EFFECT OF TRADITIONAL AND CO-OPERATIVE LEARNING APPROACH ON STUDENT-OUTCOMES

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Abstract

The present study is aimed at ascertaining the combined effect of students' conceptions of mathematics, mathematics self-efficacy and student engagement in mathematics on their academic achievement in mathematics among traditional classroom and co-operative learning approach. The study adopted the quasi-experimental approach on 159 students of standard IX studying in English medium schools. It was found that (a) The contribution of conception of mathematics to academic achievement in mathematics is the lowest followed by mathematics self-efficacy and student engagement in that order in both control and experimental groups (b) The contribution of conceptions of mathematics, mathematics self-efficacy and student engagement to academic achievement in mathematics is lower in the control group as compared to that in the experimental group, (c) The contribution of mathematics self-efficacy and student engagement to academic achievement in mathematics has doubled in the experimental group as compared to the control group, (d) The effect of conceptions of mathematics, mathematics self-efficacy and student engagement in mathematics on their academic achievement in the experimental group is large and in the control group is medium and (e) Co-operative learning group enhances the effect of conceptions of mathematics, mathematics self-efficacy and student engagement on the academic achievement of students in mathematics.

Keywords: Co-operative Learning, Conceptions of Mathematics, Mathematics Self-Efficacy, Student Engagement, Academic Achievement

Introduction :

Co-operative learning encompasses structuring classroom instruction in small groups that work together in such a way that each student's success depends on the group's success. Co-operation is does not only include having students sitting beside each other on the same table and talking with each other in order to undertake learning activities. Co-operation does not only include activities in which one student does all the work and the others put their names on the final outcome. Co-operation involves much more than being physically next to each other, deliberating material, helping or sharing material with other students. There is a vital

difference between merely putting students into groups to learn and in organizing co-operative interdependence among students. Wide-ranging research has compared co-operative learning with traditional classroom instruction using the same teachers, curriculum and assessments. Prior research has found that (a) Students who participate in co-operative learning learn substantially more, remember it better and develop improved critical-thinking skills as compared to their counterparts in traditional lecture classes, (b) Students appreciate co-operative learning more than traditional lecture classes, are more expected to attend classes, (c) Students are likely to take up jobs that necessitate teamwork.

Several researches have been undertaken both in India and abroad on co-operative learning. However, the present research differs from prior studies in that it attempts to study whether there is any effect of students' conceptions of mathematics, mathematics self-efficacy, student engagement on their academic achievement in mathematics in the traditional class and co-operative learning approach using regression analysis. The importance of this study is paramount in the urban Indian context where there are more than 75 students in a classroom in contrast to developed countries where the class size is as small as 25 students or less.

Aim of the Study

To study the combined effect of students' conceptions of mathematics, mathematics self-efficacy and student engagement in mathematics on their academic achievement in mathematics in traditional class and co-operative learning approach.

Methodology

The present study is aimed at studying the effect of traditional and co-operative learning approach on student-outcomes in terms of the combined relationship of academic achievement of students with their conception of mathematics, mathematics self-efficacy and student engagement in (a) control group and (b) experimental group. For this purpose, the researcher has manipulated the method of teaching to ascertain its effect on all the four variables, namely, students' conceptions of mathematics, mathematics self-efficacy, student engagement and academic achievement. Hence the methodology selected is the experimental one. In the present investigation, the researcher has used the pre-test post-test non-equivalent groups design as follows :

