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Effect of Implicit Theories of Intelligencee on Students' Achievement in the Subject of Mathematics at Elementary School Level

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Abstract

A person's mindset, or Implicit Theory of Intelligence (ITI), has been linked to many factors such as motivation to learn and academic achievement. This study set intended to determine how ITI affected children' academic performance in mathematics at the elementary school level. Under the typology of positivism quantitative approach was used. The study was carried through quasi experimental design. Two intact groups of grade eight students of public sector school were selected randomly. Lesson plans based on ITI were validated by the experts. The intervention period was of six weeks. Math Achievement Test (MAT) was used to find out the effect of ITI on academic achievement of students in mathematics at elementary school level. The findings indicated that ITI significantly impacted pupils' motivation and academic success in mathematics. The study recommended that the ITI activities may be used by the teachers for the elementary school students' math achievement.

Keywords: Growth Mindset; Fixed Mindset, Mathematics Achievement

Introduction

Although overall intelligence is a substantial predictor of important life experiences, current research has established the critical contribution of patterns of motivation as reasons inter-individual variability of changeability in various contexts Science education teachers and researchers took a particular interest in the expedition for potential accomplishment aspects that may be supported on an individual or group level (Yeager et al., 2022).

As far general intelligence is concerned, how well someone performs academically and how they view themselves can be greatly influenced by their implicit ideas debating whether or not intellect is fixed or adaptable. Students' performance may be impacted (ITI), mainly in thought-provoking and hard educational circumstances represents a significant academic protective factor (Dang, J., & Liu, L. 2022).

It is evidenced through the literature that due to importance of math education the researchers main focus is on how to teach math. So many methods and techniques are being used to teach math at different levels in numerous countries, including Pakistan. In the first eight grades, math and science are required subjects in Pakistani schools (Rauf & Shahed, 2015). The performance of pupils in the subject of math is ordinary or below average despite the fact that there are numerous effective ways for teaching math, which is a required component of the school curriculum in Pakistan. Table 1 Presented a data at a seminar dated 07-10-1999 on perspectives on education quality in Bhurban, Pakistan. The title of the seminar was "Basic Skills Assessment: A Pakistan".

Table 1

Average national percentage scores by subject and class

Subject	Class five
General Science	33%
math	26%

Punjab Examination Commission (PEC, 2018) and (PEC,2019) exam analysis report showed that in the eighth grade, pupils generally scored good in Islamiyat (x=74), Urdu (x=73), but performing the least well in science (x=53) and mathematics (x=52).

According to Buzzetto-Hollywood et al. (2019), student ITI significantly influences motivation and academic success. ITI refers to a person's beliefs in their capacities, regardless of their

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level of expertise in a particular field (Burgoyne et al., 2018). According to the research, ITI instruction is crucial to the teaching and learning process, particularly for students as they establish their study habits. Given its significance, the researchers conducted the current study to ascertain its impact on Punjabi elementary school kids' math achievement.

Research Objective

- To know the effectiveness of ITI on elementary school students' math achievement.

Hypotheses

Based on the objective of the current research work following hypothesis were formulated;

H_{O1}: There is not significant effectiveness of ITI on elementary school students 'math achievement.

H_1: The ITI has effectiveness on elementary school students' math achievement.

Significance of the Study

The previous research work on ITI have demonstrated that teachers who approach teaching and learning with ITI activities enable their students to grow and become deeper learners. By understanding that all kids can succeed with effort and tenacity, they aid each student in developing as a learner.

Delimitation

An achievement test used in the study was MCQs and was limited to the first three cognitive domains i.e., knowledge, comprehension, and application, of Bloom's Taxonomy of educational objectives, because later three cognitive domains require supply type questions to measure.

Limitation

The sampled school in the current study did not permit researchers to assign groups at random. This major restriction was an inevitable one.

