ENHANCING ACHIEVEMENT THROUGH EVIDENCE BASED SELF-REGULATORY INTERVENTION ON STUDENT DIFFICULTIES IN HIGH SCHOOL MATHEMATICS

Thesis
Submitted for the degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

By

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Supervised By

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UNIVERSITY OF CALICUT
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DECLARATION

I, **ABIDHA KURUKKAN**, do hereby declare that this thesis entitled as "**ENHANCING ACHIEVEMENT THROUGH EVIDENCE BASED SELF-REGULATORY INTERVENTION ON STUDENT DIFFICULTIES IN HIGH SCHOOL MATHEMATICS**" is a genuine record of the research work done by me under the supervision of Dr. ABDUL GAFOOR K. Professor, Department of Education, University of Calicut, and that no part of this thesis has been presented earlier for the award of any Degree, Diploma or Associateship in any University.

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The thesis is not revised as there was no suggestion from the adjudicators for the same. It is further certified that the soft copy of the thesis submitted is the same as the printed copy submitted herewith.

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Abidha Kurukkan

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Abstract

This study was to identify students' affective difficulties in learning mathematics and to check the effectiveness of a self-regulatory intervention, developed on the basis of these difficulties, in improving student achievement in mathematics. Itused a mixed method in an embedded sequential design. The survey phase led to the experimental phase. Survey study involved qualitative phase using 500 standard IX students from 12 schools of Malappuram and Kozhikode districts of Kerala, India. The quasi experimental quantitative phase used four intact classrooms with a total of 151 students from Malappuram district. Measures used were Questionnaire on student perception of Mathematics, Raven's standard progressive matrices (Raven, 1958), Test of prerequisites in mathematics, Mathematical goal orientation inventory (Middleton & Midgley, 1997), Tests of achievement in: fractions and pairs of equations, Scales of self-efficacy for learning: fractions and systems of linear equations, Scale of mathematical ability conception, Scale of task value of learning mathematics, and Self-regulated learning strategy questionnaire. Experimental groups were exposed to lessonsboth on evidence based self-regulatory intervention through guided and self-practice in classroom along withcontent instruction via constructivist method,whereas the control group received the same instruction on content only. Survey phase revealed that perception of mathematics as difficult and disliked subject among significant share of students in Kerala is dependent on the affective and strategic deficits in learning it. The need and importance of self-regulatory intervention is evidenced from the finding that students have less than required prerequisite knowledge and they use surface strategies. These impacted their perception of mathematics as difficult. It was further revealed that secondary school students' feeling of difficulty in mathematics is significantly associated to their motivational factors like interest, values, self-efficacy, and ability beliefs, and their learning strategies. An intervention developed based on these evidences to develop self-regulated learning, enhanced student achievement in mathematics. Self-regulated learning interventions is found effective if it is practiced at least for a fortnight or longer. It was further found that self-regulated learning interventions resulted in significant and measurable increase of self-regulated learning practices of girls. Self-regulated learning intervention enhanced mathematics achievement and self-efficacy irrespective of students' nonverbal intelligence and level of prerequisites in mathematics. It enhanced self-efficacy in mathematics especially of students with incremental belief in ability to learn mathematics. Effectiveness of self-regulated learning interventions in enhancing achievements variedalso by motivational beliefs of students. Implications are identified and listed.

Chapter I

INTRODUCTION

- *Need and Significance of the Study*
- *Statement of the Problem*
- *Definition of Key Terms*
- *Variables*
- *Objectives of the Study*
- *Hypotheses of the Study*
- *Methodology*
- *Scope and Delimitation of the Study*

Mathematics has a unique position in school subjects. This owes in part to its utility value, abstract nature, and unique language. Mathematics is unique also owing to the number of people who see it as a difficult subject. Utility value of Mathematics is on the rise in this technological era. None can think about a life without mathematics. Human life needs knowledge of mathematics. Nevertheless, a good share of student population dislikes mathematics. Students become progressively afraid of mathematics as they move from junior to senior school (Mohamed & Tarmizi, 2010).

Do students, by the end of their compulsory education, acquire the knowledge and skills in mathematics essential to everyday life? The survey conducted by the Programme for International Student Assessment (PISA), in 2009, indicates that 60 percent of 15 year old students were below the lowest level of proficiency. Among the 74 countries tested, students from two Indian states came 72nd and 73rd in mathematics. This indicates that learning outcomes still remain a challenge (Sarva Shiksha Abhiyan, 2013).

Annual Status of Education Reports (ASER) of past years (2016, 2013 & 2010) indicate that more than 50 percentage of students fail to achieve even primary objective of mathematics learning such as basic arithmetic operations. ASER (2010) observes that among the 8th standard students in Kerala, only less than twenty percentage can subtract, and 80 percentage can divide. The same for the year 2013 observes that only 18.1 percent of students can subtract, and 62.7 percent can do division. 2016 report says 20.9 percent can subtract and 53 percent can do division. Also, status of mathematics learning is very poor when compared to other nations.

In spite of achieving low in mathematics, most students find mathematics as an important subject for its practical or utilitarian value. Mathematics has a very important position in our daily life, workplace, and in the development of science and technology. We use mathematics in every facets of our daily life. Mathematics learning helps in developing analytical mind, abstract thinking, and the intellectual capabilities (Peter, 2011; Fatima, 2005). Despite the varied efforts to improve outcomes of mathematics learning, students perform very poor in mathematics (ASER, 2018).

Learning is the process of making a long-term change in mental representations through experiences (Ormrod, 2013). It results in improved performance and increases the potential for future learning (Mayer, 2002). According to the nature of content or skill to be learnt, the process of learning may change. Nature of mathematics is very different from all other school subjects by its abstract nature and its complex inter relations. But students follow the same learning strategy for mathematics as that they follow for other subjects. As mathematics is very abstract, and its major objective of learning is to apply in different situations, students can excel in performing mathematics only if they are proficient in the subject. Students' learning approaches crucially determine this proficiency. Hence the science of learning is very important as much as that of teaching.

Mathematics learning has become a topic of research in developmental psychology, neuropsychology, experimental psychology and educational psychology as well as instructional science. These researches are aimed to get a better understanding of the process of mathematical knowledge acquisition, development of mathematical skills and affective factors related to its learning, and to improve the instruction and learning of mathematics using these knowledge (Verschaffel, Dooren & Smedt, 2011). As a result of this kind of researches, the instructional science of mathematics has moved from the traditional skill-based approach to cognitive constructivist-based instruction. Researches evidence that this shift is effective in improving achievement, problem solving and many affective factors (Onwuka, 2014; Savery & Duffy, 1995; Wheatley, 1991). In classrooms of Kerala, teachers have been following constructivist instructional practice for more than one decade. But recent reports too indicate that the status of mathematics learning has not improved to a desired level. Students learning strategy may be one of the reasons for this. Beyond the constructivist instruction, students' follow blind strategies like rote memorization for learning. Teaching fails to give proper attention to the students' affective learning.

Self-regulated learning theory is a relevant area of research in educational psychology due to its consideration to both cognitive and affective factors. It is emerged as a part of social cognitive theory of learning in the last decades of twentieth century. It attends motivational, emotional, behavioral, cognitive, and other affective aspects of learning. Several motivational beliefs also came into light along with it, such as self-efficacy, task value, goal orientation and ability conception or implicit theories of intelligence. Many survey studies were conducted among students at different levels from elementary (Yıldızlı & Saban, 2016) to college level (Dörrenbächer & Perels, 2016) and among pre-service (Buzza & Allinotte, 2013) and in-service teachers (Kramarski & Michalsky, 2009), to find out the relation of their self-regulation and performance. But only a few experimental studies (Clyde, 2015; Sontage & Stoeger, 2015; Eliserio, 2012) were conducted to test the effectiveness of Self-Regulated Learning (SRL).

Previous researches show that self-regulated learning and achievement are highly related. However most of the students do not know how to self-regulate their learning. In order to cope with the developmental demands of the evolving society, it is important to develop self-regulated learning skills in students (Delfino & Persico, 2009). So, this study is a step to identify students' affective and strategic difficulties in learning mathematics and to help them to follow self-regulation for their mathematics learning and thereby to improve their mathematics achievement.

Need and Significance of the Study

Aims of mathematics learning include both cognitive and affective components (Verschaffel, Dooren & Smedt, 2011). There are many survey studies regarding students' individual factors related to mathematics difficulties. These include impact of motivation (Sartawi, Alsawaie, Dodeen, Tibi & Alghazo, 2012), gender (Felson & Trudeau, 1991; Hyde, Fennema & Lamon, 1990), socio-cultural background (Bose & Kantha, 2014; Starkey & Klein, 2008), math anxiety (Ma, 1999) and cognitive difficulties (Geary, Hoard, Nugent & Bailey, 2012). Studies on effectiveness of instructional interventions (Berch & Mazzocco, 2007; Royer & Walles, 2007) mostly concentrate on cognitive components. Most of the experimental studies in mathematics education try to improve mathematics achievement and problem solving through cognitive interventions (Irving, Pape, Owens, Abrahamson, Silver & Sanalan, 2016; Booth & Koedinger, 2012; Ding, Piccolo & Kulm, 2007; Hegedus & Kaput, 2004).

Researches on areas other than cognitive outcomes of mathematics education neglect students' strategies for learning and their affective factors. While there are many studies on, 1) effectiveness of advanced technologies in teaching and learning mathematics (Scheiter, Gerjets & Schuh, 2010;

Hershkowitz, Dreyfus, Ben-Zvi, Friedlander, Hadas, Resnick, Michal Tabach & Schwarz, 2002) and 2) ways to overcome the difficulties of special populations such as learning disabled (Hott, Isbell & Oettinger, 2014; Panjaburees, Triampo, Hwang, Chuedoung & Triampo, 2013; Stylianides & Stylianides, 2013; Gersten, Chard, Jayanthi, Baker, Morphy & Flojo, 2009); there are proportionately very few studies regarding how to improve students' mathematics learning (Stylianides & Stylianides, 2013; Bishop, 1998).

Motivation is vital in all achievement situations including mathematics learning. It influences learning and academic achievement in multiple ways, such as selection, perseverance in difficult tasks, use of learning strategies, help seeking and time management. Extensive studies are being conducted in this area (Gladstone, Häfner, Turci, Kneißler & Muenks, 2018; Gunderson, Park, Maloney, Beilock & Levine, 2018; McKellar, Marchand, Diemer, Malanchuk & Eccles, 2018; Brisson, Dicke, Gaspard, Häfner, Flunger, Nagengast & Trautwein, 2017; Cleary & Kitsantas, 2017). To solve mathematical problems, patience and persistence is very important. Often it takes a lot of time and energy to resolve a problem. Hence, in the absence of required motivation, mathematics learning will become a tough task. Academic motivation and achievement levels of adolescent students found to have a decline in the transition from elementary to high school (Snowman & McCown, 2012). So, there is a need for motivational intervention among secondary school students to overcome their difficulty.

Learning strategies and instructional strategies are not entirely different but interrelated. Usually teachers focus on instructional strategies. They often neglect how students learn and choose learning strategies. Students follow surface learning strategies like memorizing equations or sticking to class notes. Students' selection of strategies may vary by their motivational beliefs. There is a growing importance of learning strategies over instructional strategies. It is teacher's duty, besides content instruction, to support students' learning. Better understanding of causes behind students' difficulties is required to help students in their mathematics learning, to overcome their difficulties, and to improve their achievement (Berch & Mazzocco, 2007). Some important factors that affects mathematics learning are motivational beliefs, fear of mathematics, mathematics anxiety and their learning strategy (Guven & Cabakcor, 2013; Hoffman, 2010; Schommer-Aikins, Duell & Hutter, 2005). One focus of this study is the non-cognitive factors such as students' motivational belief and their learning strategies that causes for mathematics being a difficult subject.

Schools in Kerala currently practice pedagogy based on constructivism. Learners are supposed to build their own meanings and understandings. This process involves interaction of students' existing knowledge and beliefs and new experience and knowledge (Schunk, 2004; Richardson, 1997). Constructivism is surely a valid instructional philosophy. Constructivism, as practiced in mathematics teaching gives more importance to cognitive domain, compared to students' motivation and metacognition. Self-regulated learning is not an instructional strategy but a learning strategy. In self-regulated learning, students set their own goals and control their behavior to achieve them. Self-regulated learning is an effective learning strategy that positively correlates with both achievement and motivation. Researches on self-regulated learning demonstrated positive and meaningful relationship between motivation levels and learning strategies of students with academic success (Chung, 2000; Ley & Young, 1998; Butler & Winne, 1995; Pintrich & De Groot, 1990; Zimmerman & Martinez-Pons, 1990). Self-regulated learning emphasizes autonomy and control by the individual who monitors, directs and regulates actions towards goals of information acquisition, expanding expertise and self-improvement (Paris& Paris, 2001).

Numerous models of self-regulation have been proposed over the past several decades. Self-regulated learning models proposed by Zimmerman (1998) and Pintrich (2004, 1999) are some important ones. Since Zimmerman and Schunk published their work on self-regulated learning in the year 1989, a great deal of research on self-regulated learning has been undertaken. Numerous researches (Agustiani, Cahyad & Musa, 2016; Cetin, 2015; Wolters & Hussain, 2015; Mega, Ronconi & De Beni, 2014; Zimmerman, 2000; Wolters, 1998; Pintrich & De Groot, 1990) show that self-regulated learning is an important predictor of students' academic motivation and achievement, and it develops better study habits.

Researches show that self-regulated learning is an effective learning strategy. Training of self-regulated learning strategies could enhance self-efficacy (Tavakolizadch & Ebrahimi-Qavam, 2011). Affective factors such as self-efficacy, intrinsic goal orientation, and test anxiety, along with metacognitive self-regulated learning were found as significant predictors of college students' performance (Al Khatib, 2010; Pintrich, 2000; Wolters, Shirley & Pintrich, 1996).

Self-regulation and motivation are interrelated. When students are motivated to learn, they are more likely to invest the necessary time and energy needed to learn and apply appropriate self-regulated learning skills. When students are able to successfully employ self-regulated strategies, they are often more motivated to complete learning tasks (Zimmerman, 2000). Self-regulation is not viewed as a fixed and unchanging property of the person. It is a set of skills that can be learned, that can be improved through practice, and one that can be adapted from one situation to another. Complex and radically changing world increasingly requires self-initiated and self-managed learning, not simply during the years associated with formal schooling, but across the lifespan. To be maximally effective, educational practice requires an appreciation of the incredible capacity that humans have to learn and to avoid the mindset that learning abilities are fixed (Bjork, Dunlosky & Kornell, 2013).

Practicing self-regulated learning is not easy (Pressley, 1995). Children and youngsters apparently do not become self-regulated learners and problem solvers automatically and spontaneously. Many students do not know how to self-regulate their learning. The self-regulated learning process requires students to plan, monitor and assess their learning by themselves. Most students need training in how to self-regulate their learning and other cognitive processes (Winne & Nesbit, 2010).

Self-regulation of the process of knowledge and skill acquisition and of problem solving is not only a major characteristic of productive learning but also it constitutes a main goal of long-term learning process (Corte, Verschaffel & Eynde, 2000). External self-regulation of mathematics learning help students in increasing mathematics achievement.

Most of the studies on self-regulated learning theory or its correlates were survey studies. Number of experimental or intervention studies to improve students' self-regulation or to improve achievement through self-regulation are very few, and most of these were conducted among students of higher education (Weinstein, Husman & Dierking, 2000; Pressley, 1995). Intervention studies indicate self-regulated learning has long term effect and it would be useful throughout the life, also it is transferable to other learning and achievement situations (Pressley, 1995). Mean while, it is also recognized that self-regulated learning is not easy to change students as self-regulated learners within a short duration as it is a complex process (Nussbaumer, Hillemann, Gütl & Albert, 2015; Pressley, 1995).

Nevertheless, most of these studies on self-regulated learning are conducted in western countries. The investigator failed to identify any study that attempts to enhance self-regulation in mathematics learning in Indian context. Therefore, self-regulated learning is worth experimenting in enhancing student achievement in mathematics. As self-regulated learning enhances student learning, an intervention based on models of self-regulated learning and previous research on self-regulation, would help students and teachers overcome difficulties in mathematics learning and thereby improve mathematics achievement.

SRL interventions are needed especially in mathematics. Whereas children's perception of interest and importance of mathematics activity positively impact their competence beliefs, and this relation gets stronger in higher grades and in mathematics; students' perception of mathematical interest and importance of mathematics decline over grades (Fredricks & Eccles, 2002). Seventh and eighth grade students demonstrate less cognitive strategy use in mathematics than social studies and English (Wolters & Pintrich, 1998). It is only recently that experimental studies on self-regulated learning received attention of educational researchers even in developed countries and the available results do not demonstrate consensus on its effects on math learning. This scenario ratifies the significance of studying the effects of SRL in India.

The inclusion of motivational variables like self-efficacy, task values, ability conception along with gender and intelligence into their study design, on effect of self-regulation in mathematics learning is pertinent. Zimmerman, who studied the self-regulation most extensively, himself has included self-motivational beliefs (2000, 2008) like self-efficacy beliefs, expectancy beliefs, task value, goal orientations and epistemological beliefs in the models that explained SRL. Self-regulated learners with higher self-efficacy, positive consequences beliefs, high task value, learning oriented and sophisticated epistemological beliefs, analyze the task, set goals and plan the strategies to achieve their goals.

Self-efficacy, one of the motivational belief, is studied extensively in academic situations because it influences amount of effort students invest in the situation, how much time they persist in difficult situation, their resilience, development of adaptive or maladaptive thoughts, and amount of stress and depression experienced by them (Bandura, 1997). Self-efficacy is important because it influences further education. Self-efficacy works as a mediator between epistemological beliefs and mathematics achievement (Rastegar, Jahromi, Haghighi & Akbari, 2010). In spite of the accumulating evidences on the relevance of self-efficacy to academic situations, and the concomitantly more research attention to it, studies regarding mathematical self-efficacy have been conducted mostly in two areas. One stream explored the effect of mathematics self-efficacy on performance outcomes (Kaya & Bozdag, 2016; Son, Han, Kang & Kwon, 2016; Enoma & Malone, 2015; Kalaycioglu, 2015; Pajares & Graham, 1999 ;Pajares & Miller, 1994), the remaining studies explored the relation of students mathematical self-efficacy with other motivational and psychological constructs (Lau, Kitsantas, Miller & Rodgers, 2018; Kim, Dar-Nimrod & Maccann, 2018; Unlu, Ertekin & Dilmac, 2017; Putwain & Symes, 2014; Bong & Skaalvik, 2003). Whereas effect of task value beliefs on adoption of SRL strategies is known (Mousoulides & Philippou, 2005), its effect on performance outcomes is low in comparison with self-efficacy (Wolters & Pintrich, 1998).

Even the effect of mastery goal orientation on achievement is suggested to be indirect, through self-efficacy (Mousoulides & Philippou, 2005).

Self-efficacy is studied many times in relation to self-regulated learning over achievement and problem solving. Self-efficacy in learning is known to enhance in-depth processing. The reciprocal relationship between self-efficacy and SRL is demonstrated by many research findings (Jaafar & Ayu 2010; Usher, 2009). While self-regulation is significantly and positively related to self-efficacy among eighth grade students in India (Jain & Dowson, 2009), lately there are indications that at least among primary school students' association between mathematics achievement and mathematics self-efficacy are more significant than that it had with implicit theories of intelligence (Bonne & Johnston, 2016) and even above and beyond previous academic achievement (Wigfield & Eccles, 2000). Since, mathematics self-efficacy is not at required level among different populations (Hannula, Di Martino, Pantziara, Zhang, Morselli, Heyd-Metzuyanim & Goldin, 2016), and if one experiencing failure always in a particular area, would result in a low self-efficacy, and if one met with success always, would result in a high self-efficacy (Devonport & Lane, 2006), this study among other hypotheses, seeks to verify whether SRL intervention enhances student self-efficacy in school mathematics.

Relevance of task value beliefs for mathematics learning, is self-evident. Students' task value for learning mathematics is an important predictor of their activity choices in mathematics during school years, especially in high school (Eccles, Wigfield, Harold & Blumenfeld, 1993). Task interest has been shown to be the primary motivational predictor of students' use of regulatory strategies during math learning. Task value of students is known to fluctuate according to the tasks and students' task value of mathematics reduces across 5^{th} through 12^{th} grade (Wigfield & Eccles, 1992). Task value is also found related to cognitive and metacognitive strategies, though they are not as strong as self-efficacy (Pintrich, 1999; Pintrich, Smith, Gracia & Mckeachie, 1993). Among the performance goal oriented students, importance of task is stronger (Gray, 2014). Hence, this study, probes whether task values of students can be modified through SRL intervention.

There are reasons to conjecture that students' ability and their beliefs on concept of ability, and the value of task do interact with effect of SRL on student achievement. Highly intelligent and high achieving students benefited more through the training of self-regulated learning than their peers with average intelligence and scholastic achievements (Sontag & Stoeger, 2015). Individuals' conception regarding ability is also named as implicit theories of intelligence or ability conception (Dweck, 2002). People can hold different theories of intelligence for different subjects and characteristics (Dweck, Chiu, & Hong, 1995). A person with an incremental theory of intelligence found to have more strong mastery goal orientation, as they believe that ability is malleable. They view learning as a means to develop their ability or mastery. Whereas a person with fixed theories of intelligence is found to have more performance goals orientation as they believe ability is fixed, they view learning as means to exhibit their ability (Dweck & Molden, 2000; Hong, Chiu, Dweck, Lin & Wan, 1999). Implicit theories of intelligence found to have an effect on mathematics grades from junior high school onwards. While mathematics grades are higher for students with incremental theories, those are lower in case of students with entity theory. Hence this study incorporates level of intelligence, ability conception about mathematics and task value beliefs about mathematics into its design.

Gender variation is evidenced in mathematics learning, metacognitive strategies and motivational beliefs. Girls in grade seven reported more frequent use of self-regulation strategies than boys (Cleary, & Chen, 2009). But boys tend to report more incremental nature of science ability in comparison to girls (Chen & Pajares, 2010). Studies suggest that effect of gender on self-regulated learning is mediated by culture, discipline of study and age. In Asian cultures the females tend to manifest less regulatory behaviours especially in mathematics. No gender difference is found significant in the relations among motivational and strategic components of SRL, self-efficacy, study interest, mastery goal orientation, self-regulatory strategy use and naive epistemological beliefs (Braten & Stromso, 2005). Hence in this study, gender-wise effect of SRL on the mathematics learning is also investigated in this study.

Thus, this study examines students' learning strategy and affective difficulties in learning mathematics, and develops and verifies the effectiveness of self-regulated learning strategy instruction based on the identified difficulties, in improving achievement, task value, self-regulation of learning and self-efficacy in mathematics by overcoming their difficulties.

Statement of the Problem

The study is entitled as "Enhancing Achievement through Evidence Based Self-Regulatory Intervention on Student Difficulties in High School Mathematics".

This study probes the affective and strategic difficulties in learning mathematics among high school students in Kerala and develops a self-regulatory learning intervention to be imparted through guided and self-practice in classroom and verifies the impact of this SRL instruction on achievement and self-efficacy in select units of mathematics and mathematics as a whole. It further verifies whether the SRL instruction provided for two differing durations impacts the extent of task values, self-efficacy in learning mathematics and self-regulated leaning in mathematics. The effect of self-regulatory learning instruction on the above variables is studied by the levels of non-verbal intelligence, prerequisites in mathematics, ability conceptions, goal orientations and gender.

Definition of Key Terms

The important terms that appear in the title of the study stands for the following.

Achievement

Achievement in mathematics is the extent of performance of pupils in mathematics as measured in terms of two achievement tests; achievement in fractions and achievement in pairs of equations; and also, achievement in affective domain outcomes such as self-efficacy for learning fractions, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value of learning mathematics and self-regulation of mathematics learning.

Evidence Based Self-Regulatory Intervention

Evidence based in this study denotes evidences collected through a survey on student difficulties and review of related literature.

Self-regulated learning (SRL) is “being metacognitively, motivationally and behaviorally active in one’s own learning process and in achieving one’s own goals" (Eccles & Wigfield, 2002). In self-regulated learning, students adopt cognitive, metacognitive and resource management strategies of learning to achieve their goals, and simultaneously evaluate and control their learning process.

Self-regulated learning intervention in this study means a set of activities focusing on self-awareness, goal setting, and use of learning strategies, planning, monitoring, and organizational strategy.

In this study, evidence based self-regulatory intervention is an intervention on students' cognitive, metacognitive, resource management, evaluation and control strategies of their learning, developed based on evidences collected through a survey and review of related literature.

Student Difficulties in Mathematics

In this study, student difficulties in mathematics denotes affective and strategic factors that negatively influence their mathematics learning that are identified through a survey among high school students. These factors relate to interest, value, self-efficacy and beliefs regarding nature of mathematics, role of effort and ability, and student learning strategies.

Variables of the Study

This study has two phases a survey phase and an experimental phase. The qualitative survey phase of this study considers affective and strategic factors that negatively influence students' mathematics learning as variables.

The experimental phase of this study which follows a quasi-experimental pretest-posttest control group design, has independent, dependent, control and moderator variables.

Independent Variable

Self-regulated learning strategy intervention which is provided to the experimental group along with the content instruction is the independent variable. This intervention is provided as self-regulatory learning strategy instruction. The control groups do not receive this intervention. But they receive the same content instruction.

Dependent Variables

There are a set of dependent variables that are outcomes of mathematics instruction namely achievement, self-efficacy, task value of learning mathematics and self-regulated learning which are hypothesized as influenced by self-regulatory strategy instruction.

1. **Achievement in mathematics.**

Achievement in mathematics is the weighted total achievement that students gained from the two chapters, fractions and pairs of equations.

2. **Achievement in fractions.**

It is the extent to which students has achieved the cognitive objectives of learning of the chapter fractions of standard nine mathematics.

3. **Achievement in pairs of equations.**

It is the extent to which students has achieved the cognitive objectives of learning of the chapter pairs of equations of standard nine mathematics.

4. **Self-efficacy for learning mathematics.**

It is the students' perception of efficacy to learn and perform well in mathematical tasks and to succeed in mathematics and in related situations.

5. Self-efficacy for learning fractions.

It is students' judgement regarding their ability to accomplish the tasks in the chapter fractions.

6. Self-efficacy for learning systems of linear equations.

It is students' judgement regarding their ability to accomplish the tasks in the chapter pairs of equation.

7. Task value of learning mathematics.

It is the students' perception of importance, utility and enjoyability of mathematical tasks indicated by the sum score of attainment value, utility value, intrinsic value and the inverse of cost value of learning mathematics.

8. Self-regulated learning.

In self-regulated learning, students adopt cognitive, metacognitive and resource management strategies of learning to achieve their goals, and simultaneously evaluate and control their learning process. In this study it is measured through self-regulatory learning strategy questionnaire.

Control Variables

Nonverbal intelligence

Prerequisites in mathematics

Gender

Teacher

Moderator Variables

Mathematical ability conception.

This variable denotes students' perception of fixed or malleable nature of mathematical ability.

Mathematical goal orientation.

Students' orientation towards, developing or demonstrating their ability in mathematics. Two types of goal orientations were considered here, mastery goal orientation and performance approach goal orientation.

Objectives of the Study

Major objective of this study is to identify students' affective and strategic difficulties in learning mathematics and to check the effectiveness of a self-regulatory intervention developed on the basis of the identified difficulties in improving their achievement in mathematics.

Following are the specific objectives of the present study.

1) To identify the motivational factors and learning strategies that associate with difficulties in learning mathematics for high school students.
2) To develop an Intervention on Self-Regulatory Learning based on the identified factors associated to students' difficulties in learning mathematics in high school.
3) To examine the effect of Intervention on Self-Regulatory Learning, in enhancing high school students'
    i) Achievement in fractions
    ii) Self-efficacy for learning fractions
4) To examine the effect of Intervention on Self-Regulatory Learning, in enhancing high school students'
    i) Achievement in pairs of equations
    ii) Achievement in mathematics
    iii) Self-efficacy for learning systems of linear equations

iv) Self-efficacy for learning mathematics

v) Task value of learning mathematics

vi) Use of self-regulated learning

5) To test the effect of Intervention on Self-Regulatory Learning for high school students on their:

i) Achievement in fractions

ii) Self-efficacy for learning fractions

by levels of

a) Gender

b) Nonverbal intelligence

c) Prerequisites in mathematics

d) Mathematical ability conception

e) Goal orientation in mathematics

6) To test the effect of Intervention on Self-Regulatory Learning for high school students on their:

i) Achievement in pairs of equations

ii) Achievement in mathematics

iii) Self-efficacy for learning systems of linear equations

iv) Self-efficacy for learning mathematics

v) Task value of learning mathematics

vi) Use of self-regulated learning

by levels of

a) Duration of intervention

b) Gender

c) Nonverbal intelligence

d) Prerequisites in mathematics

e) Mathematical ability conception

f) Goal orientation in mathematics

Hypotheses of the Study

Hypotheses of this study were the following:

1. Students' feeling of difficulty in mathematics is significantly dependent on their
   i. Motivational factors
   ii. Learning strategies
2. Intervention on Self-Regulatory Learning significantly enhances high school students'
   i. Achievement in fractions
   ii. Self-efficacy for learning fractions
3. Intervention on Self-Regulatory Learning significantly enhances high school students'
   (i) Achievement in pairs of equations
   (ii) Achievement in mathematics
   (iii) Self-efficacy for learning systems of linear equations
   (iv) Self-efficacy for learning mathematics
   (v) Task value of learning mathematics
   (vi) Use of self-regulated learning
4. Intervention on Self-Regulatory Learning significantly enhances high school students'
   (i) Achievement in fractions
   (ii) Self-efficacy for learning fractions

   equally for

   a) Boys and girls

b) High and low levels of nonverbal intelligence

c) High and low levels of prerequisites in mathematics

d) Mathematical ability conceptions

e) Goal orientations in mathematics

5. Intervention on self-regulatory learning significantly enhances high school students'

(i) Achievement in pairs of equations

(ii) Achievement in mathematics

(iii) Self-efficacy for learning systems of linear equations

(iv) Self-efficacy for learning mathematics

(v) Task value of learning mathematics

(vi) Use of self-regulated learning

equally for

a) Short and long interventions

b) Boys and girls

c) High and low levels of nonverbal intelligence

d) High and low levels of prerequisites in mathematics

e) Mathematical ability conceptions

f) Goal orientations in mathematics

Methodology

Design of the study, tools and techniques used for data collection, sample, and statistical analysis used in this study are briefly mentioned below.

Design of the Study

Present study uses mixed method involving qualitative and quantitative phases in an embedded sequential design, with the former survey phase leading to the latter experimental phase.

Phase I: Survey phase.

