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# Predicting Academic Achievement In Mathematics : Moderating Influence Of Implicit Theory Of Intelligence

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## Abstract

The present paper seeks to compare student engagement, conceptions of mathematics, mathematics self-efficacy and academic achievement of students on the basis of entity and incremental theories of intelligence. It also seeks to ascertain the relationship of student engagement, conceptions of mathematics and mathematics self-efficacy with academic achievement of students on the basis of entity and incremental theories of intelligence. The study adopted the descriptive method with a sample of 427 students of standard ninth. It was found that student engagement, conceptions of mathematics, mathematics self-efficacy and academic achievement of students with entity theory of intelligence is significantly less than those with incremental theory of intelligence. The contribution of student engagement, conceptions of mathematics and mathematics self efficacy to academic achievement of students in the group with entity theory of intelligence is greater than that of students in the group with incremental theory of intelligence.

## Introduction

Implicit theories are defined as personal constructions about particular phenomenon that reside in the minds of individuals (Sternberg, Conway, Ketron, & Bernstein, 1981). Implicit theories are influenced, in part, by cultural traditions and expectations (Runco & Johnson, 2002) and are found to be highly stable over time (Franiuk, Cohen, & Pomerantz, 2002).Dweck and Leggett (1988) described children's implicit theories in distinguishing between their beliefs that human attributes, such as intelligence, are fixed or malleable. Children who viewed intelligence as stable and unchanging were said to have an entity theory of intelligence, whereas those who viewed intelligence as something that could be improved were described as having an incremental theory. A belief in fixed intelligence is associated with a performance goal orientation, i.e., having a concern for establishing one's ability instead of a concern for deep learning and mastery. Such students are inclined to adopt a "helpless" pattern when

responding to failure. A belief in malleable intelligence is associated with a learning goal orientation. These students exhibit mastery-oriented responses to failure and have higher achievement outcomes (Dweck & Leggett, 1988; Henderson & Dweck, 1990).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.

The present paper focuses on whether some of the significant student characteristics and behaviours differ on the basis of entity or incremental theories of intelligence. It also seeks to ascertain whether these student characteristics and behaviours have a differential relationship with academic achievement of students with entity and incremental theories of intelligence.

**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

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 (2009) 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).

**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 (Hackett&Betz,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.

**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 a public image of being a difficult subject, accessible only to the few. Learners who do well in mathematics are typically stereotyped as "bores". It is seen as a dry and boring subject. The negative conceptions of mathematics have a major impact on students' achievement, enrolment in higher education and their future career decisions (Sam, 1999). Generally, students' views of mathematics are developed based on their school learning experiences (Schoenfeld, 1989; Ernest, 1996) and how the public image of mathematics is portrayed in the society (Sam, 1999). To elaborate, in general it is believed that males are born with innate capabilities of making sense of abstract ideas and as mathematics is also an abstract level subject boys can do well as compared to girls (Walkerdine, 1998, Halai, 2006). Some of the other viewpoints students hold about mathematics include: mathematics problems have one and only one answer and they can be solved in a particular way; mathematics is a solitary activity, done by individuals in isolation; mathematics requires good memory and is only for clever ones. Thompson (1992) refers to conceptions as mental structures that encompass beliefs, concepts, meanings, propositions, mental images and other. Oaks (1994) describes conceptions as views that students hold of mathematics and what they believe is required in learning and doing mathematics. Andrews and Hatch (2000) suggest that the literature on conceptions is not clear because different researchers offer different perspectives on conceptions in terms of having cognitive and/or affective dimensions. Damon (2005) describes dispositions as traits or characters that lead a person to follow certain choices or experiences. Leatham (2006) refers to 'conceptions' as conscious or subconscious beliefs, understanding, meaning, mental images, and preferences. Based on these definitions, the working definition of these terms for the study is that 'conceptions are conscious and unconscious cognitive and affective beliefs, personal meaning, mental images and preferences constructed from experiences within 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 to succeed 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.

**Research Question :** Does the combined relationship of student engagement, conceptions of mathematics and mathematics self efficacy for students with academic achievement of students differ on the basis of students' implicit theory of intelligence?

**Definition of the Terms**

1. Academic Achievement : It refers to the marks obtained in mathematics by a student in a researcher-made test in mathematics.
2. Student Engagement : It refers to active participation in academic and co-curricular or school-related activities and commitment to educational goals and learning and includes cognitive, affective and behavioural dimensions.
3. Cognitive Engagement : It refers to a student's thoughtfulness and willingness to exert the effort necessary to comprehend complex ideas and master difficult skills, how students feel about themselves and their work, their skills and the strategies they employ to master their work and is associated with self-regulation.
4. Affective Engagement: It refers to a student's positive and negative reactions to teachers, classmates and content areas, feelings of interest, happiness, anxiety and anger during achievement-related activities.

5. Behavioural Engagement : It refers to the positive conduct and involvement in learning tasks and encompasses students' effort, persistence, participation and compliance with classroom structures.

6. Conceptions of Mathematics :These are cognitive in nature and part of knowledge regarding mathematics reflecting a student's belief systems which could be dichotomised as fragmented (mathematics involves numbers, rules and formulas) and cohesive (mathematics involves a complex logical system and way of thinking).

7. Mathematics Self-Efficacy :It refers to a student's beliefs or perceptions with respect to his or her abilities in mathematics and his/her confidence about completing a variety of tasks, from understanding concepts, solving problems in mathematics and applying it to daily activities.

8. Implicit Theory of Intelligence : It refers to a student's fundamental underlying beliefs regarding whether or not intelligence or abilities can changewhich could be dichotomised as entity theory (abilities cannot be changed) and incremental theory (abilities can be changed).