O_1 X O_2, O_3 C O_4

Where,

O1 & O3 : Pre-test Scores

O2 & O4 : Post-test Scores

X : Experimental Group

C : Control Group

Intervention Programme : In the present research, the researcher developed two instructional programmes based on (a) Co-operative Learning Model and (b) Conventional Lecture Method on chapters on linear equations in two variables, graphs, ratio and statistics was developed. The techniques used under Co-operative Learning Model in the present investigation included Jigsaw Technique and Think-Pair-Share. The researcher obtained permission from two selected schools for administering the tests and administering the treatment. The researcher first administered the pre-test on Students' Conceptions of Mathematics, Mathematics Self-Efficacy Scale, Student Engagement in Mathematics Scale and Academic Achievement Test to both, the experimental and control groups. After the pre-test, the experimental group was taught using the Co-operative Learning Model and the control group was taught using traditional lecture method. At the end of this, the post-test on Students' Conceptions of Mathematics, Mathematics Self-Efficacy Scale, Student Engagement in Mathematics Scale and Academic Achievement Test were administered to students and scores were analysed by using statistical techniques. The researcher has used this design as it was the most feasible one and the interpretation of the results has been cautiously done. The students of standard IX of both the schools were taught selected topics in Mathematics subject. The content matter covered in both the schools was the same. The treatment was given on the basis of content from the text books prescribed by Maharashtra state text book production and curriculum research, Pune. In the experimental group, the researcher taught the content matter using the Co-operative Learning Approach. Twenty-two periods from the school time table were taken up to teach the content in each school. It was spread over twelve working days. Five days per week were taken up for three weeks, teaching one to two school periods a day of thirty-five minutes' duration each. In the control group, the researcher taught using the traditional lecture method. The content was taught in both the schools in the mornings.

Sample

In the present research, the sample selected consisted of 159 students including boys and girls from standard IX of English medium schools situated in Greater Mumbai. The experimental group consisted of 78 students with 42 boys (53.85 %) and 36 girls (46.15 %). The control group consisted of 81 students with 40 boys (49.38 %) and 41 girls (50.62 %). The schools selected for the study were affiliated to the SSC Board, Mumbai with English as the medium of instruction. The schools were selected randomly using lottery method. However, the experiment was conducted on intact classes due to reasons beyond the researcher's control.

Tools

1. Students' Conceptions of Mathematics Scale (2015) : This scale developed by the researcher consists of 20 items, 10 each measuring Fragmented and Cohesive Conceptions of Mathematics. Its reliability was 0.91 (Cronbach's Alpha) and 0.86 (Test-Retest Reliability). All items were measured on a 4-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). Here, a positive score implies Cohesive Conception of Mathematics whereas a negative score implies Fragmented Conception of Mathematics.

2. Mathematics Self-Efficacy Scale (2015) : This scale developed by the researcher consists of two parts. In the first part, general beliefs of students about their confidence in learning mathematics are measured using 15 items. In the second part, a student's confidence about using mathematics in daily life using 10 items is measured. Its reliability was found to be 0.90 (Cronbach's Alpha) and 0.81 (Test-Retest). All items in Part I were measured on a 4-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = agree, 4 = strongly agree). In Part II, items were measured on a 4-point Likert-type scale (1 = very confident, 2 = confident, 3 = somewhat confident and 4 = not at all confident).

3. Student Engagement in Mathematics Scale (Kong, Wong and Lam, 2003) : It consists of three dimensions, namely, Cognitive Engagement (Surface Strategy, Deep Strategy and Reliance), Affective Engagement (Interest, Achievement Orientation, Anxiety and Frustration) and Behavioural Engagement (Attentiveness and Diligence). It contains 21, 22 and 12 items respectively to measure Cognitive Engagement, Affective Engagement and Behavioural Engagement (total 55 items). Its reliability was found to be 0.89 (Cronbach's Alpha) and 0.81 (Test-Retest Reliability). All items were measured on a 5-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

4. Academic Achievement Test Test in Mathematics : This is a researcher-made test consisting of total 40 marks and covering topics included in the intervention (instructional) programme. There are two parallel form tests, Form A for the Pre-Test and Form B for the Post-Test. This was developed on the basis of a blue-print developed by the researcher.

Techniques of Data Analysis

The present research used statistical techniques of multiple correlation coefficient and Cohen's formula of effect size.

Data Analysis

1. **Research Hypothesis H_1**: There is a significant combined relationship of students' conception of mathematics, mathematics self-efficacy and total student engagement of their academic achievement in mathematics in (a) control group and (b) experimental group.

   Null Hypothesis H_{01} : There is a significant combined relationship of students' conception of mathematics, mathematics self-efficacy and total student engagement of their academic achievement in mathematics in (a) control group and (b) experimental group.