It is an exploratory phase, during which the investigator collected data to identify causal factors that make mathematics learning difficult by using Questionnaire on student perception of mathematics administered in a semi structured focus group interview. The data is collected from 500 high school students from Malappuram, and Kozhikode districts. After data collection, the identified factors are grouped into appropriate categories. Self-regulated learning strategy focusing on helping students solve their difficulties is developed based on the findings from this phase.

Phase II: Experimental phase.

This phase followed a pretest-posttest-control group design.

1. Four intact classes were selected for the experiment, after matching them in prerequisite in mathematics and non-verbal intelligence.
2. Then they are randomly assigned to two experimental groups and two control groups.
3. The evidence based self-regulatory intervention is done by two stages along with content instruction of two chapters (1. Fractions and 2. Pairs of equations). Content instruction of the two chapters in all groups were done using constructivist instructional strategy.
    i. In the first stage, two experimental groups were given self-regulated learning strategy instruction along with content instruction of the chapter fractions.
    ii. In the second stage one more group, that was considered previously as a control group was also given self-regulated learning strategy

instruction (The stage one experimental groups continued self-regulated learning strategy as self-practice along with the content instruction of chapter pairs of equations.)

4. Effectiveness of the intervention is checked afterwards with respect to all dependent variables.

The exact design of the study procedure can be denoted as follows.

		Stage 1		Stage 2	
G_1	O_1	$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$	O_5	$X_{SRL\text{-}SP\text{-}C(T)}$	O_9
G_2	O_2	$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$	O_6	$X_{SRL\text{-}SP\text{-}C(E)}$	O_{10}
G_3	O_3	$C_{(E)}$	O_7	$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$	O_{11}
G_4	O_4	$C_{(T)}$	O_8	$C_{(E)}$	O_{12}

G_1, G_2, G_3, G_4– are intact groups matched on nonverbal intelligence and prerequisites in mathematics.

$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$ - SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by experimenter)

$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$ - SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by teacher)

$C_{(E)}$ - Content instruction (by experimenter)

$C_{(T)}$ - Content instruction (by teacher)

$X_{SRL\text{-}SP\text{-}C(T)}$ - SRL strategy self-practice + Content instruction (by teacher)

$X_{SRL\text{-}SP\text{-}C(E)}$ - SRL strategy self-practice + Content instruction (by experimenter)

$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$ - SRL strategy instruction (Guided Practice-Shorter intervention) + Content instruction (by teacher)

$C_{(E)}$ - Content instruction (by experimenter)

O_1, O_2, O_3, O_4 - Pretests on mathematical ability conception, goal orientation in mathematics, achievement in fractions, achievement in pairs of equation, self-efficacy for learning fractions, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value for learning mathematics, use of self-regulated learning.

O_5, O_6, O_7, O_8 - Posttests on achievement in fractions and self-efficacy for learning fractions

$O_9, O_{10}, O_{11}, O_{12}$ - Posttests on achievement in pairs of equation, Self-efficacy for learning systems of linear equations, Self-efficacy for learning mathematics, Task value for learning Mathematics, Use of self-regulatory learning.

Tools and Techniques

As the study focused on the difficulties, tools used for the study are:

1. Questionnaire on student perception of Mathematics
2. Raven's standard progressive matrices (Raven, 1958)
3. Test of prerequisites in mathematics
4. Mathematical goal orientation inventory (Middleton & Midgley, 1997)
5. Test of achievement in fractions
6. Test of achievement in pairs of equations
7. Scale of self-efficacy for learning fractions

8. Scale of self-efficacy for learning systems of linear equations
9. Scale of mathematical ability conception
10. Scale of task value of learning mathematics
11. Self-regulated learning strategy questionnaire
12. Lesson plans for evidence base self-regulatory intervention.
13. Lesson plans based on constructivism.

Sample

The survey is conducted on a random sample of 500 ninth standard students from twelve schools of Malappuram and Kozhikode districts.

For the standardization of the tools developed for the study, sample was 370 ninth standard students.

For the experimental study, students in four intact standard nine classrooms, from Oriental Higher Secondary School, Tirurangadi, Malappuram were the sample. There were total 151 students. These groups were matched on nonverbal intelligence and test of prerequisites in mathematics.

Statistical Techniques Used

In addition to the basic descriptive statistics, the following statistical techniques were used.

1) Chi-square test of association
2) Z test for comparing two population proportions
3) Shapiro-Wilk test of normality
4) Levene's test of homogeneity of variances
5) One-way and two-way analyses of variance (ANOVA)

6) Kruskal-Wallis test
7) Test of significance of difference between means
8) Estimation of effect size, partial eta-squared

Scope and Delimitation of the Study

This study intended to improve students' achievement in mathematics by overcoming their difficulties in learning mathematics with the help of self-regulated learning strategy. Current status of mathematics education in India indicates that students' achievement in mathematics lies far behind of expectation, and a large share of students feel mathematics as a difficult subject. So, a self-regulated learning strategy intervention is developed on the basis of identified difficulties.

Initial survey on difficulties in learning mathematics identified that lack of previous knowledge, students' learning strategies and their negative beliefs regarding mathematics make mathematics learning difficult. Students reported algebra as the most difficult area in mathematics. So, to overcome these difficulties and to improve their achievement in mathematics, self-regulated learning strategy intervention was designed.

The effect of self-regulatory strategy intervention on an array of mathematics instructional outcomes- achievement, self-efficacy, ability conceptions, task value beliefs and use of self-regulated learning are studied. A four-group design is used to counter balance the effect of content instruction by different teachers and to test the effect of duration of SRL intervention. For transacting these strategies to students, two algebra related chapters were selected from standard nine mathematics, as students reported as the most difficult area in mathematics.

Three different samples were used in this study. For identifying students' difficulties in learning mathematics focus group interview was conducted among 500 standard nine students. For the experiment part of the study four intact classrooms were used. The experiment was designed to study the effect of long term and short-term interventions. Tools were standardised in another set of samples.

Eight standardized tools with reasonable reliability and validity were developed for data collection, including two achievement tests, three scales of self-efficacy, scale of task value of learning mathematics, scale of mathematical ability conception and self-regulated learning strategy questionnaire. A test of prerequisite in mathematics and a questionnaire on student perception of mathematics were also developed as part of the study.

Control and experimental groups were taught the content by constructivist instructional strategy. Before the content instruction, self-regulated learning strategy instruction were given to experimental groups for 5 sessions of 40 minutes duration, and students practiced it along with the content. Students developed concept maps as part of instruction on organizational strategy for learning.

This study is delimited to students' difficulties related to their affective beliefs and mathematics learning strategies. It has not addressed students' cognitive difficulties such as difficulties in understanding mathematics. Initial survey on difficulties in learning mathematics is not state wide, only students from Malappuram and Kozhikode districts of Kerala were considered. The study is delimited to standard nine high school students. For the experimental part of the study, all participants were selected from one school only. The treatment is given for duration of two months only. The self-regulated learning strategy intervention is a combination of motivational and strategic components, but this study does not explore individual contributions of these components.

Chapter II

REVIEW OF RELATED LITERATURE

This study seeks to overcome students' difficulties in mathematics originating from their motivational beliefs and maladaptive learning strategies. It tests the effectiveness of self-regulated learning strategy instruction in enhancing students' achievement. Self-regulated learning strategy instruction made use of modelling of different motivational, cognitive, and metacognitive strategies, guided as well as self-practiced.

This chapter served two purposes. One, a review conducted on self-regulated learning strategies indicated that strategies help overcome students' difficulties through the use of self-regulated learning. Two, it provides a summary and explanation of the current state of knowledge on self-regulated learning and its associated factors as found in academic books and journal articles. This chapter features and correlates motivational beliefs using information gathered from academic books and journal articles.

Theoretical Overview of Self-Regulated Learning

This section covers the definitions of self-regulated learning, skills associated with self-regulation, and the important theories of self-regulation namely Zimmerman's theory of self-regulated learning and Pintrich's theory of self-regulated learning.

Preliminary Constructs

Emergence of research on self-regulated learning.

Research on self-control in behavior modification and personal development paved stones for self-regulated learning research (Meichenbaum, 1977; Kanfer, 1971). Early research on self-regulation started with personality research in therapeutic context (Schunk & Zimmerman, 2012; Bolstad & Johnson, 1972; Kanfer & Karoly, 1972; Nadel, 1953). Earlier, the mostly used terminology was self-control, instead of self-regulation (Damon, 1988). Role of self-regulation is studied in many situations of applied psychology fields like sports psychology, and health psychology. Nowadays, it is mostly applied in the field of academic learning (Zimmerman, 2008) and motor skill training (Toering, Elferink-Gemser, Jordet & Visscher, 2009; Robazza, Pellizzari & Hanin, 2004; Cleary & Zimmerman, 2001).

Research on academic learning began with behaviorist tradition which was later taken by cognitivist approach in the 1950s. Till 1980s, research on cognitive learning and motivation travelled on different roads. These two parallel paths converged by the emergence of social cognitive theories. While cognitive theories and motivational theories approach learning from different directions, self-regulated learning theories approach learning with combination of these two along with emotional and contextual components (Hall & Goetz, 2013; Zimmerman, 1998).

Definition of self-regulated learning

Proportionate to research in self-regulated learning, there are many definitions to self-regulated learning given by many researchers. Most of these definitions share similar idea that, it is a planned strategy followed by students to achieve their learning goals by directing their behavior. The term self-regulated learning is a combination of three important constructs, ‘self’, ‘regulation’ and ‘learning’ (Hall & Goetz, 2013). Self refers to students’ initiative in setting and achieving their own goals. Regulation refers to the actions taken to reduce the discrepancy between their current behavior and goal behavior. Learning is the process of acquiring knowledge and skills. On the basis of these, Hall and Goetz (2013) give a comprehensive definition for self-regulated learning. Accordingly, it signifies "a form of acquiring knowledge and skills in which learners are independent and self-motivated. Learners independently choose their own goals and learning strategies that will lead to achieving those goals. It is through evaluating the effectiveness of one's learning strategies- comparing one's current state with the target state- that learning can be modified and optimized".

Self-regulated learning is defined as the strategies that students use to regulate their cognition (i.e., use of various cognitive and metacognitive strategies) as well as the use of resource management strategies to control their learning (Pintrich, 1999). Eccles and Wigfieldin 2002, defined self-regulated learning as, being metacognitively, motivationally and behaviorally active in one's own learning process and in achieving one's own goal.

As per Schunk and Zimmerman (2012) self-regulated learning refers to "the process by which learners personally activate and sustain cognitions, affects and behaviors that are systematically oriented towards the attainment of learning goals".

Skills of self-regulated learners.

To begin and sustain self-regulated learning, the individual needs a collection of skills (Hall, & Goetz, 2013), such as

- Ability to set appropriate learning goals by themselves. Goals should be attainable by students, within the stipulated time and with optimal effort. For doing this, students need to know the objective and importance of the particular content and task.

- Ability to diagnose the discrepancy between target state and present status while they proceed through the learning process, for example to rate their progress of learning for achieving the desired goal.
- Knowledge and skills to control and direct their behavior, and to reduce the diagnosed discrepancy. That is, if one finds any discrepancy while checking the present status and target state, he or she has to find out corrective measures such as trying another learning strategy, spending more time or reducing.
- Necessary motivation to initiate and maintain the learning as another important skill for practicing self-regulated learning. That is, students need a goal and desire for learning and achievement, this makes them persist in the task and avoid other activities over the task.

Students' ability to use all these skills in their behaviors collectively would determine their success as self-regulated learners, ability in a single skill may not be effective. For example, students can achieve nothing with a good goal without sufficient motivation.

Theories of Self-Regulated Learning

There are a number of theories of self-regulated learning such as of Boekaert's three layered model (1999), Winner and Perry's four phased model (2000), Zimmerman's three phase model (1989) and Pintrich's frame work for self-regulated learning (1999 & 2004). All these theories share the similar idea that it is a process of achieving the optimum learning or achievement, through goal setting, monitoring, and controlling their motivation, cognition, behavior and context. A fundamental distinction found among these theories are whether self-regulated learning follows a hierarchical nature or process nature.

Among the models pointed above, Boekaert's (1999) and Pintrich's (1999) are of hierarchical and the remaining two are process models. In hierarchy, constructs were arranged to different levels in a given hierarchy, whereas, process-oriented model follows temporally arranged phases of learning process, for example monitoring the process of learning before evaluation. Among all these models, Zimmerman's and Pintrich's models of self-regulated learning got the popularity in self-regulated learning research. These two models were explained in the following sections.

Zimmerman's theory of self-regulated learning.

Social cognitive view of self-regulated learning was presented by Zimmerman through his three models of self-regulated learning (Panadero, 2017). Triadic analysis of self-regulated learning, Zimmerman's first model of self-regulated learning, views self-regulated learning as a reciprocal causation among three processes; personal processes, environmental and behavioral events. Then Zimmerman proposed a cyclical phases model (2000) and later revised it by adding metacognitive and volitional strategies to performance phase (Panadero, 2017). The initial cyclical model on self-regulated learning (Zimmerman, 2000) focused on cognitive process underlying self-regulated learning process. These include use of cognitive strategies, monitoring, time and learning environment management along with self-efficacy. However later researches added more motivational factors and processes as a major line of self-regulated learning research. They include goals, goal orientations, self-efficacy, task value, attributions and self-evaluation (Zimmerman & Moylan, 2009; Zimmerman, 2008; Zimmerman, 2000).

Self-regulated learning is a proactive approach to learning in which the students themselves taking initiative of their motivation, monitoring and controlling process of behavior, and successively using metacognitive strategies (Schunk & Zimmerman, 1998; Zimmerman, 1986). Zimmerman (1998) advocated that self-regulated learning is not a mental ability like intelligence and not an academic skill like mathematical skill or reading proficiency, rather it is a process of giving direction to students by themselves to achieve maximum. Zimmerman analyzed underlying processes of self-regulated learning and proposed that it follows a cyclical process with three phases (Schunk & Zimmerman, 1998).

Cyclical phases model of self-regulation.

Zimmerman's model of self-regulated learning is a process model, it presents self-regulated learning through three cyclical phases. Zimmerman presented his theory of self-regulated learning (1998) as an open-ended process following a cyclical activity. It has three phases; forethought phase, performance or volitional control phase and self-reflection phase respectively. Forethought phase covers stage setting for learning and the related motivational aspects that leads to effort (Zimmerman, 1998). Processes that occur during learning, represents performance or volitional control phase. In self-reflection phase learner look back to the experiences and assesses the effort and achievement. The obtained reflections influence the subsequent learning and advance to new or restructured forethought phase, which is plans new one from the experiences gained from the previous one.

Outline of three phases of self-regulated learning (Cleary & Zimmerman, 2012) is given in Table 1.

Table 1

Outline of Three Phases of Self-Regulated Learning

Phase I Forethought phase	Phase II Performance phase	Phase III Self-reflection phase
• Task analysis	• Self-control	• Self-judgement
• Self-motivational beliefs	• Self-observation	• Self-reaction

Phase 1: Forethought phase.

Forethought phase is the pre-activity and stage setting phase, where learner analyzes the task. It refers to the important beliefs and processes that leads to effort on task. Forethought has two categories; task analysis and self-motivational beliefs.

Task analysis in SRL.

The process of task analysis includes setting of goals, and strategic planning or formulation of strategies. Goal setting, in the process of self-regulated learning is not merely setting one or more long term goals. Instead it divides goals into many time-bound, specific, short-term sub goals, which are realistic, measurable and attainable. For example, to achieve a good grade in mathematics the student has to set goals, to regularly engage the class with keen attention, to study mathematics for a specific number of hours per week, to work out the practice questions in each chapter, to prepare very well for unit tests, to seek help from peers and teachers when needed.

The individuals have to set goals by themselves by referring to their level of achievement that should be attainable through particular level of effort. It should not be too easy as it is attainable without any effort or too difficult that could not attainable with all effort (Latham & Steele, 1983; Latham & Locke, 1979). For example, in a goal setting activity, while practicing for first time, a student with low achievement in mathematics has to set a score higher than his usual score, but should not set the maximum score as his goal.

After setting goals the individual has to plan well to accomplish all this. Good planning is fair part of self-regulated learning. The subject has to select the best method among the known methods that suits better in case of the particular task (Zimmerman, 2002).

Self-motivational beliefs in SRL

An individual's ability to set proper goals and planning skills would have little use if he/she had no motivation to use it; that is the importance of self-motivational beliefs in the forethought phase. Zimmerman later on included self-motivational beliefs (2000, 2008) like expectancy beliefs, task value, goal orientations and epistemological beliefs (Zimmerman, 1986).

Self-efficacy here refers to the individuals' beliefs about his own capability to follow self-regulatory process. Expectancy beliefs refer to the expectations regarding the consequences of achieving the goal. Task value refers to the individuals' intrinsic value and utility value to the task. It works in the absence of external rewards or when the external reward is not attractive. Goal orientation refers to the patterns of the goals. There are two patterns, performance orientation and mastery orientation. Performance orientation means the primary goal of individual to expose or show his/her competence to others. In mastery orientations individuals' aim is to master the task. Mastery orientation is found apt in promoting self-regulated learning processes than performance orientations (Zimmerman, 2000).

One's beliefs about the nature of knowledge and the ways we come to know things refers to epistemological beliefs. Epistemological beliefs are important in self-regulated learning processes because it affects self-regulated learning in some ways (Stahl, Pieschl & Bromme, 2006). For example, one who has belief that knowledge is a collection of unrelated facts will follow blind or peripheral strategies like rote learning, while one believing knowledge as a collection of interrelated facts would likely to follow deeper strategies, and will try to relate them with previous ones. And one who believes learning occurs quickly is not likely to persevere in difficult situations, but others instead of leaving the task, they will change the strategy (Snowman & McCown, 2011; Muis, 2007).

In short, in the forethought phase, a self-regulated learner with higher self-efficacy, positive consequences beliefs, high task value, learning oriented and sophisticated epistemological beliefs, analyzes the task, sets and plans the strategies to achieve the goals.

Schunk (2001) describes that young children will have difficulty in forethought phase than older children because of their limited ability to attend and follow a model, and in formulating and maintaining well-defined long-term goals.

Phase 2: Performance phase.

In the performance phase learner processes the information by focusing on the task. Performance or volitional control phase refers to the process that occurs in the time of learning effort and it would affect attainment of the goal or achievement. These processes help the learner to concentrate on task, to process the information meaningfully, and to optimize their performance (Schunk & Zimmerman, 1998; Snowman & McCown, 2011).

Processes in the performance phase are subdivided into two categories; they are self-control and self-observation.

Self-control.

Self-control includes attention focusing, self-instruction and tactics. Attention focusing refers to the actions followed by the learner to protect his attention in the task, from distractors. It includes avoiding the thoughts about failures or mistakes in previous attempts. Switching off the mobile phone while studying, to not get distracted, is an example of volitional process. The higher the self-regulation, the lower the chance for getting distracted. Higher attention focusing with low self-regulation, causes higher chances to get distracted, and for low concentration. In self-instruction the subject himself instructs the action plan to accomplish the task (Zimmerman, 1998). Tactics or task strategies are memory or comprehension guided techniques used to improve memory or comprehension of learning material (Zimmerman, 1998). Students have to choose the tactics that best suit for a particular task.

Self-observation.

Self-observation or self-monitoring process includes recording of one's behavior (self-recording) and trying out different forms of behaviors (self-experimentation). It is an important but problematic phase. It is the process of self-control or regulation as it provides feedback to learners regarding their process (Winne, 1995; Schunk & Zimmerman, 1998). Self-monitoring is more important during the early periods of learning, but as it become routine, they need less intentional monitoring. Writing learning diaries, journal and logbooks are examples for self-recording that helps the learner to monitor themselves and to be in line with goals. Self-recording helps the learner to understand his desirable and undesirable behavioral pattern in relation to learning. It creates the thought of how well they proceed to their goals; what difficulties are being faced by them and how they can overcome those. These self-recording process leads to self-experimentation. Through self-experimentation, learner might try new techniques or behavior to overcome undesirable behavioral patterns, so as to achieve better results.

Phase 3: Self-reflection phase.

In this phase, self-regulated learners critically evaluate their performance and make appropriate attributions for the result by comparing their actions with the previous one; then self-reinforcing for performance in the present task, and motivating for the next. This phase also has two categories, self-judgement and self-reaction. Each of them comprises two self-regulatory processes.

Self-judgement.

Self-judgement process includes self-evaluation and causal attributions. In self-evaluation the individual compares his or her performance with some standards like their goals or grades they achieved in the test. However, when a prescribed standard is not present, self-regulated learners evaluate how well they performed in the task with respect to their peers. Students make self-evaluative judgements through different ways like how well they attained mastery, comparing their present performance with previous, comparing their performance with their peers. The second process, attribution, is a result of self-evaluation. In this process individual analyses, the causes of the particular result and attributes the success or failure to effort, ability, difficulty of task and luck. Attributional errors cause for negative reactions like give up. Students' implicit theories of intelligence and goal orientation influence attribution (Dweck, 2000). Self-regulated learners would likely to attribute failure to controllable internal causes, like lack of effort, and this kind of positive attribution results in positive reactions. Whereas other students tend to attribute failure to uncontrollable internal causes such as lack of ability, and result in maladaptive responses.

Self-reaction.

Self-reaction category is a combination of self-satisfaction and adaptive inferences. Self-satisfaction is the pleasant feeling experienced by the learner when he recognizes that he has done the task well and has attained the goals that he set in the initial stage. Upon completion of the task, learner would have some reflections about the necessity to improve their self-regulatory skills. These are called adaptive inferences. Attribution helps to identify the sources of learning errors, along with self-reaction. So, the learner will react to the errors by correcting it through a systematic variation in their learning approach, and it continues until he discover a strategy that work best for him, for that task. This is called adaptation process. There may take many practice cycles to reach the adaptation process for an important academic skill (Schunk & Zimmerman, 1998).

When they are dissatisfied with their performance, to avoid bad experience or aversive affect, there are chances for learners making different defensive inferences, instead of having adaptive inferences (Zimmerman, & Cleary, 2009). These individuals may have little interest in the typical task and end up with the thought that there is nothing to do with improving self-regulatory skills. As a consequence of defensive inferences, these students go to maladaptive behaviors like procrastination, task avoidance and helplessness, cognitive disengagement and apathy (Gracia & Pintrich, 1994, as reported by Zimmerman & Cleary, 2006).

Younger children may find difficulty in this phase, due to their limited ability in judging their ability by comparing themselves to peers, making proper or correct attributions for their success or failure, and assessing their capabilities accurately (Snowman & McCown, 2011).

Multi-level model of self-regulation.

According to Zimmerman (2000) there are four levels for development of self-regulation namely; observation, emulation, self-control and self-regulation. Observation is vicarious induction of a skill from a proficient model. Emulation involves the general pattern or style of the performance of the model with social assistance. In self-control, learner has ability for independent display of the performance in a structured condition. In the final phase, self-regulation, the learner can adapt the skill across personal and environmental conditions.

Pintrich's theory of self-regulated learning.

Pintrich has advocated two models of self-regulatory learning. Though the first model by Pintrich (1999) was hierarchical, later he proposed a time ordered sequential model with four phases (Pintrich, 2004 & Pintrich, 2000), but without a strong assumption of linear structure. That is, each phase is not certainly preceded by the previous one. Among his models, hierarchical model got more attention than his process model. Pintrich's two models of self-regulated learning (1999, 2004) are discussed below.

1. A model of self-regulated learning (Pintrich, 1999)

Pintrich's first model of self-regulated learning is a hierarchical model, which explains role of three general categories of strategies for learning; cognitive, metacognitive and self-regulatory, and resource management strategies. This model also explain how these strategies are related to the three general motivational beliefs (Pintrich, 1999).

Cognitive learning strategies.

Learning strategies are defined as the behavior and thought such as selection, acquisition, organization or integration of new knowledge, that are followed by learners to manage their encoding process (Weinstein & Mayer, 1986). According to Weinstein, Husman, and Dierking (2000) learning strategies include "any thoughts, behaviors, beliefs, or emotions that facilitate the acquisition, understanding, or later transfer of new knowledge and skills". Learning strategies can be deep level or surface level. Reflective strategies in which learner attempts to integrate latest information with prior knowledge and thereby achieving meaningful learning, are referred as deep learning strategies. Whereas surface learning strategies refer to rot or blind memorization through rehearsals. In comparison to surface strategies, deeper strategies facilitate encoding and recall (Murayama, Pekrun, Lichtenfeld & VomHofe, 2013)

By following the work of Weinstein and Mayer (1986), Pintrich (1999) proposed rehearsal, elaboration and organizational strategies as the important categories of cognitive strategies that used in learning. Each strategy can be applied to simple task as well as complex learning tasks; for example, in rehearsal strategies, from mere rehearsal or copying to shadowing the material presented or note taking (Weinstein & Mayer, 1986).

Rehearsal strategies.

Rehearsal strategies include strategies like repetition of the content, repeating words aloud (shadowing), underlining or boxing the main points and note taking. These strategies help the learner to attain two important goals, selection (identifying and paying more attention) and acquisition (transferring it into working memory) of the material. Though the mere repetition of content is not a deep level strategy, strategies like note taking are complex strategies (Weinstein & Mayer, 1986). In mathematics, students usually use this strategy to memorize equations. But if they are using only rehearsal strategies such as revising the class notes, or repeatedly solving the problems that were solved by them or by their teacher in the classroom, or only memorizing equations to learn mathematics, they can't achieve the objectives of mathematics learning.

Elaboration strategies.

Elaboration strategies include strategies like paraphrasing, summarizing, creating analogies, relating information (that is, relating the new information with their existing knowledge), explaining the material to self or others. Generative note taking and relating the new information with existing are more elaborative deeper strategies. These strategies help the learner to improve memory by moving long term memory knowledge into working memory through integrating prior knowledge and present one (Weinstein & Mayer, 1986).

Organisational strategies.

Organizational strategies include strategies like selecting and outlining main idea from the content to be learned, creating concept maps, process charts and connection charts. This strategy helps the learner to recognize the main ideas and the relevant supporting facts and their inter connections and thereby endorsing memory. As it is a deeper strategy, it facilitates deeper understanding of the learning material than rehearsal strategies.

Metacognitive and self-regulatory strategies.

Among the two general aspects of metacognition, metacognitive knowledge and metacognitive self-regulation, Pintrich's model has focused on metacognitive self-regulation, which is self-regulation of cognition. Metacognitive knowledge refers to individual's knowledge about person or himself, and task strategy (Pintrich, 2002; Pintrich, Wolters & Baxter, 2000; Pintrich, 1999). Metacognitive self-regulation or self-regulation of cognition includes planning, monitoring and regulating of cognition (Pintrich, 1999). These strategies had found high conceptual relation to each other (Pintrich, Wolters & Baxter, 2000; Pintrich, Smith, Garcia & Mckeachie, 1993)

Planning strategies.

These strategies include goal setting for the study, quickly going through and making questions from the content before reading that, and analyzing the learning task. These strategies help the learner to select the cognitive strategies, activate prior knowledge and there by promise simple organization and comprehension of the learning material.

Monitoring.

Monitoring refers to the examination of level of achievement for the self-set goals or any other criterion. In order to guide the monitoring process and self-regulation, students must have any standards, goals or criterion to compare their performance. While reading or listening classes making sure of attention and understanding, examining comprehension of lecture, self-checking, understanding of the material by self-questioning, are examples for monitoring process. Monitoring processes help the learner understand his position, and correct it through regulation strategies (Pintrich, 1999).

Regulation strategies.

While one person monitors his performance against a criterion, it would give an account of their current level and need for betterment to bring performance in line with goal. After reading a portion, if one fails to answer self-questioning, he would go back and read it again with a slow pace for difficult portion, is an example for regulation strategy. So, monitoring process is closely related to regulation strategies. Monitoring processes suggest need for regulation strategies to get in line with their goals. Regulation strategies help learners correct their study behavior and improve their understanding (Pintrich, 1999).

Resource management strategies.

The strategies that used by learner to effectively manage and control their resources such as time, effort, environment and other people like teachers and peers, are referred as resource management strategies. It helps the students to adapt or change their environment to benefit their learning and to achieve their goals. Resource management strategies also include help seeking from teachers and peers.

Role of motivational beliefs in self-regulated learning.

The Pintrich's model of self-regulated learning discussed role of self-efficacy beliefs, task value beliefs and goal orientation in promoting, sustaining or facilitating self-regulated learning. Pintrich explored these relations in both middle school and college students (Pintrich, 1999).

2. A conceptual framework for self-regulated learning.

Pintrich (2000, 2004) proposed a process theory of self-regulated learning, ‘a conceptual framework for self-regulated learning’ with four phases (1) Forethought, planning and activation;(2) Monitoring; (3) Control; and (4) Reaction and reflection.

- Phase 1, along with planning and goal setting includes activation of perceptions and knowledge of the task and context and the self in relation to the task.
- Phase 2, includes various monitoring processes such as metacognitive awareness of different aspects of the self and task or context.
- Phase 3 concerns efforts to control and regulate their self and context
- Phase 4 includes the reactions and reflections developed in the learner, through their activities, regarding their self in relation to task and context

There are four different areas for regulation: cognition, motivation, behavior, and context in each of the four phases.

Assumptions on self-regulated learning.

Pintrich formed his conceptual framework for self-regulated learning based on four assumptions (2004).

1. Active, constructive assumption: learners are viewed as an active participant in the learning process, and they are assumed to construct their own meanings, goals, and strategies from the available information.
2. The ‘potential for control assumption’: it is assumed that learners can monitor, control, and regulate some aspects of their own cognition, motivation, and behavior and some environmental features.

3. The ‘goal, criterion, or standard assumption’: the learners compare their learning process against some type of goals, criterion or standards, to check whether their learning process meets their needs or some type of changes is necessary to meet the goal.
4. Self-regulated learning activities mediates the relation of personal and contextual characteristics, and also the relation of actual achievement or performance: learner self-regulation of their cognition, motivation, and behavior determine their eventual achievement along with direct factors like their cultural, demographic or personality characteristics, and contextual factors like classroom environment.

Phases and areas for self-regulated learning.

In his four phased time-ordered sequence model, Pintrich did not assume the phases as hierarchically or linearly structured. As the individuals progress through the task, their goals and plans may change, or may be updated based on their monitoring, controlling, and reaction process. The empirical studies also suggest that monitoring process and control or regulation processes are not mutually exclusive. Pintrich explained different areas of regulation that one can attempt to plan, monitor, control, and regulate. The columns represent areas of self-regulation, distributed over four domains, cognition, motivation, behavior and context. Instead of the phases of self-regulated learning, Pintrich explained his theory on the basis of regulation process in the four domains. Pintrich (2004) represents his whole model through a table, which is given below.

