International Journal of Education, Modern Management, Applied Science & Social Science (IJEMMASSS)
ISSN : 2581-9925, Volume 02, No. 01, January - March, 2020, pp.151-160

EFFECT OF CONSTRUCTIVIST APPROACH ON ACHIEVEMENT IN MATHEMATICS AMONG UPPER PRIMARY STUDENTS OF BHOPAL DISTRICT

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ABSTRACT

*This paper evaluates the effect of constructivist approach on the achievement of Class VII students in the subject of Mathematics. Experimental research design was employed in the study. A sample of 189 students of Standard VII were divided into experimental and control groups. Percentage analysis, arithmetic mean and standard deviation were computed to know the nature of distribution. ANCOVA was used to find the influence of different approaches on the achievement in mathematics by considering pre-achievement in mathematics and intelligence as a covariate. Significant difference was found in the achievement level of students taught through constructivist approach in Mathematics. The study concluded that constructivist approach is largely helpful in enhancing the achievement level in the subject of Mathematics***.**

Keywords: *ANCOVA, Constructivist Approach, Achievement, Mathematics*.

Introduction

Achievement is considered to be the ultimate outcome of Education. However Achievement is relative and contextual. Good achievement specially in the subject of Mathematics is the resultant of effective pedagogy, interest of the students in a particular subject, collaborative learning, motivation, and conducive environment to name a few. Most of these attributes are attributes of constructivist approach. Class room teaching practice becomes more effective, when it is well informed by an understanding of how students' learn (Nayak, 2013). So in terms of pedagogy, the development of education now requires teaching strategies that emphasize student involvement in their learning, where focus is on knowledge construction rather than knowledge transformation. Education is in a way development of desirable habits, skills and attitudes that makes an individual a good citizen, briefly we can state that education helps in shaping or modifying the behavior of an individual for adequate adjustment in the society. Education plays an important role and is a powerful instrument of progress and social change. The teaching learning process is the central focus of it. Teaching is the axis of education. In recent years the quality of education in schools and especially the effectiveness of teaching- learning have drawn the attention of educational policy planners and practitioners. Considering the need of the society, the National Council of Education Research and Training (NCERT) developed National Curriculum framework (NCF) in the year 2005. The NCF (2005) emphasizes on 'learner centered approaches' to achieve the objectives of the curriculum. The method given most prominence by NCF 2005 was constructivism.

Constructivist Paradigm

Constructivism in simple terms means learning without being taught. The teacher remains a facilitator and students take the ownership of learning. However the irony of the situation is that the Indian Classrooms are teacher dominated; some of the teachers talk much with the intention of not giving the students the room to reciprocate or discuss their queries. Teachers also heavily rely on textbooks and reference books that students consider attending classes as irrelevant. Also most of the classrooms structurally and instructionally discourage cooperation and demand students to study in isolation that require lower order skills, rather than giving them the opportunity to explore the power of collaborative learning and scaffolding them into higher order thinking skills. The emphasis is on Performance of the students which results in little recall of concepts whereas emphasis on learning generates long term understanding (Brooks and Brooks, 1999).

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Learning at school cannot become a joyful experience unless we change our perception of the child as a receiver of knowledge and move beyond the convention of using textbooks as the basis for examination (NCF, 2005). Seeking and valuing student's point of view is an important quotient which is required in a teacher. Students point of view are window into their reasoning and understanding, therefore, mere providing the experience is not enough. It needs to be powered with a patient hearing to the students point of view which may not be always right but it has to be regarded and given due importance as it is their perception with regards to their concept. The teacher should ask questions and listen carefully to pupil interpretations of the data. The teacher must motivate the students to think as clearly as they can about their ideas. The teacher by doing so will make school experiences both contextual and meaningful (Madu et al, 2013). It is at the upper primary stage, children get the first taste of the power of Mathematics through the application of powerful abstract concepts that compress previous learning and experience. This enables them to revisit and consolidate basic concepts and skills learnt at the primary stage, which is essential from the point of view of achieving universal mathematical literacy. Children are introduced to algebraic notation and its use in solving problems and in generalization, to the systematic study of space and shapes, and for consolidating their knowledge of measurement. Data handling, representation and interpretation form a significant part of the ability of dealing with information in general, which is a fundamental 'life skill'. The learning at this stage also offers an opportunity to enrich children's spatial reasoning and visualization skills.

