MATHEMATICS TEACHING RESEARCH JOURNAL
Vol 13, no 1
SPRING 2021

An Experimental Study of Collaborative Instructional Strategy (CIS) for Teaching Mathematics at Primary level in Pakistan

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Abstract: *Modern concept of education is based on students' centered learning approaches where collaborative instructional strategy is an emerging approach. It has been tested in different subjects and its effectiveness has been proved. Therefore, this experimental study investigated the effects of Collaborative Instructional Strategy (CIS) on mathematics achievement of fifth grade students. The experiment was conducted at a Government school in District Swat, Pakistan using pre-test post-test comparative group design on 64 students in two groups (control and experimental). Mathematics Attainments Test (MAT) was developed to measure students' academic achievement. Collaborative mathematics instructional lesson plans (CMIL) were also developed to teach mathematics. The collected data were analyzed though mean, standard deviation, pair sample t test and independent sample t test. The results of the experiment showed that Collaborative Instructional Strategy (CIS) has a significant positive effect on the academic achievement of Primary school students in the subject of mathematics. It was recommended that Collaborative Instructional Strategy (CIS) may be use to teach mathematics at primary level.*

Keywords: *Collaborative Instructional Strategy (CIS); Teaching Mathematics; Academic Achievement; Primary Level*

INTRODUCTION

Mathematics plays a significant part in promoting logical thinking, enhances critical thinking and develops problem-solving abilities in students. It describes various numbers and shapes systems (Ma, 2009). Mathematics is a sequential subject where the students learn in sequence i.e., previous learning provides a base for learning new concepts and skills (Mulligan, Mitchelmore, & Crevensten, 2013). It means that in order to learn how to multiply, one should already have learnt how to add two numbers. Similarly, in order to learn how to divide, subtraction provides foundations. Mathematics has always been seen as a discipline that sharpens the intellect including systematic, logical and precise thoughts. In the earliest years of 21st century, experts of mathematics found that it is the integral part of human life. The famous educationalist Frobel and Montessori had the view that mental and cultural development of an individual depends on his/her

study of mathematics (Yasoda, 2009). Mathematics plays a predominant role in our daily lives and has become an important element in the development of our world today.

Mathematics aims at the improvement of reasoning and logical cognitive abilities that enable the individuals to solve numerical and mathematical problems. Every Businessman, Banker, Medical doctor, Laborers, Vendors requires mathematical abilities to fulfill the requirements of his everyday life. Mathematical knowledge and skills are also used in different fields such as Genetics, Physics and Chemistry that calculate various formulas (Morsanyi, McCormack, & O'Mahony, 2018).

Mathematics teaching can only be defined as truly efficient, when it positively contributes to the learning of students. It is believed that an effective teaching method is the one that positively contribute to students' academic performances (Ma, 2009). To analyze mathematical concepts with a reasonable degree of certainty skillful mathematics teachers implemented a number of teaching techniques, approaches and tools to fulfill the criteria of various learning needs of students. Mathematics can be explained using a step-by-step approach to the subject (Akhtar, Rashid, & Hussain, 2020). It should never be taught as a collection of separated facts and formulas. Students and teachers consider mathematics to be a challenging subject, as they face many problems in the process of teaching and learning (Portman & Richardson, 1997). In general, mathematics is considered the driest discipline at the school, consisting of repetitive, demanding, dull, arcane and meaningless calculations that have little to do with exploration and creativity (Makroo, & Dahiya, 2014).

Teachers of mathematics around the world use a variety of teaching strategies to make teaching learning process more productive. Enríquez, de Oliveira, and Valencia (2018) found that teachers use a range of teaching strategies in the execution of mathematical activities. These strategies were; pre-instructional, co-instructional and post-instructional. Asuncion-Atupan (2013) pointed out various teaching strategies which were used in teaching of mathematics. These include; interactive, innovative, integrative, inquiry based, collaborative, experiential, meta-cognitive and reflective. Baig (2015) pointed out varieties of teaching methodologies that are used in teaching mathematics across the world. Some of these methodologies are inductive, deductive, lecture, problem solving, and activity based.