Table 2

Phases and Areas for Self-Regulated Learning

Phases and Relevant Scales	Areas for regulation			
	Cognition	Motivation/Affect	Behavior	Context
Phase 1 Forethought, planning, and activation	Target goal setting	Goal orientation adoption	Time and effort planning	Perceptions of task
	Prior content knowledge activation	Efficacy judgments	Planning for self-observations of behavior	Perceptions of context
	Metacognitive knowledge activation	Perceptions of task difficulty Task value activation Interest activation		
Phase 2 Monitoring	Metacognitive awareness and monitoring of	Awareness and monitoring of motivation and affect	Awareness and monitoring of effort, time use, need for help	Monitoring changing task and context conditions
			Self-observation of behavior	
Phase 3 Control	Selection and adaptation of cognitive strategies for learning, thinking	Selection and adaptation of strategies for managing, motivation, and affect	Increase/decrease effort	Change or renegotiate task
			Persist, give up	Change or leave context
			Help-seeking behavior	
Phase 4 Reaction and reflection	Cognitive judgments	Affective reactions	Choice behavior	Evaluation of task
	Attributions	Attributions		Evaluation of context

Regulation of cognition.

Regulation of cognition represents the activities and strategies used by students to plan, monitor and control their cognition.

i. Cognitive regulation includes setting specific cognitive goals for learning, retrieving previous knowledge of the current material to be studied and also activating the metacognitive knowledge that the students might have about the present task.

ii. Monitoring of cognition refers to the processes used by the students to monitor their progress towards their goal, monitoring their learning and comprehending to make adaptive changes in their learning (Pintrich, 2000).

iii. Cognitive control includes cognitive and metacognitive activities used by the students to engage into and to adopt and change their cognition. It includes selection and use of various cognitive strategies for various learning activities.

iv. Cognitive regulation of reaction and reflections encompass students' cognitive reaction about how they did and their attributions about their performance.

Regulation of motivation and affect.

The second aspect of self-regulated learning, regulation of motivation and affect includes the strategies that can be used by individuals to regulate their motivational beliefs such as goal orientation, self-efficacy, task value, perceptions of task difficulty, and personal interest in the task, and various coping strategies to control their affect and emotions that would help the students to overcome their negative affect such as fear and anxiety. Motivational self-regulatory strategies include positive self-talk, to control their self-efficacy, promising themselves extrinsic rewards to increase their extrinsic motivation, trying to make the material more interesting to increase intrinsic motivation and to maintain more mastery orientation in learning (Wolters, 1998).

Students can use strategies such as defensive pessimism, motivating them to increase their effort and performance to overcome the negative affect and anxiety about doing poorly (Garcia & Pintrich, 1994). Students would have attributions for the outcomes based on their emotional or affective reactions after completing the task and they can actively control their attribution to make the future task more motivating (Pintrich, 2004; 2000).

Regulation of behavior.

Regulation of behavior includes strategies used by students to control their overt behavior. It includes planning and management of time and effort. Time management strategies include strategies such as making schedules for studying, allocating time for different activities on the basis of priorities and intensity of the work. Behavioral regulatory strategy also includes help-seeking, whereas students have to decide when, why, and from whom to seek help (Pintrich, 1999; Ryan & Pintrich, 1997).

Regulation of context.

It includes efforts taken by students to regulate the tasks and contexts. Regulation of context is more difficult when compared to the regulation of cognition, motivation and behavior because it is not always under direct control of the learner; student-centered classroom offers opportunities for control and regulation of context. But opportunities for controlling the context are less in schools than in college level. Students can regulate their study environment by reducing distractors and making it more conducive for studying. These processes are also termed as environmental control (Zimmerman, 1998; Corno, 1993).

Self-Regulated Learning Related Constructs

The motivational constructs learnt extensively in relation to self-regulated learning, are discussed in this section.

Motivational beliefs that affect self-regulated learning has got attention even before getting attention to self-regulated learning from the psychologists and educationists; though motivational beliefs gained more attention as self-regulated learning theories attained a prime position in educational research. Among these motivational beliefs, self-efficacy was one of the prime motivational variables that got the highest attention followed by goal orientation, task value beliefs, and ability conceptions. All these motivational variables representing achievement motivation theories, propose that individuals' perception of their own ability and expectancies for success on particular task have important role in their motivation to accomplish the task well (Wigfield & Eccles, 1992).

1. Self-efficacy beliefs.

Self-efficacy is one of the motivational beliefs that studied extensively in academic situations, as well as in other fields. The term self-efficacy is popularized by Bandura. Albert Bandura is one who studied self-efficacy in academic situations formerly and popularized the term in education and literature. Bandura define self-efficacy for learning as one's belief about his own capability to learn or perform at designated level. He was the first psychologist who studied self-efficacy in depth. Perceived self-efficacy refers to one's perception regarding their capability to produce the desired attainment through a course of actions (Bandura, 1997). Bandura's research in self-efficacy started in the area of behavior modification. Role of self-efficacy in behavioral change was studied (Bandura & Adams, 1977; Bandura, Adams & Beyer, 1977; Bandura, 1977).

To make a success, it is very important for one to believe that he or she can accomplish the task. Self-efficacy of a person influences his or her amount of effort they expend in the situation, how much time they persist in difficult situation, their resilience, development of adaptive or maladaptive thoughts, and amount of stress and depression experienced by them (Bandura, 1997). Self-efficacy is important because it influences further education. A person will not select a task for which he has low self-efficacy. Instead, pupils will select the area for study where they think they can succeed. Also, students with low self-efficacy will have a tendency to avoid that task, whereas one with high self-efficacy will take effort and persist in the situation (Zimmerman, 2000; Schunk, 1981).

Self-efficacy has a causal or mediational role in academic situations. It is a task specific belief, one who has high self-efficacy in one area doesn't guarantee self-efficacy in some other area. For example, a student with high self-efficacy in language learning may not have self-efficacy for learning mathematics, and one who has self-efficacy for learning geometry may not guarantee self-efficacy for learning algebra (Bandura, 2006). Students develop self-efficacy in one area through their experiences in that particular area. For example, if one always experiences failure in an area, will result in a low self-efficacy, and if one always meets with success, it will result in a high self-efficacy (Devonport & Lane, 2006).

Sources of self-efficacy or factors that affect self-efficacy.

A person develops self-efficacy throughout his life by integrating information from five sources.

1. *Performance experiences.*

A powerful source of self-efficacy in one behavior domain is one's pattern of success or failure in attempts to control the situations in that domain (Bandura, 1997 & 1977). Individuals develop self-efficacy based on their pattern of successes and failures in different areas of behavior domain. Failure in an attempt in control causes diminished self-efficacy and success in this causes strengthen self-efficacy in that behavior domain.

2. *Vicarious experience.*

Observation of other people's performance is another source of self-efficacy development. This is possible when students identify themselves with their similar peers, and their behavioral consequences feels as of them. This source is not significant as performance experience.

3. *Verbal or social persuasion.*

Another source of self-efficacy is the encouragement or discouragement that one gets for engaging in particular activities, from significant others. That is our self-efficacy is influenced by what others perceive and comment about our ability. Intensity of this influence is determined by the expertise of the commentator, trustworthiness, and attractiveness (Eagly & Chaiken, 1993).

4. *Physiological states or emotional arousal*

The pleasant or unpleasant emotional state during task performance is another source of self-efficacy. If a person can successively complete a task, it would be followed by pleasant emotional state and this would result in a high self-efficacy, but if a person is not successful or failing in completing the task, it would be attached with aversive physiological arousal, and sensing low self-efficacy.

5. *Imaginal experience*

A person's imagination that behaving effectively or ineffectively can affect self-efficacy. But these imaginations are indeed influenced by their vicarious experiences and verbal persuasion. Imaginal experiences such that simply imaging themselves as doing well on mathematics can have positive effects, not that much as actual experience, on their self-efficacy. So, to develop self-efficacy in one person they can be advised to imagine the success in a hypothetical situation (Williams, 1995).

These five sources are not mutually exclusive, they are interacting dynamically to affect self-efficacy judgments.

Types of behavior affected by self-efficacy.

Academic self-efficacy is important because it affects students' learning and related behaviors, such as choice of activities, goals, their effort and persistence in academic tasks and ultimately their achievement (Bandura, 1993 & 1989).

- *Selection processes.*

Individuals' self-efficacy in different domains affects their goals and activities. A person with self-efficacy in several areas is more likely to go for different goals and activities compared to those with low self-efficacy. It affects their course and career selection. When a student has low self-efficacy for learning mathematics, chances for avoiding mathematics related activities or courses would be high.

- *Cognitive processes.*

Students with high self-efficacy for solving complex problems, tends to use higher-level cognitive processes like analysis, synthesis and evaluation than students with low self-efficacy. Students with low self-efficacy, by holding the belief that they are not capable of doing more, stick to low level activities.

- *Motivational processes.*

Those who believe they can succeed tend to work longer and harder to accomplish the goal, than those who have low self-efficacy.

- *Affective processes.*

While confronting with the challenging tasks students with high self-efficacy experience excitement and curiosity accomplish the task, but those with low self-efficacy would experience anxiety and depression.

Mathematics learning and self-efficacy beliefs.

Effect of self-efficacy beliefs in the domain of mathematics learning and performance is not lucidly explained as the number of studies related to mathematics self-efficacy is not enough among different populations (Hannula, et al., 2016). Studies regarding mathematical self-efficacy were conducted mostly in two areas. One stream explored the effect of mathematics self-efficacy on performance outcomes (Kaya & Bozdag, 2016; Son, Han, Kang & Kwon, 2016; Enoma & Malone, 2015; Kalaycioglu, 2015; Pajares & Graham, 1999 ;Pajares & Miller, 1994), the remaining studies explored the relation of students mathematical self-efficacy with other motivational and psychological constructs (Lau, Kitsantas, Miller & Rodgers, 2018; Kim, Dar-Nimrod & Maccann, 2018; Unlu, Ertekin & Dilmac, 2017; Putwain & Symes, 2014; Bong & Skaalvik, 2003).

Multon, Brown and Lent (1991) found that self-efficacy and performance relation in mathematics is stronger among low achieving students than high achievers. This relation is changing according to age also; stronger relation is shown among students in high school and higher standards than elementary. Mastery experiences are found as the most consistent and powerful source of self-efficacy among the different sources of mathematical self-efficacy. Other sources of self-efficacy are not that consistent (Hannula, et al. 2016; Usher & Pajares, 2008). Mathematical self-efficacy and performance are found to have reciprocal relationship, though the effect of achievement on self-efficacy is more dominant (Hannula, et al. 2014).

2. Implicit theories of intelligence.

Dweck (2000 & 1986) studied the attributional patterns of students in achievement situations and identified that there are adaptive and maladaptive patterns; they are mastery oriented and helplessness pattern respectively. She presented this view as a pattern of cognitive-affect-behavior. The helplessness pattern of behavior is characterized by avoidance of challenges and corresponding adverse effect (decline) in performance. Whereas, mastery-oriented patterns of behavior are characterized by seeking challenging tasks and persistently striving for growth even under failure. Dweck and Legget (1988) noticed that these two kinds of students were initially equal in ability. They understood that high ability, success in school, praising of students' intelligence or students' confidence in their intelligence are not contributing always to development of mastery-oriented patterns of attribution (Dweck & Sorich, 1999; Dweck, 2000). This made interest in them for further studies. Dweck studied this in detail.

Analysis of behavior patterns of seeking or avoiding challenging tasks firstly led researchers to the conceptualization of goals. They proposed a goal model for achievement situation that, there are two kinds of goals; one is performance goal, in which individuals are concerned with gaining approval for their competence from others, and the second is learning goal, in which the individuals are concerned with improving their competence (Dweck & Elliott, 1983). And it is noticed that students with performance goals tend to follow helplessness pattern and students with learning goals tends to follow mastery-oriented pattern (Leggett & Dweck, 1986; Elliott & Dweck, 1988; Dweck & Leggett, 1988).

Further investigation that why individuals with same ability possess these kinds of different goals, led them to the formulation of implicit theories of intelligence or self-theories. Self-theories explain a broader view regarding peoples' beliefs about fixedness or malleability of their personal characteristics like ability, personality characteristics (Dweck & Molden, 2000). People can hold different theories of intelligence for different subjects and characteristics (Dweck, Chiu, & Hong, 1995), for example, one believes that his or her ability in language can be developed, that is malleable, and his or her ability in mathematics is fixed (Dweck, & Molden, 2000). As per this theory people possess two views about development of intelligence; one is that intelligence is fixed entity, which is associated to helplessness pattern, and the second view is that intelligence is malleable, and it is associated to mastery-oriented pattern. Later this conceptualization was developed as a theory, implicit theories of intelligence. As it is the individuals' conception regarding ability it is also named as ability conception (Dweck, 2002).

Dweck presented her model as a social-cognitive approach to motivation. It explains the two ways in which people understand the development of intelligence or ability; it is inborn and fixed or it is malleable and can be expanded. These two entirely different views are entity theory of intelligence or fixed mindset, and incremental theory of intelligence or growth mindset.

Fixed mindset / entity theory of intelligence.

Each one has a certain level of intelligence or ability, and they can't improve this level, this belief represents entity theory of intelligence or fixed mindset. Individual holds the belief that ability is stable, uncontrollable trait of an individual (Woolfolk, 2010), different individuals have variable levels of ability, they cannot do anything to change it, there is nothing to do with effort or hard work. For such students taking more effort for learning or achieving something means it is above their ability, or they possess less ability.

Growth mindset /incremental theory of intelligence.

The individual holds the belief that ability as an unstable and controllable trait. It is a product of effort, or hard work and it is malleable. One can expand his or her ability through effort, and by increasing knowledge through practice and hard work. Incremental theory involves the belief that "intelligence consists of an ever-expanding repertoire of skills and knowledge, one that is increased through one's own instrumental behavior" (Dweck & Bempechat, 1983). Malleable theory of ability interprets setbacks as a result of lack of effort or reflection on use of learning strategy and to rethink on strategy use and self-regulation, then leads to learning and development.

Effect of implicit theories of intelligence on motivational variables.

Students' implicit theories of intelligence were found to be significant predictors of their motivational variables.

Effect on goals.

A person with an incremental theory of intelligence found to have more strong mastery goal orientation, as they believe that ability is malleable. They view learning as a means to develop their ability or mastery. Whereas a person with fixed theories of intelligence, found to have more performance goal orientation as they believe ability is fixed, they view learning as means to exhibit their ability (Dweck & Molden, 2000; Hong, Chiu, Dweck, Lin & Wan, 1999).

Effect on effort beliefs.

Students with incremental theory view make effort as the way to success, while students with entity theory feel more effort as a reflection of less ability (Dweck & Molden, 2000).

Effects on attribution.

Students with incremental theory attributes failure to external controllable causes, whereas those who with entity theory attribute failure to uncontrollable internal causes. Incremental theorists attribute more to effort, but entity theorists attribute more to ability (Hong, Chiu, Dweck, Lin & Wan, 1999).

Effects on strategies.

Failure leads to rethinking for better strategies in case of incremental theorists, then spend more time for studies. Whereas in case of entity theorists failure suggest them that it is because of the lack of ability and better strategies can do nothing, then avoiding that subject and disposing strategies (Costa& Faria, 2018).

Effect on grades.

Implicit theories of intelligence found to have an effect on mathematics grades from junior high school onwards. While mathematics grades improve for students with incremental theories, those decline in case students with entity theory.

3. Task value.

Task value refers to the individual's beliefs regarding value of the task. It includes individual perception about the importance of the task, intrinsic interest in the task, utility value of the task, and perceived negative aspects. Task value is a construct discussed by Atkinson (1958) as a part of the expectancy value theory of motivation proposed by him. Atkinson was one among the theorists who started achievement motivation theory (Mcclelland, Atkinson, Clark, & Lowell, 1953) and paved stones for academic motivation theories and motivational beliefs. As per the expectancy value theory, motivation and related efforts are products of individual expectancies for success and the value they attached to it (Vialle, Lysaght & Verenikina, 2005). Atkinson's model explains expectation of success and value that are attached to the task as two sources of motivation. Atkinson (1964) defined task value as the incentive value obtained by anticipated success. It relates to degree of difficulty of the task. Task value interacts with the task choice in a way that individual will tend to accomplish task that are valued by them and avoid accomplishing the task that are not valued by them.

On the basis of Atkinson's expectancy value theory, study of values followed two fundamentally different approaches. One is based on incentive value, it includes utility value theories such as of Edwards (1954), Raynor (1982) and attainment value theories such as of Battle (1965), Rotter (1982). Second stream studied broader human values like role of personal values in behavioral choices (Feather 1982; Rokeach, 1979). Eccles et al. (1983) extensively studied the task value, and integrated these two perspectives in their studies (Wigfield & Eccles, 1992; Eccles 1984).

Eccles with her colleagues (1983) developed an extensive theory of task value by following the earlier studies of Lewin (1938), Tolman (1952), and Atkinson (1957) (Wigfield & Eccles, 1992). Eccles et al. (1983) studied subjective task value as a product of personal values and general attitudes. They defined task value as a cognitive construct than as a motivational construct, and studied task value as a social psychological reason for students' choices in achievement situations; though expecting conscious and unconscious reasons for choices of individual in achievement settings, they gave prime importance to conscious aspects of individual choices.

The task value is determined by the characteristics of the task such as difficulty of the task, time taken for completing the task and the individual determinants such as their goals, needs, values and interest (Eccles, 1984). Task value theory says that an individual value attached in engaging in a particular task would be influenced by how well it contributes to fulfill their needs, to reach their goals, and affirm personal values (Eccles, 1984).

Components of task value.

Eccles et al. (1983) conceptualized task value as having three components namely attainment value, interest or intrinsic value, and utility value; and, later, added one more component- cost value (Wigfield & Eccles, 1992; Eccles, 1984).

Attainment value.

Importance of performing well on a task is represented by attainment value. Attainment value of a task will be high in case of difficult task if they think that they can accomplish it successfully. Battle (1965) defined attainment value as “it is the importance to the individual for achievement in a given task and should determine the length of his persistence in working at it”. Attainment is influenced by perceived challenges of the task, and the chance for success on the task. A person's attainment value would be high in tasks which provides a chance to demonstrate their self-schema. For example, one who thinks himself as bright and bright people can perform well in mathematics, their attainment value in mathematics would be very high (Wigfield & Eccles, 1992).

Intrinsic value.

It is a construct similar to intrinsic motivation (Wigfield & Eccles, 1992). The pleasure one achieves as doing the task refers to intrinsic value. Eccles, (1984) defined "intrinsic value is the inherent enjoyment on gets from engaging in the task". The enjoyment that an individual experience by performing a task is called intrinsic value. For example, some students like to solve mathematical problems and enjoy the challenging tasks in mathematics. It is the subjective or intrinsic interest of a person in the particular task (Wigfield & Eccles, 1992).

Utility value.

It is more extrinsic when compared to other values. It refers to how well the task will contribute to the future goals such as career goals. It is the judgement of individual regarding the usefulness of the task in any manner it can be in daily living, higher studies or in the career. Utility value of the task is determined by how well it will contribute to individual's goals and future plans. For example, to take a science stream in higher secondary classes or for an engineering career, it is important to learn mathematics.

Cost value.

It was not there in the initial theory (Wigfield & Eccles, 1992; Eccles, Adler, Futterman, Goff, Kaczala, Meece & Midgley, 1983) but they added it as a component later. It represents all negative aspects of engaging in the task, including emotional states such as anxiety or fear of failure as well as the amount of effort they need to take to successfully complete the task.

Influences on task values.

Task value is conceptualized as a function of individual's needs, goals and self-perceptions along with perceived qualities of task. Each students' past experiences, social stereotypes and by differential information from significant others, decides individual differences in task value. Personal needs, values and self-schemata, cost of success, and previous affective experiences in similar tasks mediate development of task value among students (Eccles, 1984).

Wigfield and Eccles (2000) identified children's expectancies for success and self-efficacy beliefs as the significant predictors of their later grades in mathematics beyond previous grades and achievement value; and their subsequent task values as the strongest predictors of further course selection in mathematics. Efficacy beliefs also interacts with the task value. For example, a student with the necessary self-efficacy for mathematics learning and less task value for mathematics would not care about achieving higher skills in mathematics; also, the same would happen for students with less self-efficacy and high task value (Eccles 1984).Task value is also found related to cognitive and metacognitive strategies, though they are not as strong as self-efficacy (Pintrich, 1999; Pintrich et al., 1993; Pintrich, Smith, Gracia & Mckeachie, 1991). Eccles (1992) reported that students' task value of mathematics reduces across 5th through 12th grade. Hence, students' task value for learning mathematics is an important predictor of their activity choices in mathematics during school years especially in high school (Eccles, Wigfield, Harold & Blumenfeld, 1993).

Strategies that Promote Self-Regulated Learning

To promote the use of self-regulated learning strategies among students, teachers can follow different strategies individually or in combinations. Effects of strategies such as use of different learning strategies (Marée, Van Bruggen & Jochems, 2013; Lim, Lee & Grabowski, 2008), goal setting strategies (Clarke, 2013; Kitsantas, Robert & Doster, 2004; Butler, 1997; Schunk, 1990), self-monitoring strategies (Kitsantas, Robert, & Doster, 2004; Butler & Winne, 1995) volitional control strategies (Boekaerts & Corno, 2005), developing metacognitive knowledge (Pintrich, 1999) and organizational strategies (Pintrich, 1999; Weinstein & Mayer, 1986) in improving students self-regulated learning were studied. Some strategies that were experimented for improving students' learning behaviour are discussed here.

Goal setting strategy.

Goal setting theory was first proposed by Locke and Latham (1990) in organizational settings. Then onwards the theory has expanded into many domains including education. It is a theory of motivation explaining how one can perform better in achievement-oriented tasks. Goals are the primary source of motivation to people.

Locke and Latham defined goal as the object or aim of an action. In classroom or learning situations, it might be the level of achievement or grades to be attained. Achievement is the primary outcome variable, and it is the accomplishment of articulated learning goals (Guskey, 2013). Students' attitudes, interests, feelings, beliefs and dispositions collectively contribute to effective goals. Effective goal setting is a key to success. It helps to accomplish the task within stipulated time. Hard work in the presence or absence of goals give different results (Donovan, 2008). Goal setting provides a direction for learning (Marzano, Pickering & Pollock, 2001). Goals works as a standard for self-regulated learning process. Zimmerman suggested that setting short term goals to learning process would improve students' self-regulated learning (2004).

Role of learning diaries and feedback in promoting self-regulated learning.

Writing learning-protocols is a powerful tool that helps the students to monitor and regulate their learning behavior (Nückles, Hübner & Renkl, 2009). In this, students are instructed to write down their reflections on learning contents previously presented; also they have to record how much they understood from the lesson, what they do not understand and what can be done to eradicate this gap. Berthold, Nückles and Renkl (2007) conceptualized a learning protocol as “a writing assignment for learners to be performed as a follow-up course work activity. Mere documentation of a periods work cannot be named as learning protocol, rather it is the reflection of the learner on their learning process, planning strategies, and regulation strategies”. Writing learning-protocol helps the learners to identify the learning materials they have already understood well and those they have identified comprehension difficulties (Berthold, Nu¨ckles & Renkl, 2007; Chi, Bassok, Lewis, Reimann & Glaser, 1989). This helps the learner to identify remedial cognitive activities and could be able to assess the learning outcomes realistically (Berthold, Nu¨ckles & Renkl, 2007). Several studies have demonstrated that writing learning-protocol enhances learning outcomes (Nückles, Hübner & Renkl, 2009; Wong, Kuperis, Jamieson, Keller & Cull-Hewitt, 2002; Connor-Greene, 2000).

In case of naive learners, it should be difficult to follow sophisticated learning strategies even though they are writing learning-protocol. Hence it can't guarantee students’ use of metacognitive and cognitive strategies (Nu¨ckles, Schwonke, Berthold & Renkl, 2004). So, it is suggested that for an optimal result through writing learning-protocol, provide systematic prompts for writing learning-protocol (Berthold, Nu¨ckles & Renkl, 2007). Prompts can be questions or hints regarding their use of cognitive and metacognitive strategies used for their understanding of the contents. Berthold, Nu¨ckles and Renkl, (2007) used prompts such as ‘‘How can you best organize the structure of the learning content?’’ and ‘‘which main points haven’t I understood yet?’’, and found that it improved student’s learning.

Externally provided feedback helps the learner understand the state of achievement. Feedback provides external guidance for a learner to guide their learning. It would help the learner perceive discrepancy between current state and goal state (Carver & Scheier, 1990) and to regulate their behavior in line with their goal (Butler & Winne, 1995). Analysis and feedback of students’ learning behavior on this support students’ self-regulated learning strategy use, through improving their calibration of self-monitoring and regulation of behavior (Butler & Winne, 1995).

Balzer, Doherty, and O'Connor (1989) described three types of cognitive feedback; task validity feedback, cognitive validity feedback, and functional validity feedback. Task validity feedback provides the learner with cues regarding successful strategies to the particular task. Cognitive validity feedback conveys extent of the learners understanding of the strategies or it provides the feedback on the problem of their strategy. Functional validity feedback provides the learner about their actual achievement and estimated achievement by them. External feedback can enhance self-regulation as it provides calibration and hence increases learner’s effective engagement in the task. Without external feedback, students with little knowledge of self-regulation cannot have an optimal performance. So external feedback is proposed as a way to make students self-regulated (Balzer, Doherty & O'Connor, 1989).

Organization of learning contents.

Organization of the learned materials is a cognitive strategy that enhances self-regulated learning (Pintrich, 1999). Organization of learning contents through the identification of main ideas and interlinking of concepts is found to be effective in students' use of cognitive strategies and hence in improving self-regulated learning (Pintrich, 1999; Weinstein & Mayer, 1986). Engaging in concept mapping activities helps the learners organize their learning. Concept maps help the learner organize information in a topic or chapter and find out the relations there in and provide an organized structure for the total content. Concept maps organize the knowledge to main and sub topics so that it can be remembered easily.

Studies Relating Self-Regulated Learning and Allied Constructs with Mathematics Outcomes

Studies from Indian and foreign sources that relate self-regulated learning and allied constructs with math outcomes were reviewed mostly from online sources and books. Such studies are rare from India. Most of the studies on self-regulation in school context are survey studies. However lately intervention on self-regulation that seek to enhance mathematics outcomes are being reported. A few studies which are done on mathematics related subjects like sciences are also included as they were found relevant from the perspective of this study. Mathematics outcomes studied are achievement and problem solving. Studies reviewed are categorized under three major sections namely- self-regulated learning and mathematics, studies relating implicit theories of intelligence and mathematics outcomes and studies on task value, goal orientations and self-efficacy in mathematics.

Studies on Self-Regulated Learning and Mathematics

Under this section, 29 studies on self-regulated learning related constructs including self-efficacy, epistemological beliefs, goals, and metacognitive competence are abstracted. The studies are mostly on middle school and high school students with a few ones on student teachers and university students. The outcome variables used are mostly achievement, mathematics understanding, mathematics reasoning and problem solving. Motivational outcomes like cognitive activation, motivation, metacognitive competence, cognitive engagement are also studied. These studies do not demonstrate agreement regarding the effect of SRL on achievement. Many of the studies indicate failure of SRL intervention to enhance knowledge or use of SRL strategies. Available studies indicate SRL is more effective among females than males. Level of intelligence, task interest and epistemological beliefs contribute to the effectiveness of SRL in improving mathematics outcomes. It is also seen that age or grade level has an impact on the effect of SRL on mathematics outcomes with many studies indicating its effect more in the lower grades than higher grades.

Zimmerman and Martinez-Pons (1986) compared 10th grade students using of self-regulated learning strategies in their classroom learning, homework and study among high achieving and low achieving students (40 each). High achieving students displayed significantly higher use of self-regulated learning strategies in their studies, success seeking, social assistance, seeking help from elders, seeking information, organizing and transforming, keeping records and monitoring, goal setting, etc., but except self-evaluation strategy.

Zimmerman and Martinez-Pons (1990) studied the effect of self-regulated learning strategy use on middle school and higher secondary school students' mathematics self-efficacy, among gifted and regular students (90 in each group). They found that use of self-regulated learning strategy, and mathematical self-efficacy was significantly higher among gifted students when compared to regular students. And the use of self-regulated learning strategy is more among higher secondary students that is 11th graders than 8th grade, and their use is higher than that of 5th graders.

Wolters, and Pintrich (1998) compared differences in students' motivation and self-regulated learning in the contexts of English, social studies, and mathematics, with focus on effects of gender, subject areas (mathematics, social studies, and English) on motivation. Through motivation they considered variables such as task value, self-efficacy, and test anxiety, and self-regulated learning (comprises use of cognitive and regulatory strategies). These variables were studied in relation to classroom academic performance among 545 seventh and eighth grade students using a survey design employing an adaptation of Motivated Strategies for Learning Questionnaire (Pintrich, et al., 1993). ANOVA, multivariate regression revealed that boys possess more adaptive self-efficacy beliefs than girls in mathematics learning. Self-efficacy and test anxiety vary according to gender and subject. It is found that students' use of cognitive strategies are higher in the context of social science and English learning than that of mathematics learning. Also, the relation between performance outcomes and self-efficacy beliefs are found more significant than that of task value beliefs. And this nature of relation is found true in all the three learning contexts.

Pape, Bell, and Yetkin (2003) experimented developing mathematical thinking and self-regulated learning in a sample of 55 seventh-graders' on mathematics classroom teaching. The strategy mainly focused on developing awareness in students that they are the agents in the learning process, also the strategy supported students' strategic behaviours and attributions. With Strategy Observation Tool, they observed that students improved their mathematical reasoning, and ability to communicate mathematical understanding after strategy intervention.

Mousoulides, and Philippou, (2005) surveyed 194 pre-service teachers of Cyprus to study Students' motivational beliefs such as self-efficacy beliefs, task value beliefs, and goal orientation, as predictors of self-regulation strategies use and mathematics achievement employing an adaptation of MSLQ. The study results revealed that self-efficacy predicted achievement in mathematics over the use of self-regulation strategies. Mastery goal orientation is not a direct predictive factor of self-regulation, but is a strong predictive factor of self-efficacy and therefore has an indirect effect on achievement through self-efficacy. It is found that task value beliefs are the only predictive factor of self-regulation strategies use.

Perels, Gurtler, and Schmitz (2005) studied Training of self-regulatory and problem-solving competence and its effects on students' self-regulation, problem-solving competence in mathematical word problems on 249 eighth-graders with higher learning competences in Germany. Experimental study using four groups (a) self-regulation, (b) combined training (self-regulation and mathematical problem-solving), (c) problem-solving training, (d) control group (no training). Self-regulation questionnaire adopted a number of scales from different instruments, and an aggregate of this is used for measuring SRL. Factorial univariate analysis of variance revealed that mathematical problem-solving ability and competence use of self-regulated learning can be improved through this kind of short training, it seems to be more difficult to train self-regulatory compared to problem-solving competencies.

