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INTERACTION EFFECT OF CO-OPERATIVE LEARNING MODEL AND STUDENTS' IMPLICIT THEORY OF INTELLIGENCE ON STUDENTS' CONCEPTIONS OF MATHEMATICS

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ABSTRACT

The study seeks to ascertain whether co-operative learning model is equally effective in enhancingstudents' conceptions of mathematics amongstudents with high and low levels of Implicit Self Theory. The experiment was conducted on 159 students of standard IX studying in schools affiliated to the SSC Board and with English as the medium of instruction. It has used two tools, namely, Conceptions of Mathematics Scale and Implicit Theory of Intelligence Scale. It was found that in the experimental group taught by co-operative learning, students' conception of mathematics is Cohesive for students with high and low scores on Implicit Theory of Intelligence. It implies that the co-operative learning model is equally effectivein enhancing students' conceptions of mathematics among students with high as well as low levels of implicit theory of intelligence. On the other hand, in the traditional teaching class,students' conception of mathematics was fragmented for students with high and low score on implicit theory of intelligence. Besides, it was found that the effect of the co-operative learning model on students' conceptions of mathematics ishigh. The effect of students' implicit theories of intelligence had a moderate effect on their conceptions of mathematics.

KEYWORDS :*Co-operative Learning, Implicit Theory of Intelligence, Students' Conceptions of Mathematics, Mathematics.*

Co-operative Learning in Classrooms : Commencing in the late 1970s, research by Webb (1980) on group processes in classrooms andtheir effects initiated to offersubstantiation of their worth. Webb (1991) revealed, for example, that students inclined to help one another when they worked together on small group activities;intellectually able students deepened their learning by explaining concepts to peers in need ofsupport, redefining what is meant by self regulated learning. Lower achieving students benefited from the explanations provided by able peers, as well as from students whodisplayed good work habits. The subsequent generation of research on co-operative learning and many classroom interventions was theory-driven which supported these early findings. The earlier findings focused on intellectual ability of students.Today, co-operative learning is the structured, systematic instructional technique in which small groups work together to achieve a common goal (Slavin, 1991). Co-

operative learning strategies employ many of the following characteristics and strategies in the classroom: positive interdependence with structured goals, face-to-face interaction, individual accountability, heterogeneous ability grouping, social skills, sharing of leadership roles and group processing. It is found to influence a large number of cognitive as well as affective student-outcomes such as academic achievement (Tunga, 2015; Jebson, 2012; Dheeraj & Rimakumari, 2013; Russo, 2014; Swab, 2012; Parveen & Batool, 2012; Gull & Shehzad, 2015), understanding of the mathematical concepts, students' attitudes toward the subject and their academic competencies (Altamira, 2013), mathematics achievement and attitudes towards mathematics (Zakaria, Chin & Daud, 2010; Hossain & Tarmizi, 2013; Grech,2013), students' active involvement (Cheng, 2011), achievement in science classrooms (Jayapraba, 2013; Altun, 2015), students' approaches to learning with learning styles as a mediating variable (Colak, 2015), student engagement (Herrmann, 2013),academic success, lesson attitude and practicing skills (Bayraktar, 2011), need for cognition (Dee Castle, 2014), retention level of students (Chianson, Kurumeh and Obida, 2010; Tran, 2014), self-regulated learning (Güvenç, 2010) andinterest in and the application of music into core academic subjects (Egger, 2014). Besides, research has also been conducted onteachers' and students' perceptions towards co-operative learning(Xuan, 2015), effects of co-operative learning and embedded multimedia on mathematics learning (Slavin, Sheard, Hanley, Elliott&Cheung, 2013), learning style as a grouping technique (Bachmann, 2010), the effect of metacognitive scaffolding embedded within co-operative learning on mathematics conceptual understanding and procedural fluency in learning and solving problems (Jbeili, 2012; Vijayakumari & D'Souza, 2013; Cheong, 2010), Teachers' reflections on co-operative learning (Gillies&Boyle, 2010), co-operative learning in distance learning (Kupczynski, Mundy, Goswami & Meling, 2012) and classroom participation of students placed at risk for societal failure (Drakeford, 2012). A large majority of these studies deal with academic achievement of students. Very little work has been done on the effects of co-operative learning on students' conceptions of mathematics.

The other variable of interest to the researcher is student's implicit theory of intelligence.

