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Interaction Effect of Co-Operative Learning Model and Students' Implicit Theory of Intelligence on Students' Mathematics Self Efficacy

Introduction

The study seeks to ascertain whether co-operative learning model is equally effective in enhancing students' Mathematics Self-Efficacy among students with incremental and entity theory of intelligence. 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, Mathematics Self-Efficacy Scale and Implicit Theory of Intelligence Scale. It was found that in the experimental group taught by co-operative learning, Mathematics Self-Efficacy is higher in students with incremental theory of intelligence as compared to those with entity theory of intelligence. However, the co-operative learning model is effective in enhancing students' Mathematics Self-Efficacy among students with incremental as well as entity theory of intelligence. On the other hand, in the traditional teaching class, Mathematics Self-Efficacy did not differ significantly among students with incremental and entity theory of intelligence. Besides, it was found that the effect of the co-operative learning model on students' Mathematics Self-Efficacy is high. The effect of students' implicit theories of intelligence had a high effect on their Mathematics Self-Efficacy.

Co-operative Learning in Classrooms

Co-operative learning is an efficacious teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to enhance their understanding of a subject. There are three fundamental ways students can interact with each other as they learn, namely, (a) they can *compete* to see who is "best", (b) they can work *individualistically* on their own toward a goal without paying attention to other students or (c) they can work *co-operatively* with a vested interest in each other's learning as well as their own. Of these three interaction patterns, competition is presently the most dominant in the Indian context. This sense of competition is already quite pervasive when students enter school and grows stronger as they progress through school. Over the past several years, different approaches to co-operative learning have been proposed by different individuals such as those of David Johnson and Roger Johnson (Johnson et al., 1994), Slavin (1994, 1995) and Shlomo Sharan and Yael Sharan (Sharan, 1995; Sharan & Sharan, 1994). Past

research has shown that co-operative learning has been effective in facilitating academic achievement of students. Commencing in the late 1970s, research by Webb (1980) on group processes in classrooms and their effects initiated to offer substantiation 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 of support, redefining what is meant by self regulated learning. Lower achieving students benefited from the explanations provided by able peers, as well as from students who displayed 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) and interest in and the application of music into core academic subjects (Egger, 2014). Besides, research has also been conducted on teachers' 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' Mathematics Self-Efficacy.

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 flexible feature 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.

Mathematics Self Efficacy

Self-efficacy refers to a learner's beliefs about his/her ability to realise certain tasks. In an academic context, self-efficacy reflects how confident students are in performing specific tasks. The documented prominence of self-efficacy in academic achievement has activated extensive interest in specific factors that affect a student's self-efficacy beliefs. Bandura's (1997) social-cognitive theory proposed that self-efficacy is most strongly affected by one's previous performance and research largely supports this (Chen & Zimmerman, 2007). His theory also suggests that self-efficacy is affected by observing others (e.g. watching peers succeed at a task), verbal persuasion (e.g. encouragement from parents and teachers), and interpretation of physiological states (e.g. lack of anxiety may be a signal that one possesses skills). According to Bandura (1997), individual's beliefs about his efficacy can be developed by four main sources of influence. These are mastery experiences (performance accomplishments), vicarious experiences, social persuasions and physiological factors. Self-efficacy predominantly regarding mathematics has been found to be related to mathematics achievement in western settings (Betz & Hackett, 1983; Pajares & Graham, 1999; Pajares & Schunk 2001; Zimmerman, 2000), however, very less is known how self-efficacy operates in non-western population, particularly in samples from developing countries.

Need of the Study

Very little prior work on co-operative learning has focused on students' mathematics self-efficacy. Students' mathematics self-efficacy is 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' mathematics self-efficacy. Thus, it is expected to enhance mathematics self-efficacy in students 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' mathematics self-efficacy. This forms the basis of the present research.

If the co-operative learning model is effective, the question arises as to what moderating variables are responsible for this effectiveness. The present study hypothesises that the co-operative learning model will have differential effectiveness for students with different levels of implicit self theory of intelligence on students' mathematics self-efficacy. In comparison 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 of teaching-learning. Besides, the co-operative learning model is hypothesised to have particular advantages as to the need for competence : the student's experience of responsibility for a segment of 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 and implicit self theory of intelligence of students on their mathematics self-efficacy.

Research Questions

1. Do the experimental and control groups' post-test scores on students' mathematics self-efficacy 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' mathematics self-efficacy?
3. What are the effect sizes of co-operative learning model, implicit theories of intelligence and their interaction on students' mathematics self-efficacy?

Method

The present study is aimed at enhancing mathematics self-efficacy of secondary students through the use of Co-operative Learning Model. The researcher attempts to provide answer to the question, "Is there an interaction effect of Co-operative Learning Model and the Implicit Theory of Intelligence on students' mathematics self-efficacy?" The researcher has manipulated the method of teaching to ascertain its effect on students' mathematics self-

efficacy. 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
Entity Theory	Adjusted Mean Students' Mathematics Self-Efficacy Score	Adjusted Mean Students' Mathematics Self-Efficacy Score
Incremental Theory	Adjusted Mean Students' Mathematics Self-Efficacy Score	Adjusted Mean Students' Mathematics Self-Efficacy Score

Here, Adjusted Mean Students' Mathematics Self-Efficacy 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 two instructional 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 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' Mathematics Self-Efficacy and the Implicit Theory of Intelligence Scale 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' Mathematics Self-Efficacy was administered on the 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 Model. 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.

Participants

In the present research, the sample selected consisted of 159 students – both boys and girls from standard IX of English medium schools situated in Greater Mumbai. The experimental group had 78 students out of which 42 (53.85 %) were boys and 36 were girls (46.15 %). The control group had 81 students out of which 40 (49.38 %) were boys and 41 (50.62 %) were girls. 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.