Kramarski and Mizrachi (2006) experimented online discussion and self-regulated learning and their effects of instructional methods on mathematical literacy employing 4 levels of instructional: online discussion without metacognitive guidance, online discussion embedded within metacognitive guidance, face-to-face discussion with metacognitive guidance, and face-to-face discussion without metacognitive guidance in 86 seventh grade Israeli students. Metacognitive questionnaire and literacy test were employed. MANCOVA revealed that Students who were exposed to metacognitive guidance (online+meta, ftf+meta) attained a higher level mathematical literacy than did online and ftf students; also online+meta students outperformed the ftf+meta students. Online metacognitive group outperformed ftf meta on total score with moderate effect.

In a study by Pauli, Reusser, and Grob (2007), analysed a video-based reform-oriented mathematics instruction to know the teaching for understanding and/or self-regulated learning, they surveyed 79 teachers and their 1407 eighth grade students from Switzerland. Two levels of mathematics instruction viz., reform-oriented mathematics instruction: two dimensions, surface level of instruction, teachers reported how frequently they provided opportunities for self-regulated learning (student orientation); and deeper level of instruction, teachers reported the frequency of chances given by them for independent problem solving in their respective classes (cognitive activation) when studied using multi-level structural equation models. It is reported that students' learning experiences were improved after self-regulated learning opportunities. Substantial positive effect of the factor ‘‘opportunities for self-regulated learning'' on cognitive activation as perceived by students and student orientation as well as on students' emotional experience.

Muis (2008) used a mixture of survey and experimental design to examine relations in the context of mathematics problem solving on epistemic profiles and self-regulated learning of undergraduate mathematics (268) and statistics (24) students. They employed Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1991) and the Psycho-Epistemological Profile (PEP; Royce & Mos, 1980) (Rationalism, Empiricism, Metaphorism) to obtain data. More metacognitive self-regulation is reported by those who profiled as predominantly rational, than individuals profiled as predominantly empirical, and it is replicated in the problem solving.

Perels, Dignath and Schmitz (2009) evaluated an intervention in regular math classes to test the effectiveness of an intervention programme in improving mathematical achievement using 53 sixth-grade students. This experimental study used Self-regulation questionnaire (Perels et al., 2005) and ANOVA to reveal that self-regulation intervention is effective to promote self-regulation competencies and mathematical achievement of 6th-grade students within regular mathematics lessons.They found that the self-regulated learning intervention improved students self-regulated learning competencies, mathematical achievement but it does not improve students' motivation and problem solving.

Jain, and Dowson, (2009) in survey study employed structural equation modelling to explore mathematics anxiety as a function of multidimensional self-regulation and self-efficacy with gender and Mathematics anxiety built into the design. The sample was 232 Eighth grade students from India. Motivated Strategies for Learning Questionnaire and the Mathematics Anxiety Scale provided the data. It was found that self-regulation strategies are negatively related to mathematics anxiety, and self-regulation is significantly and positively related to self-efficacy, which is significantly and negatively related to mathematics anxiety. Also, the study found that eighth graders are not as good self-regulators as compared to younger students.

Cleary and Chen (2009) studied variations across grade level and math context in self-regulation, motivation, and math achievement in middle school in 880 suburban middle-school students of US. In the survey, they employed Self-Regulation Strategy Inventory-Self-Report (SRSI-SR) (Cleary, 2006), Task Interest Inventory (TII) (Cleary, 2006), and Perceived Instrumentality Inventory (PII) (measure of perceived instrumentality or task value, Cleary, 2006). ANOVA and linear regression analysis revealed that seventh graders exhibited a more maladaptive self-regulation and motivation profile than sixth graders, achievement groups in seventh grade (high, moderate, low) were more clearly differentiated across both self-regulation and motivation than achievement groups in sixth grade (student motivation and use of self-regulation strategies vary across grade level), task interest was shown to be the primary motivational predictor of students' use of regulatory strategies during math learning, girls reported more frequent use of self-regulation strategies than boys. The effects were of small to medium size.

Usher (2009) qualitatively studied sources of middle school students' self-efficacy in mathematics in grades 6-8 of US. Semi structured interviews, self-efficacy measure with four levels (mathematics skill SE, SE for SRL in mathematics, grade SE and SE to complete a variety of mathematics related courses) revealed that students' self-regulated learning, teaching structures, and course placement as important factors related to self-efficacy. Also, the study observed that there existed a reciprocal relation between students' SE and SRL.

Bracha and Revach (2009) experimentally tested self-regulated learning in mathematics teachers' professional training and its impact on their problem-solving skills, mathematical and pedagogical knowledge of 64 elementary school teachers in Israel. MANCOVA revealed that Teachers in the SRL program out performed those in the no-SRL program on various problem-solving skills (e.g. reflection and conceptual mathematical explanations) and lesson planning (e.g., task demands and teaching approach). Treatment group outperformed the non-treatment group in teachers' mathematical knowledge, mathematical explanation quality and in pedagogical knowledge with strong effect size.

Acara and Aktamis (2010) studied teachers' academic achievement in mathematics teaching course as a product of self-regulation strategies. The study is conducted among prospective elementary school teachers. Specifically, Self-regulation strategies (motivational beliefs, cognitive and meta-cognitive and resource managing strategies), and gender were studied in relation to mathematics teaching efficacy and academic achievement level in "math teaching" course of 129 student teachers by adopting Motivated Strategies for Learning Questionnaire and semi-structured interview. Statistically significant correlation was found between female students' academic achievement level in "Math Teaching" course and their strategy awareness and using in relation to motivation and self-organization ($r=0.242$, $p<0.05$). However, there was no significant relationship for males ($r=0.054$, $p>0.05$).

Puteha and Ibrahimb (2010) surveyed among form four students, regarding their usage of self-regulated learning strategies in the context of mathematical problem-solving. The study followed a case study approach among 249 secondary school students and used Motivated Learning Strategies Questionnaire-Revised (MSLQ-R), and interview. There is significant relationship between motivation and learning strategies, and between the self-regulated learning strategies and the students' performance of problem-solving, $r = 0.49$.

Computer supported collaborative learning strategies were used by Lazakidou and Retalis in 2010, to help the students in acquiring self-regulated problem-solving skills in mathematics. The effectiveness is studied among 68 primary class students. Computer-based instructional method (with three phases; observation, collaboration and semi-structured guidance, based on Sternberg's model of problem solving in an authentic context), observation and testing followed with repeated measures ANOVA revealed that children's performance improved over ten sessions, with significant increase in metacognition and problem-solving (SRL strategies).

Rastegar, Jahromi, Haghighi and Akbaria (2010) studied the relation of epistemological beliefs and mathematics achievement, along with the role of mathematics self-efficacy, achievement goals, and cognitive engagement in this relationship, among 473 university students. Subscale of cognitive engagement (MSLQ) by Pintrich et al. (1991), self-report questionnaires of achievement goals and mathematics self-efficacy by Middleton and Midgley (1997) were administered. Correlation, and path analysis revealed that cognitive engagement, mathematics self-efficacy, and achievement goals, mediating the relationship between dimensions of epistemological beliefs and math achievement.

Jaafar and Ayu (2010) correlated mathematics self-efficacy and meta-cognition among 203 University Students. With Mathematics Self-Efficacy Questionnaire and Mathematics Meta-Cognition Questionnaire, most of the respondents have a moderate level in mathematics self-efficacy and also in mathematics meta-cognition. There is a positive relationship between mathematics performance and mathematics self-efficacy [$r(203)=0.311$; $p< 0.05$] and also with mathematics meta-cognition [$r(203)=0.216$; $p < 0.05$].

Throndsen (2011) conducted a longitudinal study among 27, second standard students to study the relations between their basic mathematical skills and their use of strategies in mathematics, their metacognitive competence and motivational beliefs; and how this relation changes at various levels of basic mathematical skills. The students were divided into three performance groups that has very good students, good students, and not so good students to study the differences in their use of strategies in mathematics. They found that students in these groups differ in several aspects of self-regulated learning. Among the measures taken at 3 intervals during the course indicated that high performing students use more advanced strategies every time. Above their uses advanced maths strategies, students' good performance in mathematics is found to have relation with their domain specific metacognitive competence, effort attribution for failure, ability attribution for success, hyper filled self-efficacy.

Friedrich, Jonkmann, Nagengast, Schmitz and Trautwein (2013) studied differentiation and agreement between teachers' and students' perceptions of self-regulated learning and math competence. Self-regulated learning strategies: reactional self-regulated learning strategies (subcomponents goal setting and planning Behavior), and actional self-regulated learning strategies (volition, concentration and effort) were explored in 73 mathematics teachers, and their

1289 fifth grade students in Germany using Self-Description Questionnaire (SDQ; Marsh, 1990) and perceptions of students' self-regulated learning strategies (slightly modified from Otto, 2007). Exploratory structural equation modeling (ESEM) revealed that Teachers' and students' assessments of students' math competence/self-concept showed the highest agreement. Teachers could rate students' use of self-regulated learning, and hence differentiate them on this basis.

González-Pienda, Fernández, Bernardo, Núñez and Rosário (2014) studied the effect of a 12-session intervention intended to increase knowledge and use of self-regulated learning strategies and study time among secondary students (N= 277) in Spain. They found that intervention improved students' knowledge of self-regulated learning and study time but not the use of self-regulated learning. Also, students those who were low on self-regulated learning in pretest benefited most through intervention. So, the experiment pointed out that the strategy was more effective for at risk students.

Clyde (2015) studied the effectiveness of an intervention in improving high school students' engagement on self-regulated learning process. The study was conducted with the help of the classroom teachers. The researcher gave training to teachers on self-regulated learning strategies and they provided these strategies to students in their classrooms. For this study 98 Canadian high school students were selected. The strategy mainly included cognitive strategies, goal setting Strategies, and self-monitoring strategies. They found that the strategy did not improve students' academic self-regulation and academic engagement.

Sontag and Stoeger (2015) studied the effect of training self-regulated learning among 4th graders (n=322) from Germany, through an experimental study. Highly intelligent and high achieving students benefited more through the training of self-regulated learning than their peers with average intelligence and scholastic achievements. High achievers' preference for self-regulated learning increased immediately and it continued for long term, but students with high intelligence benefited in their use of self-regulated learning only in long run. Also, students with high intelligence and high achievements improved their achievement after getting trained in self-regulated learning.

Bellhäuser, Lösch, Winter, and Schmitz (2016) developed a web-based training program to foster self-regulated learning, and studied its effect on Self-regulated learning knowledge, self-regulated learning behavior, as well as on self-efficacy. They used learning diaries along with questionnaire measures of self-regulated learning. The study is conducted among 211 University students of Germany. The intervention improved students' knowledge of self-regulated learning and self-efficacy, but a slightly negative effect was found for the mathematics test. Learning diaries made a positive effect. While going through the components of self-regulated learning, they observed that students planning and self-instruction strategies were improved significantly, but goal setting and cognitive learning strategies were not improved that much, also self-motivation and distraction avoidance were not changed due to web-based self-regulated learning training, and the training reduced students' reflection.

DiFrancesca, Nietfeld and Cao (2016) conducted a survey study to identify important differences in self-regulated learning practices of high- and low-performing college students (N=41). They observed no difference in prior knowledge, general ability, and self-efficacy of high and low achieving students;

over the duration of the course they observed difference in metacognitive monitoring, use of low-level study strategies, and self-efficacy among low and high achieving students. Initial course performance was found as a better predictor for the total course achievement than self-regulated learning components. Also, they noticed that self-regulated learning measures did not predict achievement, it did not align with the measures of monitoring judgements and interview data, and based on this finding they criticized self-regulated learning self-report data.

Cleary, Velardi and Schnaidman (2017), experimented the effectiveness of a comprehensive psycho educational intervention program (SREP) designed by Cleary and Platten (2013) with an objective to develop effective strategic and regulatory patterns of thinking and action to overcome low motivation, poor self-awareness, deficient strategic skills, and below-average academic performance for academically vulnerable and at-risk middle and high school students. In the present study they examined effectiveness of SREP in improving the motivation, strategic skills, and mathematics achievement of academically at-risk middle school students among forty-two 7th grade students. After intervention they found that students who were trained through SREP improved their strategic attributions, adaptive inferences, and they used to more strategic approaches to test preparations than the comparison group. Over 2 years of practice with SREP this group differed significantly in mathematics achievement. The teacher who provided training to students on SREP reported it as a socially valid intervention.

Cueli, Rodríguez, Areces and García González-Castro (2017) conducted an experimental study to analyze the effectiveness of hypermedia tool in improving secondary school students' usage of assessment strategy, planning and executing strategies, and knowledge of self-regulatory strategies. They also analyzed effectiveness of this among students with low, medium and high academic performance, and among students with low, medium and high perceived knowledge, for this purpose 624 students were selected. Using univariate covariance analyses (ANCOVAs) and Student-t tests they found that the strategy is not effective in improving students' knowledge of strategies.

Kahreh, Imani, Haseli, and Mansour (2018) studied the effect of twelve section training in self-regulated learning strategies method on mathematics anxiety among thirty high school students and found that training in self-regulated learning strategies reduces mathematics anxiety.

Studies Relating Implicit Theories of Intelligence and Math Outcomes

In this section seven studies relating implicit theories of intelligence to mathematics and science outcomes including choice of mathematics, achievement in mathematics and motivation as well as self-regulated learning in mathematics are summarized. The studies are either on students in middle or lower level school or among undergraduate students or teachers. Results indicate that interventions focusing on implicit theories of intelligence can enhance incremental beliefs and related epistemological beliefs and thereby improve achievement in mathematics. Effect of incremental beliefs are visible by junior high school onwards. Available studies indicate a gender effect in favour of boys regarding the incremental beliefs and their beneficial effects.

Braten and Stromso (2005) conducted a survey study to check the dimensions of personal epistemology and implicit theories of intelligence, and to examine the role of these in motivational and strategic components of self-regulated learning. To conduct the study they selected Norwegian post-secondary students, comprise 178 business administration students and 108 student teachers. They found that the two subsamples differed significantly in their conception of intelligence, with a disfavoring result in business administration students. It indicated the disciplinary differences in the conception of intelligence. Among the identified dimensions of epistemological beliefs, speed of knowledge acquisition, knowledge construction and modification, certainty of knowledge and control of knowledge acquisition, only the last one found significant relation with implicit theories of intelligence. Results showed that, motivational and strategic components of SRL is better predicted by dimensions of epistemological beliefs than implicit theories of intelligence, and negative relation was found between self-efficacy, study interest, mastery goal orientation, self-regulatory strategy use and naïve epistemological beliefs. No gender difference is found significant in any of these findings.

Blackwell, Trzesniewski and Dweck (2007) studied the relation between implicit theories of intelligence and Mathematics achievement, and observed their trajectory of grades through a longitudinal study among seventh graders. They found that incremental theories of intelligence had a positive association with low helpless response, high effort belief, and positive strategies. Result showed that the effect of implicit theories of intelligence is more prevalent as they approach to junior high school; and it is not evident in their previous grades. In the same study they experimented the effect of eight session teaching incremental theory intervention, and found that it improves the achievement and changes the theories of intelligence of entity believers.

Chen and Pajares (2010) investigated the relation between implicit theories of ability and epistemological beliefs among grade six students (N=508) and effect of these two variables on motivation and achievement. In this study they explained academic motivation as a combination of self-efficacy, self-efficacy for self-regulation (SESRL), and achievement goal orientations. They analyzed role of gender and ethnicity in this ground. Among the entire variable they assessed, only in case of implicit theories of science ability found significant gender difference; boys tend to report more incremental nature of science ability in comparison to girls. Naïve epistemological beliefs and fixed view of science ability found having significant correlation, whereas sophisticated epistemological beliefs found to have correlation with incremental view of science ability. Achievement in science is found indirectly affected by incremental theory of science ability through mastery goal orientation, self-efficacy for self-regulation, and epistemological beliefs about justification of knowledge and development; it is affected negatively and indirectly by entity theory of science ability through performance avoidance goal orientations, epistemological beliefs about source and certainty of scientific knowledge.

In a study conducted by Greene, Costa, Robertson, Pan and Deekens (2010) among undergraduates (sample size 171) explored interaction of students' prior knowledge and their implicit theories of intelligence with their use of self-regulated learning and academic performance. They found that self-regulated learning works as a benevolent moderator of these, that is self-regulated learning increases the positive effect of prior knowledge and decreases negative effects of entity beliefs. They found that, though the effect size was quite small, implicit theories of intelligence had a negative relation with prior knowledge and level of quality self-regulated learning. Self-regulated learning influenced learning, the same time it moderated how students' implicit theories of intelligence and prior knowledge influenced conceptual understanding in a hypermedia learning environment.

Romero, Master, Paunesku, Dweck, and Gross (2014) studied the role of implicit theories of intelligence in determining academic and emotional outcomes among middle school students in US (sample size 115). They found that students with incremental theories of intelligence achieved higher grades, and their theories of intelligence tend to predict choices of math course beyond their grades. Students with incremental theories of intelligence likely to take more challenging mathematics courses. Difficulty level of math courses they took over time is determined by their theories of intelligence.

Bonne and Johnston (2016) conducted a study among 91 primary school students from New Zealand to check the association between implicit theories of intelligence, mathematics self-efficacy, and mathematics achievement. Also they checked the effectiveness of a teacher implemented micro intervention in changing students' implicit theories of intelligence. They found that association between mathematics achievement and implicit theories of intelligence are less significant than it had with mathematics self-efficacy. Study results denied the dichotomous and unidimensional conceptualization of entity and incremental theories of intelligence. The intervention resulted in a reduced entity theory and enhanced incremental theory, and a significantly increased achievement and self-efficacy in Mathematics.

Braten, Lien and Nietfeld (2017) conducted two experimental studies among undergraduates of Norway and US to check and compare the effectiveness of a brief task instruction in view of changing students fixed mindset beliefs on rational thinking task. With a same design and task instruction an experiment is conducted among Norwegian undergraduates (230 students) and US undergraduates (225 students). The task instruction made a significant difference in male Norwegian undergraduates that is they profited from the particular instruction and performed good in rational thinking task. But this instruction made no change in male and female undergraduates of US and female undergraduates of Norway.

Studies on Task Value, Goal Orientations and Self-Efficacy in Mathematics

There are eight studies in this section. They deal with mathematics utility, students' effort, approaches to learning and importance of task-values. There are conflicting findings regarding the changes in mathematics interest as students move up in schools. Results also indicate influence of learning approaches on other mathematics learning motivational factors including self-efficacy.

Gender and developmental differences in student's competence and value beliefs among 1st through 12th grade was studied by Fredricks, and Eccles (2002). A longitudinal study of 514 students in the US from 1st grade through 12th grade is conducted with the help of Hierarchical linear modelling. The main findings are children's perception of interest and importance of mathematics activity are positively related to their competence beliefs and this relation found stronger in higher grades and in mathematics than sports. Parents rating of student's ability and students' perception of competency were found correlated. Students' math competencies and interests declined significantly from 1st to 12th grade. Boys believed that they are competent in mathematics than girls. Students' mathematical interest and importance of mathematics found declining over grades.

Nurmi and Aunola (2005) studied the relation of academic performance and self-concept of ability with their motivational patterns such as value of mathematics, reading, and writing among primary school students. This longitudinal study was conducted among 211 primary school students from Finland, by observing them from the beginning of first grade through the end of second grade. They found that students' motivation pattern changes from beginning of grade 1 to the end of grade 2. From the first grade itself students have differentiated patterns of task motivation in mathematics, writing and reading. The identified four motivational groups among students, are high school motivation, high math motivation, low reading motivation, and low math motivation. Percentage of students in the low math motivation increased, and in the low reading motivation decreased in the course of study. Students in the low reading motivation group tend to move to high math motivation group. A decrease in students' self-concept of reading ability associated with a concurrent move into high math motivation group. The children who were in low math motivation group in the beginning showed less progress in mathematics performance than others at the end of grade 2.

A study conducted among 280 third grade high school students in Iran by Azar, Lavasani, Malahmadi, and Amani (2010) to analyze relation of self-efficacy, goal orientations, task value, with students use of deep level or surface learning strategies in mathematics and their achievement in mathematics. They found that both self-efficacy and task value has positive correlation with the mastery and performance approach goals, deep approaches for learning mathematics, and mathematics achievement. Self-efficacy has a negative relation with the performance avoidance goals. They found that mathematical goal orientation mediates learning approaches, that is mastery goals positively influences deep approaches and negatively the surface approaches, whereas performance approach and performance avoidance goals have positive effects on surface approaches in learning mathematics. Also, they found that deep approaches for learning mathematics have direct positive and significant effect on mathematics achievement.

Gray (2014) examined how well the students' task value in mathematics can be explained in relation to their perceptions of that tasks, role in satisfying their assimilating (ability to fit in their classmates) or differentiating (ability to stand out their classmates) needs. The study is conducted among 106 STEM focused high school students in USA. Results indicate that students find task as important for them when they find it satisfy their differentiation need or assimilation need. Also they found that among the performance goal focused students, importance of task is stronger. They also found that task value of students fluctuates according to the tasks.

Yurt (2015) studied the relationship between task value, expectancy and math performance among middle school students of Kenya (n=200). They found that mostly students believe math class requires high level of effort, it is quite useful and important, and it is important to attend their future plans. Cost value, that encompasses two components task, difficulty and required effort, influences math performance directly and indirectly. Task difficulty affects math performance negatively, whereas required efforts influences math performance positively. Also, task difficulty exhibits low and medium level and negative correlations with utility value of the task whereas required effort exhibits low and medium level and positive correlations with utility value of the task. Required effort is found to have indirect and positive effect on expectancy-related beliefs. Attainment value component and intrinsic interest component of task value are found to have medium and high level of correlation to each other, and a positive correlation with expectancy. Also, expectancy believe affects mathematics performance positively, that is students with high expectancy value have high mathematics performance.

A study conducted by Luo, Ng, Lee, and Aye (2016) to find out the mediational role of self-efficacy, value and achievement emotions in parenting practice and homework behaviour. This study is conducted in a large sample of 8th graders (N=2648) from Singapore. The found that mathematical self-efficacy, value, pride, enjoyment, boredom, and homework distraction were experienced more by boys than girls. Self-efficacy and value in Mathematics were found to have positive relation with mathematics enjoyment, pride, and homework effort, negative relation to boredom, anxiety and homework distraction. Math self-efficacy, value, enjoyment, pride, and homework effort are positively related to parental expectancy and involvement, whereas parental expectancy and involvement are negatively related with math boredom and anxiety.

Gaspard, Häfner, Parrisius, Trautwein, and Nagengast (2017) studied the difference in the value belief regarding different subjects and also the difference in these by students grade and gender. The study is conducted among 830 students from grade 5 to 12 from Germany. They found that achievement value, personal value, utility for daily life, utility for job, utility for school, and social utility were perceived highest in English and mathematics by students than German, biology, and physics. Effort and emotional cost were perceived highest in physics, somewhat higher in German and math, and relatively low English and biology. This is almost true for all grades and gender. Though, lower beliefs were reported by students in higher grades.

Gaspard, Wigfield, Jiang, Nagengast, Trautwein, and Marsh (2018) studied how well the achievement in multiple domain is predicted by their expectancy and task value. The study is conducted among 5th to 12th graders (N=857) from German schools. The result showed that students' self-concept, intrinsic value, experiment value and utility value increases, and cost value decreases as the student moves to higher grades, these finding are true in all domain subjects, English, German, mathematics, biology, and physics. Also, they found that intrinsic value, personal importance, utility for job, and effort and emotional cost are highly domain-specific. Dimensional comparisons of student's expectancy beliefs and values were found nearly similar for near domains such as Maths and physics or German and English.

Conclusions from Review of Literature

A host of cognitive and emotional factors within and outside the learner reciprocally impacts SRL in learners irrespective of level of education

Self-regulated learning research has been conducted across all three levels of education, mainly studied its relation to cognitive and affective academic outcomes, and factors affecting self-regulatory behavior. These studies demonstrated moderate to strong effect of self-regulatory behavior on academic outcomes in primary, secondary and tertiary levels of education including higher education and professional training. Studies demonstrate that self-regulated learning strategies causes upto 51 percentage of variance in academic performance. Use of metacognitive strategies are found to be the strongest predictor of self-regulated learning. In adult learners, it is found that self-regulated learning strategies vary with the personality dimensions. Also, the students' high intellectual abilities and consciousness tend to result in effort regulation, regulation of time and use of higher cognitive skills. It is found that motivational variables such as interest, epistemological beliefs, achievement orientations intervene with the use of self-regulated learning strategies. More metacognitive strategies were used by students with high interest, empirical profile (epistemological belief), and with mastery approach goal orientation; use of less metacognitive strategies is reported by students with fear of failure. Use of self-regulated learning or metacognitive strategies correlated negatively with the academic procrastination.

Self-efficacy and problem solving are studied closely in connection with SRL and found to enhance in-depth processing

Self-efficacy is a variable explored by quite a few studies related to self-regulated learning. Self-regulated learning as well as its components such as self-efficacy and self-evaluation were positively correlated with mathematics performance among middle schoolers (Mousoulides & Philippou, 2005). It was established that the self-efficacy and self-regulated learning of the students were reciprocally related, at the same time self-regulation is predicted by self-efficacy. Self-efficacy has a unique contribution in self-regulated learning on academic achievement above and beyond previous academic achievement, socioeconomic status, gender and personality traits (Wigfield & Eccles, 2000). Relation of self-regulated learning with intelligence and self-esteem are confirmed in some other studies. In depth processing and thus performance on inferential questions, but not factual questions were enhanced by self-regulated learning among middle school graders.

How gender, cultural context and the discipline impacts SRL and consequent academic outcomes are not has been settled

Gender difference is observed across components of self-regulated learning. Boys possess more adaptive self-efficacy beliefs than girls in mathematics learning (Wolters & Pintrich, 1998). Studies suggest that discipline of study and individual variables such as culture and age range mediates the relation between gender and self-regulated learning. It is observed that self-regulatory behaviour of females in Asian cultures were found different from that of European and American culture. In Asian cultures, self-regulatory behaviors are found less among females, especially in mathematics, though in the European and American samples, it is not manifested. Girls showed significantly lower self-regulation in mathematics, academic self-efficacy and interest among a Korean sample. However, there are studies that reports that female students were scoring moderately higher on help-seeking strategies, utility value and on performance anxiety than male students. Also, girls reported more frequent use of SRL strategies, especially in mathematics (Cleary & Chen, 2009). Positive relation between self-regulated learning strategies such as cognitive and meta cognitive strategies and academic achievement were demonstrated among female high school students. Among the diverse disciplines, minor mean differences emerged on all the sub dimensions of SRL though no clear regularity on any discipline's favour was perceived. No clear difference in SRL on any discipline or discipline favour in SRL is observed, though there are minor mean differences in SRL along diverse disciplines.

SRL can be enhanced even through short term regular classroom interventions

Effectiveness of self-regulated learning can be enhanced through practice. There are studies that demonstrated the effectiveness of targeted interventions from kindergarten onwards in enhancing use of self-regulated learning strategies and it even works in teacher preparations. Different strategies were studied in view of developing self-regulation among students. It is found that supporting classroom environment in kindergarten would help the learner in developing self-regulated learning. Self-regulatory judgement and thus performance will greatly be enhanced by strategies training in the case of 5th and 6th graders. In respect to these findings, it is important to support the growing awareness of themselves as agents of the learning process. Observing a human model engaging in self-assessment, task selection or both could be effective for acquiring self-assessment and task selection skills in case of secondary school students.

Number of experimental studies on self-regulated learning was very few before 2010, where after more experimental studies on self-regulated learning are reported, though the number is still very few when compared to survey studies on self-regulated learning. Different experimental studies give different results. Intervention improved students' knowledge of self-regulated learning, study time, and self-efficacy but not the use of self-regulated learning, and engagement, though students with high intelligence and high achievements improved their achievement after training of self-regulated learning. Also found that it is effective when practiced for a longer period.

DiFrancesca, Nietfeld and Cao (2016) suggest the problems of self-regulated learning self-report data as a reason for negative results.

Moderate to strong effects of self-regulation on mathematics related outcomes is evidenced

Motivated Strategies for Learning Questionnaire (Pintrich, et al. 1993) is the most frequently used measure of self-regulated learning in mathematics learning. Studies evidenced that teachers are capable of differentiating between students' use of self-regulated learning. Also, studies demonstrated that teachers can understand students' use of self-regulated learning as it is evident to them through students' behaviors. In almost half of the studies reported, the variable was studied in close relation to self-regulated learning in mathematics is self-efficacy, followed by problem solving, task value beliefs and anxiety. Recently, there is a shift towards experimental studies beyond the exploratory surveys especially in self-regulated learning in mathematics. Compared to self-regulated learning studies in general, there are more studies among 6 to 8 grade students in the case of mathematics outcomes, and fairly good number of studies at secondary and tertiary levels but less when compared to those on 6^{th} and 8^{th} graders. Moderate to strong effects of self-regulation were observed in mathematics related outcomes such as self-efficacy and test anxiety, mathematics anxiety and cognitive strategy use irrespective of level of education. It is observed that students use greater cognitive strategy in English and social science than mathematics. In mathematics learning, one of the primary motivational predictors of students' use of regulatory strategies is task interest, as with general learning. Students' self-efficacy and test anxiety varied by gender.

Strategy training through methods including semi-structured guidance, and face-to-face discussion enhances SRL in mathematics.

Though the process of self-regulation training is not easy, opportunities for it, activate cognition and positive emotional experiences. Some studies demonstrated that, even short training can improve self-regulation competencies. Computer based strategies were also found effective in improving self-regulation components. A computer based instruction with three phases; observation, collaboration and semi-structured guidance, was found effective in increasing metacognitive and problem-solving competencies among primary class students. A strategy training among primary students enhanced mathematics performance as well. Metacognitive guidance among secondary school students improved their mathematical literacy. All these evidences indicate that, though it is difficult, self-regulated learning can be improved with the use of different strategies.

Ability conception or implicit theories of Intelligence influences self-regulated learning

Incremental beliefs predicted higher achievements, and they influenced the course selection. Its effect is higher among high school students than in other stages of schooling. Small interventions with explicit instruction can change students' implicit theories of intelligence and hence improve achievement and self-efficacy in mathematics. Interventions are found to be more effective among boys than girls. Self-regulated learning moderates the role of implicit theories of intelligence and it reduces the negative effects of entity beliefs. Naive epistemological beliefs show relation with the fixed mindset and sophisticated epistemological beliefs show relation to incremental belief, and self-regulated learning is better predicted by epistemological beliefs and self-efficacy than implicit theories of intelligence. Yet, other studies found that implicit theories of intelligence influences self-regulated learning.