Implicit Theories of Intelligence : There are two frameworks in this model. Students may hold different ''theories'' about the nature of intelligence. Some believe that intelligence is more of an unalterable, fixed ''entity'' (an entity theory). Others think of intelligence as a flexiblefeature that can be developed (an incremental theory). When a student holds an entity theory of his/her intelligence, he/she tends to orient more toward performance goals, the goal of gaining favourable judgments of his/her attributes and avoiding negative ones, becomes concerned with demonstrating that he/she has a sufficient amount of it and with avoiding a demonstration of deficiencies. He/she may explain negative performance more in terms of their lack of ability than effort, which would render him/her susceptible to helpless reactions in the face of failure. On the other hand, when a student holds an incremental theory of his/her intelligence, he/she tends to orient more toward learning goals, the goal of increasing his/her ability. Such a student may focus on effort that can be capitalised for enhancing his/her ability. In situations of failures, he/she may be more mastery-oriented, looking for ways to improve his/her ability and performance, such as employing more effort or engaging in remedial activities. Research has shown that, even when students on both ends of the continuum show equal intellectual ability, their theories of intelligence shape their responses to academic challenge. Compared to entity theorists, incremental theorists have been found (a) to focus more on learning goals (goals aimed at increasing their ability) versus performance goals (goals aimed at documenting their ability (Dweck & Leggett, 1988); (b) to believe in the utility of effort versus the futility of effort given difficulty or low ability (Hong,

Chiu, Dweck, Lin, & Wan, 1999); (c) to make low-effort, mastery-oriented versus low-ability, helpless attributions for failure (Henderson & Dweck, 1990); and (d) to display mastery-oriented strategies (effort escalation or strategy change) versus helpless strategies (effort withdrawal or strategy perseveration) in the face of setbacks (Robins & Pals, 2002). Researchers have assessed the consequences of these two different frameworks for student outcomes (Hong et al., 1999; Robins & Pals, 2002; Stipek & Gralinski, 1996). In a study of students undergoing a junior high school transition, Henderson and Dweck (1990) found that students who endorsed more of an incremental view had a distinct advantage over those who endorsed more of an entity view, earning significantly higher grades in the first year of junior high school, controlling for prior achievement. Blackwell, Trzesniewski & Dweck (2007) found that the belief that intelligence is malleable (incremental theory) predicted an upward trajectory in grades in mathematics over the two years of junior high school, while a belief that intelligence is fixed (entity theory) predicted a flat trajectory.An intervention teaching an incremental theory to 7th graders (N=48) promoted positive change in classroom motivation.

Students' Conceptions of Mathematics : Mathematics is at the heart of many successful careers and successful lives for societal development, particularly in the extraordinary and accelerating change circumstances. However, in reality, most people in general and students in particular dislike mathematics. Mathematics has an open picture of being a troublesome subject, available just to the few. Learners who do well in arithmetic are commonly stereotyped as "bores". It is viewed as a dry and exhausting subject. The negative originations of science majorly affect understudies' accomplishment, enrolment in advanced education and their future vocation choices (Sam, 1999). For the most part, understudies' perspectives of science are created in view of their school learning encounters (Schoenfeld, 1989; Ernest, 1996) and how people in general picture of arithmetic is depicted in the general public (Sam, 1999). To expand, when all is said in done it is trusted that guys are conceived with intrinsic capacities of understanding theoretical thoughts and as science is additionally a unique level subject young men can do well when contrasted with young ladies (Walkerdine, 1998, Halai, 2006). A portion of alternate perspectives understudies hold about arithmetic include: science issues have one and just a single answer and they can be settled especially; science is a singular movement, done by people in disconnection; science requires great memory and is just for astute ones. Thompson (1992) alludes to originations as mental structures that incorporate convictions, ideas, implications, recommendations, mental pictures and other. Oaks (1994) depicts originations as perspectives that understudies hold of science and what they accept is required in learning and doing arithmetic. Andrews and Hatch (2000) propose that the writing on originations is not clear on the grounds that distinctive scientists offer alternate points of view on originations regarding having intellectual as well as emotional measurements. Damon (2005) portrays miens as qualities or characters that lead a man to take after specific decisions or encounters. Leatham (2006) alludes to "originations" as cognizant or subliminal convictions, understanding, which means, mental pictures, and inclinations. In view of these definitions, the working meaning of these terms for the study is that 'originations are cognizant and oblivious subjective and full of feeling convictions, individual importance, mental pictures and inclinations built from encounters inside and beyond schooling.