Measures

1. Mathematics Self-Efficacy Scale : This scale was developed by the researcher in 2015. It 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 and validity were established in the Indian context during a pre-pilot study (Cronbach's Alpha = 0.90 and Test-Retest Reliability = 0.81). 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).
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-way ANCOVA and wolf's formula. To compare the post-test score on mathematics self-efficacy 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' Mathematics Self-Efficacy.

Results

1. Comparison of Students' Mathematics Self-Efficacy Scores by Intervention and Implicit Theory of Intelligence

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

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

	EG	CG	Total
Entity Theory	26.43	10.71	16.89
Incremental Theory	37.55	12.04	27.09
Total	31.96	11.62	

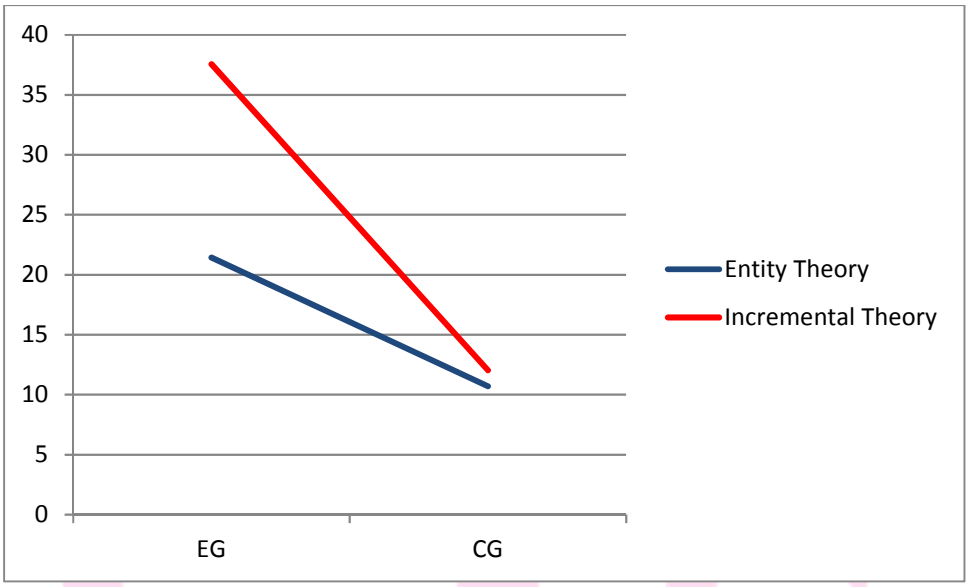
a) When the technique of two-way ANCOVA was applied to compare the post-test scores on Students' Mathematics Self-Efficacy after partialling out the effect of

pre-test scores, the F-ratio for intervention effect was found to be Fy.x = 20.87 ($p < 0.0001$). This F-ratio is therefore significant. The Mean post-test score on Students' Mathematics Self-Efficacy from the experimental group was found to be significantly greater than that of the control group (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 = 19.64 ($p < 0.0003$). This F-ratio is therefore significant. The Mean post-test score on Mathematics Self-Efficacy of students with high score on implicit theory of intelligence was found to be significantly greater than that of students with a low score on implicit theory of intelligence (after controlling for the pre-test scores using ANCOVA. i.e. students with incremental theory of intelligence had a higher score on Cohesive Mathematics Self-Efficacy than the students with entity theory of intelligence.

c) The F-ratio for interaction effect was found to be Fy.x = 11.12 ($p = 0.007$). This F-ratio is significant. Besides, in both the groups, the mean Mathematics Self-Efficacy 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.

The interaction effect of the intervention programme and the implicit theory of intelligence on students' Mathematics Self-Efficacy is shown in the following figure.



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

Table 2 : Effect Size

Independent Variables / Dependent Variable	Intervention Effect		Implicit Theory of Intelligence Effect	
	Effect Size	Magnitude	Effect Size	Magnitude
Mathematics Self-Efficacy	2.96	High	1.51	High

Conclusions

It may be concluded that :

- The co-operative learning model is effective in enhancing Mathematics Self-Efficacy of students.
- As compared to the traditional method of teaching, the co-operative learning is found to be more effective in enhancing Mathematics Self-Efficacy for students with both entity and incremental theory of intelligence.
- The effect size of the co-operative learning model on Mathematics Self-Efficacy of students is high.
- The implicit theory of intelligence has a significant effect on Mathematics Self-Efficacy of students.
- Students with incremental theory have a higher mean Mathematics Self-Efficacy than students with entity theory of intelligence.
- The effect size of the implicit theory of intelligence on Mathematics Self-Efficacy of students is high.
- There is a significant interaction effect of co-operative learning model and implicit theory of intelligence on Mathematics Self-Efficacy of students.
- In the experimental group, the mean Mathematics Self-Efficacy of students with incremental intelligence is significantly greater than that from students with entity intelligence.
- In the control group, the mean Mathematics Self-Efficacy of students with incremental intelligence does not differ significantly from students with entity intelligence.

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 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 a 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 among students.

The present study contributed to an understanding of how Co-operative Learning Model could be used effectively for teaching of Mathematics to students with entity and incremental theory of intelligence with the objective of enhancing their Mathematics Self-Efficacy. The present study's findings are partially supported by Gocłowska et al. (2015) who found that entity theory was negatively and incremental theory was positively related to co-operative preferences. However, it is noteworthy that teaching through co-operative learning enhances Mathematics Self-Efficacy even in students who feel that their intelligence is fixed.

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 Mathematics Self-Efficacy 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-learning process, 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 Mathematics Self-Efficacy in students and develop a deep approach to learning mathematics.

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