ISBN:978 0 9943656 20
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INTERACTION EFFECT OF CO-OPERATIVE LEARNING MODEL AND STUDENTS' IMPLICIT THEORY OF INTELLIGENCE ON STUDENT ENGAGEMENT IN MATHEMATICS

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Abstract

The study seeks to ascertain whether co-operative learning model is equally effective in enhancing student engagement for students with having high and low level of Implicit Self Theory. The study uses factorial design for conducting the experiment. The experiment was conducted on 161 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, student engagement in mathematics and Implicit Theory of Intelligence Scale. The researcher has developed an instructional programme for co-operative learning. The techniques used to test the hypotheses include ANCOVA. It was found that in the experimental group taught by co-operative learning, there was no difference between students with high and low scores on Implicit Theory of Intelligence in the cognitive, affective and behavioural engagement. It implies that the co-operative learning model is equally effective in enhancing student engagement in mathematics among students with high, as well as low levels of implicit theory of intelligence. On the other hand, traditional teaching was found to be more effective in enhancing cognitive and affective engagements of students with a low score on implicit theory of intelligence as compared to those with a high score on implicit theory of intelligence. Behavioural engagement of students in the control group was found to be lower in case of students with high level of Implicit Theory of Intelligence as compared to those with a low level of Implicit Theory of Intelligence. Besides, it was found that the effect of the co-operative learning model on students' cognitive and affective engagement is high, whereas on their behavioural engagement is moderate. As compared to the traditional method of teaching, the co-operative learning is found to be more effective in enhancing cognitive and behavioural engagement for students with entity and incremental theory of intelligence.

Keywords: Co-operative Learning, Implicit Theory of Intelligence, Student Engagement, Mathematics.

1. Co-operative Learning in Classrooms

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 are 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). Cooperative 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 rolesand group processing. It is found to influence a large number of cognitive, as well as affective student-outcomes such as academic achievement (Jebson, 2012; Parveen & Batool, 2012;

Swab, 2012; Dheeraj & Rimakumari, 2013; Russo, 2014;Gull & Shehzad, 2015; Tunga, 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; Grech, 2013; Hossain & Tarmizi, 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 &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, et al., 2013), learning style as a grouping technique (Bachmann, 2010), the effect of meta cognitive scaffolding embedded within cooperative learning on mathematics conceptual understanding and procedural fluency in learning and solving problems (Cheong, 2010; Jbeili, 2012; Vijayakumari & D'Souza, 2013), Teachers' reflections on cooperative learning (Gillies&Boyle, 2010), co-operative learning in distance learning (Kupczynski, et al., 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.

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

2. 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 capitalized 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 et al., 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 (Stipek & Gralinski, 1996; Hong et al., 1999; Robins & Pals, 2002). 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 and Dweck (2007) found that the belief that intelligence is malleable (incremental theory) and 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.

3.Student Engagement

The term student engagement refers to the degree of responsiveness, curiosity, attentiveness, optimism and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education. In common parlance, the concept of "student engagement" is founded on the belief that learning improves when students are inquisitive, interested, or inspired, and that learning tends to suffer when students are bored, dispassionate, disaffected, or otherwise "disengaged." Stronger student engagement or improved student engagement are common instructional objectives conveyed by educators. Astin (1984) defines student engagement as "the amount of physical and psychological energy that the student devotes to the academic experience" (p. 518). This definition is used in the current study to define the theory of student engagement. Kuh (2003) provides an integrated definition encompassing the cognitive, affective and behavioral aspects of engagement while highlighting the reciprocal responsibility of both the students and the institution to fostering engagement; as explained in this definition, student engagement is "the time and energy students devote to educationally sound activities inside and outside of the classroom, and the policies and practices that institutions use to induce students to take part in these activities" (Kuh, 2003, p. 25). Kuh (2009a, 2009b, 2009c) opines that the more students study a subject, the more they know about it and the more students practice and get feedback from faculty and staff members on their writing and collaborative problem solving, the deeper they come to understand what they are learning and the more adept they become at managing complexity, tolerating ambiguity, and working with people from different backgrounds or with different views. In the present study, student engagement has been conceptualized in terms of cognitive, affective and behavioural dimensions as outlined by Kuh (2003).