Mathematics may be categorised as fragmented and cohesive. Fragmented conceptions are those in which the subject matter is perceived as consisting of numbers, rules and formulae. In these descriptions, students focus on parts of mathematics rather than the whole subject. Besides, students holding fragmented conceptions relied more on algorithms to solve problems. Cohesive conceptions, on the other hand, are about describing mathematics as a complex logical system that is used to

understand real-life contexts and situations related to the subject. In cohesive conceptions, the subject matter is perceived as a logical system that provides insight into the complexities of everyday situations. Crawford et al. (1998) indicate that (1) fragmented conceptions are associated with learning where the attention and activities centre on reproducing knowledge and (2) cohesive conceptions are associated with learning in which a more global and personal perspective is adopted in an attempt to construct one's own understanding. It is evident from these explanations that students who hold cohesive conceptions are expected tosucceed in situations where higher order learning skills and good outcomes are encouraged. This suggests that it is important to encourage cohesive conceptions, in order to promote higher order learning skills, for improving the learning and teaching of mathematics.

NEED OF THE STUDY

Very little prior work on co-operative learning has focused on students' conception of mathematics. Students'conception of mathematicsis seen as vital due to its association with achievement. Besides, it is imperative to understand whether a student's implicit theory of intelligence interacts with co-operative learning and influences students'conception of mathematics. Thus, it is expected to enhance students' conceptions of mathematics with incremental theory of intelligence. Prior research has found that co-operative learning enhance students' attitude towards learning. Besides, peer support in co-operative learning is expected to create an environment which nurtures students with an entity belief in intelligence. On the other hand, in the Indian context co-operative learning model was found to be more effective for students with mastery goals (which are a part of incremental theory of intelligence) whereas the traditional lecture method is found to be more effective for students with performance goals (which are a part of entity theory of intelligence) (Pandya, 2011). Thus, there is a gap in knowledge concerning the interaction effect of students' implicit theory of intelligence and co-operative learning on students' conceptions of mathematics. This forms the basis of the present research.

If the co-operative learning model is effective, the question arises as to what mediatingvariables are responsible for this effectiveness. The present study hypothesises that the co-operativelearning model will have differential effectiveness for students with different levels of implicit self theory of intelligence on students' conceptions of mathematics. Incomparison to direct instruction, there will also be a better chance to feel autonomous because students have more flexibility in structuring the learning process. However, for autonomy in learning to be effective, it is essential that one's implicit self theory of intelligence suits the techniques and methods ofteaching-learning. Besides, the co-operative learning model is hypothesised to have particularadvantages as to the need for competence : the student's experience of responsibility for a segmentof the material and of acting as an expert source for other students is conceived to give the student an experience of feelings of competence that is uncommon in conventional forms of instruction.

Aim of the Study : The broad aim of the research was to study the effects of co-operative learning model andimplicit self theory of intelligence of students on their conceptions of mathematics.

RESEARCH QUESTIONS

1.Do the experimental and control groups' post-test scores on students' conceptions of mathematics differ when their pre-test scores are controlled?

2.What are the effects of co-operative learning model,implicit theories of intelligence and their interaction on students' conceptions of mathematics?

3.What are the effect sizes of co-operative learning model, implicit theories of intelligence and their interaction on students' conceptions of mathematics?

METHOD

The present study is aimed at enhancing conceptions of mathematicsof secondary students through the use of Co-operative Learning Model. The researcher attempts to provide answer to thequestion, "Is there an interaction effect of Co-operative Learning Model and the Implicit Theory of Intelligence on students' conceptions of mathematics?" The researcher has manipulated the method of teaching to ascertain its effect on students' conceptions of mathematics.Hence the methodology selected is the experimental one. In the present investigation, the researcher has used the 2×2 factorial design as follows :

Group / Level of Implicit Theory of Intelligence	Experimental Group	Control Group
Low Implicit Theory of Intelligence (Entity Theory)	Adjusted Mean Students' Conceptions of Mathematics Score	Adjusted Mean Students' Conceptions of Mathematics Score
High Implicit Theory of Intelligence (Incremental Theory)	Adjusted Mean Students' Conceptions of Mathematics Score	Adjusted Mean Students' Conceptions of Mathematics Score

Here, Adjusted Mean Students' Conceptions of Mathematics Score is one in which the effect of pre-test has been removed from the post-test.

Intervention Programme: In the present research, the researcher developed twoinstructional programmes based on (a) Co-operative Learning Model and (b) Conventional Lecture Method. In the present research,instructional programme on chapters on linear equations in two variables, graphs, ratio and statistics wasdeveloped. 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 andadministering the treatment. The researcher first administered the pre-test on Students' Conceptions of Mathematics and the Implicit Theory of Intelligence Scale to both, the experimental and control groups. After the pre-test, the experimental groupwas taught using the Co-operative Learning Model and the control group was taught usingtraditional lecture method. At the end of this, the post-test on Students' Conceptions of Mathematicswas administered on the students andscores were analysed by using statistical techniques. The researcher has used this design as it wasthe 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 basisof 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 theCo-operative Learning Model. Twenty two periods from the school time table were taken up to teachthe content in each school. It was spread over twelve working days. Five days per week were takenup for three weeks, teaching one to two school periods a day of thirty five minutes duration each. Inthe control group, the researcher taught using the traditional lecture method. The content was taughtin both the schools in the mornings.