Achievement in Mathematics

A strong foundation in mathematics is particularly important as it allows children to better acquire new and advanced knowledge in mathematics, which contributes to successful participation in tertiary education and an increasingly knowledge-based society. For children, good achievement in mathematics will be integral to a great many aspects of their lives. These aspects include time, money and budgeting, being fair to others, claiming rights, recognizing and generalizing from symbols and patterns, using technology, interpreting information, thinking systematically and creatively, making things, and solving problems. The importance of mathematical learning has repeatedly been emphasized by educators and politicians (Wilkins & Ma, 2002). Both teachers and parents have paid attention to students' performance in mathematics and their progress every year. Politicians have also called for improving students' overall performances and closing students' achievement gaps. Until teachers and parents recognize what factors influence their students' mathematics achievement and improvement, they will be unable to help them make substantial academic progress. Figure 1 enumerates a number of reasons for lack of achievement in mathematics.

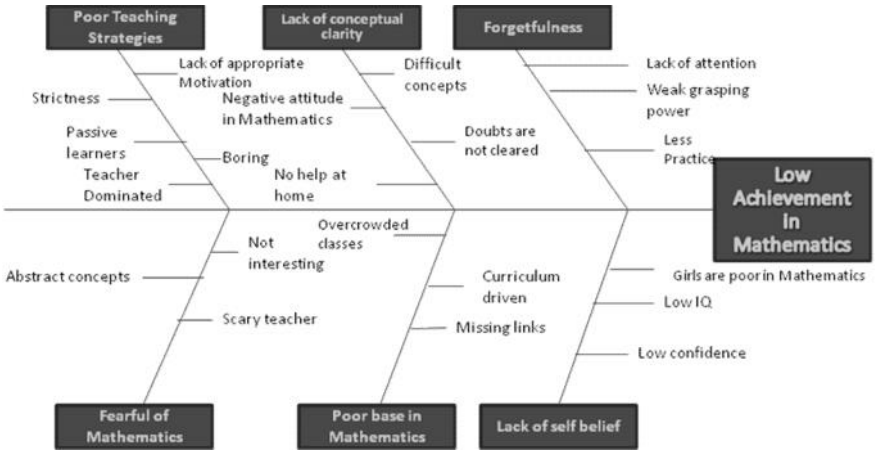

Figure 1: Reasons for Lack of Achievement in Mathematics

Mathematics achievement survey in India indicates that only 40 % of students are able to perform in the upper primary classes (MHRD, 2016). The statistics of 40% is not very encouraging. The students cited various reasons for the low achievement in Mathematics like Poor teachings strategies, Lack of conceptual clarity, forgetfulness, fearful of mathematics, poor base in mathematics, lack of self belief among a few. The constructivist learning environment gives the students the confidence to collaborate with other students to explore, explain and elaborate their thoughts. It also gives them the opportunity freely ask questions and clarify their doubts thus generating interest, engagement and in the process improving achievement in Mathematics.

Merits of Constructivist Approach

Constructivist approach is grounded on the premise of active learning whereby students learn best by constructing new schemas linking it with their past experience. Meaningful learning is ensured in this kind of environment. Students work out solutions to problems in their indigenous way. They demonstrate the ability to learn much more than they could have been explicitly taught by teachers; Constructivist approach promotes self learning and collaborative learning.