4. Need of the Study

Very little prior work on co-operative learning has focused on student engagement. Student engagement is seen as important due to its association with achievement (Marks, 2000) school retention and favorable lifelong outcomes (Taylor &Nelms, 2006), as well as with social and psychological wellbeing. Besides, it is imperative to understand whether a student's implicit theory of intelligence interacts with co-operative learning and influences student engagement. Thus, it is expected to enhance student engagement in students with incremental theory of intelligence. Prior research has found that co-operative learning enhances 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 that the 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 their student engagement. This forms the basis of the present research.

If the co-operative learning model is effective, the question arises as to what mediating variables are responsible for this effectiveness. The present study hypothesizes that the co-operative learning model will have differential effectiveness for students with different levels of implicit self-theory of intelligence. 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

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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.

5. 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 student engagement in Mathematics.

5.1 Research Questions

1. Do students' post-test scores on student engagement in mathematics and its dimensions differ when students' pre-test scores are controlled?
2. What are the effects of co-operative learning model, implicit theories of intelligence and their interaction on student engagement in mathematics and its dimensions?
3. What are the effect sizes of co-operative learning model, implicit theories of intelligence and their interaction on the student engagement in mathematics and its dimensions?

5.2 Method

The present study is aimed at enhancing student engagement of secondary students through the use of Co-operative Learning Model. The researcher attempts to provide answers to the question, "Is there an interaction effect of Co-operative Learning Model and the Implicit Theory of Intelligence on student engagement in Mathematics?" The researcher has manipulated the method of teaching to ascertain its effect on student engagement in 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 Student Engagement Score	Adjusted Mean Student Engagement Score
High Implicit Theory of Intelligence (Incremental Theory)	Adjusted Mean Student Engagement Score	Adjusted Mean Student Engagement Score

Here, Adjusted Mean Student Engagement Score is one in which the effect of pre-test has been removed from the post-test.

5.3 Teaching Method

Instructional Material: In the present research, the researcher developed an instructional plan based on Co-operative Learning Model and Conventional Lecture Method. In the present research, instructional plan 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 Student Engagement in Mathematics 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 to use traditional lecturing methods. At the end of this, the post-test on Student Engagement in Mathematics 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 Cooperative 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.

5.4 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.

5.5 Measures

1. Student Engagement in Mathematics Scale: This scale was developed by 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 and validity were established in the Indian context during a pre-pilot study (Cronbach's Alpha = 0.89 and Test-Retest Reliability = 0.81). All items were measured on a 5-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).
2. Implicit Theories of Intelligence (Self-Theory): This scale was developed by De Castella and 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.

6. 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 student engagement in mathematics after separating 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, student engagement in mathematics.

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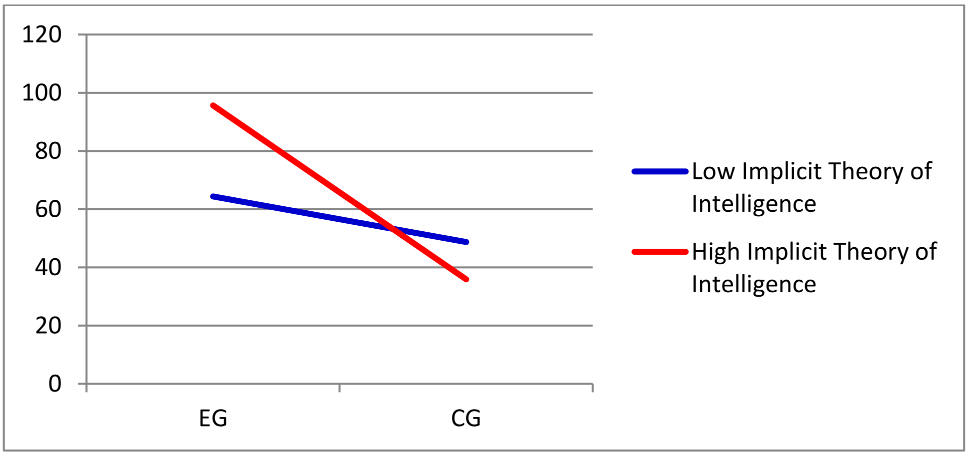
7. Results