   In order to test this hypothesis, the statistical technique of multiple regression correlation was used wherein, multiple correlation coefficient was computed of Academic Achievement in Mathematics (AAM) on students' Conceptions of Mathematics (COM), Mathematics Self-Efficacy (MSE) and Student Engagement in Mathematics (SEM) twice, once for students in the control group (CG) and once for students in the experimental group (EG).

Multiple Correlation of AAM with COM, MSE and SEM for students of CG

Here, the variable AAM is denoted by 4, variable COM is denoted by 1, variable MSE is denoted by 2 and variable SEM is denoted by 3.

Table 1 shows the matrix of correlation of AAM with COM, MSE and SEM for students of CG.

Table 1 : Matrix Of Correlation Of Aam With Com, Mse And Sem For Students Of Cg

	COM (1)	MSE (2)	SEM (3)	AAM (4)
COM (1)	1.00	0.2508	0.1967	0.2910
MSE (2)	0.2508	1.00	0.2631	0.3129
SEM (3)	0.1967	0.2631	1.00	0.3303

The Issue of Multi-Collinearity : The extent of multi-collinearity was computed using the following two methods :

a) The determinant of $'XX$ can be used as an index of multi-collinearity. Since the matrix is in correlation form, the possible range of values of the determinant is $0 \leq |'XX| \leq 1$. If $|'XX| = 1$, the regressors are orthogonal, while if $|'XX| = 0$, there is an exact linear dependence among the regressors. The degree of the multi-collinearity becomes more severe as $|'XX|$ approaches zero (Paul, 2012). In the present case, $|'XX| = 0.8467133961272777$. This implies that the magnitude of partial multi-collinearity is very low and within tolerable limits.

Table 2 shows Variance Inflation Factors (VIF) for the independent variables included in the study :

Table 2 : Magnitude Of Vif For Cg

No.	Variable	VIF
1	COM-MSE	2.023
2	COM-TSE	2.09
3	MSE-TSE	1.037
	Mean VIF	**1.717**

Since the individual VIF as well as Mean VIF < 10, the extent of multi-collinearity is much below the permissible limit (Jeeshim and KUCC, 2002). Hence it may be concluded that the multi-collinearity is not statistically significant.

Before proceeding further, Mardia's Multivariate Normality Test was computed which showed that (a) g1p = 0.09314, chi.skew = 0.7656 and p.value.skew = 0.8941, (b) g2p = 8.0421, z.kurtosis = 0.08761 and p.value.kurt = 0.8765 and (c) chi.small.skew : 0.8631 and p.value.small : 0.9147. This implies that the data are multivariate normal.

This is shown mathematically as follows : AAM = f (COM, MSE, SEM)

This implies that AAM is a function of COM, MSE and SEM.

The relationship of AAM (4) with COM (1), MSE (2) and SEM (3) in the CG is shown statistically through the multiple regression equation as follows :

$$R_{4.123}^2 = \beta_{41.23}r_{14} + \beta_{42.13}r_{24} + \beta_{43.12}r_{34}$$

The following are the statistics obtained from the data :

Multiple Correlation of AAM with COM, MSE and SEM :

$R_{4.123}^2 = 0.3209$ (P<0.0001) and $R_{4.123} = 0.5665$

$$R^2_{4.123} = 0.0719 \; + 0.1028 + 0.1462 = 0.3209$$

This is followed by testing the significance of the β coefficients obtained in the preceding multiple regression equation as follows in table 3.

Table 3: Significance Of B Coefficients For Aam In Cg

Variable	Standardised Regression Weight	Magnitude	t	LoS
COM	$\beta_{14.23}$	0.2471	3.02	0.01
MSE	$\beta_{24.13}$	0.3285	4.12	0.01
SEM	$\beta_{34.12}$	0.4426	6.89	0.01

The research hypothesis is accepted at P<0.0001. In other words, there is a significant combined relationship of academic achievement of students with their conception of mathematics, mathematics self-efficacy and student engagement in CG.

It may be seen that 7.19%, 10.28% and 14.62% of the variance in AAM is explained by COM, MSE and SEM respectively. Overall, 32.09% of the variance in AAM is explained by these three variables taken together in CG.