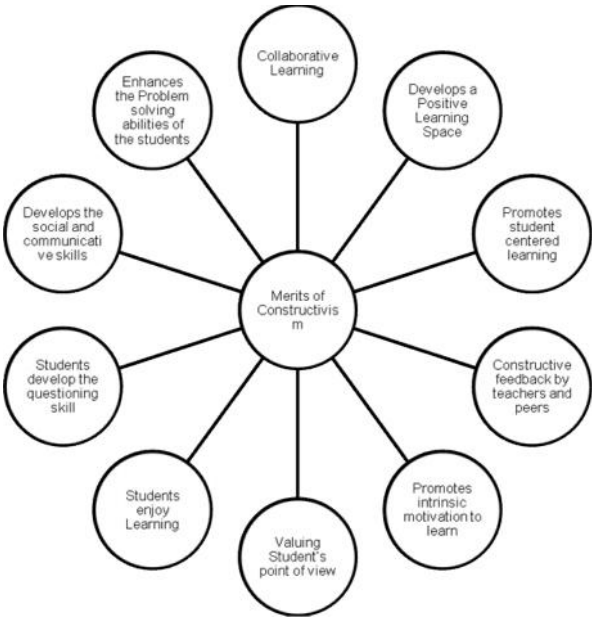

Figure 2: Merits of Constructivism

Need and Significance of the Study

Teachers try to transmit the knowledge to students that is prescribed in textbook, assess students' learning through getting them to define or apply rules in a prescribed way. There are many underlying facts which needs to be kept in mind while teaching mathematics which is in fact often overlooked like a) most of the students have a sense of fear regarding mathematics as it is abstract in nature; b) mathematics learning consists mainly of memorization of rules for solution of textbook problems; c) students memorize rules without understanding why they are doing any of it; d) the learning requirements of the talented minority in the class are often not addressed; e) assessment methods used encourage reproduction of rote memorized facts, algorithms and mechanical procedures of computations. This develops a perception of mathematics as a set of rules, algorithms and procedures; f) teachers of Mathematics are not adequately prepared for providing experiential learning keeping child at the centre.

Mathematics is perceived to be a difficult subject at school (Akhter and Akhter, 2018). In reality, no one can teach mathematics. Effective teachers are those who can stimulate students to learn mathematics. Mathematics teachers have a huge opportunity in teaching the subject. If the teacher uses the time in just routine activities and drilling exercises the teacher is hampering the cognitive development of the child and is killing the interest of the students at large. On the other hand if she uses the time to challenge the students by posing questions according to their mental capabilities and scaffolding them to get the answers, she is helping the child to reach the zone of proximal development. This would bring about holistic development in children making them independent thinkers and problem solvers which is the ultimate aim of education. Mathematics subject has a lot of phobia attached to it. One reason cited is the ineffective teaching of the mathematics teachers. The teachers do a superficial teaching without actually bothering to check the understanding of the students. The students hardly reflect on the concepts and rarely connect it with daily life experiences. This is largely affecting the interest and achievement of the students in Mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding (Clements & Battista, 2009).

Most of mathematical concepts are highly abstract in nature (Ferrari, 2003). Teaching mathematics is a challenging task which can be accomplished only by adopting learner centred pedagogy. So that abstraction can be visualized in concrete reality sense. Teachers must have a sound base for mathematical concepts to engage the students on their understanding of the respective concepts. Teaching in ways that encourage and nurture the students' quest to resolve cognitive conflict and conquer academic challenges fosters the creative and constructive problem solving ability in the students to become a true constructor of mathematical knowledge. For this we need every school organisation to come up with a learning process governed by Constructivism. Constructivism is a learning technique wherein the learner looks for meaning in the learning process and the ownership of learning is solely with the learner. The role of the educator is restricted to merely being a facilitator who would nudge the students directionally. On the contrary in conventional class teachers emphasise on procedural understanding considering themselves to be good teachers. In a constructivist classroom, the teacher is not the transmitter of knowledge but the facilitator of learning (Tobin and Tippins, 1993). Constructivism is a learning theory based on the belief that knowledge is not something that can be delivered by the teacher to the students. Rather, knowledge is constructed by learners through an active mental process of development. Learners are the builders and creators of meaning and knowledge. Constructivist beliefs have recently been applied to teaching learning situation in the classroom. Meaningful learning occurs through rethinking old ideas and coming to formulate new conclusions about new ideas (Gray, 1997).