Chapter III

METHODOLOGY

- *Design of the Study*
- *Variables of the Study*
- *Tools and Techniques Used for Data Collection*
- *Sample*
- *Procedure of the Study*
- *Statistical Analyses used for the Study*

This study is intended to analyze students' difficulties in learning mathematics, and to check the effectiveness of an evidence-based self-regulatory intervention in improving students' achievement in mathematics, use of self-regulated learning in mathematics, and their affective beliefs such as task value and self-efficacy in learning mathematics. This chapter gives a detailed description of design of the study, variables of the study, tools used for data collection, sample selected for the study, and methods used for data analysis.

Design of the Study

This study employs mixed method, as qualitative data collection is embedded within a quasi-experimental design. A two-phase embedded design with a before-intervention approach helped to obtain the qualitative data to shape the research intervention. A combination of qualitative and quantitative methods is used to answer different research questions within an embedded sequential design (Hanson, Creswell, Clark, Petska & Creswell, 2005). At the beginning, qualitative research provides contextual understanding of student difficulties and associated factors in learning high school mathematics. The general relationships among these variables were uncovered through a survey. Qualitative data was used to determine what would work as self-regulatory intervention in the local classroom context and then used a quantitative research to test the effectiveness of an intervention programme developed based on the earlier qualitative data. Precisely, qualitative data obtaining procedures were embedded in an experimental design before the intervention, to inform the development of the treatment. The qualitative data collection was carefully designed to help in developing measuring instruments in addition to shaping the intervention. However, essentially, qualitative data plays a supplemental role within the overall experimental design.

In this mixed study, with an embedded experimental model, which is the most commonly used variant of the Embedded Design (Creswell & Plano Clark, 2007), qualitative data is embedded within a quasi-experimental design and the priority is evidently for the quantitative experimental methodology. As this study required qualitative information before the intervention a two-phase model is used. The approach is largely sequential as the qualitative data helped in shaping the intervention as well as the research instruments and to some extent in choosing the participants and the topics on which intervention is to be carried out. Qualitative data with focus group interviews, survey questions and analysis of extant literature on self-regulatory learning in school mathematics were used. However, the approach is also concurrent in that it used diaries to get data during interventions to encourage participants to follow strategies provided during self-regulatory intervention. Figure 1 shows the outline of the study.

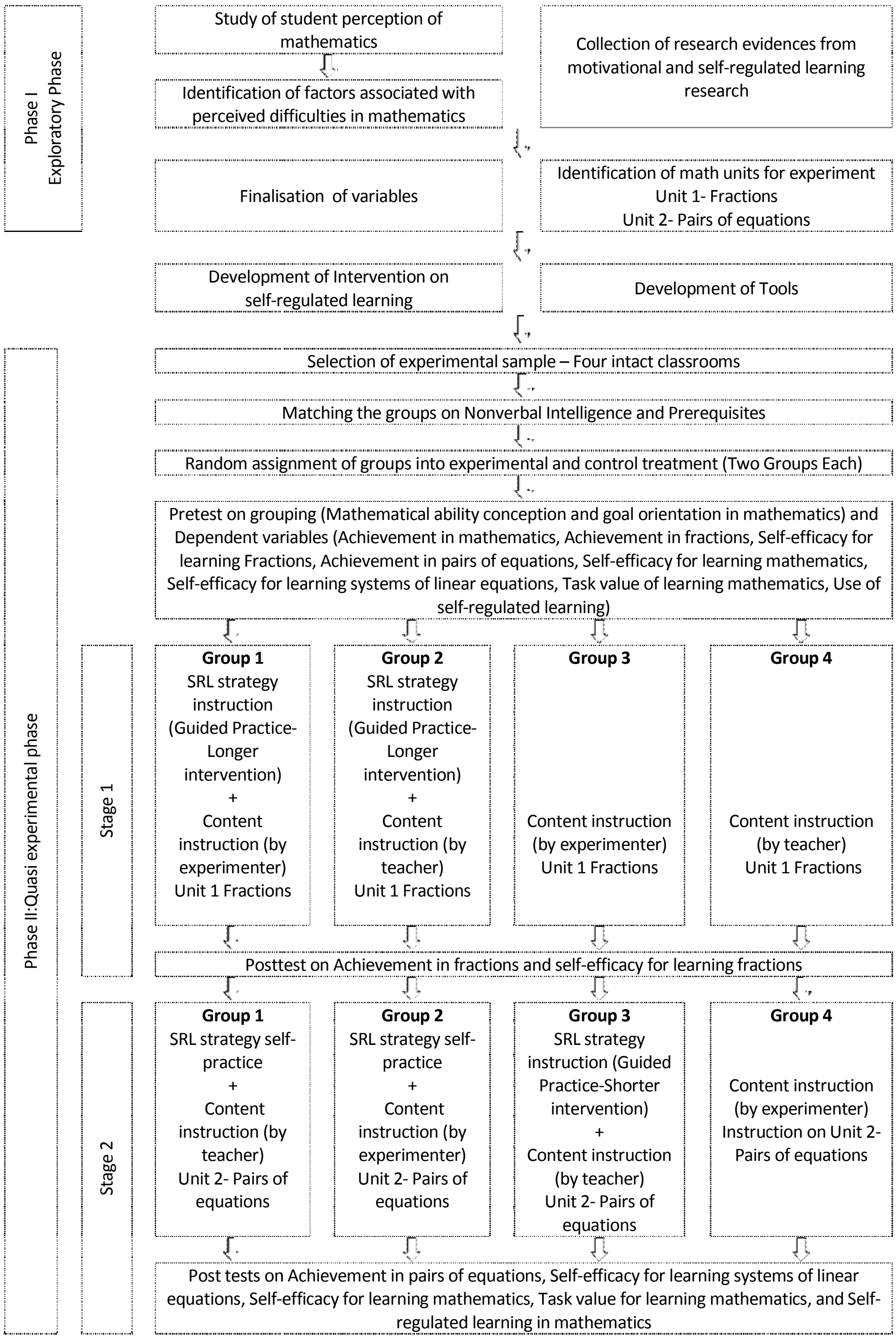

Figure 1: Outline of the study

Variables of the Study

This study has two phases.

Variables in Phase I

Phase I of the study is to identify factors that makes students' mathematics learning difficult. It includes motivational and strategic variables that associate with perceived difficulties in learning mathematics such as self-efficacy beliefs, value beliefs, ability beliefs, interest. Gender differences among students in their feeling of difficulty were also studied.

Variables in Phase II

The experimental part of the study investigates effectiveness of evidence-based self-regulatory intervention in improving students' achievement in mathematics, in comparison to the current practices followed by the school curriculum. Evidence-based self-regulatory intervention is the learning strategy developed on the basis of self-regulated learning theory and evidences from self-regulated learning research, and motivation research followed by students, to overcome the affective difficulties and drawbacks of learning strategies that are identified through a qualitative survey.

There are independent, dependent, control, and moderator variables.

Independent variable.

Independent variable in this study is self-regulated learning strategy intervention. It involves guided practice only/guided practice cum self-practice of the following strategies.

- Know themselves as learners (report of each one's prerequisites in mathematics, ability conception belief and use of cognitive and metacognitive learning strategies in the classroom are discussed within the light of high achievers' behavior in this matter).

- Task value (Know the subject of mathematics)
- Goal setting (Plan your learning accordingly)
- Learning diary (Monitor your learning)
- External regulation (Teacher comments, correction plan on learning diary)
- Concept map (Organize the learning or learned materials).

Self-regulated learning strategy intervention has four levels; which are.

i. SRL strategy instruction (Guided Practice-Longer intervention)
ii. SRL strategy instruction (Guided Practice-Longer intervention) + SRL strategy self-practice
iii. SRL strategy instruction (Guided Practice-Shorter intervention)
iv. Control (No SRL strategy instruction)

Dependent variables.

Since the study is aimed at enhancing mathematics achievement through a self-regulatory intervention, the dependent variables are a set of cognitive and affective measures of achievement in mathematics. They include the following; achievement in mathematics, self-efficacy for learning mathematics, task value of learning mathematics and use of self-regulated learning strategy in mathematics.

Achievement in mathematics variables.

There are three achievement related dependent variables.

1. *Achievement in mathematics.* Achievement in mathematics is the weighted total achievement that students gained from the two chapters, fractions and pairs of equations.

2. *Achievement in fractions.* It is the extent to which student has achieved the cognitive objectives of learning of the chapter fractions of standard nine mathematics.

3. *Achievement in pairs of equations.* It is the extent to which student has achieved the cognitive objectives of learning of the chapter pairs of equations of standard nine mathematics.

Self-efficacy for learning mathematics variables.

Since effectiveness of the self-regulatory intervention is measured also against self-efficacy for learning mathematics, there are three self-efficacy variables. They are:

4. *Self-efficacy for learning mathematics.* It is the students' perception of efficacy to learn and perform well in mathematics related tasks and to succeed in mathematics and in related situations.

5. *Self-efficacy for learning fractions.* It is students' judgement regarding their ability to accomplish the tasks in the chapter fractions.

6. *Self-efficacy for learning systems of linear equations.* It is students' judgement regarding their ability to accomplish the tasks in the chapter pairs of equation.

In addition to the above achievement and self-efficacy variables two other motivational construct variables are also considered as dependent variables.

7. ***Task value of learning mathematics***. It is the students' perception of importance, utility, enjoyability and cost of mathematical tasks. It is measured using scale of task value of learning mathematics, with four

dimensions, attainment value, utility value, intrinsic value, and cost value, which is a negative aspect of task value.

8. ***Self-regulated learning strategy***. This denotes extent of students' use of cognitive, metacognitive, time management and help seeking strategies for learning mathematics. It is measured using self-regulated learning strategy questionnaire.

Control variables.

Nonverbal intelligence and prerequisites in mathematics were controlled among the experimental and control groups; by matching mean scores of these variables among the groups. Gender and teacher were controlled in the study. Hence four variables are controlled in the study.

1. ***Nonverbal intelligence***. The experimental and control groups were matched on the mean scores on Raven's progressive matrices, and hence do not vary among the four treatment groups.
2. ***Prerequisites in mathematics***. The experimental and control groups were matched on the mean scores on test of prerequisites in mathematics, and hence do not vary among the four treatment groups.
3. ***Gender.*** The effect of self-regulatory strategy instruction on the dependent variables are studied separately for boys and girls.
4. ***Teacher***. Teacher who instructs the content of mathematics vary among the treatment groups. Both the experimenter and the regular school mathematics teacher taught the chapters of fractions and pairs of equations. The effect difference in teaching by these two if any were controlled by counter balancing.

Moderator variables.

Since the study verifies whether the effect of self-regulatory strategy instruction on achievement, self-efficacy, task value and self-regulatory learning is modified by mathematical ability conception and mathematical goal orientation of students, these two are the moderator variables in this study.

1. ***Mathematical ability conception***. Students possess two kinds of beliefs regarding the development or nature of mathematical ability. Based on students' perception of fixed or malleable nature of mathematical ability, there are two kinds of mathematical ability conceptions, entity beliefs and incremental beliefs respectively. It is measured using scale of mathematical ability conception.
2. ***Mathematical goal orientation.*** Students' orientation towards developing or demonstrating their ability in mathematics refers to goal orientation. Two types of goal orientations in mathematics were considered here, mastery goal orientation and performance approach goal orientation.

Tools and Techniques Used for Data Collection

As indicated in the design of this study, it progresses through two phases. After Phase I, the study developed experimental intervention and tools required for the study, which was done partly based on the phase I qualitative study. The major tools used in this study are as follows.

1. Questionnaire on student perception of mathematics
2. Raven's standard progressive matrices (Raven & Kratzmeier, 1988)

3. Test of prerequisites in mathematics
4. Mathematical goal orientations inventory (Middleton & Midgley, 1997)
5. Scale of mathematical ability conception
6. Test of achievement in fractions
7. Test of achievement in pairs of equations
8. Scale of self-efficacy for learning mathematics
9. Scale of self-efficacy for learning fractions
10. Scale of self-efficacy for learning systems of linear equations
11. Scale of task value of learning mathematics
12. Self-regulated learning strategy questionnaire
13. Intervention on self-regulatory learning

Each tool, that were used for data collection are described in this section.

1. Questionnaire on Student Perception of Mathematics

Self-regulated learning strategy is a motivation-based instructional strategy. Hence, for introducing self-regulated learning strategy in mathematics learning, the study required to identify the difficulties that are felt by students in learning mathematics, to analyze their motivation to learn mathematics and if they lack it, to know the reasons should be. Learning difficulties in mathematics here refers to problems in the academic skills sourced from emotional and motivational difficulties and inadequate learning strategies. This study focus on motivational or emotional factors that influence learning of mathematics, but do not completely avoid cognitive factors.

Purpose.

Everyone possesses likes and dislikes towards each subject. These likes and dislikes may be formed by their experience. As the subjects vary in their nature, students' likes also vary. Students feel mathematics as a difficult subject because of different reasons. Difficulties in learning mathematics in this study refers to challenges to optimum learning or achievement sourcing from by learners' affective beliefs. This questionnaire is planned to identify the reasons for mathematics being a difficult subject. Here, the main objective is to find out the affective and strategic factors that negatively influence students' mathematics learning at high school level.

A review was conducted for identifying factors that affect learning of mathematics. The identified factors can be divided into three broad categories namely, individual factors, task related factors, and environmental factors. Individual factors are internal to the individual, or under control of the individual. Factors that are external to individual are named as environmental factors. Task related factors are those related to the particular task. This questionnaire gives importance to motivation related internal factors like interest, fear or anxiety, task value beliefs, self-efficacy, ability conception beliefs regarding mathematics, goal orientation and some relevant external or task related factors that affect motivational factors. The literature evidence that these variables influence learning, at the same time they are closely interconnected (Grootenboer & Marshman, 2016).

This questionnaire identifies students' affective factors and learning strategies that literature reveals to influence learning of mathematics, and seeks to know why students feel mathematics as a difficult subject, why they dislike mathematics, to know about the difficulties faced by students in mathematics learning in and out of classroom. Most of the items are open ended.

Planning.

Major purpose of this questionnaire is to collect data about students' likes, dislikes regarding mathematics and reasons for these, their identified and given reasons for mathematics being difficult or easy, beliefs regarding the nature of mathematics, difficult areas in mathematics, motivational beliefs concerning mathematics, and their goal and study strategies in learning mathematics. This questionnaire among the other things is to fulfill the following objectives.

To know the percentage of population who like/dislike mathematics

To know the reasons to like/dislike mathematics

To know the learning strategies used by students for learning mathematics

To understand the goals and motivational beliefs of students with regards to mathematics learning including task value, interest, self-efficacy, ability conception, and goal orientation.

Item writing.

This questionnaire is consists of 60 items, regarding students' likes and reason for likes, their perception regarding their level of achievement in mathematics and reason for this level of achievement, reasons for mathematics being difficult or easy, expectancy related behavior, beliefs regarding the nature and learning of mathematics , teacher related factors, difficult area in mathematics, the strategies to learn mathematics regular class and for exams, time spent daily for learning mathematics, fear of mathematics and related behaviors, and goal related behavior. There are open ended as well as closed items. Copies of Malayalam and English versions of Questionnaire on student perception of mathematics are provided as Appendices A1 and A2 respectively.

Administration and scoring.

The questionnaire was administered as focus group interviews. Students discussed and analyzed their problems in the group. The researcher explained the purpose of interview to the students. Students were asked to record their own response after discussing the easiness and difficulties of mathematics in group. The discussion is aimed at brainstorming regarding the problems of mathematics learning. The data obtained from the students were first analyzed qualitatively by categorizing their responses. Proportion of students in beliefs were found out, and the relation between students' different beliefs, likes and dislikes were analyzed quantitatively using chi-square test.

2. Raven's Standard Progressive Matrices (SPM) (Raven & Kratzmeier, 1988)

Ravens' standard progressive matrices is a nonverbal group test of intelligence. It measures educative component of *g* equivalent to cognitive theory of Spearman (Sbaibi, Aboussaleh & Ahami, 2014; Raven & Kratzmeier, 1988). It includes ability to form new insights, to recognize meaning, to perceive and to identify relationship (SPM manual). The test is apt for measuring ability to form perceptual relations of persons with age range from 6 to adult. It is a short, robust and valid test of intelligence with 60 items, grouped to five sets, with 12 items in each and arranged in the increasing order of difficulty. All are in the form of puzzle pictures with one missing part. The raw scores can be calculated by finding the total scores by giving one point for each correct response. For the raw scores there are given percentile ranks for different norm groups in the manual (Raven & Kratzmeier, 1988).

This well-known test is used in this study to quantify Non-verbal intelligence of participants in the intervention phase. SPM raw scores were used here because it is used only for grouping purpose, and no recent percentile norms are available for SPM on Indian population (the only available percentile norms for India is from 1988 Mumbai sample) (Raven, 1958; Raven & Court, 2000). As it is an outdated one, this norm is not used here. Students are classified as high and low on non-verbal intelligence by using median of raw scores (fiftieth percentile) as the cut point.

3. Test of Prerequisites in Mathematics (for standard IX students)

This test was developed by the researcher with the supervision of supervising teacher, to measure the extent of achievement of prerequisite knowledge and skills for students to learn the two chapters - fractions and pairs of equations - of standard IX mathematics in Kerala. It is true for all subjects that all learning builds on what is already known (Ambrose, Bridges, Dipietro, Lovett & Norman, 2010; Briggs, 1991). This is truer to mathematics learning. For easy understanding in mathematics, it is important to recall and connect the relevant prerequisites quickly to the present topic. If students are high on previous knowledge, and they are able to use it at appropriate time, it offers a strong foundation for knowledge development (Ambrose, Bridges, Dipietro, Lovett, & Norman, 2010).

Mathematics curriculum and textbooks are arranged in such a way that all prerequisites for a particular topic would have been learnt previously, in preceding years or chapters. But usually, it has been witnessing that most of the students do not possess the relevant prerequisites. Phase I of this study revealed that forgetting of the previous content is one major reason for mathematics being difficult. To check how well students possess these prerequisites, all the prerequisites needed for chapters- fractions and pairs of equations- were identified. A test was made on the basis of these. For a good understanding of present chapter, they need basics in algebra as well as fractions.

Planning.

The test was made for two purposes.

1. To match the experimental and control groups on prerequisites for learning the two chapters- fractions and pairs of equations.

2. To include the identified concepts and skills in the self-regulatory strategy instruction. That is, prerequisites have great relevance in mathematics learning, lack of this is reported as one of the major reasons for mathematics being difficult. So, to enhance achievement in mathematics students were subjected to prerequisite test. Then students discussed the reports on pre-requisite achievement in mathematics in relation to their difficulties in learning mathematics. This was one way to make the students aware that they feel mathematics as difficult subject not because of nature of subject but because of their lack of previous knowledge.

The chapter Fractions is a bridge to algebraic fractions and operations of algebraic fractions from numerical fractions and arithmetic operations using fractions. Students have already learnt numerical fractions and its operations. In this chapter, they would learn operations with the algebraic fractions, develop general principles for number series using fractional numbers, explain some general principles of comparing fractions with the help of algebra, explain rules of fractional operations in algebraic form, and to write a common fraction in decimal form and as sum of decimal fraction and common fraction. All the prerequisites they need to learn these and to solve problems, were included in the test. Testing time is fixed as one hour and the whole test include 60 items.

Item writing.

Items in the Test of prerequisites in mathematics (for standard IX students) were made on the basis of school mathematics in standards 1 to 8. The researcher analyzed content of mathematics text books from standard 1 to 8 to know what the students have already learnt in relation to fractions. The chapter objectives, content, and problems or drill works in the chapters were also analyzed. Care is taken to include all the topics that students learnt in previous class in relation to unit 'fractions'. The 60 items test has two sections. In Section 1, all 45 items are objective multiple-choice selection type with four choices, a, b, c, and d, and in section 2, all 15 items are short-answer type. For multiple choice items, distracters were chosen from commonly expected error responses. In each area, very basic easy questions and questions with average difficulty were included.

Section 2 constitutes 15 items on division problem, to find factors of a number, equal fractions in numerical form and algebraic form, to identify larger or smaller fractions number, to change fractional number to decimal form, and to write algebraic form of a given word problem. Areas of items and examples for them are given in Table 3.

Table 3

Selected Areas of School Mathematics in Standards I to VIII for the Test of Prerequisites in Mathematics with Examples of Items

Section	Area	Item No.	Example
Section 1	Knowledge of fractional numbers	1	In the given numbers which one is written in the form of fractions a) 7.6 b)$\frac{7}{6}$ c) 7^2 d) 7 ÷ 6
	To change a mixed fractions to improper fractions and vice versa	6	$5\frac{1}{4}$ = ……… ? a)$\frac{5}{4}$ b)$\frac{6}{4}$ c)$\frac{21}{4}$ d)$\frac{10}{4}$
	Smallest form of a fractions	8	Simplest form of $\frac{21}{56}$ a)$\frac{8}{3}$ b)$\frac{1}{3\ 5}$ c)$\frac{3}{8}$ d)$\frac{3}{7}$
	Equal fractions	9	From the given, find out the equal fractions for$\frac{8}{11}$. a)$\frac{24}{3\ 3}$ b)$\frac{10}{13}$ c)$\frac{11}{8}$ d)$\frac{4}{22}$
	Reciprocal form of a fractions	13	What is the reciprocal of $\frac{x}{y}$? a)x b) y c)$\frac{y}{x}$ d)xy
	Operations with numerical fractions	18	$\frac{21}{7}$--- $\frac{10}{7}$ = ……………? a)$\frac{2}{7}$ b)$\frac{11}{14}$ c)11 d)$\frac{11}{7}$
	Decimal forms	24	Decimal form of $\frac{84}{5}$ a)8.4 b)16.8 c) $16\frac{4}{5}$ d)16.5
	Basics of algebra	37	$\frac{n+n}{n}$ =? a)$\frac{1+n}{n}$ b)$\frac{2}{n}$ c)2 d)1
Section 2	Factorization of a number	47	What are the factors of 42?
	Translation of verbal statements to algebraic expressions	58	Write the algebraic form of "Sum of a number and its square"

Students were instructed to answer the items as per the instructions. A copy of Malayalam and English versions of test of prerequisites in mathematics is provided as Appendices B1 and B2 respectively. Response sheet and scoring key of test of prerequisites in mathematics are provided as Appendices B3 and B4 respectively.

Scoring procedure.

All correct response were scored '1', and incorrect responses were '0'. Maximum possible score is 60. As the test aimed to know about the level of prerequisite of students (criterion test), no customary item analysis procedures were followed.

For classifying the students in experimental sample based on their prerequisite knowledge, median score (50^{th} percentile) was used as the cut point. Accordingly students were categorized as high and low on prerequisites in mathematics.

4. Mathematical Goal Orientations Inventory (Middleton & Midgley, 1997)

This instrument developed over a period of eight years by a group of researchers at the University of Michigan, measures mastery goal orientation, performance approach goal orientation, and performance avoidance goal orientation specifically to mathematics domain (Middleton & Midgley, 1997). The items are validated for students from grade 5 through 9. Goal orientation with the highest scale average is identified as the students' mathematical goal orientation. Authors report high internal consistency for the instrument. Confirmatory factor analysis attests to the discriminant validity of the scales. In this study only the two scales, Mastery Goal Orientation and Performance Approach Goal Orientation are used.

5. Scale of Mathematical Ability Conception

This tool developed as part of this study is based on the theory of ability conception or implicit theories of intelligence developed by Dweck (Dweck, 2002; Cain & Dweck, 1989). Ability conception or implicit theories of intelligence is a construct having a simple unitary theme with two extremities namely entity view and incremental view (Dweck, Chiu & Hong, 1995). As per the entity view, subject believes that intelligence or ability is a static trait of individual and she/he cannot do much to change it as it is a inborn property. In incremental view, subject believes that ability can be improved through constant effort. Based on this theory, a tool to measure general view of ability conception is developed (Blackwell, Trzesniewski & Dweck, 2007). A recent version of implicit theories of intelligence scale includes six items, with six-point scale (Blackwell, Trzesniewski & Dweck, 2007). Later it is used in studies related to specific discipline by asking the same questions in relation to specific discipline. In line with of Dweck's view that implicit theories are conceptually domain specific, some recent researchers have developed tool to measure ability conception in specific disciplines. Ilhan and Cetin (2013) developed an eleven-item scale to measure mathematics oriented implicit theories of intelligence scale (MOITIS). But instead of using a uni-factor model, they followed a two-factor model and used separate items to measure mathematical ability conceptions.

In Dweck's and colleagues scale (Blackwell, Trzesniewski & Dweck, 2007), they used more conceptual items regarding general implicit theories of intelligence. Instead, this study aimed to measure students' beliefs regarding role of effort and inborn ability in mathematics with the view that they can be more directly/easily understood. Dweck's theory of implicit intelligence and the characteristic behaviors explained by her for each two views paved stones for the current instrument.

This scale intended to assess the students' belief regarding role of ability and effort, which one is more influential in mathematics learning and achievement. The tool is developed in such a way that it measures a uni-factor continuous variable, the low score represents entity view (mathematical ability as fixed and inborn); and the high score represents the incremental view (mathematical ability as malleable and can be improved through planned effort).

Item writing.

There were fifteen items in the draft tool, in which high score of eleven items represents entity view and the remaining represents incremental view (item numbers- 3, 6, 8, 12). There are more entity items (negative) because Dweck's study found that the incremental item itself biases the student's responses (Dweck, Chiu & Hong, 1995). Because of this, she included only entity items in her former studies. All the items were written such that one end represents incremental view and the other end represent entity view. The item with entity view were reverse coded so as to get high score as a measure of incremental view. Two items are illustrated below.

- Mathematics skills are developed through continuous effort. (Item no. 3)
- Proficiency in mathematics is an inborn talent. (Item no. 4)

Scoring.

For each item, there are five response options- strongly disagree (1), disagree (2), neither agree nor disagree (3), agree (4), strongly agree (5). The items in which high score represents entity view are reverse scored. The total score for all fifteen items (so that a high score will represent incremental view and low score will represent an entity view) represent the students' tendency to approach incremental view.

Item analysis.

The scale is tried out on a random sample of 370 standard nine students. Item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item are given in Table 4.

Table 4

Result of Item Analysis on Scale of Mathematical Ability Conception

Item no. (draft tool)	M_1	M_2	SD_1	SD_2	*t*	Item no. (final tool)
1*	2.93	2.24	1.25	1.05	4.24	1
2*	1.65	1.42	0.99	0.75	1.85	--
3	4	3.32	1.15	1.25	4.00	2
4*	4.38	2.76	1.04	1.39	9.34	3
5*	4.62	2.5	0.91	1.42	12.55	4
6	4.85	3.96	0.52	1.38	6.05	5
7*	3.2	1.97	1.48	1.09	6.69	6
8	4.3	3.16	0.96	1.43	6.63	7
9*	4.56	2.52	0.95	1.47	11.69	8
10*	2.89	2.01	1.56	1.19	4.48	9
11*	3.66	2.19	1.42	1.38	7.41	10
12	1.71	1.83	1.23	1.25	0.69	--
13	3.39	3.38	1.39	1.56	0.05	--
14*	4.72	2.71	0.82	1.43	12.20	11
15*	4.62	2.76	0.83	1.39	11.48	12

Note: * Negative items

Items for final tool were selected if discrimination power (*t* value) is greater than 2.58. Accordingly, twelve items were selected for the final tool. Copies of the draft and final versions of scale of mathematical ability conception along with their English translations are provided in Appendices C1, C2, C3 and C4 respectively.

Validity.

Validity of the scale of mathematical ability conception is established by correlating the scores from this scale with mathematics oriented implicit theory of intelligence scale (Ilhan &Çetin, 2013). Mathematics oriented implicit theory of intelligence scale is an eleven-item scale measuring two factors separately, entity beliefs in mathematics and incremental beliefs in mathematics. For the validation, sum of scores in the subscales incremental beliefs in mathematics and reverse coded scores of entity beliefs in mathematics, of mathematics oriented implicit theory of intelligence scale was used. Validity coefficient obtained is .8 (N=32).

Reliability.

Test-retest method of reliability and Cronbach's alpha were employed to establish reliability. The test is administered twice among forty students of standard nine with two-week interval. The test-retest coefficient of reliability was found to be .83 (N=40). Cronbach's alpha coefficient obtained is .69 (N=370).

Tests of Achievement in Mathematics

Two achievement tests- Test of achievement in fractions, and Test of achievement in pairs of equations- were developed. They were used as pre-tests and post-tests during the two stages of the experimental phase. Tests were developed according to the chapter content and objectives given in the textbook and teachers' handbook. Achievement in mathematics is then obtained as the weighted total of the achievement in fractions and achievement in pairs of equations.

Item analysis of the tests of achievement in fractions and pairs of equations were conducted on a sample of 300 students using the conventional procedure of item analysis (Ebel, 1991) with estimations of discrimination power and item difficulty based on upper and lower 27 percent (81 in each group). Difficulty index (DI) and discriminating power (DP) of each item were calculated using the following equations.

$$\mathrm{DI} = \frac{UH + LH}{2N}$$

And

$$\mathrm{DP} = \frac{UH - LH}{N}$$

Where,

DI - Difficulty index

DP - Discrimination power

UH- Number of correct answers among the 27% of those with highest test scores.

LH - Number of correct answers among the 27% of those with lowest test scores.

N - Total number of students in both groups (here 81).

6. Test of Achievement in Fractions

This test measures level of achievement of a student in the listed objectives in the chapter Fractions. In planning stage, the researcher thoroughly analyzed the objectives of the chapter and content areas in Teachers' handbook (SCERT, 2016) to decide weightage to each area. The objectives of the unit were: to learn different ways of determining equality of fractional numbers, to identify different procedures for finding equal fractional numbers for a given fractional number, explain different ways for equating two fractions, and to explain all these with help of algebra and to solve problems related to this, and change fractions to decimal numbers. Appropriate weightage was given to the content, difficulty level and cognitive objectives. The test is developed on the basis of six cognitive process objectives of revised Bloom's taxonomy (Krathwohl, 2002; Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich & Wittrock, 2001).

Planning.

This test is planned to measure the achievement of standard nine students in the chapter 'Fractions'. An objective type test with four choices is planned. As the test is meant to differentiate the students according to their achievement, easy, average and difficult items were included in the test. The test is planned for 45 minutes with 25 objective type items. A blue print with objective wise and content wise distribution of items was prepared as in Table 5.