Furthermore, experts didn't impose any restrictions on the use of instructional methods in teaching mathematics but it needs to be in accordance with the demands of a particular syllabus unit, available teaching resources, nature and number of students in a class. Various teaching methods, their advantages and disadvantages along with the applications of each teaching method of mathematics were employed by researchers across the globe. Banning (2005) identified numerous mathematics teaching approaches used worldwide, such as teacher-centered (deductive), learner-centered (inductive), consultative and collaborative, content-focused, and classroom-focused approaches. Sindu (2010) discussed different teaching techniques for mathematics, such as verbal

work, handwritten work, drilling, assigning homework sheet, individual self-study and group activities. Le Donne, Fraser, and Bousquet, (2016) found three underline strategy namely active learning, cognitive learning and teacher directed method. Active learning promotes engagement of students in their own learning thereby encouraging discussions, group work and cooperation. Cognitive learning promotes stimulation and critical thinking among students and making them able learners to identify their issues. This method encourages students to a great extent to exhibit their creativity in classroom. This method also ensures maximum participation of students in teaching learning process.

Team teaching is the essence of collaborative instructional strategy. In Team Teaching, the responsibility of teaching the students is distributed among two or more teachers. Both teachers carry out different tasks at a time, for example one of the teacher speaks while the other one writes on the board. At a time, two or more teachers are involved in the teaching process. They may or may not be present in the same classroom. For example, one teacher may be teaching the class, while the others may be planning. Both instructors have to deliver similar lessons to the students. For example, one teacher writes the lesson on the board while the other shows to the class related content on a chart. Team teaching includes the general instructor, as well as the special instructor planning and instructing academic subject content to all the students in the class together. Another form of team teaching is taking turns preparing for lessons to change the pace and emphasis while at the same time the other one is monitoring. One teacher will eventually lecture while the other offers examples to help in clarification key features (Knackendoffel, 2005).

According to Badiali and Titus (2010), “the term team teaching has been used to describe some sort of teacher collaboration regarding teaching.” In this case, synchronous team teaching is regarded as the closest form of instructional relationship because it holds the biggest amount of mutual liability. Team teaching provides innovation and creativity in working with another teacher. Synchronized teaming happens when both teachers are involved instructing to the whole class of students. They synchronize their teaching by showing curriculum together. Bauwens and Hourcade (1997) stated that through team teaching, the initial implementation of new material is shared by two teachers who jointly prepare and deliver the intended academic subject matter to all students as simply and briefly as possible. At different times each may take primary responsibility for particular kinds of teaching or parts of the curriculum.

On the other hand, in Pakistan, teachers of mathematics use traditional teaching strategies for teaching which are deductive or teacher centered strategies. These strategies don’t allow the teacher to link mathematics to daily life. In Pakistani classrooms teachers usually begin the topic by selecting formulas and asking students to memories those formulas. The teachers do not explain the background and concepts of the topic they are teaching (Amirali & Halai, 2010).

In contrast to deductive teaching strategies, collaboration is a successful inclusive strategy where multiple teachers share their knowledge and skills in one or more classrooms (Lin, & Xie, 2009).

Collaborative instruction is an instructional strategy in which teachers work together on specific subject. In collaborative teaching strategy teachers help each other to solve a particular problem in day to day instructions. In countries with an advanced educational system such as United States, Australia, Canada, United Kingdom teachers use the inductive teaching strategies like collaborative instructional strategy.

Researchers have proven conclusively that collaborative instructional strategy enhanced learning of the students in advanced countries (Fatimah, Rajiani, & Abbas, 2020; Kahiigi Kigozi, et al, 2012). It enhances students' prospect towards logical arguments, offers reasoning and consistency in critical thinking in various circumstances. Teachers also acquire valuable knowledge in their subject when working collaboratively with one another. Its importance lies in the combined efforts used to achieve common instructional objectives and resolve the issues. It is also useful in alleviating and elaborating the mathematical concepts of students. Most instructors, department heads, parents, teachers and students believed that collaborative teaching strategy is successful in teaching learning processes (McDuffie, Scruggs, & Mastropieri, 2007).