It is a known fact that proper understanding of mathematics is necessary for success not only academically in the present class but also in the future. Mathematics is there in all walks of life, it is necessary that proper understanding of the mathematics is inculcated in the students especially at the upper primary level where the concepts of abstract mathematics are laid. There have been a number of studies where effective means of teaching mathematics is stated but none has been conducted which test the interest of students in mathematics. For creating interest in any subject it is necessary to make it intriguing and exciting by posing challenges which are achievable. Constructive approach is a method which enables the teachers to create learning situations in classroom which make them inquisitive and creative. Many studies of its utilization has been conducted abroad, not much has been done in India. Constructive approach has been utilised mostly in science, not much has been done using the approach in mathematics. It is necessary to use such a method in mathematics and finds its effect especially on the students interest and achievement in the subject. The present study aims to do just the same.

The study is useful to curriculum developers, policy makers, administrators, planner, school management, book-develops, teachers, students, all stakeholders and the society as a whole as they will have a new perspective of the aspect and will frame a base for further positive change in the area of mathematics education. Henceforth the investigator has tried to investigate the effect of constructivist approach on achievement in mathematics of upper primary students of Bhopal district; so that with the help of the results of this research, good practices may be developed for the alleviation of fear of mathematics especially among the students of upper primary classes and in scaling achievement in Mathematics and ultimately enhancing educational quality.

Objectives

- To study the level of achievement in mathematics among the students of class VII before and after the treatment
- To study the level of achievement in mathematics among the boys and girls of class VII before and after the treatment.
- To study the effect of treatment, gender and their interaction on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence as covariates.

Hypothesis

- There is no significant effect of treatment, gender and their interaction on the mean scores of Achievement in Mathematics by taking intelligence as covariate.

Literature Review

Mathematics is an interesting subject but most of the students learning the subject are scared of the subject. It is majorly because of the way it is taught in the classrooms leaving little room for the students to make meaning out of it. The topic selected for the study intends to make a difference in the teaching learning situation and is of paramount importance for the present day school education. The reviews consist of varied literature in the form of research papers, documents, dissertations, books, articles, etc., collected both from the western researches along with the similar studies conducted in India.

Chung (2004) investigated the effectiveness of two different theoretical models, constructivist and traditional approach on academic achievement in establishing Mathematical connections in learning basic facts of multiplication. Significant difference was found between two instructional methods; constructivist approach was more effective in the conceptual development of third-grade students' from concrete to symbolic levels and symbolic to concrete connections in multiplication.

Heinze (2005) studied Mathematics achievement and interest from a differential perspective. The study focused on students' Mathematics achievement and their interest in Mathematics as well as on the relation between these two constructs. The study found that Interest in Mathematics is a prominent predictor for mathematics achievement.

Jong Suk Kim (2005) investigated the effects of a constructivist teaching approach on student academic achievement, self concept and learning strategies. The sample of 76 six graders were divided into two groups. Constructivist teaching is more effective than traditional teaching in terms of academic achievement. 2. Constructivist environment was preferred to a traditional classroom.

Harani (2008) conducted a study on "Effectiveness of Constructivist Based Approach for Teaching Mathematics at Secondary Level". Major findings of the study were (a) The experimental group is significantly higher in learning Mathematics than the control group (b) There is no significant difference between boys and girls in their achievement in Mathematics among the experimental group (c) There is no significant difference in the achievement of students from various socio economic background.

Nayak (2011) studied the effect of constructivist environment on achievement in Mathematics at elementary level. Findings of the study revealed that constructivist learning approach significantly improved students' achievement in mathematics as compared to using a traditional expository teaching method and most of the students were improved their abilities of understanding and reflection. Investigator indicated that constructivist learning approach can help them to understand, integrate and clarify mathematical concept.

Methodology

The study is an experimental research study where the investigator has utilized randomized block pre-test post-test control group design for the present study. The symbolic representation of the research design is given in figure 3.