1. Comparison of Cognitive Engagement Scores by Intervention and Implicit Theory of Intelligence
    a) When the technique of two-way ANCOVA was applied to compare the post-test scores on students' cognitive engagement in mathematics after partialling out the effect of pre-test scores, the F-ratio for intervention effect was found to be Fy.x = 18.39 ($p < 0.0001$). The Mean post-test score on students' cognitive engagement in mathematics from the experimental group (My.x = 77.20) was found to be significantly greater than that of the control group (My.x = 43.81) (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 = 10.64 ($p < 0.0019$). The Mean post-test score on students' cognitive engagement in mathematics of students with high score on implicit theory of intelligence (My.x = 66.24) was found to be significantly greater than that of students with a low score on implicit theory of intelligence (My.x =56.21) (after controlling for the pre-test scores using ANCOVA.i.e. students with incremental theory of intelligence found co-operative learning more beneficial in enhancing cognitive engagement than the students with entity theory of intelligence.
    c) The F-ratio for interaction effect was found to be Fy.x = 9.55 ($p < 0.008$). The mean cognitive engagement of students from the experimental group with a high score on implicit theory of intelligence is significantly greater than that the students with a low score on implicit theory of intelligence. On the other hand, in the control group, the mean cognitive engagement of students with a low score on implicit theory of intelligence is significantly greater than that the students with a high score on implicit theory of intelligence.However, the mean cognitive engagement of students from the experimental group for students with high as well as low levels of implicit theory of intelligence was found to be greater than that of the control group.
    d) This implies that co-operative learning is found to be more effective in enhancing cognitive student engagement for students with entity as well as incremental theories of intelligence as compared to the traditional method of teaching.

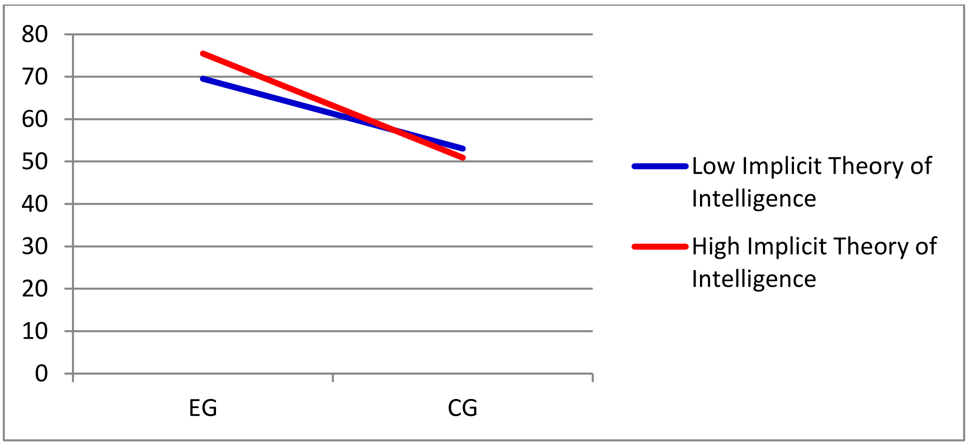
The interaction effect of the intervention programme and the implicit theory of intelligence on students' cognitive engagement are shown in the following figure.



2. Comparison of Affective Engagement Scores by Intervention and Implicit Theory of Intelligence

a) When the technique of two-way ANCOVA was applied to compare the post-test scores on students' affective engagement in mathematics after partialling out the effect of pre-test scores, the F-ratio was found to be Fy.x = 15.49 ($p < 0.0013$). The Mean post-test score on students' affective engagement in mathematics from the experimental group (My.x = 71.97) was found to be significantly greater than that of the control group (My.x = 52.23) (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 = 1.51 ($p < 0.2419$). There is no significant difference in the Mean post-test score of students' affective engagement in mathematics of students on the basis of their level of implicit theory of intelligence.
c) The F-ratio for interaction effect was found to be Fy.x = 5.35 ($p < 0.037$). The mean affective engagement of students from the experimental group with a high score on implicit theory of intelligence is significantly greater than that the students with a low score on implicit theory of intelligence. However, in the control group, there is no significant difference in the affective engagement of students on the basis of their level of implicit theory of intelligence.

The interaction effect of the intervention programme and the implicit theory of intelligence on students' affective engagement are shown in the following figure.