Research studies also suggested that collaborative instructional strategy is more successful than solo instruction. Wadkins, Wozniak and Miller (2004) suggested that in teaching mathematics collaborative instructional strategy increases not only the bilateral confidence and reverence between teaching colleagues but also seeks to have a significant effect on the academic attainments of learners. Hence, the study intends to use Collaborative Instructional Strategy (CIS) for teaching mathematics in Pakistan to find out its effects on the mathematics achievement of primary school students. Therefore, this experimental study was designed to investigate the effects of Collaborative Instructional Strategy (CIS) for Teaching Mathematics at Primary level in Swat, Khyber Pakhtunkhwa, Pakistan.

METHODOLOGY

This research study was carried out for six weeks in government primary school in Barikot Swat, Pakistan. Sixty four (64) male students of 5^{th} grade took part in the experiment. These students were aged between 10 to 12 years and they belonged to different family backgrounds. Pre-test post-test two-group comparative experimental research design was utilized to examine the effectiveness of Collaborative Instructional Strategy. The experiment was conducted by the principal author and two volunteers from the sample school. The researcher explained the objectives of the study and the details of the course content to be covered in the study to the teachers. The collaborative teacher was trained on of Collaborative Instructional Strategy. He was informed about the general methodologies and techniques of collaborative teaching and his role was explained to him in the teaching process.

Both the control and experimental groups were instructed in separate classrooms. The principal author and one math teachers instructed the experimental group using Collaborative Instructional Strategy, while a control group was instructed by one teacher. The two teachers teaching to

experimental group mutually planned and delivered the lesson plans. They implemented the collaborative mathematics instructional lesson plans (CMIL). The lesson plans were designed in such a way that both teachers presented lesson by collaborative ways that is, one teacher teach one assist. Figure 1 diagrammatically represents this concept.

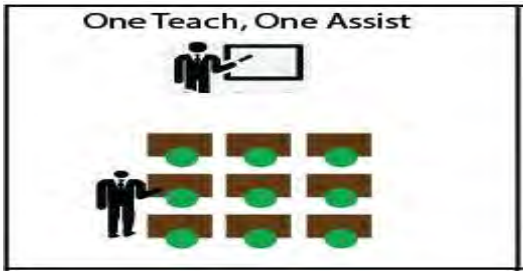

Figure 1: Collaborative teaching Models, one teach one assist

Mathematics Attainments Test (MAT) was developed to measure the achievements of students. The questions in this test were selected from 5th grade mathematics text books of Khyber Pakhtunkhwa and Punjab. The test consisted of Fifty (50) items, divided into two sections to test two aspects (strands) of mathematics, i.e. Numbers and arithmetic operations (Addition, Subtraction, Multiplication, and Division) and Highest Common Factors (HCF) & Least Common Multiples (LCM). Table-1 shows specification of Mathematics Achievement Test (MAT).

Serial Number	Topics (Content)	Knowledge Ability (KA)		Comprehension Ability (CA)		Application Ability (AA)		Total	
		No. of Test items	% Score in Test	No. of Test items	% Score in Test	No. of Test items	% Score in Test	No. of Test items	% Score in Test
1	Basic Arithmetic	7	23.33	5	16.67	2	6.67	14	46.67
2	HCF and LCM	6	20	3	10	7	23.33	16	53.33
	Total	13	43.33	8	26.67	9	30	30	100

Table 1: Specification Table of Mathematics Achievement Test (MAT)