Literature Review

The study of ITI has received considerable attention from researchers in many areas (Knee et al., 2003; Tamir et al., 2007; Aronson et al., 2002; Spinath et al., 2003; Chen et al., 2008), with evidence that both academic and emotional learning is impacted by this implicit factor (Blackwell et al., 2007; Walton and Cohen, 2011; Cohen et al., 2006; Yeager et al., 2013). Although everyone has a different perspective on intelligence, some people like to think of it as something that is both malleable and immutable Others believe that (entity theory or ideas) is adaptable and subject to change (growth mindset, incremental theory, or beliefs). In other words, those who hold to an entity or fixed conception of intelligence frequently think that their success depends on the stability of their talents and abilities, and the stability of those skills and abilities (Dweck, 1999; Hong et al., 1999).

Because of this, people frequently establish performance goals that centre on showcasing their skills and garnering favourable evaluations (Dweck, 1999; Pepi et al., 2015). A growth mind-set is characterized by believing that certain Characteristics can be strengthened with practise over time, thereby increasing the likelihood of adopting goals for learning, choosing difficult tasks, and implementing adaptive methods (Dweck, 1999). Since these beliefs are largely unconscious to the individuals, the schematic knowledge structures they incorporate function as "implicit theories."

There have been extensive studies investigating the learning techniques and outcome factors in the academic context (Dweck, 1999; Dweck and Leggett, 1988) There is a continuum of implicit theories that frame students' specific mind-sets from entity to incremental belief along a continuum, creating distinctive systems of meaning (Hong et al., 1999). When face with challenging situations and hindrances, responses of students can vary (Dweck and Sorich, 1999; Henderson and Dweck, 1990; Dweck and Leggett, 1988; Dweck, 1999) eventually affecting their learning process and performance.

While they frequently have little relationship with general cognitive capacity, and ITI (Dweck et al., 1995; Robins and Pals, 2002) study of previous researches have looked at how incremental or entity beliefs affect students' academic performance (Hong et al.,1999; Robins and Pals, 2002; Stipek and Gralinski, 1996). As a result of the entity theory, which believes intelligence is largely determined, performance goals are often set higher (Dweck and Leggett, 1988) and positive assessments, which are prioritized above learning (Robins and Pals, 2002; Elliott and Dweck, 1988). As a result, low performance is not addressed with work (Hong et al., 1999), ineffective strategies are assumed (Robins and Pals, 2002) setbacks are the cause of failure (Henderson and Dweck, 1990) all of which lead to academic helplessness.

In contrast, proponents of incremental theory frequently prioritise learning goals (Robins and Pals, 2002; Dweck and Leggett, 1988) place a high emphasis on work (Hong et al., 1999) and use response styles that are mastery-oriented (Robins and Pals, 2002; Henderson and Dweck, 1990). Those who trust in incremental theory have faith in that intelligence can be established, and if faced with challenging situations, they are likely to intensify their efforts to overcome difficulties, thus acquiring new skills. Performance deficiencies are attributed a lack of effort as opposed to incapacity, and remediation actions are designed to remedy inadequate performance (Hong et al., 1999). Performance deficiencies are attributed rather than a lack of ability, to a lack of effort, and remediation actions are designed to address a lacklustre performance (Hong et al., 1999).

Positive academic performances are linked to pupils' implicit views about intelligence (Burnette et al., 2013; Dweck, 2006).

It has been shown that implicit theories do influence achievement directly for students who believe in incremental or entity theories typically perform better than those who believe in a malleable or dynamic theory of intelligence. Dweck and Leggett (1988) argue that self-regulatory profits should be affected by implicit theories of achievement for them to indirectly predict achievement. (Romero et al., 2014; Blackwell et al., 2007; Mullensiefen et al., 2015).

Studies on ITI and academic performance has examined a number of variables to determine how they affect ITI and performance. According to studies examining gender differences, girls possess the most prevalent notions of ability and intelligence (Dweck, 1999; Pepi et al., 2006). By contrast high achievers and low achievers of grade 08, girls expressed more intellectual learning (Henderson and Dweck, 1990).

Furthermore, in research it was explored, increment lists and people who believe that intelligence is fixed may have similar expectations about academic success, but might differ when faced with circumstances that demand academic performance. Researchers have found that incremental theories of intelligence may eventually compound the effects of academic cycles that are particularly challenging, like junior high school, on a student's learning process.