3. Comparison of Behavioural Engagement Scores by Intervention and Implicit Theory of Intelligence

a) When the technique of two-way ANCOVA was applied to compare the post-test scores on students' behavioural engagement in mathematics after partialling out the effect of pre-test scores, the F-ratio was found to be Fy.x = 25.49 ($p < 0.0003$). The Mean post-test score on students' behavioural engagement in mathematics from the experimental group (My.x = 39.87) was found to be significantly greater than that of the control group (My.x = 21.71) (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 = 11.09 ($p < 0.0004$). Students with high score on implicit theory of intelligence have a significantly greater Mean post-test score of students' behavioural engagement in mathematics as compared to those with a low score on implicit theory of intelligence, i.e. students with incremental theory of intelligence found co-operative learning more beneficial in enhancing behavioural engagement than the students with entity theory of intelligence.
c) The F-ratio for interaction effect was found to be Fy.x = 13.36 ($p < 0.0001$). The mean behavioural engagement of students from the experimental group with a

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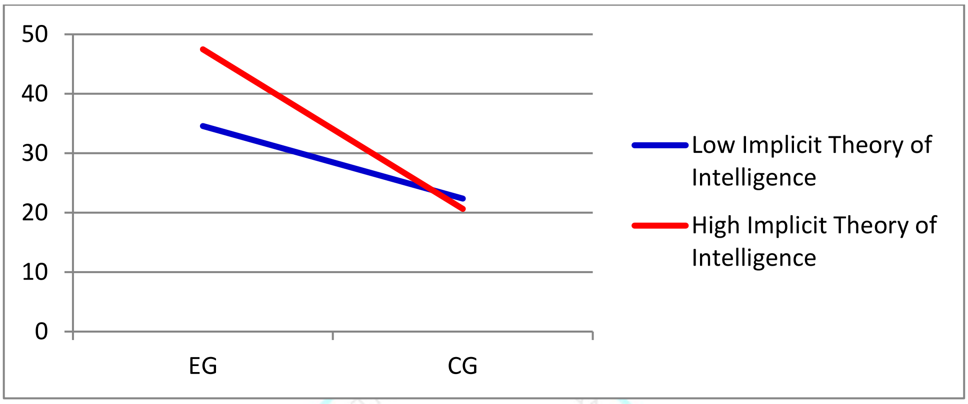
high score on implicit theory of intelligence is significantly greater than that the students with a low score on implicit theory of intelligence. However, in the control group, there is no significant difference in the behavioural engagement of students on the basis of their level of implicit theory of intelligence.

d) This implies that co-operative learning is found to be more effective in enhancing behavioural student engagement for 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' behavioural engagement are shown in the following figure.



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

Table 1 : Effect Size

Independent Variables / Dimensions of Student Engagement	Intervention Effect		Implicit Theory of Intelligence Effect	
	Effect Size	Magnitude	Effect Size	Magnitude
Cognitive Engagement	2.72	High	0.82	High
Affective Engagement	1.73	High	--	--
Behavioural Engagement	3.12	High	1.04	High

Conclusions

It may be concluded that:

- The co-operative learning model is effective in enhancing the cognitive, affective and behavioural engagement of students.
- The effect size of the co-operative learning model on the cognitive, affective and behavioural engagement of students is high.
- The implicit theory of intelligence has a significant effect on the cognitive and behavioural engagement of students.
- The effect size of the implicit theory of intelligence on the cognitive and behavioural engagement of students is high.

- There is a significant interaction effect of co-operative learning model and implicit theory of intelligence on the cognitive, affective and behavioural engagement of students.
- The mean cognitive, affective and behavioural engagement of students with high implicit theory of intelligence is significantly greater than those with low implicit theory of intelligence in case of the experimental group.
- The mean cognitive engagement of students with high implicit theory of intelligence is significantly lower than those with low implicit theory of intelligence in case of the experimental group.
- There is no significant difference in the mean affective and behavioural engagement of students with high and low implicit theory of intelligence in case of the control group.
- As compared to the traditional method of teaching, the co-operative learning is found to be more effective in enhancing cognitive and behavioural engagement for students with entity and incremental theory of intelligence.

Discussion

This present study contributed to an understanding of how the 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 cognitive, affective and behavioural engagement. 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.

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 cognitive and behavioural engagement amongst students taught through co-operative learning. Students who are taught through the co-operative learning model, on account of higher 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 cognitive, affective and behavioural engagement of students.

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