Pilot test was carried out in Government Primary School Aboha, Swat. The mathematic achievement test was administered to a group of eighty (80) students. Item difficulty index (P) and item discrimination index (DI) were used for item analysis. In the first place the initial selection was made on Discrimination index (DI) . The items having difficulty index within the range of .1 and .9 were retained, and items having discrimination index below .1 and above .9 were rejected (Suruchi & Rana, 2014; Pande, Pande, Parate, Nikam, & Agrekar, 2013; Shad, Fatima, Fatima, & Chiragh, 2018; Badkur, Suryavanshi, & Abraham, 2017). The items having Difficulty index from 30% to 70% were retained (Patil & Patil, 2015; Shad, Fatima, Fatima, & Chiragh, 2018; Pande, Pande, Parate, Nikam, & Agrekar, 2013). The mathematics achievement test (MAT) composed of fifty (50) Multiple Choice Question (MCQs) items. Twenty items were rejected, seventeen on the basis of discrimination index (DI), two on the basis of difficulty index and one as well as on the basis of the experts' opinions. The test was validated by a team of specialists (experts). Colomer (2008) stated that the majority opinion about an item is based on the responses of at least four judges out of the six judges. On the basis of students poor attendance four (two from experimental and two from the control group) students' post-test scores were excluded from the study. Finally, the scores of 60 students were taken (30 in experimental and 30 in the control group).

RESULTS

Groups	*Pre-test*	*Mean ($\bar{x}$)*	*Post-test*	*Mean ($\bar{x}$)*
Control	*30*	*10.23*	*30*	*15.50*
Experimental	*30*	*9.90*	*30*	*21.23*

Table 2: Mean scores of experimental and control groups on the Measure of Mathematical Achievement Test (MAT)

Table 2 shows that the mean scores of the control group in pre-test and post-test were 10.23 and 15.50, respectively. Likewise, the mean scores of the experimental group in pre-test and post- test were 9.90 and 21.23, respectively, which means that the mean scores of experimental group increased significantly after the treatment.

Groups	*N*	*Mean($\bar{x}$)*	*S.D*	*t-value*	*P value*
Control	*30*	*15.50*	*5.36*	*– 4.12*	*.000*
Experimental group	*30*	*21.23*	*5.43*		

Table 3: Difference between mean of post-test scores of control and experimental groups on Mathematical Achievement Test (MAT)

Table 3 illustrates the mean scores and S.D of control group was 15.50 and 5.36 and the mean scores and S.D of experimental group was 21.23 and 5.43 respectively. The t-value was – 4.12 and the p-value was .000 which is highly significant and concluded that the mean scores on Mathematical Achievement Test (MAT) of the experimental group, who were taught through collaborative instructional strategy, was better than the mean scores of the control group.

Group	*N*	*Mean($\bar{x}$)*	*S.D*	*t value*	*P value*
Control	*30*	*6.83*	*2.82*	*– 3.54*	*.001*
Experimental	*30*	*9.43*	*2.87*		

Table 4: Difference between mean scores of control and experimental groups in knowledge ability on Mathematical Achievement Test (MAT)

Table 4 illustrates the mean scores and S.D of control group was 6.83 and 2.82 and the mean scores and S.D of experimental group was 9.43 and 2.87 respectively. The t-value was – 3.54 and the p-value was .001 which is significant and concluded that the mean scores of knowledge ability on Mathematical Achievement Test (MAT) of the experimental group, who were taught through collaborative instructional strategy, was better than the mean scores of the control group.

Groups	*N*	*Mean($\bar{x}$)*	*S.D*	*t value*	*P value*
Control	*30*	*3.83*	*1.97*	*– 4.49*	*.000*
Experimental	*30*	*5.83*	*1.44*		

Table 5: Difference between mean scores of control and experimental groups on comprehension ability on Mathematical Achievement Test (MAT)

Table 5 illustrates the mean scores and S.D of control group was 3.83 and 1.97 and the mean scores and S.D of experimental group was 5.83 and 1.44 respectively. The t-value was – 4.49 and the p-value was .00 which is highly significant and concluded that the mean scores of comprehension ability on Mathematical Achievement Test (MAT) of the experimental group, who were taught through collaborative instructional strategy, was better than the mean scores of the control group.

Group	*N*	*Mean($\bar{x}$)*	*S.D*	*t-value*	*P value*
Control group	*30*	*4.83*	*1.62*	*– 2.32*	*.024*
Experimental	*30*	*5.97*	*2.13*		

Table 6: Difference between mean scores of control and experimental groups in Application ability on Mathematical Achievement Test (MAT)

Table 6 illustrates the mean scores and S.D of control group was 4.83 and 1.62 and the mean scores and S.D of experimental group was 5.97 and 2.13 respectively. The t-value was – 2.32 and the p-value was .024 which is not significant and concluded that there is no significant difference between the mean scores of control and experimental groups.