Moreover, incremental theories may influence students' conduct in college, such as increasing help-seeking, to show more behaviours that are protective of their achievement (Shively and Ryan, 2013). In certain extremely difficult disciplines, like math, implicit beliefs of intelligence can have a big impact (Romero et al., 2014; Blackwell et al., 2007; Bostwick et al., 2017), due to the pupils who exert the struggle and resources required to get over learning complications. Students who view intelligence more flexible are typically better prepared to adapt to and thrive in demanding or stressful situations.

Because implicit views of intelligence among students' academic disciplines can differ (Dweck, 1999) additionally, compared to broad or unspecific beliefs, Domain-specific ideas include generally Ideas specific to a domain include objectives, the attributions academic success (Bandura, 2006).

Moreover, concept of aptitude vary widely from culture to culture, as well (Rammstedt and Rammsayer, 2000; Furnham, 2000). Culture can influence implicit conceptions of intelligence, which are perceptions and assessments of one's own and other people's intelligence (Dweck and Leggett, 1988). According to Lim et al. (2012) pupils of Asia and Africa placed a higher value on social intelligence and matters facilitating social and interpersonal relationships, while Westerners placed a higher value on classic academics (such as mathematics) when assessing intelligence. Whether societies are more collectivist or individualistic may affect concepts of intelligence. Understanding cultural differences in expectations regarding intellectual ability can be gained by studying implied intelligence theories diagonally in cultures (Steinberg, 2000). Implicit theories of intelligence (ITI) are shown to improve students' academic performance in a variety of subjects, particularly in the sciences, according to the literature. A gap was found that there is little work done in Pakistani academic settings. In order to assess how implicit ideas of intelligence affect children's academic performance in primary school mathematics, this study is focused on ITI.

Methodology

Purposefully, a public school in Pakistan's Multan district was chosen. The research's intervention required a school with modern technology, including an LCD, the Internet, a sound system, and an uninterruptible power supply. Under quasi experimental designs, the investigation was conducted using a matching-only pre-test post-test control group design.

Table 2

Design of Research Study

Groups	Pre-test	Intervention	Post test
Experimental	MAT	Teaching with ITI	MAT
Control	MAT	Teaching with traditional methods	MAT

Note: MAT: Math achievement test ITI: Implicit theories of intelligence

Sample

The sampled school in the current study did not permit researchers to assign groups at random. This was a study limitation; thus, the researchers chose two intact groups at random for intervention. The school created the groups for Grade 7 pupils in accordance with policy based on the students' annual results for Grade 7. Eighth grade was divided into five parts (A through E). There were 35–40 pupils per section. Two portions, C and E, were chosen at random by the researcher. Each experimental group had 35 people, as did the control group. To choose the experimental group, a coin was tossed.

Instrument

The Math Achievement Test (MAT) is the tool used to assess pupils' proficiency in mathematics. The accomplishment test had 25 things total. The exam was created using a scientific process that used an appropriate specification table to maintain the test's level of difficulty (Mitchell & Jolley, 2010). The instrument was approved by the experts. There were four specialists consulted. They included two STEM education specialists and two teachers at the elementary school level. Their insightful suggestions were taken into consideration, and their perspectives were valued.

Procedure

ITI activities were used to teach mathematics to the experimental group whereas conventional approaches were used for the control group. In contrast to the control group, the experimental group's student participants received the ITI intervention for a 06-week period. A table of specifications was created to uphold the text's authenticity. The inclusion of the entire chosen syllabus from the eighth-grade mathematics textbook released in Lahore, Pakistan, by the Punjab Curriculum and Textbook Board. Nearly every lesson plan presented a concept map relevant to that day's topics on Liquid Crystal Display (LCD). The lesson plans used in this study have used videos and animations related to implicit theory of intelligence. Videos and animations related to the topics in the math were downloaded from the official website of e-learn Punjab. The main characteristics of this intervention were, group formation of students for collaborative learning, scaffolding, teacher modelling, and competitions among groups. The competition among groups continued from the beginning to the end of the lesson. The ITI activities i.e., challenges, persistence, effort, praise, success of others and learning goal orientation added to the lesson plans were based upon the mentioned four learning theories i.e., behaviorism, constructivism, communities of practice, and connectivism. How these activities were put into action by the researchers in the experimental stage.