Table 5

Blue Print for Test of Achievement in Fractions

Content \ Objectives	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total number of items
Equal fractions		*1*	*3, 7*	*2,14*		*13*	6
Cross multiplication	*4, 9*	*5*		*15*		*16*	5
Comparison of fractions			*17, 18, 19, 20*	*8, 22*	*21*		7
Operations with fractions	*6*		*10, 11, 12*				4
Decimal forms			*23, 24, 25*				3
Total	3	2	12	5	1	2	25

Note: Figures in italics are the item numbers

Item writing.

According to the blueprint provided in Table 5, twenty-five items were prepared by carefully analyzing content of textbook and Teacher's Handbook and by referring previous question papers. Illustrative items for each cognitive domain objectives are given in Table 6.

Table 6

Illustrative Items from Test of Achievement in Fractions for Each Cognitive Domain Objective

Cognitive Objective	Illustrative items	
	Item No.	Item
Remembering	4	If $\frac{a}{b} = \frac{p}{q}$, then which of these equations is true? a)$aq = pb$ b)$ap = bq$ c)$ab = pq$ d) $a = p$
Understanding	1	Which of the following is an equivalent fractions of $\frac{p}{q}$? a)$\frac{q}{p}$ b) $\frac{p}{q}$ c)$\frac{p^2}{q^2}$ d)$\frac{pq}{p}$
Applying	19	If $\frac{7}{8} > \frac{x}{5}$, then which of the following can be the value of $'x'$? a)4 b)5 c) 6 d) 7
Analyzing	22	If $\frac{a}{b} = \frac{p}{q}$ and $a < b$, then which of the following is accurate? a)$q < p$ b)$aq < bp$ c)$ap < bq$ d)$p = q$
Evaluating	21	If $\frac{a}{b} = \frac{p}{q}$ and $a < b$, then which of the following shows the relationship between p and q? a)$p > q$ b)$q < p$ c)$p = q$ d)$p < q$
Creating	16	If $\frac{a}{b} = \frac{p}{q}$, then which of the variables in $\frac{a+p}{b+nq}$ must be avoided to make it equal to $\frac{a}{b}$? a)p b)b c)n d) q

Administration and scoring of the test.

Students were given 45 minutes to complete the test. Test and response sheet were given separately, and students were advised to choose their response by encircling the letter denoting correct response. Each correct response carried one score and incorrect response carried zero score with total possible score ranging between 0-25.

Item analysis.

Results of item analysis are given in Table 7.

Table 7

Data and Results of Item Analysis of Tests of Achievement in Fractions

Item No. (Draft tool)	LH	UH	DP	DI	Item No. (Final Tool)
1	8	20	0.15*	0.17	--
2	29	72	0.53	0.62	1
3	7	12	0.06*	0.12	--
4	34	61	0.33	0.59	2
5	53	78	0.31	0.81*	--
6	31	68	0.46	0.61	3
7	10	26	0.20*	0.22	--
8	27	60	0.41	0.54	4
9	46	61	0.19*	0.66*	--
10	18	55	0.46	0.45	5
11	5	10	0.06*	0.09	--
12	9	22	0.16*	0.19	--
13	18	59	0.51	0.48	6
14	10	73	0.78	0.51	7
15	9	52	0.53	0.38	8
16	35	73	0.47	0.67*	--
17	16	61	0.56	0.48	9
18	8	29	0.26	0.23	--
19	19	53	0.42	0.44	10
20	34	65	0.38	0.61	11
21	10	57	0.58	0.41	12
22	12	29	0.21*	0.25	--
23	5	38	0.41	0.27	13
24	11	45	0.42	0.35	14
25	9	41	0.40	0.31	15

Note: * indicates outside the limits of DI or DP

Items with DP greater than .3 and DI in between .4 and .6 were selected to final tool. Copies of draft and final versions of the test of achievement in fractions along with their English translations are provided in Appendices D1, D2, D5 and D6 respectively. Copies of draft and final versions of the response sheet are provided as Appendices D3 and D7 respectively. Copies of draft and final versions of scoring key of test of achievement in fractions are provided as Appendices D4 and D8 respectively.

Validity.

Content validity of test of achievement in fractions is ensured by covering all learning objectives in the chapter fractions as testified in the blue print in Table 5.

Reliability.

Split-half reliability of the whole test estimated by grouping the items on the basis of discrimination power [two groups were formed (Group 1: 1,2,5,9, 13, 14, 15, 7 and Group 2: 3, 4, 6, 8, 10, 11, 12, 7)] was found to be $r = .69$ (N= 300).

7. Test of Achievement in Pairs of Equations

This test measures level of achievement of a student in the listed objectives in the chapter 'Pairs of Equations'. In the planning stage, the researcher thoroughly analyzed the objectives of the chapter and content areas in Teachers' handbook (SCERT, 2016) to identify what content weightage should be given to each area. The objectives of the unit were: to write linear equations in first degree and second degree in two variables for word problems, and to find out their solutions. Appropriate weightage was given to the content, difficulty level and cognitive objectives. The test is developed on the basis of six cognitive process objectives of revised Bloom's Taxonomy (Krathwohl, 2002; Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich & Wittrock, 2001).

Planning.

This test is planned to measure the achievement of standard nine students in the chapter ‘Pairs of Equations’. An objective type test with four choices per item is planned. As the test is meant to differentiate the students according to their achievement; easy, average and difficult items were included in the test. The test is planned for 45 minutes with 20 objective type items. A blue print with objective wise and content wise distribution of items is prepared as in Table 8.

Table 8

Blue Print for Test of Achievement in Pairs of Equations

Objectives / Content	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating	Total number of item
Pairs of equations	*6*	*1,2,3, 4,5*	*10,13,14,15, 16, 19, 20*	*7,11, 17,18*	*12*	*8,9*	20
Total	1	5	7	4	1	2	20

Note. Figures in italics indicate item number.

Item writing.

Twenty items were prepared by carefully analyzing content of textbook and Teacher’s Handbook and by referring previous question paper of pairs of equations according to the blueprint in Table 8. Illustrative items from each cognitive domain objectives are given in Table 9.

Table 9

Illustrative Items from Test of Achievement in Pairs of Equations for Each Cognitive Domain Objective

Cognitive Objective	Item No.	Illustrative Items Items
Remembering	6	Which of the choices given below is equal to $x^2 - y^2$? a) $(x+y)(x+y)$ b) $(x-y)^2$ c) $(x-y)(x-y)$ d) $(x+y)(x-y)$
Understanding	2	If $\frac{y+12}{2} = 15$, then $y =$ _____? a) 42 b) 5 c) 25 d) 18
Applying	10	What is the value of u in the equation $u + 2t = 24$ if the value of t is 6? a) 36 b) 9 c) 18 d) 12
Analyzing	7	You get the same two-digit number when the sum of the digits of this number is multiplied by 7 and 3is added to the product, and when the difference of the digits is multiplied by 20 and subtracted 8 from the product. Which is the two-digit number? a) 52 b) 25 c) 42 d) 24
Evaluating	12	The sum of digits in a two-digit number is 8. The digit with the place holder of one is 2 times the tenth placeholder plus2. Which is the number? To solve this problem, Salim and Rafi consider x as the tenth placeholder and y as the placeholder of one. The equations made by Salim and Rafi are given below. Equations written by Salim $10x + y = 8 \quad --(1)$ $2x + 2 = y \quad --(2)$ Equations written by Rafi $x + y = 8 \quad --(1)$ $2x + 2 = y \quad --(2)$ Considering the equations, which choice is accurate? a) Both equations written by Salim is correct b) Both equations written by Rafi is correct c) First equation written by Salim is correct d) Second equation written by Rafi is incorrect
Creating	8	Find two numbers, of which their difference is 4 and the difference of their squares is 64. a) $10,\ 6$ b) $8,\ 4$ c) $12,\ 8$ d) $11,\ 7$

Administration and scoring of the test.

Students were given 45 minutes to complete the test. Test and response sheet were given separately, and students were advised to choose their response by encircling the letter denoting correct response. Each correct response carried one score and incorrect response carried zero score with total possible score ranging between 0-20.

Item analysis.

Results of item analysis are given in Table 10.

Table 10

Data and Results of Item Analysis of Test of Achievement in Pairs of Equations

Item No. (Draft tool)	LH	UH	DP	DI	Item No. (Final Tool)
1	21	63	0.52	0.52	1
2	30	78	0.59	0.67*	--
3	19	65	0.57	0.52	2
4	13	67	0.67	0.49	3
5	30	76	0.57	0.65*	--
6	12	54	0.52	0.41	4
7	14	68	0.67	0.51	5
8	17	75	0.72	0.57	6
9	18	64	0.57	0.51	7
10	11	77	0.81	0.54	8
11	10	73	0.78	0.51	9
12	25	36	0.14*	0.38	--
13	13	71	0.72	0.52	10
14	22	65	0.53	0.54	11
15	16	77	0.75	0.57	12
16	18	74	0.69	0.57	13
17	20	73	0.65	0.57	14
18	24	78	0.67	0.63	15
19	23	52	0.36	0.46	16
20	11	48	0.46	0.36	17

Note: * Indicates outside the limits of DI or DP

Items with DP greater than .3 and DI in between .35 and .6 were selected to final tool resulting in a 17-item test. Copies of draft and final versions of the test of achievement in Pairs of Equations along with their English translations are provided in Appendices E1, E2, E5 and E6 respectively. Copies of the response sheet are draft and final versions are provided in Appendices E3 and E7 respectively. Copies of scoring key of draft and final versions of test of achievement in Pairs of Equations are provided in Appendices E4 and E8 respectively.

Validity.

Content validity of test of achievement in pairs of equations is ensured by covering all learning objectives of the chapter; and by obtaining the judgement of mathematics teachers.

Reliability.

Reliability estimated by split-half method the items were grouped on the basis of discrimination power. Group 1: 1, 3, 6, 7, 8, 11, 12, 15, 16 and Group 2: 2, 4, 5, 9, 10, 13, 14, 17, 16)] found to be was r= .85 (N= 300).

8. Scale of Self-Efficacy for Learning Mathematics

This tool is developed as part of this study to measure self-efficacy in mathematics of high school students. Self-efficacy belief is a person's belief, perception or judgement regarding his own ability to accomplish a particular task; it may differ from his or her actual ability. Their previous experience of success or failure in related previous situations are the main determining factor of self-efficacy. Bandura (1997) defined self-efficacy for learning as one’s belief about his own capability to learn or perform at a designated level. Self-efficacy beliefs affect actions by intervening in motivational, cognitive, and affective processes (Bandura, 1989). It is not global trait, one’s self-efficacy beliefs may differ with respect to subjects, and within the subject. Self-efficacy for learning mathematics here refers to students' perceived efficacy to learn and perform well in mathematics related tasks. It is the perception of students regarding their ability to succeed in mathematics, and in related situations, not their ability in mathematics.

Planning.

A scale of self efficacy is constructed after an extensive literature review on that construct. Bandura (2006) advices to consider level, generality and strength while measuring self-efficacy. Strength is not considered here because it has to do nothing in item writing but is put to use while interpreting the scores. The self-efficacy of a person is intended to measure level, strength and generality of their efficacy belief. Self-efficacy scale should cover a person's perception of ability across different domains of activity, under different levels of task demands within the domain and under different situational circumstances. Bandura notifies that while measuring self-efficacy, sub skills must be analyzed and included in it (Bandura, 1997; Bandura, 2006). So a conceptual analysis of functioning of mathematics learning and a comprehensive analysis of task gradation and task demands were done, and along with the analysis of different activity domains of mathematics learning.

Item writing.

Item writing is guided by level and generality of students' efficacy belief in learning mathematics. Levels of self-efficacy are measured due to the fact that, students may differ in their perceived efficacy to learn mathematics while the task is easy, moderate or difficult. So, students were asked to rate their self-efficacy in learning easy, moderate and difficult mathematics tasks and their ability to perform different tasks according to the cognitive domain objective of learning mathematics. Generality of self-efficacy is the difference in people's perceived efficacy across domains of activity. It refers to the efficacy beliefs in accomplishing the task in wide range of activities versus certain domains. For example, one maybe efficacious in learning algebra, but not in geometry, and in classroom situations but not in general activities. Generality can vary by degree of similarity of activities, modalities on which abilities are expressed, and the features of situations. The items were constructed by keeping in mind that the different facets of mathematics learning, types of capabilities included in learning mathematics, and the different situations in which these abilities might be used. There are 20 items in the draft scale.

Illustrative items with corresponding item numbers in draft tool are given below.

- I can understand the details covered in a question (Item number 4).
- I can perform well in algebra (Item number 14).
- I can answer to a question even if it is not clear on the necessary information (Item number 20).

Scoring procedure.

Students were asked to respond to what extent (in percentage) they are confident in accomplishing the given task. Five response categories with equal distance were given from zero percent to 100 percent. Response categories are ‘I do not think I can do’ (0%), ‘I can do them sometimes’ (25%), ‘I can do them to an extent’ (50%), ‘I can do them well’ (75%), and ‘I can do them really well’ (100%). All statements were written in positive form. For each statement, a response of 0% is given one score, 25% given 2 score, 50% given 3 score, 75%

given 4 score and 100% given 5 score. Sum of the scores on all statements in the scale gave the total score of self-efficacy for learning mathematics. Maximum possible score for the scale is 100 and minimum score is 20.

Item analysis.

The scale is tried out on a random sample of 370 standard nine students and item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item is given in Table 11.

Table 11

Data and Result of Item Analysis of Scale of Self-Efficacy for Learning Mathematics

Item no. (draft tool)	M_1	M_2	SD_1	SD_2	t	Item No. (final tool)
1	3.79	2.67	0.77	0.97	9.02	1
2	4.33	2.6	0.79	0.92	14.24	2
3	3.31	2.2	0.94	0.96	8.25	3
4	3.86	2.45	0.90	0.95	10.80	4
5	3.79	2.33	0.80	0.79	13.01	5
6	4.08	2.26	0.88	1.00	13.63	6
7	4.09	2.56	1.00	1.09	10.39	7
8	4.43	2.79	0.64	0.98	14.04	8
9	4.3	2.74	0.70	0.96	13.11	9
10	4.19	2.56	0.65	0.82	15.60	10
11	3.98	2.48	0.83	0.90	12.20	11
12	3.88	2.25	0.71	0.69	16.44	12
13	3.67	2.07	0.80	0.86	13.62	13
14	3.56	1.93	1.03	0.79	12.54	14
15	4.15	2.56	0.85	1.07	11.68	15
16	4.84	3.65	0.47	1.23	9.08	16
17	4.56	3.4	0.61	1.05	9.53	17
18	3.12	1.83	0.86	0.78	11.14	18
19	3.94	2.36	0.83	0.77	13.97	19
20	3.41	2.04	1.03	0.82	10.45	20

All the 20 items in the draft tool had *t* value greater than 2.58. Hence, all the items were included in the final scale. Copies of the scale of self-efficacy for learning mathematics (Malayalam and English versions) are provided as Appendices F1 and F2 respectively.

Validity and reliability.

Concurrent validity of the test is established using self-efficacy for learning and performance subscale of MSLQ (Pintrich, 1991). It has 8 items. Students were asked to judge their ability to accomplish the task as well as their confidence in their skill to perform that task (n=32). MSLQ is intended to assess self-efficacy for learning any subject. Students were advised to rate their ability to accomplish mathematics related task. The criterion validity is evidenced in the high relationship (r=.82) found. The scale indicated construct validity as the score significantly correlated against mastery goals (r=.25), and performance approach goals (r=.16), and did not significantly relate with performance avoidance goal orientation (r=.01) in mathematics (Middleton & Midgley, 1997).

Test-retest method of reliability with an interval of 2 weeks in between each administration and Cronbach's alpha were employed to verify reliability. The test-retest reliability (r=.88, N=40) and Cronbach's alpha coefficient (r=.89, N=370) indicates high stability and consistency of the Scale of Self-Efficacy for Learning Mathematics score.

9. Scale of Self-Efficacy for Learning Fractions

This scale is developed as part of this study to measure self-efficacy for learning fractions among standard nine students. Self-efficacy for learning fractions means students' judgement regarding their ability to accomplish the tasks in the chapter Fractions.

Planning.

The scale of self-efficacy for learning fractions is intended to measure the students' self-efficacy for doing task in the subtopics- equal fractions, cross multiplication of fractions, comparison of fractions, operations with fractions, and to change a fraction into its decimal form. The chapter objectives and learning tasks were analyzed to prepare the scale. As in the case of scale of self-efficacy for learning mathematics, the respondents were asked to rate their confidence level on a five-point scale ranging from 0 percent confidence to 100 percent confidence on different tasks in the chapter.

Item writing.

Sixteen items were written for the scale to measure students' self-efficacy in fractions. Items were written in view of learning objectives in the Teacher's Handbook and the learning tasks and problems provided in the textbook.

Illustrative items with corresponding item numbers in draft tool are given below.

- I can generate a new equivalent fractions, if given with two equal fractions (Item number 5)
- I can find the sum of any two fractions (Item number 8)

Scoring procedure.

Students were asked to respond to what extent they are confident in accomplishing the given task in the unit 'Fractions' in terms of percentages. Five response categories with equal distance were given from 0% to 100% . Response categories are 'I do not think I can do' (0%), 'I can do them sometimes' (25%), 'I can do them to an extent' (50%), 'I can do them well' (75%), and 'I can do them really well' (100%). All statements were written in positive form. For each statement, a response of 0% is given one score, 25% is given 2 score, 50% is given 3 score, 75% is given 4 score and 100% is given 5 score. Sum of the scores on all the statements in the scale gave the total score of self-efficacy for learning fractions. Maximum possible score for the scale is 80 and minimum score is 16.

Item analysis.

The scale is tried out on a random sample of 370 standard nine students and item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item has given in Table 12.

Table 12

Data and Result of Item Analysis on Scale of Self-Efficacy for Learning Fractions

Item no. (Draft Tool)	M1	M2	SD1	SD2	*t* value	Item no. (Final Tool)
1	4.45	2.66	0.76	1.17	12.88	1
2	4.52	2.33	0.64	1.02	18.22	2
3	3.96	2	0.83	0.79	17.11	3
4	4.46	2.45	0.73	1.05	15.73	4
5	4.4	2.36	0.71	0.93	17.47	5
6	4.76	2.92	0.51	1.14	14.68	6
7	4.43	2.53	0.70	0.89	16.75	7
8	4.19	2.17	0.71	0.78	19.21	8
9	4.19	2.23	0.73	0.92	16.66	9
10	4.62	2.7	0.68	1.04	15.47	10
11	4.2	2.2	0.90	0.89	15.83	11
12	3.73	2.1	0.79	0.96	13.12	12
13	3.42	2.14	0.88	0.94	9.93	13
14	3.74	2.1	1.00	0.83	12.58	14
15	3.89	2.03	0.85	0.93	14.78	15
16	3.54	2.24	0.93	1.16	8.74	16

Table 12 shows that all the 16 items have *t* value greater than 2.58. Hence, all the items were included in the final scale. Copies of scale of self-efficacy for learning fractions (Malayalam and English versions) are provided in Appendices G1 and G2 respectively.

Validity and reliability.

Concurrent validity of the test is established against scale of self-efficacy for learning mathematics. The correlation between the scores on self-efficacy for learning fractions and self-efficacy for learning mathematics is positive and high (r=.82, N= 370).

Test-retest method and Cronbach's alpha were employed to reliability. The test-retest reliability coefficient with an interval of 2 weeks between the administrations is r=.84 (N=40). Cronbach's alpha coefficient is .92 (N=).

10. Scale of Self-Efficacy for Learning Systems of Linear Equations

This scale is developed in this study to measure self-efficacy for learning systems of linear equations of standard nine students. Self-efficacy for learning systems of linear equations is meant to measure students' judgement regarding their ability to accomplish the tasks in the chapter 'Pairs of Equations'.

Planning.

Self-efficacy for learning systems of linear equations measures students' self- efficacy for doing tasks in the chapter of 'Pairs of Equations'. In this unit students learn to solve verbal problems, by converting verbal statements to algebraic expression. Statements were developed on these tasks. The respondents were asked to rate their confidence level on a five-point scale ranging from zero percent confidence to 100 percent confidence on different tasks in this chapter.

Item writing.

Five items were written for the scale to measure students' self-efficacy for learning systems of linear equations. Items were written in view of learning objectives in the Teacher's Handbook, the learning task and problems provided in the textbook.

Illustrative items with corresponding item numbers in draft tool are given below.

- I can find the value of the variable in a first order algebraic equation with one variable (Item number 2).
- I can solve problems outside my mathematics classroom using algebraic equations (Item number 5).

Scoring procedure.

Students were asked to respond to what extent they are confident in accomplishing the given task in the chapter of pairs of equations in terms of percentages. Five response categories with equal distance were given from 0% to 100% . Response categories are 'I do not think I can do' (0%), 'I can do them sometimes' (25%), 'I can do them to an extent' (50%), 'I can do them well' (75%), and 'I can do them really well' (100%). All statements were written in positive form. For each statement, a response of 0% is given one score, 25% given 2 score, 50% given 3 score, 75% given 4 score and 100% given 5 score. Sum of the scores on all the statements in the scale gave the total score of self-efficacy for learning systems of linear equations. Maximum possible score for the scale is 25 and minimum score is 5.

Item analysis.

The scale is tried out on a random sample of 370 standard nine students and item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item are given in Table 13.

Table 13

Data and Result of Item Analysis on Scale of Self-Efficacy for Learning System of Linear Equations

Item no. (Draft tool)	M_1	M_2	SD_1	SD_2	*t* value	Item no (Final tool)
1	3.78	1.82	0.77	0.77	17.96	1
2	4.08	2.13	0.91	0.84	15.81	2
3	3.81	1.9	0.79	0.77	17.32	3
4	4	2.05	0.82	0.88	16.24	4
5	3.94	1.84	0.80	0.76	18.99	5

Table 13 shows that all the 5 items have *t* values greater than 2.58, so all the items were included in the final scale. Copies of the scale of self-efficacy for learning systems of linear equations (Malayalam and English versions) are provided in Appendices H1 and H2 respectively.

Validity and reliability.

Concurrent validity of the test is established using scale of self-efficacy for learning mathematics. The correlation coefficient between score on self-efficacy for learning mathematics and self-efficacy for learning systems of linear equations is found to be .70 (n=370).

Test-retest method and Cronbach's alpha were employed to establish reliability. The test is administered twice among forty students with a two-week interval. The reliability coefficient was found by calculating correlation between scores of the students in each administration. The test-retest coefficient of reliability was found to be .72 (n=40). Cronbach's alpha coefficient is .77 (n=40).

11. Scale of Task Value of Learning Mathematics

Task value is a person's perception of importance, utility, and enjoyability of a particular task. Eccles et al. (1983) explained task value as a function of attainment value, intrinsic value, utility value, and cost value. Attainment value is the personal relevance of doing well on a task. Intrinsic value is the enjoyment obtained by the individual due to performing the task. Utility value is the perception of person regarding the usefulness of task in his or her goals. Cost value is the cost of engaging in a task, that is what one person has to sacrifice for engaging in the particular task and also the amount of effort needed for task completion.

Planning.

This scale intended to measure high school students' task value beliefs of learning mathematics. Task value of learning mathematics refers to the students' perception of importance, utility, enjoyability and cost of learning mathematics in doing mathematical tasks. The scale follows the task value theory of Eccles (1983).

Item writing.

The scale consists of 12 items covering the four components of task value. Each component with item examples is given below.

Attainment value of learning mathematics.

This is the personal relevance of doing well on mathematical tasks. There are three items to measure this component.

Examples.

- I think the topics covered in mathematics classes are important (item number 1)
- It is important for me to understand mathematics really well (item number 3)

Utility value of learning mathematics.

It is the perception of students regarding the utility of tasks in mathematics in achieving their goals. There are four items to measure this component.

Examples.

- I think many topics covered in mathematics are not useful (item number 5, negative item)
- Learning mathematics is essential to meet my goals (item number 7)

Intrinsic value of learning mathematics.

It is the enjoyment or interest that students experience by performing the mathematical task. There are three items to measure this component.

Examples.

- Mathematics is interesting (Item number 8)
- I like to learn mathematics (Item number 10)

Cost value of learning mathematics.

Cost value of learning mathematics is the cost of engaging in the mathematical task over other tasks. It is the negative aspect of task value. There are two items to measure this component.

Examples.

- Learning other subjects is better than learning mathematics (Item number 11, negative item)
- Learning mathematics would not be a waste of time (Item number 12)

Scoring procedure.

Students were asked to rate how strong they feel true about the given statements on a five-point scale. For each item, there are five response options, utterly false (1), almost false (2), neither true nor false (3), almost true (4), and utterly true (5). The high score represents high task value in learning mathematics.

Item analysis.

The scale is tried out on a random sample of 370 standard nine students and item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item are given in Table 14.

Table 14

Data and Result of Item Analysis on Scale of Task Value of Learning Mathematics

Item no. (draft tool)	M_1	M_2	SD_2	SD_1	t	Item no. (final tool)
1	3.99	4.84	0.37	1.20	6.76	1
2	3.73	4.60	0.83	1.07	6.42	2
3	3.97	4.83	0.43	1.11	7.26	3
4	3.57	4.66	0.52	1.18	8.48	4
5*	2.61	4.17	1.21	1.17	9.28	5*
6*	3.15	4.69	0.81	1.40	9.54	6*
7	3.60	4.69	0.63	1.15	8.33	7
8	3.17	4.70	0.50	1.38	10.43	8
9	3.29	4.55	0.66	1.34	8.47	9
10	3.44	4.85	0.39	1.17	11.48	10
11*	2.31	4.29	1.01	1.20	12.61	11*
12	3.72	4.8	0.60	1.26	7.75	12

Note: *negative item

Items for final tool were selected if discrimination power (t value) is greater than 2.58. Accordingly, twelve items were selected for the final tool. Copies of the scale of task value of learning mathematics (Malayalam and English versions) are provided in Appendices I 1 and I 2, respectively.

Validity and reliability.

Concurrent validity of the test is established using task value subscale of MSLQ. It has 6 items. Students were asked to rate the given statements using a seven point scale on how well the statements are true about them. The validity coefficient obtained is .83 (n=32).

Test-retest method and Cronbach's alpha were employed to establish reliability. The test is administered twice among forty students with a two-week interval. The test-retest coefficient of reliability was found to be .78 (n=40). Cronbach's alpha coefficient is .69 (n=40).

12. Self-Regulated Learning Strategy Questionnaire

Self-regulated learning strategy questionnaire is a self-reporting instrument intended to assess students' use of different cognitive and metacognitive strategies, time management, and help seeking in learning mathematics. This instrument measures secondary school students' use of cognitive strategies (such as rehearsal, elaboration and organization), metacognitive strategies (such as planning, monitoring, and regulating), time management strategies and help seeking in the context of mathematics learning. Pintrich model of self-regulated learning (1999) worked as the theoretical basis of the tool. Pintrich and colleague developed MSLQ (Motivated Strategies for Learning Questionnaire, 1991) to measure self-regulated learning with two scales named motivation and learning strategies. It is a popular instrument used in many researches. This study did not use it because of three reasons. One, as MSLQ is developed for college students' self-regulated learning, there are items that do not suit to younger students. Second, MSLQ measures self-regulated learning in general, but the nature of mathematics learning is different from other subjects in many learning aspects. Lastly, it is a seven-point scale, and for high school students, a smaller scale with five scale points may be more suitable.

Though the questionnaire is developed on the basis of Pintrich's model of self-regulated learning (1999), motivational beliefs were not included in this scale. Self-regulated learning strategy questionnaire comprises four Likert type subscales- cognitive strategies, metacognitive self-regulation, time management and help seeking. The scale gives total score and subscale scores.

Cognitive strategy subscale. It includes three strategies, rehearsal, elaboration, organization. Students were asked to write their use of each strategy in the domain of mathematics learning. Rehearsal strategies refers to any kind of strategies where the repetition of the content is the means of learning. The draft scale consists of three items on this dimension. Elaboration strategies relate to previous knowledge with material to be learned and explaining the content to someone else and thereby improving memory. These items were developed on different elaboration strategies identified in the context of mathematics. The draft scale consists of three items in this dimension. Organization is a strategy by which learner makes connections between the subparts and integrate or organize the whole information so as to improve memory. The draft scale consists of four items in this dimension.

Metacognitive self-regulation subscale. Metacognitive self-regulation refers to strategies used by the learner to plan, monitor, and regulate their goal-directed behavior. As these three strategies have high conceptual relation (Pintrich, Wolters, & Baxter, 2000; Pintrich 1999), this scale does not have subscales based on the three dimensions. 1) Planning consists of the strategies used by a learner to plan his behavior according to objective or goal. It includes setting goals, and planning the time and behavior accordingly. The draft scale consists of six items on this dimension. 2) Monitoring is the process of checking how well students are proceeding to their goals. This part includes 5 items; among them, one item is adopted from MSLQ, (that is item number 8 is similar as 33^{rd} item in MSLQ). 3) During regulation process, as a result of monitoring process learner would come to understand the need for a change in behavior and to bring back it in line with the goals. These strategies are explained in regulation process. It includes 9 items in draft scale.

Time management. This subscale includes items regarding planning, utilization, and control of students' time. There are six items in this subscale.

Help seeking. This includes items regarding how well students utilize other people to reach their goals and to overcome their difficulties. Here other people include teachers, peers and family. This subscale includes three items.

Planning.

Nature of mathematics is entirely different from other subjects, so is its learning too. Use of each strategy is asked in the context of mathematics learning. In the case of learning of mathematics, rehearsal strategies cannot be considered as a complex learning strategy.

Item writing.

Items were prepared on the basis of the studies of Weinstein and Mayer (1986) and Pintrich (1999). Examples of statements in the eight dimensions belonging to four subscales in self-regulated learning strategy questionnaire is given in Table 15.

Table 15

Examples of Statements in the Eight Dimensions Belonging to Four Subscales in Self-Regulated Learning Strategy Questionnaire

Subscales	Dimension (No. of items in draft)	Example
Cognitive strategy	Rehearsal (3)	Whenever I learn a lesson in mathematics, I memorize the equations in it
	Elaboration (3)	Whenever I learn concepts or equations in mathematics, I learn how they are derived
	Organization (4)	I make notes on major concepts in a lesson when it is covered
Metacognitive self-regulation	Planning (6)	I usually begin my learning with a goal
	Monitoring (5)	I make sure that I understand the material that the teacher covers in class
	Regulation process (9)	Whenever I lose attention in class, I try to bring it back
Time management	Time management (6)	I make very good use of my study time
Help seeking	Help seeking (3)	I seek help from teachers and friends when I do not understand mathematics topics

Item analysis.

The scale is tried out on a random sample of 370 standard nine students and item analysis was performed using conventional procedure advocated by Edwards (1957) for Likert type statements. Statistics and *t* value for each item is given in Table 16.

