared with their pre-test achievement score in mathematics.
- It is concluded that the control group students, who were taught through the conventional method of teaching differed significantly in their post test achievement, when compared with their pre-test achievement in mathematics. The means of the post-test achievement scores of the experimental and control group students in mathematics are 19.31 and 12.87 respectively. It is clear from the above table that, the calculated 't' value 1.86 is greater than the table value 2.69 at 0.01 level of significance indicating that there is a significant difference between the mean post test achievement scores of the experimental group students, taught by Bar Model of Teaching and control group students, taught by Conventional Method.
- The means of the post-test achievement scores of the experimental group students, who took and did not take tuition (special training) in mathematics, are 6.17 and 11.05 respectively. The above table further reveals that the calculated 't' value i.e., 1.66 is less than the table value 2.69 at 0.01 level which indicates that tuition-taking students and non tuition-taking students do not differ significantly in their post-test achievement in mathematics. Hence, the null hypothesis is not rejected.
- The means of the post-test achievement scores of the experimental group students with and without mathematics as their favorite subject are 19.8 and 19.2 respectively. The above table further reveals that the calculated 't' value 0.70 is less than the table value 2.69 at 0.01 level which indicates that there is no significant difference in the achievement score in mathematics among the

students whose favorite subject is Mathematics and the students whose favorite subject is not mathematics. . Hence, the null hypothesis is not rejected.

CONCLUSIONS

The analysis of data, led to the important findings as given below:

1. The Control and Experimental group students differ significantly in their posttest achievement scores in mathematics, with a higher mean by the experimental group students, indicating the higher level of effectiveness of the Bar model of teaching.
2. The Experimental group students differed in their pre and posttest achievement scores in mathematics, with a higher mean in the post test, indicating the effectiveness of Bar model of teaching.
3. The sub – groups of the experimental group students, formed on the bases of their special training, favorite subject did not differ significantly in their post-test achievement scores in mathematics, indicating that these factors do not influence the effectiveness of Bar model of teaching.

On the basis of the above findings, the present study concludes that the Bar Model is more effective than the Conventional Method of Teaching Mathematics at the secondary level.

SUGGESTIONS AND RECOMMENDATIONS

On the basis of the findings and conclusions, the present study offers the following suggestions and recommendations:

1. Awareness programmes about Singapore Math and Bar Model of teaching have to be organized to mathematics teachers at different levels.
2. Bar model of teaching mathematics has to be introduced at the primary and secondary levels of education in India.
3. In-service training programmes for the primary and secondary level teachers of mathematics have to be organized with model lessons and demonstrations in Bar model of teaching.
4. The existing primary and secondary level text books have to be revised, incorporating the Bar model lessons.

CONCLUSION

The present study is an initial attempt to ascertain the effectives of teaching algebra to secondary level students the Bar Model in the Indian context. The study has proved the greater effectiveness of the Bar model in comparison to that of the Conventional method of teaching mathematics at the secondary level. Hence, in line with the mathematics education scenario of Singapore, curricular changes are the need of the hour here in order to make the best use of this innovative model with proven effectiveness in India too for the larger benefit of Indian students.

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