Data Analysis and Results

The data obtained as a result of the MAT test was entered into SPSS version 26. Descriptive Statistics and inferential statistics computed achievement of students in the subject of math.

Table 3

Comparison of the MAT using the results of the pre- and post-tests

Groups	*X*	*SD*	*t-value*	*df*	*Sig. (2-tailed)*
experimentation (pre-test)	13.59	.868	-28.625	34	.000
experimentation (post-test)	21.33	1.122			
Control group (pre-test)	13.43	.837	-1.000	34	.313
Control group (post-test)	13.46	.840			

Note: p=0.05 and n=35

Based on the outcomes of the pre- and post-tests, Table 3 compares the MAT scores of the same group. According to the values in this table, the experimental group outperformed. on the post test (mean: 21.33; SD: 1.122) than on the pre test (mean: 13.46; SD:.840). Statistics from the repeated measures Pre- and post-test scores differ according to paired sample t-test results. for the experimental group that is statistically significant, with a value of t (34) =-28.625, p0.001. Due to ITI activities, it was anticipated that the experimental group would perform better on the MAT post-test.

Table 4

Pre- and post-test scores for the MAT are compared between independent groups.

Groups	*X*	*SD*	*t-value*	*df*	*Sig.(2tailed)*	Cohen's *d*
Experimentation (pre-test)	13.59	.868	.620	68	.548	
Control group (pre-test)	13.43	.837				
Experimentation (post-test)	21.33	1.122	31.460	68	.000	7.4
Control (post-test)	13.46	.840				

Note: p=0.04-0.05 and n=35

MAT test (pre and post) results for independent groups are contrasted in Table 4. The outcomes of this table showed that both the experimental and control groups performed equally on the pre-test. Control group and experimental groups (mean: 13.43, SD:.837) Pre-test results for the experimental and control groups revealed no statistically significant difference, according to independent sample t-test statistics (t(68) =.620, p>0.001). The statistical significance of this difference is indicated by Cohen's d value of 7.4.

Discussion

On the basis of results, It was found that there was a significant effect of ITI on students' achievement in the subject of math at elementary school level. The findings of this study are congruent with those of earlier investigations (Aronson et al., 2002; Blackwell, 2007; Fitzakerley 2013; Yeager 2016). The previous studies showed that ITI intervention had a significant effect on achievement (Sarrasin et al., 2018).

Schools emphasise students' abilities while emphasising the importance of achievement. This contributes to the environment where performance is overvalued. Students' motivation propels them forward, moving them closer to success and accomplishment (Lee & Chung 2014). But it is more likely that students won't ever be inspired to use the strategies they have learned if they don't understand the relevance of the lesson's material in real life (Aikenhead, 2006; Kuhn & Muller 2014; Zeidler, 2014).

Conclusion

According to the study's findings, ITI activities are beneficial for teaching class VIII children mathematics. ITI activities consist of learning objectives, challenges, rewards, efforts, success of others, and perseverance. Because it has a connection to academic perseverance, the learning goal orientation activity was included (Dweck, Walton, & Cohen, 2014). In Dweck, further five activities are summarised (2006). Farrington (2013) asserts that the ITI has a beneficial association with deeper learning and that using this methodology would help students become competent in the subject of mathematics. Based on the aforementioned findings, it is advised that elementary school math teachers put these teaching strategies into practise. According to the nature and breadth of scientific issues, math teachers are advised to incorporate these exercises into their lessons.

Recommendations

1. According to the nature and range of math themes for teaching mathematics, it is advised that elementary school teachers may use ITI activities.
2. To increase kids' willingness to learn math, elementary school teachers are advised to use ITI activities in their lessons.

Recommendations for Future Researchers

1. As a sample of responders, this study focused on eighth-grade math students. It is advised that future researchers test the impact of ITI intervention on pupils in other grade levels as well.
2. It is advised that future researchers use the supply types test to examine the same factors with an emphasis on higher order cognitive domains. For accurate testing of higher cognitive domains, they can alter the study level.

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