Multiple Correlation of AAM with COM, MSE and SEM for students of EG

Table 4 shows the matrix of correlation of AAM with COM, MSE and SEM for students of EG.

Here, the variable AAM is denoted by 4, variable COM is denoted by 1, variable MSE is denoted by 2 and variable SEM is denoted by 3.

Table 4 : Matrix Of Correlation Of Aam With Com, Mse And Sem For Students Of Eg

	COM (1)	MSE (2)	SEM (3)	AAM (4)
COM (1)	1.00	0.3412	0.3965	0.3115
MSE (2)	0.3412	1.00	0.4298	0.4784
SEM (3)	0.3965	0.4298	1.00	0.5961

In the present case, |'XX| = 0.8941267395906819. This implies that the magnitude of partial multi-collinearity is very low and within tolerable limits. Table 5 shows Variance Inflation Factors (VIF) for the independent variables included in the study :

Table 5 : Magnitude Of Vif For Eg

No.	Variable	VIF
1	COM-MSE	1.95
2	COM-TSE	1.03
3	MSE-TSE	1.47
	Mean VIF	**1.483**

Since the individual VIF as well as Mean VIF < 10, the extent of multi-collinearity is much below the permissible limit (Jeeshim and KUCC, 2002). Hence it may be concluded that the multi-collinearity is not statistically significant.

Before proceeding further, Mardia's Multivariate Normality Test was computed which showed that (a) g1p = 0.0851, chi.skew = 0.8645 and p.value.skew = 0.9256, (b) g2p = 8.0564, z.kurtosis = 0.08764 and p.value.kurt = 0.8933 and (c) chi.small.skew : 0.8764 and p.value.small : 0.8764. This implies that the data are multivariate normal.

The relationship of AAM (4) with COM (1), MSE (2) and SEM (3) in the EG is shown statistically through the multiple regression equation as follows :

$$R^2_{4.123} = \beta_{41.23}r_{14} + \beta_{42.13}r_{24} + \beta_{43.12}r_{34}$$

The following are the statistics obtained from the data :

Multiple Correlation of AAM with COM, MSE and SEM :

$R^2_{4.123} = 0.5963$ (P<0.0001) and $R_{4.123} = 0.7722$

$R^2_{4.123} = 0.1123 + 0.1946 + 0.2894 = 0.5963$

This is followed by testing the significance of the β coefficients obtained in the preceding multiple regression equation as follows in table 6.

Table 6 : Significance Of B Coefficients For Aam In Eg

Variable	Standardised Regression Weight	Magnitude	t	LoS
COM	$\beta_{14.23}$	0.3605	3.02	0.01
MSE	$\beta_{24.13}$	0.4068	4.12	0.01
SEM	$\beta_{34.12}$	0.4855	6.89	0.01

The research hypothesis is accepted at P<0.0001. In other words, there is a significant combined relationship of academic achievement of students with their conception of mathematics, mathematics self-efficacy and total student engagement in EG.

It may be seen that 11.23%, 19.46% and 28.94% of the variance in AAM is explained by COM, MSE and SEM respectively. Overall, 59.63% of the variance in AAM is explained by these three variables taken together in EG.

Table 7 shows a comparison of the contribution of COM, MSE and SEM to AAM in CG and EG.

Table 7 : Contribution Of Com, Mse And Sem To Aam In Cg And Eg

VARIABLE	CG	EG
COM	7.19%	11.23%
MSE	10.28%	19.46%
SEM	14.62%	28.94%
Total 100R^2	**32.09%**	**59.63%**

Formula of Cohen's Effect Size in Multiple Correlation

(http://www.real-statistics.com/multiple-regression/statistical-power-sample-size-multiple-regression/):

$$f^2 = \frac{R^2}{1 - R^2}$$

$f^2 = 0.02$ represents a small effect, $f^2 = 0.15$ represents a medium effect and $f^2 = 0.35$ represents a large effect.

Table 8 shows comparison of the effect size of the multiple correlation in CG and EG.