Table 16

Data and Result of Item Analysis on Self-Regulated Learning Strategy Questionnaire

Subscale	Dimension	Item No. (Draft tool)	M_1	M_2	SD_1	SD_2	*t*	Item No. (Final tool)
Cognitive strategy	Rehearsal	1	2.29	4.28	1.20	0.87	13.45	1
		2	2.38	4.41	1.29	0.84	13.21	2
		3	2.01	4.12	1.11	0.81	15.41	3
	Elaboration	4	2.77	4.19	1.33	0.87	8.92	4
		5	2.3	4.16	1.44	0.88	11.01	5
		6	3.25	4.39	1.31	0.74	7.57	6
	Organization	7	2.89	4.48	1.26	0.66	11.17	7
		8	2.63	4.43	1.27	0.79	12.03	8
		9	2.44	4.31	1.33	0.68	12.54	9
		10	1.87	3.87	1.15	1.01	13.05	10
Metacognitive self-regulation	Planning	11	3.27	4.64	1.37	0.64	9.05	11
		12	3.29	4.71	1.36	0.56	9.68	12
		13	2.41	4.22	1.28	0.88	11.64	13
		14	2.78	4.38	1.24	0.81	10.81	14
		15	2.54	3.89	1.18	0.99	8.77	15
		16	2.58	4.45	1.16	0.64	14.06	16
	Monitoring	17	3.04	4.63	1.25	0.68	11.21	17
		18*	2.31	2.56	1.50	1.57	1.15	--
		19	2.71	3.91	1.39	1.22	6.51	18
		20	3.15	4.63	1.22	0.60	10.91	19
		21	2.65	4.13	1.16	0.92	10.02	20
	Regulation	22	2.37	4.14	1.15	0.98	11.68	21
		23	2.84	4.36	1.34	0.81	9.71	22
		24*	2.6	2.23	1.21	1.10	-2.27	--
		25	3.34	4.61	1.32	0.67	8.59	23
		26*	2.44	3.77	1.35	1.41	6.80	24
		27	3.26	4.56	1.16	0.81	9.20	25
		28*	2.45	3.97	1.20	1.23	8.83	26
		29*	2.65	3.57	1.37	1.49	4.56	27
		30*	2.55	4.1	1.34	1.15	8.76	28
Time management	Time management	31	2.3	4.21	1.23	1.02	11.98	29
		32*	2.08	3.71	1.11	1.25	9.76	30
		33	2.52	4.35	1.30	0.74	12.23	31
		34	2.99	4.52	1.28	0.67	10.61	32
		35*	2.11	3.77	1.17	1.14	10.14	33
		36*	2.06	4.56	1.30	0.81	16.32	34
Help seeking	Help seeking	37	3.03	4.83	1.37	0.38	12.70	35
		38*	2.28	4.79	1.31	0.41	18.28	36
		39	3.05	4.86	1.32	0.35	13.25	37

Note*:* *Negative item

Items for final tool were twelve items with discrimination power (*t* value) greater than 2.58. Copies of the draft and final versions of Self-regulated learning strategy questionnaire with their English translations are provided as Appendices J1, J2, J3 and J4 respectively.

Validity and reliability.

Concurrent validity of the test is established using MSLQ scores as the criterion. Students were asked to rate the use of strategy in learning mathematics (n=40). Reliability of the test is established through the test-retest reliability (n=32) as well as Cronbach's alpha. Reliability and validity indices of each subscale are given in Table 17.

Table 17

Reliability and Validity Indices of Self-Regulated Learning Strategy Questionnaire and its Subscales

Subscales	Test-Retest reliability coefficient(n=40)	Cronbach's alpha(n=370)	validity coefficient(n=32)
Cognitive strategies	.92	.8	.92
Rehearsal	.86	.7	.80
Elaboration	.74	.48	.78
Organization	.86	.65	.81
Metacognitive self-regulation	.92	.82	.92
Time management	.82	.57	.80
Help-seeking	.70	.38	.75
Self-regulated learning strategy	**.94**	**.89**	**.92**

13. Evidence based Self-Regulatory Intervention

From the survey phase, it is identified that, for learning mathematics students make use of mostly peripheral strategies like memorizing mathematical equations or working out the same problems that had been solved by their teacher in the classroom, though they are instructed using constructivist instructional strategy. They found forgetting of previous contents, rapid forgetting, hardness of mathematics, and their lack of knowledge about how to learn mathematics, and difficulty in understanding mathematics as the reasons for mathematics being difficult. And regarding learning of mathematics, they hold the beliefs such as learning of it is not worth, only people with high intelligence can learn, it is a difficult subject, ability to understand it easily is more or less an inborn ability, it should be learned by heart, it can't be learned by all, they never understand it, not interesting, it is boring, effort will not produce better learning, and a person's chance for failing or succeeding in mathematics is fixed. Also, they are not aware of the values of the content and task they have been learning and doing in their mathematics classroom.

Evidence based self-regulatory intervention in this study is a self-regulated learning strategy instruction. It is a teaching-learning package designed to overcome identified students' difficulties in learning mathematics so as to improve achievement in mathematics. It is developed on the basis of existing self-regulated learning models of Zimmerman (2000, 2008) and Pintrich (1999, 2004) and on the basis of evidences from other previous research on motivational and cognitive variables.

The intervention is on six areas, namely, know themselves as learners, task value, goal setting, learning diary, weekly monitoring, and organizational strategy. The first three parts of intervention is completed before starting the lesson, 4th and 5th are practiced along with the content instruction, and the last one after completion of the content instruction. These six strategies are given in detail.

i. Know themselves as learners (3 Sessions).

Aim.

To develop self-knowledge among students regarding their level of prerequisites, ability conceptions and their use of different learning strategies, and hence to correct students' maladaptive beliefs and inappropriate learning strategies.

Meaning of self-knowledge.

Self-knowledge includes person's knowledge about their own strength and weaknesses, their motivational beliefs. It is important to develop self-knowledge of cognition and motivation among students (Pintrich, 2002). Students' knowledge of strategies and self-knowledge will influence students learning behavior and motivational beliefs (Pintrich, 2002).

Student activity.

This part of intervention intended to develop self-knowledge of motivation, cognitive processing, and learning strategies. So, this part of strategy instruction includes three topics of discussion, 'importance of prerequisites', 'role of mathematical ability conception', and 'learning strategy'.

Students were first given with the individual reports of their level of (score) prerequisites in mathematics, scores on ability conception and use of learning strategies with a comparison to better scores.

Teacher support.

Self-knowledge is a part of metacognition. In this section the report of test of prerequisites in mathematics, their mathematical ability conception and learning strategy were discussed in comparison to adaptive strategies with an objective that make the students aware of themselves as learners and their maladaptive thoughts.

Rehearsal and Feedback.

A brief report was given to students about their beliefs regarding mathematics learning, their learning strategy and previous achievement. On the basis of their scores, it is explained how it would contribute to their achievement in future contents or the achievement in the upcoming chapter. To discuss each topic, a 40 minutes class period is used.

Importance of prerequisites.

Aim.

Understanding the significance of prerequisites and to make relevant prerequisites among the students.

Student activity.

Students were given scores on the test of prerequisites in mathematics. Mathematics follows a logical order and most high school contents are continuation of the previously learnt materials. Linking the mathematical idea, fact or procedure to the previous or existing knowledge is necessary for a thorough understanding of the content (Hiebert & Carpenter, 1992). Mathematical knowledge is built upon the knowledge in its lower level. In the initial survey, students pointed that their main reason for mathematics learning being difficult is forgetting of the learned materials. Also, most students believe that there is no interrelation between different topics of mathematics. So, this part of strategy instruction, intended to make the students aware of their level of prerequisite in mathematics and how it will contribute to their further learning.

Teacher support.

Teacher started this phase using discussion with the students about the nature of mathematics. Nature of mathematics is different from the other subjects so its learning, too. Learning of mathematics is compared to construction of a complex building, or structure; each brick can be mathematical concepts. In mathematics, we learn each content using knowledge from the previous chapters or standards. A building to be strong, its foundation work or base should be strong enough. So, when we lack knowledge of some basic concepts, or prerequisites it would be difficult to build upon the structure, that is they would feel mathematics as difficult to learn. They reminded that, neglecting the importance of prerequisites, they often study without connecting the new content to the old one or learning the new contents without having the relevant prerequisites. This makes their current learning difficult, and the learning of higher levels of this topic would get more difficult. Hence, it is very important to have relevant prerequisites in case of mathematics.

Rehearsal and feedback.

Teacher prompted students to observe their peers, those who usually scores high in mathematics, they have scores in this prerequisite test also. Actually, their high score in the prerequisites make further learning easier. After making the students aware of the importance of prerequisites in learning mathematics, the test paper of prerequisite test is given to students and directed them to study all that matters.

Role of mathematical ability conception.

Aim.

To correct students’ entity beliefs in mathematics.

Student activity.

In this section students' scores in mathematical ability conception is discussed. A score below 34 indicate a student with clear entity theory of mathematical ability [one standard deviation less than mean (41)], and greater than 48 indicate a clear incremental belief. The views with which we approach the things affect our behavior. Students with low score in ability conception, believe that mathematical skills are more an inborn ability and effort has to do nothing to change that level of ability. When you possess this kind of a belief chance to avoid the activity or chance for not taking more effort would be very high. Difficulty in mathematics can be a product of your belief that mathematics is a difficult subject and mathematical ability cannot be developed through effort. As one believes effort will not produce ability, reduces the chances for taking effort are reduced and it leads to reduced ability.

Teacher support.

Suppose you possess a belief that mathematics ability is fixed and you cannot improve it through effort, your behavior would be shaped according to this. Therefore, there will be a tendency to take less effort to improve the mathematical skills. Gradually, you would lose many topics in mathematics. So, while learning continuation of these topics in later classes, just because of lack of prerequisite you will find it difficult. That is lack of prerequisites along with fixed ability belief, makes your mathematics learning more miserable. Gradually, it might be come a very difficult subject for you. This will again strengthen your belief that ability in mathematics is fixed. Actually, you experience failure just because of your less effort, but read it as less ability, and fail to understand failure as an indication of less effort than less ability. So, now check your ability after taking necessary effort to learn the chapter of fractions. In this chapter, try to learn all the listed prerequisites then start to learn the chapter to check the difference.

Those who are at the top in mathematics have studied it well in the previous class and continue the same level of effort in the present situation as well. They attend classes well and follow up at home. Those who are backward in mathematics may have lost necessary knowledge from many classes, for a smooth understanding of mathematics they have to correct this first.

Rehearsal and feedback.

Then selected two students with high prerequisites scores and high incremental beliefs, and they explained their learning behaviors to the students.

Learning strategy.

Aim.

To insist students to use more deep level strategies for learning

Rationale.

From initial survey, it was identified that a large number of students follows peripheral learning strategies such as memorizing mathematical equations, or sticking into class notes than drill work from textbooks or other sources. If students do not have knowledge of different learning strategies, they can't use it. So, this part of strategy instruction is intended to analyze students' use of different learning strategies and to insist them to deep level strategies for learning mathematics.

Student activity.

Report indicating students' use of rehearsal strategies, elaboration strategies, and organization strategies, given to students. Discussed the benefits and effects of each learning strategies with students. Rehearsal strategies are less effective in mathematics when compared to other strategies. While you are memorize equations or learning only the class notes, you are following rehearsal strategies. This would not help you to remember the learned contents for a long time and to solve an unfamiliar problem. Instead of only memorizing an equation you can also internalize how this equation is formed, this would enhance your memory.

Teacher support.

Repeatedly solving the same problem that were solved by your teacher, or solving the same type of questions would not help you improve yourself. But, solving unfamiliar problems would help you solve any kind of problem.

Use of organizational strategy would help you find connection between different topics and to get a holistic picture, which would enhance your memory.

Rehearsal or feedback.

Making concept maps, short notes are examples for organizational strategy, students were advised to make a note on main points of chapter after learning it.

ii. Task value (one session).

In the initial survey most students replied that they did not know why they were learning most of the topics in mathematics. So, it is decided to explain the importance of the present task, that is the chapter of fractions. Both its use in daily life and higher education are explained. In this part of strategy instruction, students also practiced skimming through the chapter.

Task value of the current chapter.

Aim.

To stimulate the importance of various classroom activities related to topic of fractions

Student activity.

Describe the importance of learning the topic, various venues of its applicability, and to locate different scenarios in which concepts from the topic can be applied.

Teacher support.

In this lesson, Fractions, you mainly deal with similar fractions, operations in comparing fractions and converting them into their decimal forms. You must have learned these operations or their simplified versions in your early grade levels. You specifically learn algebraic forms of these fractions in this class. You will learn how to explain the general expression of various operations of fractions using algebra, and then prove that they are correct using algebra. While this lesson makes operations using fractions simpler, it also creates smooth transition from arithmetic to algebra.

We will find the topics covered in this lesson useful in two different ways. One of them is that fractions are used in a variety of fields ranging from culinary arts to share markets (provide explanation through related examples). Another use of fractions is in your future studies, in mathematics as well as in other subjects. In mathematics, knowledge on fractions is required for simplifying algebraic expressions containing fractions. Similarly, you will have to use fractions in probability, which is an important topic in statistics. Probability is often required in learning biology and economics. Knowledge and understanding of fractions are needed in chemistry as well; to figure out the exact amount and proportion of different chemical compounds during the preparation of other compounds and mixtures when combining different chemical compounds. Problems in physics also involve algebraic expressions with fractions.

Skimming through the text

Skimming is a selective reading strategy focusing on main ideas of a text.

Student activity.

Students were instructed to go through the chapter once with an explanation of the outline of the chapter.

iii. Goal Setting (one session)

Goal setting strategy.

Aim.

To understand the need of setting goals and how to set meaningful goals

Rationale.

Importance of goal setting and how it affects performance are explained to the students through two simple experiments. How to set goal and characteristics of good goals were explained then provided a goal planner sheet, and they set their own goals for learning fractions.

Student activity 1.

Tell students that they are going to play a game. Ask students to have their pen and a sheet of paper. Ask them to put as many as “x” marks as they can in one minute. Ask them to check how many marks they are able to put in. Ask them to set a target if they are given another minute. After recording the current and target scores of 4 students, the group is given time for their second trial. Compare the scores from both trials. Repeat the trial again by setting another target. Discuss the difference in scenarios with set targets and without set targets.

Student activity 2.

Ask students to write numbers from 1 to 7 without any order. Ask them to multiply the first two digits, multiply the digit that has a place holder of one with the third number, and then multiply the digit that has a place holder of one in the calculated number with the fourth number, and so on. Tell them that they are supposed to continue the process all over again when they reach the seventh number. Show an example on the blackboard before the students begin to do the activity. Ask them to solve as many as possible in one minute. Inquire about how well they have done in the first minute. Ask them to set a target if they are given another minute, and to compare the scores from both trials.

Teacher support.

From these two activities, you have seen the difference between completing a task with and without setting a goal. How are they different? You try to meet the goal when you set it. You can achieve more by setting goals and trying to meet those goals. You can improve the quality of a task when you deal with it by setting a goal rather than by just completing it. It is important to set goals for better results. You are supposed to learn how to set goals.

Suppose your goal is to become an engineer. In order to be an engineer, you must write the entrance examination after scoring decently on your plus two courses with the science option. You are supposed to receive better scores in mathematics and science in your 10^{th} grade examination in order to get into the plus two course with the science option. And, you will need to learn mathematics and science really well in your early grade levels to score better in your 10^{th} grade examination. Let us consider your current grade level. You are required to learn every lesson well to score high in the final examination. We cannot learn all these topics at once. We need to learn them while they are covered in class. If you wait to learn a lesson until it is completely covered in class, you will not have enough time to learn every subject on time. So, to avoid this situation, we can set goals for each day and subject. In addition, we need to make sure that we proceed in accordance with the set goals. We must evaluate ourselves to find out how far we have been with these goals every week, and resolve our mistakes or difficulties wherever necessary.

If we set a major (long-term) goal and do not break it down into smaller short-term goals, we would get fed up because of the feeling that we do not have anything new during the completion of the task, which eventually make the activities slow. Therefore, it is necessary to break down major goals into its components.

When setting goals, always set the ones that can be met. First of all, set goals that are easily achieved, and then set bigger goals and those require hard work. Make the goals time bound, with a clear plan of a timeline in meeting each of them, and meet those goals within that timeline.

A few examples are introduced here to help you set goals effectively. Based on the information given to you so far, the advantages of effective goals are detailed. We understand that the goals must be appropriate, reachable, clear, objective, and measurable.

Rehearsal or feedback.

Then students were directed to find a time bounded main goal for learning the chapter fractions on their own, and set some process goals to reach that.

Goal planner.

Aim.

To set a goal for learning in the chapter fractions.

Student activity.

Students were directed to set a goal for learning the chapter and given them a goal planner sheet (a format of goal planner sheet is attached as appendix K) to write down their goal and related matters, such as the relevance of their goal and expected time to reach the goal.

iv. Learning diary and weekly monitoring.

Aim.

To promote the monitoring process and to help the students in monitoring process.

Rationale.

Though the students have a set goals, goals do not guarantee result because they may fail to go with goals. Monitoring and volitional control is a necessary part to reach those goals. If a student fails to achieve the goals it may trigger negative emotions to override the goals. So volitional control is a necessary part of self-regulated learning. How the students managed their time and resources, how much of the task work has been completed, how well they moved towards goals, and what they have done to overcome the difficulty in regulation of behavior, can be recorded (Boekaerts & Corno, 2005). As this process self-regulation is entirely in the hands of the students, teacher can do a little on this. To help students in this process a learning diary is maintained and the teacher gave feedback to students on reflections on their monitoring process.

Preparing learning diaries is a self-recording process. Learning diaries, journal and logbooks are examples for self-recording. It helps the learner to understand his desirable and undesirable behavioral patterns in relation to learning.

Student activity.

Learning diary is provided to students to write their self-assessment in view of monitoring their learning process. Monitoring is an important part of self-regulated learning, students have to review their learning to correct their learning behavior. A sheet printed with prompts was given to students to record their learning process (a format of learning diary is attached as Appendix L). Prompts are 'strategy activators' that promote students to apply cognitive and metacognitive strategies in their learning (Schraw, 1998). Students are instructed to write down their reflections on the learning content presented in that week based on the prompts such as what they do not understand well and what they can be done to overcome their difficulties in understanding. Also, they were instructed to list the main points they have learned in that week.

Teacher support.

Teacher provided feedback on students' monitoring process on a weekly basis, as their ability to monitor their learning process may not be well developed.

v. Organize the learning (one session).

Aim.

To organize students' learning in the chapter of Fractions

Rationale.

Concept maps invented in 1972 to check the conceptual understanding of students; subsequently used for different purpose such as a learning tool. Concept map can be used as tool for organizing learned material. Using concept maps students can relate different concepts, whereas it provides them a kind of knowledge portfolio. This whole picture gives a new and enriched learning environment. Concept maps built by students give them a basis for life long meaningful learning (Novak & Canas, 2009).

Concept maps help the students relate different topics in mathematics. It helps the learners get a big picture relation and organization of the content, it enhances comprehension and integration of the contents, and hence improves memory. Forgetting previous content is reported by students as the reason of mathematics being difficult. Organization of the content would enhance memory.

Student activity.

Students made a chart of main points they have learnt in the chapter fractions (A model concept chart on chapter fractions is attached as Appendix M1).

Implementation of self-regulatory learning strategy instruction.

Self-regulatory learning intervention with the above five strategies were initially implemented through guided practice in the experimental groups and then was followed up with self-practice in two of the three treatment groups as given below.

Self-regulatory strategy instruction-guided practice.

The above five strategies learned in six sessions were rehearsed and practiced with weekly monitoring by the experimenter during the instruction of fractions for 3 weeks. This is described as self-regulatory learning instruction-guided practice.

Self-regulatory learning strategy instruction- guided practice-shorter intervention.

A group which was not received Self-regulatory instruction guided practice during the teaching of fractions were given opportunity to rehearse and practice with weekly monitoring by the experimenter during the unit pairs of equation for 2 weeks. This group is described as self-regulatory learning instruction- guided practice-shorter intervention.

Self-regulatory instruction self-practice.

Those students who have undergone self-regulatory intervention guided practice during the three weeks of instruction on fractions were given opportunity to self-practice of the self-regulatory strategies. Here, teacher did not monitor or give feedback on their practice of strategies. But students were encouraged to self-practice by enquiring about the progress and motivating to continue the practice.

Self-regulatory learning instruction- longer intervention.

Two groups of students who received both guided practice and self-practice are described as having self-regulatory learning instruction- longer intervention.

Sample used for the Study

The study has used to set of samples, one for Phase I survey and the second for experimental study.

Sample used in Survey Phase (Phase: I)

For phase I, 500 standard nine students were selected from 12 schools of Malappuram and Kozhikode districts using stratified random sampling by giving proper consideration to strata like locale and type of school. It comprised 250 boys and 250 girl students. List of twelve schools where from data was collected is given in Table 18.

Table 18

List of Schools from where Students were Drawn into Phase I Sample

Sl. No.	Name of Schools
1	SPBHSS Ramanattukara, Kozhikode
2	UHHSS Chaliyam, Kozhikode
3	OHSS Tirurangadi, Malappram
4	GVHSS Cheruvannoor, Kozhikode
5	GVHSS Meenchanda, Kozhikode
6	GHSS Tirurangadi, Malappuram
7	GVHSS Vengara, Malappuram
8	GVHSS Trikulam, Malappuram
9	GGVHSS FEROK, , Kozhikode
10	AKMHSS Kotoor, Malappuram
11	MSP HSS Malappuram, Malappuram
12	GVHSS Chetiymkinar, Malappuram

Sample Used in Experimental Phase (Phase: II)

For experimental phase, four intact standard nine classrooms were selected from Oriental Higher Secondary School, Tirurangadi, Malappuram. Details of sample selected for experimental phase is given in Table 19.

Table 19

Details of the Sample Used in Experimental Phase

Sub sample based on	Category	No. of students			
		G1	G2	G3	G4
Gender	Boys	19	14	16	20
	Girls	18	25	21	18
Level of intelligence	Low intelligence	14	21	18	16
	High intelligence	23	18	19	22
Level of prerequisite	Low prerequisite in mathematics	18	24	15	17
	High prerequisite in mathematics	19	15	22	21

These four groups were tested for matching nonverbal intelligence and test of prerequisites.

Match of experimental and control groups on nonverbal intelligence, prerequisites in mathematics.

Statistical indices of distribution of nonverbal intelligence for the experimental and control groups are given in Table 20.

Table 20

Mean and SDs of Nonverbal Intelligence, and Prerequisite in Mathematics Scores in the Four Intact Classrooms Taken as Sample for Experimental Phase

Control variables	G1(N=37)			G2(N=39)			G3(N=37)			G4(N=38)		
	M	*SD*	*S-W*	*M*	*SD*	*S-W*	*M*	*SD*	*S-W*	*M*	*SD*	*S-W*
Nonverbal Intelligence	45.57	6.33	.95	45.26	5.32	.96	44.81	5.94	.97	45.71	4.83	.98
Prerequisites in Mathematics	21.57	9.24	.92**	18.85	7.0	.83**	21.89	7.46	.81**	21.03	7.17	.94**

Note. S-W, Shapiro-Wilk statistic

*** p<.01, * p<.05*

Table 20 shows that, the mean scores on nonverbal intelligence are almost equal in the four groups. Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of nonverbal intelligence for all groups. Levene's test of homogeneity suggest that the variances of nonverbal intelligence of the groups were equal, [F (3, 147) =1.10, p>.05]. Therefore, distribution of scores on nonverbal intelligence of the experimental and control groups is normal and the variances of this are homogeneous among the groups.

There is no significant difference between the mean scores on nonverbal intelligence of the four groups [F (3, 147) =0.19, p>.05].

Shapiro-Wilk test of normality suggests that distribution on scores of prerequisites in mathematics is not normal in any group. Levene's test of homogeneity suggest that the variances of prerequisite of the groups were equal, [F (3, 147) =1.19, p>.05]. Therefore, distribution of scores on prerequisites of the experimental and control groups is deviated from normality and the variances of this are homogeneous among the groups.

As the distribution of scores on prerequisites of the four groups deviated from normality, instead of *F* test, Kruskal-Wallis *H* test was used to compare the four groups. The Kruskal-Wallis *H* test showed that there is no significant difference among scores of prerequisites in Mathematics of the four groups [χ^2 (3) = 5.17, p> .05] with mean rank of prerequisites in mathematics G_1=78.58, G_2=62.73, G_3=83.86 and G_4=79.45.

Comparability of phase I and phase II samples on student affective and strategic difficulties.

Before imparting the experimental treatment, how well the experimental sample reflects the characteristics of survey sample was examined so as to ensure that the experimental sample is not significantly different from the population of standard nine students in Kerala. The two samples were compared on beliefs such as cost value ('Learning other subjects is better than learning mathematics'), role of inborn ability ('Mathematics can't be learnt by all'), interest ('Mathematics is interesting'), fixed faith ('Those who fail in mathematics keep on failing, whereas those who pass keep on passing'), self-efficacy ('I can be successful in mathematics', 'I never understand mathematics') and on their like toward mathematics ('I like mathematics'). This was done by testing whether experimental samples are comparable with survey sample on the select affective beliefs about mathematics using '*Z*' score test for two population proportion.

To compare the two samples on the selected beliefs that were studied in the survey phase, items matching with these beliefs were selected from the measures that obtained from pretests in the experimental phase. Validity of these items were verified by computing correlation of the particular item score with its whole measure score, and reliability by correlating the pretest score and posttest score of those items among control group. In order to be comparable, scale items in the second phase were changed to categories by coalescing suitable scale points. Items were selected from scale of task value of learning mathematics, from the scale of mathematical ability conception, and from scale of self-efficacy for learning mathematics.

The item selected were the following.

<u>From the scale of task value of learning mathematics</u>

1. 'I like mathematics' (item number 9, validity= .595, reliability=.34),
2. 'Mathematics is interesting' (item number 8, validity= .48, reliability=.75),
3. 'Learning other subjects is better than learning mathematics' (item number 11, validity= .56, reliability=.12).

<u>From the Scale of mathematical ability conception</u>

4. 'Proficiency in mathematics is an inborn talent' (item number 4, validity= .46)
5. 'Mathematics is a subject that anyone can learn' (item number 8, validity=.33)

6. ‘I never understand mathematics’ (item number 15, validity= .56)
7. ‘Those who fail in mathematics keep on failing, whereas those who pass keep on passing’ (item number 9, validity= .58).

From scale of self-efficacy for learning mathematics

8. ‘I can be successful in mathematics’ (Item number 8, validity= .58, reliability=.44)

After selecting these items, each group’s status on these beliefs before and after intervention were compared.

Results of comparison of two populations using Z score are given in Table 21.

Table 21

Comparison of Survey Sample and Experimental Sample on Selected Beliefs

Affective Belief	No. of individuals in sample 1 (Percentage)	No. of individuals in sample 2 (Percentage)	Z score
It is better to learn other subjects than Mathematics	353 (70.6)	94 (62.25)	1.94
Ability to understand mathematics easily is more or less an inborn ability	258 (51.6)	75 (49.67)	0.42
Mathematics can’t be learned by all	249 (49.8)	86 (56.95)	-1.54
I never understand mathematics	242 (48.4)	60 (39.74)	1.87
Mathematics is not interesting	172 (34.4)	55 (36.42)	-0.46
A person’s chance for failing or succeeding in mathematics is fixed	119 (23.8)	45 (29.80)	1.49
I can’t succeed in Mathematics	96 (19.2)	22 (14.56)	1.29
I like mathematics	270 (54)	108 (71.52)	-3.82**

Note. Sample 1 size: 500; Sample 2 size: 151. ***p*<.01

There is no significant difference between two population proportions on their affective beliefs except for their like toward mathematics. In case of the like, proportion of students who like mathematics in the experimental sample is significantly higher than that of survey sample.

Procedure of the Study

The study proceeds through two phases, one initial survey phase and then an experimental second phase.

Procedure of Phase I: Survey.

Based on the literature review on students' affective beliefs, teacher relation, and use of learning strategies, a Questionnaire on student perception of mathematics is developed. It includes both open ended and closed items. This questionnaire was administered to standard nine students using focus group interview technique.

Students were asked to discuss their feeling of difficulty or easiness in mathematics, and their reasons thereof, then to record their responses. Through a qualitative analysis, students perceived reasons for mathematics being difficult, their maladaptive motivational beliefs, and learning strategies were studied. Then, self-regulated learning strategy was planned by including proper strategies to overcome these affective difficulties and inappropriate learning strategies in mathematics by choosing appropriate self-regulatory strategies suggested by the review of literature.

Procedure of Phase II: Experiment

In the second phase, a plan for self-regulated learning strategy intervention is formulated by combining the evidences from phase I data on student difficulties in learning mathematics, research evidences from motivational and self-regulated learning research to overcome these difficulties. Then effectiveness of the evidence-based self-regulatory intervention is assessed with the help of a quasi-experimental pretest posttest control group design as following.

1. Four intact classes were selected for the experiment, after matching them on prior achievement and non-verbal intelligence.
2. The classes were randomly assigned to two experimental groups and two control groups.
3. Evidence based self-regulatory intervention is done by two stages along with content instruction of two chapters (1. Fractions and 2. Pairs of equations). Content instruction of the two chapters in all groups were done using constructivist instructional strategy.
   i. In the first stage, two experimental groups were given self-regulated learning strategy instruction along with content instruction of the chapter fractions.
   ii. In the second stage, one more group from the previously control groups also was given self-regulated learning strategy instruction (The stage one experimental groups continued self-regulated learning strategy as self-practice along with the content instruction of chapter pairs of equations.)
4. Effectiveness of the intervention is checked afterwards with respect to all dependent variables.

Design of the experiment.

The pretest posttest control group design used in this study is a multiple group and two stage design with three treatment groups and one control group. The design is denoted as follows.