RESULTS AND DISCUSSIONS

This experimental study examined the effect of Collaborative Instructional Strategy on the academic achievement of 5th grade mathematics students. The main findings of the study were that those students who were taught mathematics through Collaborative Instructional Strategy showed better performance that those taught by traditional teaching strategies. It was also found that those students who were taught mathematics through collaborative instructional strategy showed that their knowledge and comprehension abilities improved significantly that those taught by traditional teaching strategies. However, the study found no significant difference in application ability of control and experimental groups.

This means that collaborative instructional strategy is more effective teaching method for teaching mathematics at primary level. Zhang and Cui (2018) established that collaborative learning improve students' cognitive performance, promote social interaction and positive learning behavior. The findings of this study was supported by Ahmad et al. (2017) who found that collaborative teaching method is effective and useful in teaching Calculus I. The scores for basic knowledge and knowledge of Calculus I show statistically significant increase. The findings by Othman, (2020) that collaborative teaching was more effective in development of students and teachers professionally support the findings of the current study. Qaisar (2011) conducted his research work on the impact of Collaborative teaching on 8th grade students' achievement in mathematics revealed that Collaborative teaching significantly effects students' conceptual learning specifically their conceptual understanding and procedural knowledge. Pires (2020) investigated use of cognitive strategies in a collaborative learning environment fond that students' use of elaboration strategies has positively correlated to academic achievement. Van Leeuwen and Janssen (2019) results show that several aspects of teacher guidance are positively related to student collaboration. Collaborative teaching has yields positive effects on the academic achievement of students in advance countries such as the United States, United Kingdom, China, Australia, Canada, etc. (McDuffie, Scruggs, & Mastropieri, 2007). The results of the study are also consistent with the results of the studies conducted by (Murawski & Lee Swanson, 2001; Jang, 2006; Goddard, Goddard, & Tschannen-Moran, 2007).

In our classrooms mathematics teaching is transmitted without the actual purpose and application, students do not know the constructive concept of mathematics. At primary level mathematics teachers only teach text books and use white board instead of concepts of everyday life. They solve mathematics only by formulas. Therefore teaching through traditional methods of mathematics is the main case of student's low performance. The traditional mathematics teaching strategies neither yield effective results, nor produces effective mathematics graduates. The conventional

lecture method is based on how to explain mathematics. Throughout the teaching learning process, in traditional teaching strategies, the instructor has an active role and provides knowledge to students while the students remain passive.

Collaborative learning and teaching is the process of consultation and collaboration. It enhances students' learning and strengthens the relationship among professional colleagues. In reality, there are several educational areas that require so much cooperation and coordination. This is particularly significant in inclusive classrooms, where teachers in the classroom can usually work with specialist teachers, counselors, health professionals, teacher assistants and parents.

CONCLUSIONS

The study concluded that teaching mathematics through collaborative instructional strategy (CIS) was more effective than single teacher traditional lecture demonstration at primary level and collaborative mathematics instructional lesson plans of co-teacher showed better results and enhanced students learning.

RECOMMENDATIONS

Based on the findings of this study it was recommended that;

- The collaborative instructional strategy (CIS) may be used for teaching mathematics at various levels to improve students' academic achievement and to encourage students to avoid rote memorization in their learning. This would not be possible without the capacity building of the school teachers in teaching methodologies through trainings and workshops or refreshing courses.
- Likewise, it was recommended that the collaborative instructional strategy (CIS) may be prioritized in pre-service teaching programs especially in pedagogy of science subjects. Government may provide more teachers to primary schools in order to encourage collaborative instructional strategy (CIS) in our classrooms.
- So far, there is a very limited research work about collaborative instructional strategy in Pakistan. Therefore, research studies are recommended to investigate the usefulness of this strategy at all levels.

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