Table 8 : Comparison Of The Effect Size Of Multiple Correlation In Cg And Eg

Group	Effect Size	Magnitude
CG	0.1516	Medium Effect
EG	1.4771	Large Effect

It can be seen from table 8 that in the traditional teaching group (control group), the effect size of COM, MSE and SEM is medium whereas in the co-operative learning group (experimental group), the effect size of COM, MSE and SEM is large.

Conclusion : It can be seen from the preceding analysis that :

a. The contribution of conception of mathematics to AAM is the lowest followed by MSE and SEM in that order in both CG and EG.

b. The contribution of COM, MSE and SEM to AAM is lower in the control group as compared to that in the experimental group.

c. The contribution of MSE and SEM to AAM has doubled in the experimental group as compared to the control group.

d. Co-operative learning group enhances the effect of COM, MSE and SEM on the academic achievement of students.

e. The effect of students' conceptions of mathematics, mathematical self-efficacy and student engagement in mathematics on their academic achievement is large in the experimental group with co-operative learning approach and moderate in the control group taught by the traditional method.

Discussion : It can be seen from the conclusion that the contribution of MSE and SEM to AAM has doubled in the experimental group as compared to the control group. This implies that due to co-operative learning approach, students' mathematics self-efficacy and student engagement are influenced which in turn influences their academic achievement of students. In other words, students' mathematics self-efficacy and total student engagement mediate the relationship between co-operative learning approach and academic achievement of students.

A study by Crawford et al (1994) found in their study that a large majority of students (91%) with fragmented conception of mathematics follow surface approach to learning mathematics whereas a large majority of students (90%) with cohesive conception of mathematics follow deep approach to learning mathematics. They further found that (a) students with a cohesive conception of math tended to achieve at a higher level ($p < .05$) and (b) students with a deep approach to learning math tended to achieve at a higher level ($p < .01$). The present study has found that co-operative learning approach enhances students' cohesive conception of mathematics. This in turn implies that these students would follow a deep approach to learning mathematics leading to better academic achievement.

When students are exposed to co-operative learning approach in the class, they get social and academic support from their peers. This is expected to strengthen their mathematics self-efficacy beliefs. On the other hand, students exposed to traditional teaching of mathematics may have a feeling of inadequacy in comparison with peers which is likely to undermine their mathematics self-efficacy beliefs.

Linnenbrink and Pintrich (2003) opine that behavioural engagement is the observable behaviour seen in the classroom. This involves the efforts put in by students into mathematical tasks and how students interact with their peers the teacher in terms of their readiness to seek help, attend the classes and so on. Higher self-efficacy is expected to boost perseverance while handling difficult mathematical concepts and problems. On the other hand, lower self-efficacy leads to feelings of helplessness and an early acceptance of failure. Moreover, students with low self-efficacy are less likely to seek help from peers as they fear that others will interpret their difficulty as foolishness or ignorance. Co-operative learning reduces such feelings of foolishness or ignorance in the students through positive interdependence among students and thus students' behavioural engagement is enhanced. Besides, the way that co-operative learning sessions are structured and how the peers and teacher interact with students is significant in cognitive engagement of students. Strong self-efficacy beliefs imply that student believes that they can complete a task. A student with a strong self-efficacy is likely to engage with appropriate cognitive strategies in order to

complete it. Students who doubt their ability to undertake and complete a task are less likely to persevere in applying cognitive and meta-cognitive strategies and will become disengaged if success is not immediate. In addition, affective engagement includes the personal interest that the student has in the mathematics, the utility that the student feels the subject brings and the general importance of mathematical knowledge and skills to longer term goals or desires and hence is motivated to engage in learning.

Regarding student engagement, Ganotice and King (2014) in their study on social influences on students' academic engagement and science achievement found that peer support seemed to be more salient compared to parental and teacher support in enhancing student engagement. Co-operative learning provides ample social and academic peer support. Hence, student engagement in co-operative learning is found to be higher as compared to students from the traditional class. Besides, engagement leads to sustained interaction and practice (Ervin, Meltzer and Dukes, 2007). Social involvement is a source of influence on learning and intellectual development of students (Pascarella, 1985; Pike, 1999; Pike, Kuh & Gonyea, 2003). This in turn leads to stronger influence academic achievement of students in the co-operative learning group as compared to those in the control group.

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