Experimental Group (E)	**R**	**O_1**	**X**	**O_2**
Control Group (C)	**R**	**O_1**		**O_2**

Fig 3: Graphical Representation of randomized pre-test post-test control group design

In figure 3 the randomized pre-test post-test control group design is graphically represented. "E" and "C" indicates experimental and control groups respectively and "R" indicates that the members of the groups were randomly assigned to each group. An "X" indicates the treatment given to the experimental group (in the present study 'teaching through constructivist method). "O_1" indicates a pre-test and "O_2"indicates post-test on the dependent variables. The vertical positioning of the O's indicates that they took place at the same point in the experiment

The sample consisted of 189 students. Out of the selected students 94 were from urban background and 95 were from rural background. Further, from the urban background 42 government and 52 private school students were selected. Likewise, from the rural background 44 government and 51 private school students were selected. The final sample consisted of 107 boys and 82 girls. The experimental group from different schools had 97 students of which 55 were boys and 42 were girls. The control group from different schools had 91 students of which 51 were boys and 40 were girls.

For collection of the data Standard Progressive Matrices developed by J.C. Raven was used to measure the intelligence of the students; the interest of student in Mathematics was measured using Mathematics Interest Inventory developed by L. N. Dubey; Achievement Test in Mathematics developed by the investigator was used to measure the achievement of the students in Mathematics. As treatment, lesson plans were developed after discussion with the subject teachers and topics which required conceptual understanding were given preference. The experimental group was taught through the constructivist approach by the investigator and control group was taught through the traditional approach by the concerned subject teacher.

Data Analysis and Findings

Achievement in mathematics among the students before and after the treatment

The first objective of the study is "to study the level of achievement in mathematics among the students of class VII before and after the treatment" for which the research question is 'What is the level of achievement in mathematics among the students of class VII before and after the treatment?' The achievement in mathematics was measured by using the Achievement Test in Mathematics developed by investigator. According to the scores of achievement in mathematics obtained, the students were categorized as having need for improvement, below average, average, good and very good achievement in mathematics. The level wise achievement in mathematics of all the student is presented in figure 4

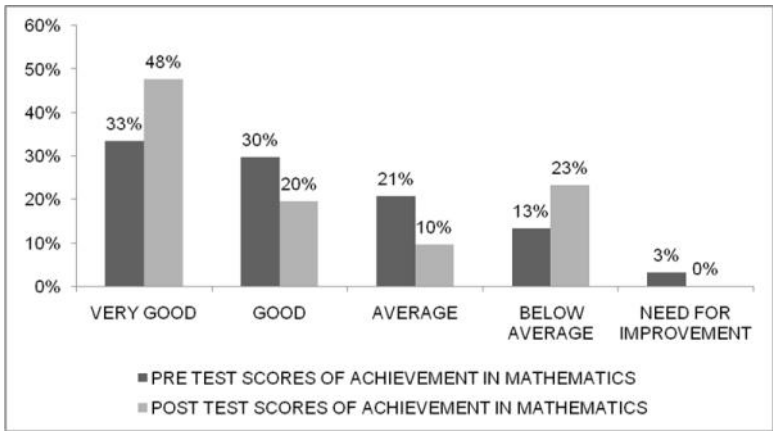

Figure 4: Level of achievement in mathematics among students before and after the treatment

From figure 4 it can be seen that before the intervention 33% of the students had very good level of achievement in mathematics, 30% had good, 21% had average, 13% had below average and 3% needed improvement in mathematics while after the intervention, 48% had very good level of achievement, 20% had above average, 10% had average, 23% had below average and none were in the need for improvement level of achievement in mathematics. From the above it can be inferred that after the intervention a large number of students who were earlier having low achievement in mathematics are having better achievement in mathematics after the intervention.