Participants

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

Measures

1. Students' Conceptions of Mathematics Scale : This scale was developed by the researcher in 2015. It consists of twenty items, 10 each measuring Fragmented and Cohesive Conceptions of Mathematics. Its reliability and validity were established in the Indian context during a pre-pilot study (Cronbach's Alpha = 0.91 and Test-Retest Reliability = 0.86).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.Implicit Theories of Intelligence (Self-Theory) : This scale was developed by De Castella & Byrne (2015). It consists of two subscales, namely, Entity Self Beliefs Subscale and Incremental Self Beliefs Subscale with a total eight items.Its reliability and validity were established in the Indian context. Its reliability and validity were established in the Indian context during a pre-pilot study (Cronbach's Alpha = 0.87 and Test-Retest Reliability = 0.82). All items were measured on a 5-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree). The scoring is done in such a way that a high score implies incremental theory of intelligence whereas a low score implies entity theory of intelligence.

TECHNIQUES OF DATA ANALYSIS

The present research used statistical techniques of two-wayANCOVA and wolf's formula. To compare the post-test score on students' conceptions of mathematics after partialling out the effect of pre-test scores by levels of implicit theory of intelligence, the technique of two-way ANCOVA was used. Wolf's formula was used to measure the extent of effectiveness of the Co-operative Learning Model and Implicit Theory of Intelligence on the dependent variable, namely, Students' Conceptions of Mathematics.

RESULTS

1.Comparison of Students' Conceptions of MathematicsScores by Intervention and Implicit Theory of Intelligence

Table 1 shows Students' Conceptions of Mathematics Scores (Adjusted for Pre-Test Scores) by Intervention and Implicit Theory of Intelligence.

Table 1 : Students' Conceptions of Mathematics Scores (Adjusted) by Intervention and Implicit Theory of Intelligence

	EG	CG	Total
Entity Theory	10.98	-9.58	3.17
Incremental Theory	18.56	-4.43	13.36
Total	17.51	-3.24	

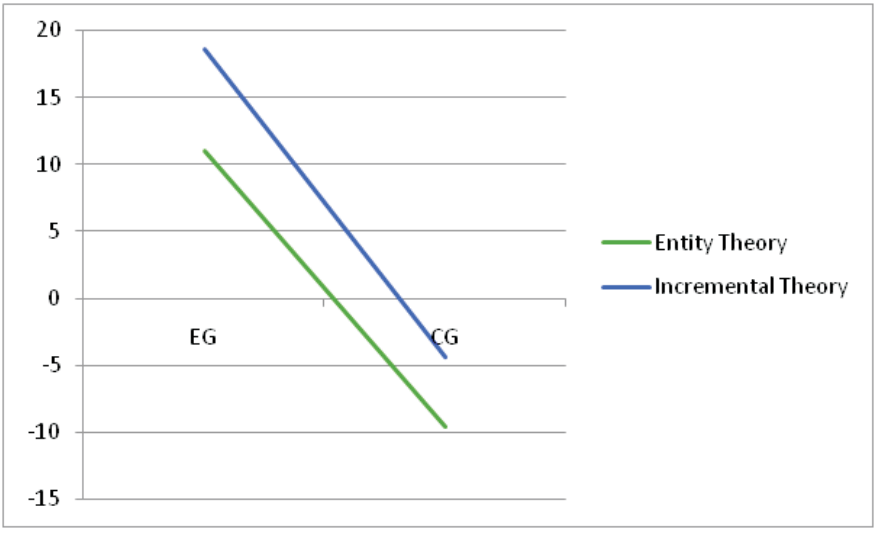
a)When the technique of two-way ANCOVA was applied to compare the post-test scores on Students' Conceptions of Mathematicsafter partialling out the effect of pre-test scores, the F-ratio for intervention effect was found to be Fy.x = 22.07 ($p < 0.0001$). This F-ratio is therefore significant. The Mean post-test score on Students' Conceptions of Mathematicsfrom the experimental group (My.x = 17.51) was found to be significantly greater than that of the control group (My.x = -3.24) (after controlling for the pre-test scores using ANCOVA.