**Objectives of the Study**

1. To compare (a) academicachievement of students in mathematics, (b) student engagement, (c) conceptions of mathematics and (d) mathematics self efficacy of students on the basis of entity theory of intelligence and incremental theory of intelligence.

2. To study academicachievement of students in mathematics in relations to their student engagement, conceptions of mathematics and mathematics self efficacy for students with entity theory of intelligence and incremental theory of intelligence.

**Method :** The study adopted the descriptive method of the causal-comparative and correlational types.

**Sample of the Study** : It included 427 students of standard IX from English medium schools situated in Greater Mumbai and affiliated to the SSC board.It included 211 boys and 216 girls. The sample was selected using a three-stage sampling technique in which at the first stage, schools were selected using stratified random sampling technique from three strata, namely, South Mumbai, North Mumbai and Central Mumbai. At the second stage, schools were selected using stratified random sampling technique from two strata, namely, private-aided and private-unaided schools. At the third stage, students were selected from intact classes.

**Measures**

1. Student Engagement in Mathematics Scale : This scale was developed by Kong, Wong & 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. 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.

3. 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).

4. Academic Achievement Test : This is measured using a researcher-made test in mathematics.

5. 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.

**Results**

1. Research Hypothesis 1 : There is a significant difference in the student engagement (SE), conceptions of mathematics (CM),mathematics self efficacy (MSE)and academic achievement (AA) among students with entitytheory of intelligence (ETI) and incremental theory of intelligence (ITI).

Null Hypothesis 1 : There is no significant difference in the student engagement, conceptions of mathematics, mathematics self efficacy and academic achievement among students with entity theory of intelligenceand incremental theory of intelligence.

The technique used to test this hypothesis is the t-test. The following table shows the relevant statistics for this hypothesis.

Table 1 : Relevant statistics for comparing the variables by implicit theory of intelligence

| Details | SE | CM | MSE | AA |
|---|---|---|---|---|
| ETI | 149.83 | 6.71 | 56.65 | 12.56 |
| ITI | 198.69 | 13.92 | 78.49 | 19.39 |
| t-ratio | 12.57 | 4.93 | 8.48 | 5.74 |
| P | 0.0001 | 0.005 | 0.0005 | 0.004 |
| $100\ \omega^2$ | 27.06 | 5.40 | 14.44 | 7.18 |

It can be seen from the preceding table that in the case of SE, CM, MSE and AA, the Mean score of students with incremental theory of intelligence is significantly greater than that of students with entity theory of intelligence.Thus, the null hypothesis is rejected.

2. Research Hypothesis 2 : There is a significant combined relationship of student engagement, conceptions of mathematics and mathematics self efficacy for students with academic achievement among students with entity theory of intelligence.

Null Hypothesis 2 : There is no significant combined relationship of student engagement, conceptions of mathematics and mathematics self efficacy for students with academic achievement among students with entity theory of intelligence.

The technique used to test the null hypothesis is multiple correlation. There were 219 students in the sample with entity theory of intelligence. The multiple correlation of student engagement, conceptions of mathematics and mathematics self efficacy on academic achievement of students with entity theory of intelligence is 0.6548 ($P<0.0004$). Further, 14.36%, 10.93% and 17.59% of the variance in academic achievement of students can be attributed to student engagement, conceptions of mathematics and mathematics self efficacy respectively. Thus, the null hypothesis is rejected.

3. Research Hypothesis 3 : There is a significant combined relationship of student engagement, conceptions of mathematics and mathematics self efficacy for students with academic achievement among students with incremental theory of intelligence.

Null Hypothesis 3 : There is no significant combined relationship of student engagement, conceptions of mathematics and mathematics self efficacy for students with academic achievement among students with incremental theory of intelligence.

The technique used to test the null hypothesis is multiple correlation. There were 208 students in the sample with incremental theory of intelligence. The multiple correlation of student engagement, conceptions of mathematics and mathematics self efficacy on academic achievement of students with incremental theory of intelligence is 0.5037 ($P<0.005$). Further, 10.25%, 7.93% and 7.19% of the variance in academic achievement of students can be attributed to student engagement, conceptions of mathematics and mathematics self efficacy respectively. Thus, the null hypothesis is rejected.

**Conclusions** :

1. The Mean Student Engagement, Conceptions of Mathematics, Mathematics Self Efficacy and Academic Achievement of students with incremental theory is significantly greater than that of students with entity theory of intelligence.27.06%, 5.40%, 14.44% and 7.18% of the variance in Student Engagement, Conceptions of Mathematics, Mathematics Self Efficacy and Academic Achievement of students can be attributed to their implicit theory of intelligence.

2. 14.36%, 10.93% and 17.59% of the variance in academic achievement of students can be attributed tostudent engagement, conceptions of mathematics and mathematics self efficacy respectively.

3. 10.25%, 7.93% and 7.19% of the variance in academic achievement of students can be attributed to student engagement, conceptions of mathematics and mathematics self efficacy respectively.

4. It cab seen that the contribution ofstudent engagement, conceptions of mathematics and mathematics self efficacy to academic achievement of students in the group with entity theory of intelligence is greater than that of students in the group with incremental theory of intelligence.

**Discussion :** A **b**eliefin malleable or incremental theory of intelligence enables a student to engage more fully in classroom and school life cognitively, affectively and behaviourally; have a more comprehensive conception of mathematics and enables him/her to be more confident about mathematical abilities as compared to students with fixed or entity theory of intelligence. At the same time, Student Engagement, Conceptions of Mathematics, Self Efficacy contribute more to Academic Achievement among students with entity theory of intelligence as compared to those with incremental theory of intelligence thereby implying a need to focus on the teaching-learning of students with entity theory of intelligence.

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