Level of achievement in mathematics among the boys and girls before and after the treatment

The second objective of the study is "to study the level of achievement in mathematics among the boys and girls of class VII before and after the treatment." for which the research question is 'What is the level of achievement in mathematics among the boys and girls of class VII before and after the treatment?' These scores were collected by bifurcating the data pertaining to boys and girls and analysing them separately. According to the scores of achievement in mathematics obtained, the boys and girls were categorized as having need for improvement, below average, average, good and very good achievement in mathematics. The level wise achievement in mathematics of boys and girls is presented in figure 5.

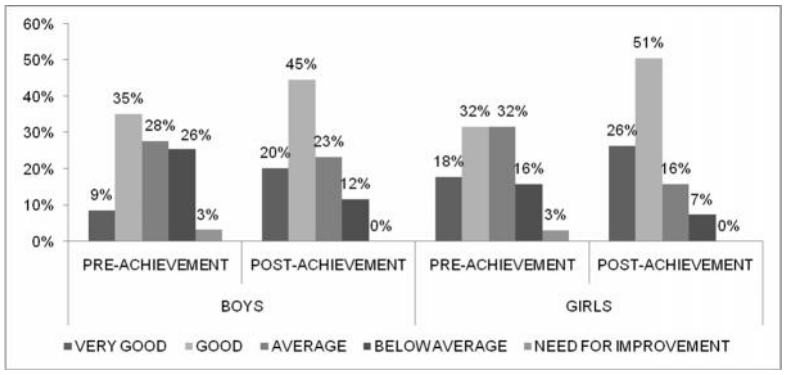

Figure 5: Level of achievement in mathematics among boys and girls before and after the treatment

From figure 5, it can be seen that among the boys before the intervention when their achievement in mathematics was tested, 9% had very good level of achievement in mathematics, 35% had good, 28% had average, 26% had below average and 3% were in the need for improvement level of achievement in mathematics but after the treatment when their achievement in mathematics was measured it was found that 20% had very good level of achievement, 45% had good, 23% had average, 12% had below average and none were in the need for improvement level of achievement in mathematics. Further, among girls before they were taught using the constructive approach, 18% had very good level of achievement in mathematics, 32% had good, again 32% had average, 16% had below average and 3% were in the need for improvement level of achievement in mathematics but after attending the classes conducted by the investigator using the constructive approach it was found that 26% had very good level of achievement in mathematics, 51% had good, 16% had average, 7% had below average and none were in the need for improvement level of achievement in mathematics. From above it can be inferred that use of constructive method in teaching is beneficial in enhancing the achievement in mathematics of both boys and girls.

Effect of Treatment, Gender and their Interaction on Achievement in Mathematics by taking Pre-Achievement in Mathematics and Intelligence as Covariate

The third objective of the study was 'to study the effect of Treatment, Gender and their Interaction on Achievement in Mathematics by taking Pre-Achievement in Mathematics and Intelligence as Covariate' for which the hypothesis formed was 'there is no significant effect of treatment, gender and their interaction on the mean scores of achievement in mathematics by taking pre-achievement in mathematics and intelligence as covariate.' There were two levels of Treatment, namely, Constructivist Approach and Lecture Method. Males and Females were the two levels of Gender. Pre-Achievement in Mathematics and Intelligence were the two covariates. Achievement test in mathematics prepared by the investigator was administered to the students before and after the treatment in order to measure the achievement in mathematics and to know the effect of treatment. For measuring the intelligence of the students, Standard Progressive Matrices developed by J. C. Raven was utilized. The data were analyzed with the help of Two-Way ANCOVA. The results are presented in Table 1 and 2, below.