b)The F-ratio for implicit theory of intelligence effect was found to be Fy.x = 31.64 ($p < 0.00028$). This F-ratio is therefore significant. The Mean post-test score on Conceptions of Mathematics of students with high score on implicit theory of intelligence (My.x = 13.36) was found to be significantly greater than that of students with a low score on implicit theory of intelligence (My.x =3.17) (after controlling for the pre-test scores using ANCOVA.i.e. students with incremental theory of intelligence had a higher score on Cohesive Conceptions of Mathematicsthan the students with entity theory of intelligence.

c)The F-ratio for interaction effect was found to be Fy.x = 2.12 ($p = 0.71$). This F-ratio is therefore not significant. Besides, in both the groups, the mean Conceptions of Mathematics of students with a high score on implicit theory of intelligence was significantly greater than that the students with a low score on implicit theory of intelligence.

d)This implies that co-operative learning is found to be more effective in enhancing Conceptions of Mathematicsfor students with entity as well as incremental theories of intelligence as compared to the traditional method of teaching.

The interaction effect of the intervention programme and the implicit theory of intelligence on students' conceptions of mathematics is shown in the following figure.



2. Computation of the Magnitude of the Effect Size Using Wolf's Formula

Table 2 : Effect Size

	Intervention Effect		Implicit Theory of Intelligence Effect	
	Effect Size	Magnitude	Effect Size	Magnitude
Conceptions of Mathematics	2.19	High	0.50	Moderate

CONCLUSIONS

It may be concluded that:

- The co-operative learning model is effective in enhancing Conceptions of Mathematicsof students.
- The effect size of the co-operative learning model on Conceptions of Mathematics of students is high.
- The implicit theory of intelligence has a significant effect on Conceptions of Mathematics of students.
- The effect size of the implicit theory of intelligence on Conceptions of Mathematics of students is moderate.
- There is no significant interaction effect of co-operative learning model and implicit theory of intelligence on Conceptions of Mathematicsof students.
- As compared to the traditional method of teaching, the co-operative learning is found to be more effective in enhancing Conceptions of Mathematics for students with entity and incremental theory of intelligence.
- The Conceptions of Mathematics of students from the experimental group is Cohesive whereas that of students from the control group is Fragmented.
- In the experimental group, the mean Conceptions of Mathematics of students was Cohesive whereas in the control group, it was Fragmented.

DISCUSSION

The findings show that if a student (with incremental theory of intelligence) focuses on effort that can be capitalised for enhancing his/her ability, he/she may be more mastery-oriented, looking for ways to improve his/her ability and performance, such as employing more effort or engaging in remedial activities. Such a student will benefit more from co-operative learning. Besides, co-operative learning is therefore found to develop in students a belief that by using mathematics we can generate new knowledge, mathematics is a set of logical systems which have been developed to explain the world and relationships in it, mathematics provides an insight into the complexities of our reality, it is a theoretical framework describing reality with the aim of helping us understand the world, it is like a universal language which allows people to communicate and understand the universe, uses logical structures to solve and explain real life problems, is concerned with formulae and applying them to everyday life and situations, is logical system which helps explain the things around us, is models which have been devised over years to help explain, answer and investigate matters in the world and is a dynamic discipline, constantly changing as a result of new discoveries from experimentation and application. In other words, co-operative learning is expected to develop a deep approach to learning mathematics in students.

This present study contributed to an understanding of how Co-operative Learning Modelcould be used effectively for teaching of Mathematics to students with entity and incremental theory of intelligence with the objective of enhancing their Conceptions of Mathematics. The present study's

findings are partially supported by Gocłowska et al. (2015) who found that entity theory was negatively and incremental theory was positivelyrelated toco-operative preferences.

One of the reasons for the intervention programme being more effective for incremental learners as compared to the entity learners is that failure can motivate incremental learners to try harder, but can undermine entity learners, destroying their fragile self-belief. This is corroborated by findings of Shih (2011) which state that the incremental theory of intelligence predicted positive affect and constructive coping. By contrast, the entity theory was positively correlated with negative emotions and self-handicapping. Besides, teaching through co-operative learning model helps students to get social support of peers. This is expected to enhance Conceptions of Mathematics amongst students taught through co-operative learning and make it more cohesive.Students who are taught through co-operative learning model, on account of higher academic and social interaction and support are likely to relish a challenge and persevere in the face of setbacks.

As teacher education institutions in India advocate constructivist approach to teaching-learningprocess, of which, co-operative learning is an important part, it is imperative that nurturing incremental theory of intelligence amongst students emerges as a significant theme to highlight. However, it is necessary to understand the role of teacher efficacy in the use of co-operative learning and enhancing incremental theory of intelligence amongst students so as to enhance cohesive conceptions of mathematics in students and develop a deep approach to learning mathematics.

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