Table 1

Summary of Two Way ANCOVA for Treatment, Gender and their Interaction on Achievement in Mathematics by taking Pre-Achievement in Mathematics and Intelligence as Covariate

Sources of Variance	Df	$SS_{y.x}$	$MSS_{y.x}$	$F_{y.x}$	Remark
Treatment (A)	1	1337.03	1337.03	24.44	p<0.01
Gender (B)	1	677.82	677.82	12.39	p<0.01
A X B	1	944.08	944.08	17.26	p<0.01
Error	183	10011.21	54.71		
Total	188				

Table 2: Mean, SD and N for achievement in mathematics of students by Group and Gender

Gender	Group	Mean	SD	N
Boys	Experimental	45.45	6.73	55
	Control	32.13	10.87	52
	Total	38.98	11.17	107
Girls	Experimental	46.10	7.42	42
	Control	39.83	11.88	40
	Total	43.04	10.28	82
Total	Experimental	45.73	7.01	97
	Control	35.48	11.89	92

From Table 1 and 2, it can be seen that the adjusted F-Value for Treatment is 24.44, which is significant at 0.01 level of significance with df=1/183. It reflects that the adjusted mean scores of Achievement in Mathematics of students taught through Constructivist Approach and Lecture Method differ significantly when Pre-Achievement in Mathematics and Intelligence were taken as covariates. So there was a significant effect of Treatment on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence of students as covariates. Thus the null hypothesis that there is no significant effect of Treatment on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence of students as covariates is **rejected**. Further the adjusted mean score of

Achievement in Mathematics of Constructivist Approach Group is 45.73 which is significantly higher than those of Lecture Method Group whose adjusted mean score of Interest in Mathematics is 35.48. It may, therefore be said that students taught through Constructivist Approach were found to have significantly higher Achievement in Mathematics than those of Lecture Method Group when Pre- Achievement in Mathematics and Intelligence were taken as covariates.

Further from Tables 1 and 2 it can be seen that the adjusted F-Value for Gender is 12.39 which is significant at 0.01 level of significance with df=1/183. It reflects that the adjusted mean scores of Achievement in Mathematics of Boys and Girls differ significantly when Pre- Achievement in Mathematics and Intelligence were taken as covariates. So there was found significant effect of Gender on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence as covariates. Thus the null hypothesis that there is no significant effect of Gender on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence of students as covariates is rejected. Further the adjusted mean scores of Achievement in Mathematics of Boys is 38.98 which is significantly lower than those of Girls whose adjusted mean score of Achievement in Mathematics is 43.04. It may, therefore be said that Girls were found to have significantly higher Achievement in Mathematics than Boys when Pre-Achievement in Mathematics and Intelligence were taken as covariates.

On further analyzing, from Tables 1 and 2 it can be seen that the adjusted F-Value for interaction between Treatment and Gender is 17.26 which is significant at 0.01 level of significance with df=1/183. So there was significant effect of interaction between Treatment and Gender on Achievement in Mathematics when Pre- Achievement in Mathematics and Intelligence were taken as covariates. Thus the null hypothesis that there is no significant effect of interaction between Treatment and Gender on Achievement in Mathematics by taking Pre- Achievement in Mathematics and Intelligence as covariates is rejected. Hence it can be inferred that there is combined effect of Treatment and Gender on the mean scores of Achievement in Mathematics.

Conclusion

From the above findings the following conclusions can be enumerated:

- After the intervention a large number of students who were earlier having low achievement in mathematics are having better achievement in mathematics after the intervention.
- Use of constructive method in teaching is beneficial in enhancing the achievement in mathematics of both boys and girls.
- Constructive method in teaching has improved the achievement in mathematics of students from both government and private schools.
- Students from both rural and urban schools benefit from constructive method in teaching as it has improved their achievement in mathematics
- Students taught through Constructivist Approach were found to have significantly higher Achievement in Mathematics than those of Lecture Method Group.
- There is combined effect of Treatment and Gender on Achievement in Mathematics.
- Constructivist Approach was found to benefit both students of Urban and Rural Locality although it benefited more to students from Rural Locality.
- There is combined effect of Treatment and Locality on Achievement in Mathematics.
- Although Constructivist Approach has benefitted both the students of Government and Private Schools when it comes to achievement in mathematics, there is no significant benefit to any one group.
- There is no combined effect of Treatment and Type of School on Achievement in Mathematics.
- Constructivist Approach was found to benefit both students from government and private school although it benefited more to students from private school.
- Higher the intelligence higher will be the achievement in mathematics.

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