		Stage 1		Stage 2	
G_1	O_1	$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$	O_5	$X_{SRL\text{-}SP\text{-}C(T)}$	O_9
G_2	O_2	$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$	O_6	$X_{SRL\text{-}SP\text{-}C(E)}$	O_{10}
G_3	O_3	$C_{(E)}$	O_7	$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$	O_{11}
G_4	O_4	$C_{(T)}$	O_8	$C_{(E)}$	O_{12}

G_1, G_2, G_3, G_4–	are intact groups matched on nonverbal intelligence and prerequisites in mathematics.
$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$ -	SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by experimenter)
$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$ -	SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by teacher)
$C_{(E)}$ -	Content instruction (by experimenter)
$C_{(T)}$ -	Content instruction (by teacher)
$X_{SRL\text{-}SP\text{-}C(T)}$ -	SRL strategy self-practice + Content instruction (by teacher)
$X_{SRL\text{-}SP\text{-}C(E)}$ -	SRL strategy self-practice + Content instruction (by experimenter)
$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$ -	SRL strategy instruction (Guided Practice-Shorter intervention) + Content instruction (by teacher)
$C_{(E)}$ -	Content instruction (by experimenter)
O_1, O_2, O_3, O_4 -	Pretests on Mathematical ability conception, goal orientation in mathematics, achievement in fractions, achievement in pairs of equation, Self-efficacy for learning fractions, Self-efficacy for learning systems of linear equations, Self-efficacy for learning mathematics, Task value for learning Mathematics, Use of self-regulatory learning.
O_5, O_6, O_7, O_8 -	Posttests on achievement in fractions and Self-efficacy for learning fractions
$O_9, O_{10}, O_{11}, O_{12}$ -	Posttests on achievement in pairs of equation, Self-efficacy for learning systems of linear equations, Self-efficacy for learning mathematics, Task value for learning Mathematics, Use of self-regulatory learning.

Procedure during the Experimental Phase

As indicated in the design, the experimental phase of the study proceeded in two stages.

Stage 1. Self-regulatory strategy instruction guided practice and instruction of unit Fractions.

The procedure followed in Stage 1 of experiment can be summarized as follows.

1. From the four groups of students in the sample for experimental phase, two groups were randomly assigned to experimental treatment (SRL Guided practice) and the remaining two groups to control.
2. Pretests on mathematical ability conception, goal orientation in mathematics, achievement in fractions, achievement in pairs of equation, self-efficacy for learning fractions, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value for learning mathematics, use of self-regulatory learning were administered in all four groups.
3. The experimental treatment groups were given self-regulated learning strategy instruction along with the instruction on “Fractions”. In both groups’ strategy instruction is given by the researcher. In Self-regulated learning guided practice (SRL Guided practice), students get strategy instruction first time and practicing the self-regulated learning with external help for monitoring through feedback from the researcher.
4. Content instruction in one treatment group and in one control group were done by the researcher and in the remaining, their mathematics teacher (same teacher for both the groups) taught the content on fractions.

5. Posttests on Achievement in fractions and Self-efficacy for learning fractions were administered to all the four groups.

Stage 2. Self-regulatory strategy instruction guided practice self-practice and instruction of unit pairs of equation.

The procedure followed in Stage 2 of experiment can be summarized as follows.

1. One more group, previously in control treatment, were given self-regulated learning strategy instruction for a short-term intervention [SRL Guided practice- Short term or SRL strategy (Shorter intervention)].
2. Researcher and teacher were swapped (against the stage 1) among the groups for content instruction on pairs of equations.
3. Content instruction on pairs of equation in one treatment group and in one control group were done by the researcher and in the remaining, their mathematics teacher (same teacher for both the groups).
4. Students in the previous experimental groups (SRL Guided practice) continued the practicing of self-regulated learning strategy by practicing self-regulated learning on their own without monitoring of the researcher [group renamed as SRL strategy (Longer intervention)]. – i.e., longer self-regulated learning intervention group.
5. Posttests on achievement in pairs of equation, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value for learning mathematics, use of self-regulatory learning were administered to all four groups.

The flow of activities during the experimentation and the proposed scheme of comparison of the four treatment groups is depicted in Figure 2.

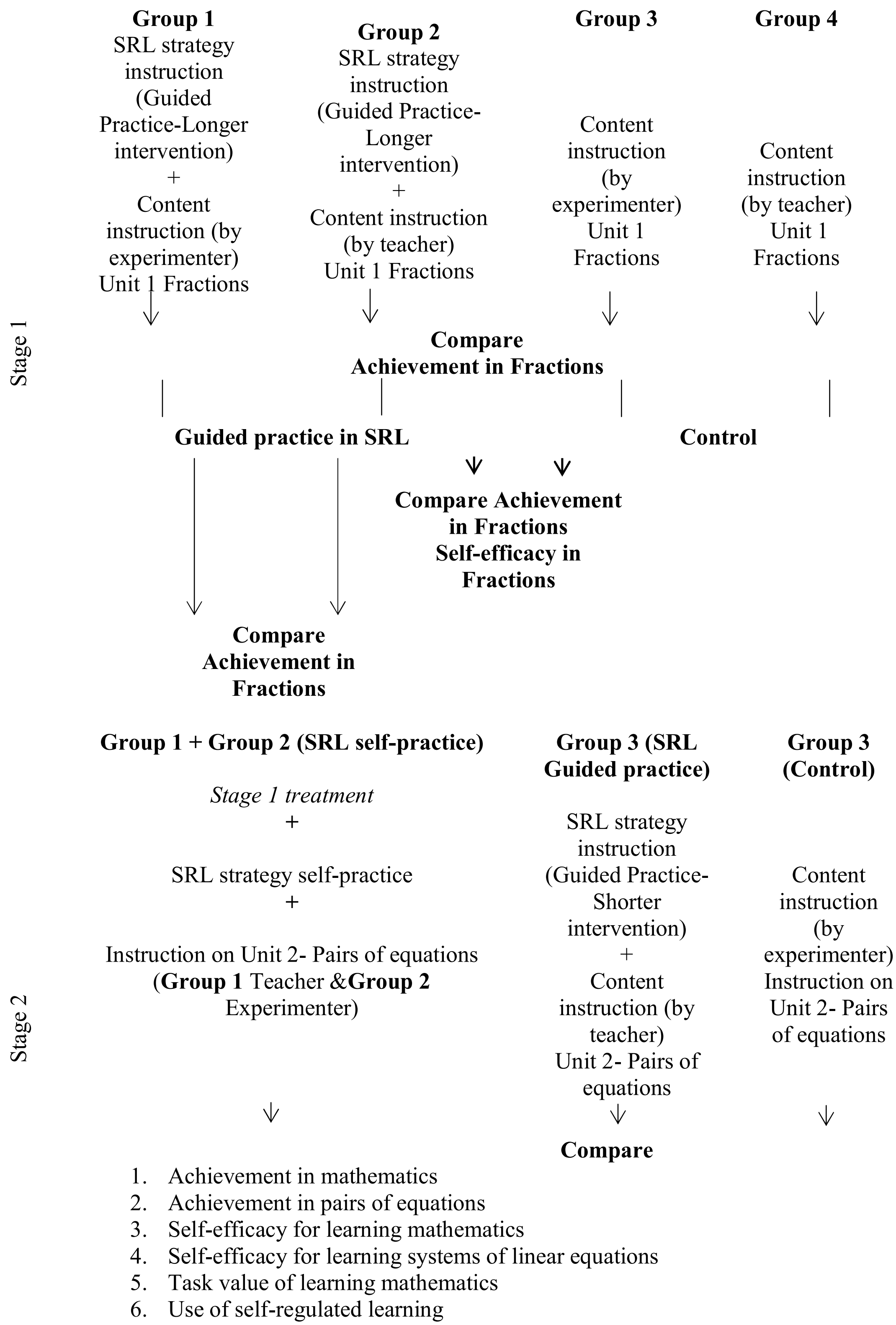

Figure 2. Scheme of comparison of the four treatment groups

It may be noted that in stage 2, students in the previous experimental groups (SRL Guided practice) continued the practicing of self-regulated learning strategy by practicing self-regulated learning themselves without monitoring by the researcher and the group renamed as SRL strategy (Longer intervention). As these students have gone through two stages of treatment, and received more time to practice self-regulated learning, this group is also named as longer self-regulated learning intervention group.

In stage 2 of experiment, one group, previously in control treatment, was given self-regulated learning strategy instruction for a short-term intervention. This group is called SRL strategy (Shorter intervention). Thus, there are three type treatment groups; longer self-regulated learning intervention group called SRL strategy (Longer intervention), encompasses two intact classrooms], one short term treatment group called as SRL strategy (Shorter intervention) in one classroom, and control group in one classroom. This was done with an objective that to know how the duration of intervention interacts with effect of intervention. It would help to know whether the time duration to practice self-regulated learning strategy effects the treatment. So, there are two experimental treatment groups 1) Two longer treatment groups namely SRL strategy (Longer intervention), considered as single group and 2) one short-duration group namely SRL strategy (Shorter intervention) and one control group. In the analysis these groups were considered as three treatment groups; SRL strategy (Longer intervention), SRL strategy (Shorter intervention), and control group. Effectiveness of self-regulated learning strategy instruction on dependent variables other than achievement in fractions, and self-efficacy for learning fractions, were analyzed in this stage.

Statistical Analyses Used for the Study

Mainly percentage analysis is used to analyze the survey data. Also, to check the association between students' likes and different motivational beliefs chi-square test of association (Pearson) is used. This is a nonparametric test used to test the association or relationship between two categorical variables for a randomly selected data.

In the experimental phase, four groups were randomly selected for experiment. Appropriate statistical tests were used to match the groups and to analyze the data towards testing the hypotheses. Data analyses were done with the help of SPSS software. The statistical techniques used in analysis were described briefly in the following headings.

Chi-Square Tests of Association

Pearson's chi-square is the most commonly used chi-square test (Brewer & Kuhn, 2010, pp. 129). Chi square test is a nonparametric test used to find out association between two categorical variables. In this test the observed number of cases in each cell of categories with the expected number of cases in these cells, are tested for association. The categories or variables are said to be associated if the observed and expected frequencies differed significantly (Merlo & Lynch, 2010, pp. 48). A statistically significant chi-square value indicates that the degree of association between variables observed is systematic and not attributable to random error (Connor-Linton, 2010, pp 148).

Analysis of Experimental Data

A series of tests were conducted in a planned way in order to answer the research hypotheses and to ensure that various conditions for using the statistical procedures are satisfied. The pattern of statistical procedures applied on experimental data is depicted in the scheme of analysis in Figure 3.

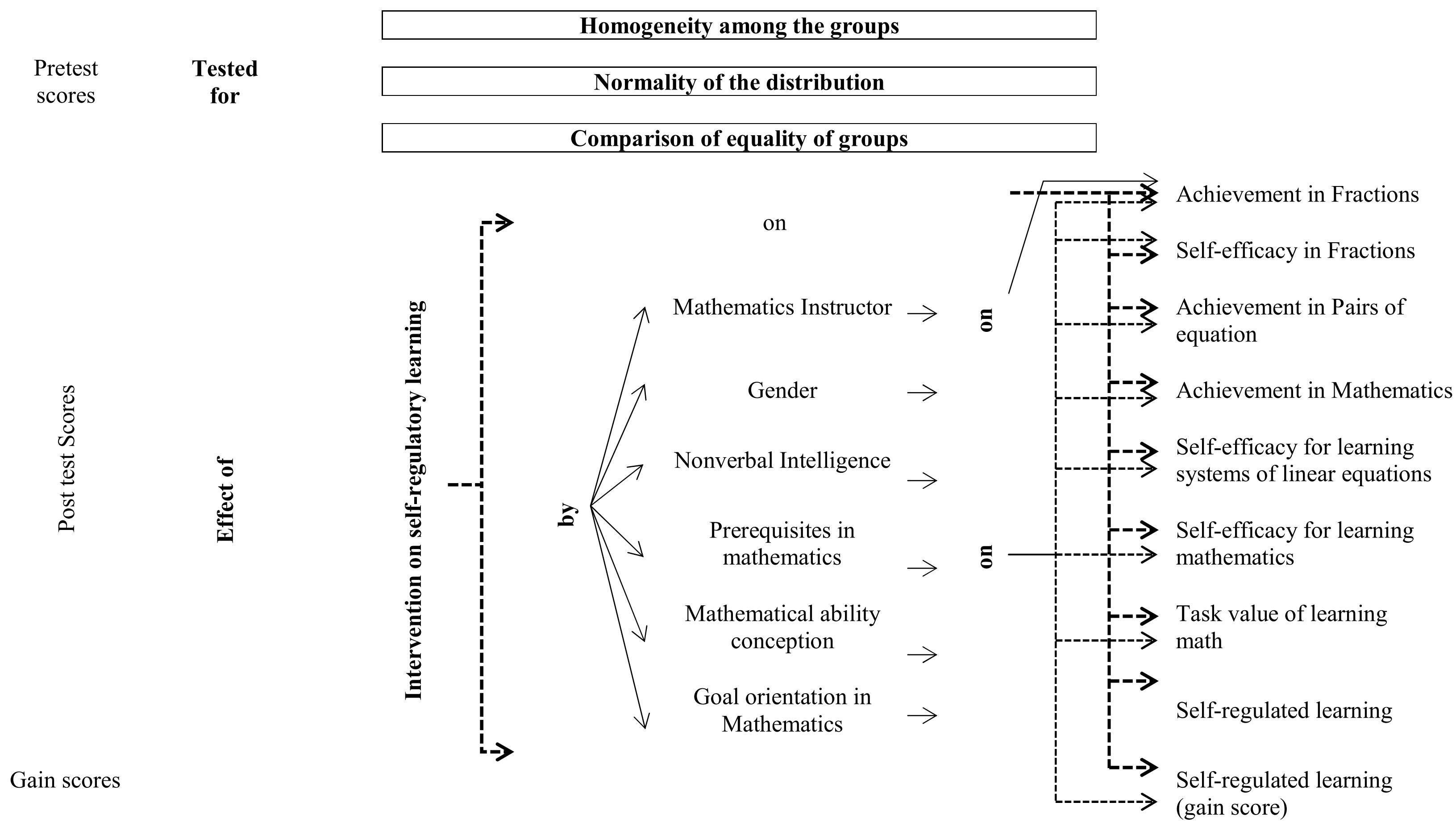

Figure 3: Scheme of analysis of Phase II experimental data

The various statistical techniques used for conducting the analyses indicated in the above scheme of analysis are the following.

Z test for comparing two population proportions

Z test is used for comparing two population proportions. The null hypothesis of the test is that there are no differences between two population proportions (Osborn, 2006).

Formula for calculating Z for comparing two proportions is,

$$Z=\frac{(p_1-p_2)-[\frac{1}{2}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)]}{\sqrt{pq\left(\frac{1}{n_1}+\frac{1}{n_2}\right)}}$$

Where p is the proportion of p_1 and p_2 when considered together as one sample and q is $1-p$.

Basic descriptive statistics

Basic descriptive statistics such as mean, median, mode, standard deviation, skewness and kurtosis of distribution of control and grouping variables and pretest scores of dependent variables were calculated. These distributions were plotted to identify the nature of distribution. This is done for two reasons, one is to match the groups and second is to verify the assumption of ANOVA.

Shapiro- Wilk test of normality

Normality is the most common assumption of parametric tests. Shapiro-Wilk test of normality (1965) is a more appropriate test of normality for small sample size. The test statistic is obtained by dividing the square of an appropriate linear combination of the sample order statistics by the usual symmetric estimate of variance (Shapiro &Wilk, 1965). Null hypothesis of this test is the data is normally distributed. Thus Shapiro-Wilk test statistic (w) of a distribution with significance value greater than 0.05 represents a normal distribution. The range of Shapiro-Wilk test statistic is zero to one; value near one represents normality and near zero represents rejection of normality (Razali & Wah, 2011; Yap & Sim, 2010).

Levene's Test of Homogeneity of Variances

Homogeneity of variance among groups is one of the assumptions of ANOVA. Homogeneity of variance means variance across samples are equal. Levene's test for equality of variances is used to measure the variances in data of two or more groups (Levene, 1960). The null hypothesis of this test is that the variances are equal among all groups. Alternative hypothesis is that there is a statistically significant difference in the variances of at least one group. That is, if Levene's test statistic (F) significance level is greater than .05, then the samples have equal variance and if it is less than .05, then the variances are not equal among groups.

Analysis of Variance (ANOVA)

One-way analysis of variance (ANOVA) is used to evaluate whether there is any statistically significant difference between the means of two or more independent groups (Urdan, 2011). ANOVA gives only the result that at least one group is significantly different from others, but it does not give which group is different from one another *t* test is used to find out the difference in groups. The main assumptions of ANOVA are, dependent variable should be categorical in nature, independent variable should be a continuous variable, that is measured in interval or ratio scale; and distribution of dependent variables should follow an approximate normality and homogeneity (Leech, Barrett & Morgan, 2011). So, to verify the assumptions of ANOVA distribution of pretest scores of each dependent variable were studied first. Using Shapiro - Wilk test of normality and Levene's test of homogeneity.

ANOVA is used to check whether there is any difference in the mean pretest scores of four groups before treatment, and latter to check the effectiveness of the treatment. A series of one-way and two-way ANOVAs were performed to find out the effect of self-regulated learning strategy instruction.

Kruskal-Wallis Test

Kruskal-Wallis test is used instead of one-way ANOVA to verify significance of difference in a continuous dependent variable by a categorical independent variable. The Kruskal-Wallis test is used in this study where the variable under consideration does not follow a normal distribution. Since this test is a non-parametric, it can be used instead of ANOVA.

Test of significance of difference between means

Wherever ANOVA has indicated a significant difference among three or more groups t test is used to compare the mean scores of two groups, from among the three or more groups. Also wherever the number of groups is less than three, group means are compared using test of significance of difference between means.

Effect size (Partial eta-squared)

Effect size is a measure of the strength of the relationship between variables (Levine, &Hullett, 2002). It is a nonzero value that represents the extent to which a null hypothesis is false (Piasta & Justice, 2010). An effect size measure in the context of an experimental research explains the degree of variability in a dependent variable that can be accounted for by the independent variable (Sheskin, 2010). In case of ANOVA, effect size is the proportion of variance explained by a certain effect versus total variance (Qiaoyan Hu, 2010). There are several ways to measure effect size on the basis of characteristics of variables. In ANOVA eta-squared and partial eta-squared are used to find out effect sizes. Partial eta-squared is the ratio of variance due to an effect to the sum of the error variance and the effect variance (Fay & Boyd, 2010).

Unlike value from eta-squared (range 0 to 1), the value of partial eta-squared can be greater than one, both of them gives same value for one-way ANOVA, but in case of two-way ANOVA partial eta-squared gives a greater value (Qiaoyan Hu, 2010; Fay & Boyd, 2010; Cohen, 1973). Partial eta-squared can be calculated using the following formula (Levine & Hullett, 2010).

$$\text{Partial } \eta 2 = \frac{\text{ssbetween}}{(\text{ssbetween} + \text{sserror})}$$

In behavioral science studies with a moderate sample size, partial eta-squared effect size values are interpreted as .09= small, .14= medium, and .22= large (Richardson, 2011; Fay & Boyd, 2010).

Chapter IV

ANALYSIS

- *Students' Motivational Factors, Learning Strategies and Difficulties in Learning Mathematics*
- *Summary of Findings on Motivational Factors, Learning Strategies and Difficulties in Learning Mathematics among High School Students in Kerala*
- *Effect of Self-regulated Learning Strategy Instruction*
- *Effect of Self-Regulated Learning Strategy Instruction on Dependent Variables*
- *Summary of Findings on Effect of Self-Regulated Learning Strategy Intervention on Achievement in Mathematics among High School Students in Kerala*

This study aimed to check the effectiveness of an evidence-based self-regulatory intervention in enhancing achievement in mathematics of high school students by reducing their difficulties in learning mathematics, that are identified through a survey. The study proceeds through two phases, first survey phase, to identify students' maladaptive affective beliefs and learning strategies, and an experimental second phase. The analysis of each part is given separately in this chapter. The survey data is analyzed mainly by qualitative methods. Quantitative methods are used wherever possible to find out the association between different beliefs. In the experimental phase, there are data from pretests and posttests. The effect of strategy instructions on achievement is studied using mean difference analysis with ANOVA. Before conducting ANOVA, the data were analyzed to verify that the variables are normally distributed, there is homogeneity among groups, and there are no significant outliers.

Results of analysis are presented under two broad sections corresponding to the two phases of the study namely, survey phase and experiment phase. The results of analysis of data from survey phase is presented under the titles, association between motivational factors, learning strategies and difficulties in learning mathematics. After this, analysis of data from experimental phase are presented under multiple heads.

Students' Motivational Factors, Learning Strategies and Difficulties in Learning Mathematics

In order to identify the motivational factors and learning strategies that associate with difficulties in learning mathematics for high school students the following were done. Through qualitative survey and review of related literature, the affective and strategic factors that impact student learning in mathematics were documented. Then proportion of students perceiving these affective and strategic factors in their mathematics learning were identified. For this students' relative like or dislike towards mathematics, perception of their level of achievement, strategies they use to learn mathematics, their perception of difficulty and the reasons thereof were studied. Then relation of students' liking of mathematics with their beliefs about mathematics and learning strategies were explored, against their interest, values, self-efficacy, ability beliefs and learning behaviors in mathematics. Then relation of students' feeling of difficulty of mathematics with their beliefs about mathematics and learning strategies were explored, against their interest, values, self-efficacy, ability beliefs and learning behaviors in mathematics.

Students' Like and Difficulty in Mathematics, Reasons thereof, and Learning Strategies

The percentage of students liking mathematics against other subjects, the gender difference in like towards mathematics, students' perception of their level of achievement in mathematics, the strategies they use to learn it along with their reasons for mathematics being difficult or easy especially in relation to the nature of the subjects and their learning behaviours are explored.

Students' relative like or dislike of mathematics against other school subjects.

Number and percentage of high school students who selected their most liked and disliked subject from a list of ten school subjects were given in Table 22.

Table 22

Frequency and Percentage of Students who Most Liked and Most Disliked School Subjects

Subject	Most Liked Subjects		Most Disliked Subjects	
	Number of students	% of students	Number of students	% of students
Malayalam	96	19.2	20	4
Biology	93	18.6	14	2.8
Mathematics	87	17.4	157	31.4
English	67	13.4	44	8.8
Social Science	64	12.8	70	14
Physics	24	4.8	52	10.4
IT	23	4.6	6	1.2
Chemistry	17	3.4	47	9.4
Hindi	16	3.2	72	14.4
Arabic	5	1	3	0.6
No specific subject	8	1.6	15	3
Total	500	100	500	100

Among the school subjects, Mathematics is ranked third in percent of students (17.4%) reporting it as "the most liked subject", with Malayalam (19.2%), and Biology (18.6%) being liked by more students. Students attribute their like to good teacher and interesting teaching, easiness to learn and understand practical importance of mathematics and their penchant for solving mathematical problems.

Percentage of students who identify mathematics as "the most disliked subject" (31.4%), is more than that for any other school subject; with Hindi (14.4%) and then Social Science (14%) being next in line of the most disliked school subjects. Students attribute their dislike to the felt difficulty in understanding, learning and solving problems in mathematics and in following their teacher, in addition to rapid forgetting, lack of interest and dislike towards the teacher.

Association between mathematics as students' most liked or disliked subject and their gender were studied. Result is given in Table 23.

Table 23

χ^2 Test Using 2x2 Contingency Table of Mathematics as Most Liked/Disliked Subject and Gender of Students

	Subject	Gender		Chi^2
		Boys	Girls	
Like	Mathematics	33	54	6.14*
	Other Subjects	217	196	
Dislike	Mathematics	94	63	8.92**
	Other Subjects	156	187	

*p<.05, **p<.01

Like (17.4%) as well as dislike (31.4%) for mathematics is gender dependent. Among the students who like mathematics over other subjects there are significantly more girls (62.1%) than boys (37.9%) [χ^2 (1, N=500) =6.14, p<.05] and among the students who dislike mathematics more than other subjects there are significantly more boys (59.9%) than girls (40.1%) [χ^2 (1, N=500) =8.92, p<.01].

Association of students' gender with mathematics being their most liked and disliked subject are demonstrated using bar diagram in Figure 4.

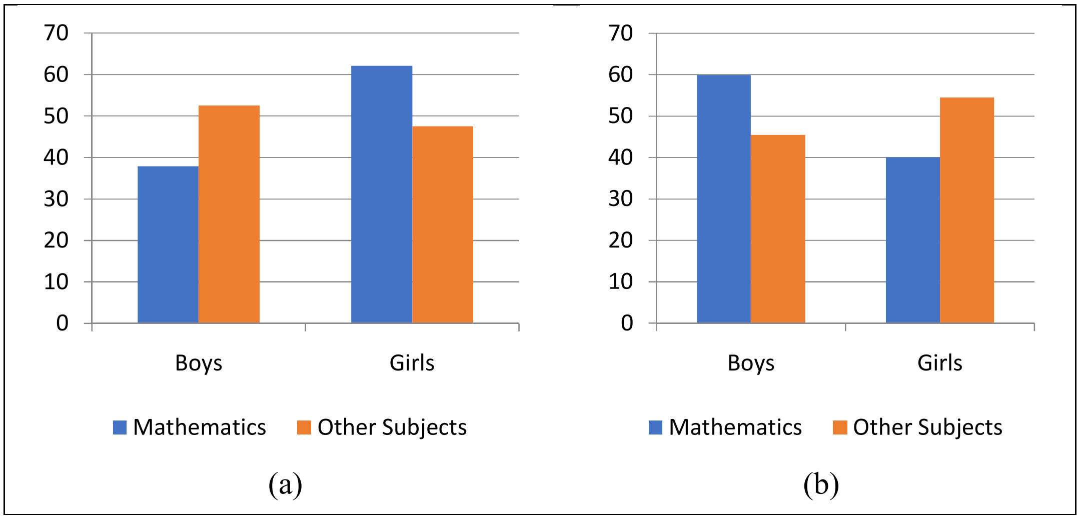

Figure 4: Bar diagram showing percentage of students reporting (a) Mathematics and other subjects as their most liked school subject by gender, (b) Mathematics and other subjects as their most disliked school subject by gender

Students' like or dislike towards mathematics.

Number of students who like or dislike mathematics and its association with gender were given in Table 24.

Table 24

χ^2 Test Using 2x2 Contingency Table of Like/Dislike towards Mathematics and Gender of Students

Gender	Like	Dislike	Total	Chi2
Boy	111	139	250	18.55**
Girl	159	91	250	
total	270	230	500	

**p<.01

Majority of students (54%) like mathematics but a good share of students (46%) dislikes mathematics. Gender significantly affects liking or disliking mathematics ; more girls (58.9%) than boys (41.1%) like mathematics and more boys (60.4%) than girls (39.6%) dislike mathematics [$\chi^2(1, N=500)=18.55, p<.01$].

Association of students' gender with like or dislike towards mathematics is demonstrated using bar diagram in Figure 5.

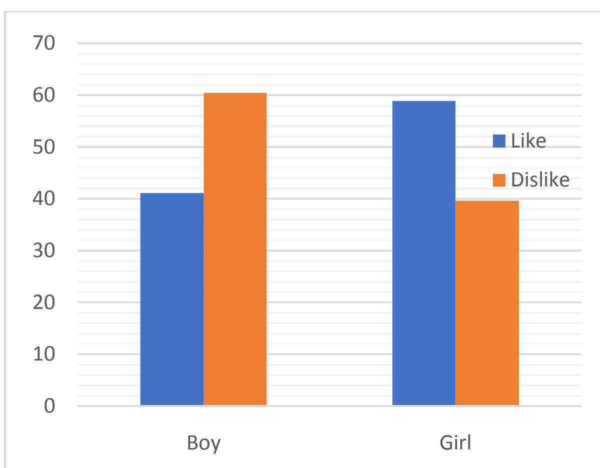

Figure 5. Bar diagram showing percentage of students reporting like or dislike towards mathematics by gender

Apart from the reasons mentioned to like mathematics over other subjects, students attribute their liking to ease of the subject, easiness to score high marks, and its value in developing higher thought processes. Students attribute their dislike to repeated failures in mathematics, regular external help needed to learn, and their ignorance of how to learn mathematics.

Students' perception of their level of achievement.

Nearly 38 percent of students perceive themselves as good at mathematics. Reasons given by students for being good in mathematics are good teacher and teaching, attending the class well, good understanding of mathematics, liking mathematics, interest in mathematics, easiness to learn and their grasp of basics. Three hundred and eleven students (62.2%) perceive themselves as backward in mathematics because of difficulty in learning and understanding classroom transactions and mathematics concepts, forgetting, lack of basics, learning that demand repeated effort, and their failure to perform in examinations.

Students' strategies to learn mathematics.

Students perceive the best strategies for learning mathematics as learning beyond class works by doing exercise in the textbook or other sources (40.2%), memorizing mathematical equations (30.8%) and focusing on class notes (29%). And when preparing for examinations, students follow the strategies like workout exercise from textbooks or other sources (40.8%), focusing on class notes (35.8%), memorizing mathematical equations only (20%) and 3.4% students are not at all learning for examinations.

While considering the study routine of students, around 8 percent of students are not learning the content beyond the regular classes, about 14 percent are learning for 5 to 10 minutes per day only, around 17 percent students learn mathematics 15 minutes per day, around 41 percent study for 30 to 45 minutes and 20 percent study for 1 to 2 hours.

Students' reason for mathematics being difficult.

Reasons for mathematics being difficult were identified by students and given in Table 25.

Table 25

Frequencies of Factors Identified by Students for Mathematics Being Difficult

	Reasons that makes mathematics learning difficult	Frequency	Percentage
Learner factor	Forgetting of previous content	297	59.4
	Rapid forgetting	282	56.4
Subject nature	As mathematics is hard to learn	200	40
	Don't know how to learn mathematics	172	34.4
	Can't understand mathematics	169	33.8
	I am less able to learn mathematics	149	29.8
Process factor	Nobody to help at home	145	29
	Not learning well	138	27.6
	Can't understand math class	94	18.8

Other reasons provided by lesser number of students are fear about mathematics, dislike towards mathematics and mathematics teachers, confusions regarding equations, lack of time and interest.

Reasons students attribute for mathematics being difficult tends to influence their perception of best strategy (memorizing mathematical equations, focusing on class notes and learning beyond class works by doing exercise in the textbook or other sources) for learning mathematics or strategy followed by them for preparing examinations. This can be seen in Table 26.

Table 26

χ^2 Test Using 2 x 3 Contingency Table of Students' Strategies for Learning Mathematics and Forgetting of Previous Content as A Reason for Mathematics Being Difficult

		Students' strategies for learning mathematics			Chi^2
		Memorizing equations only	Practicing class notes	Solving problems from different sources	
Forgetting of previous content is a reason for mathematics being difficult	No	68	68	67	7.59*
	Yes	86	77	134	

*p<.05

Perception of forgetting of previous content as a reason for mathematics being difficult (n=297) is significantly associated to students' perception of best strategy for learning mathematics [χ^2 (2, N=500) =7.59, p<.05]. Significantly more students who perceive forgetting of previous content prefer doing exercise in the textbook or other sources (45.1%) than students who do not perceive forgetting of previous content as a reason for mathematics being difficult (33%, n=203). But its relation with selection of other strategies, memorizing mathematical equations (29% vs. 33.5%) and focusing on class notes (25.9% vs. 33.55%), is not significant. This association is further demonstrated using bar diagram in Figure 6.

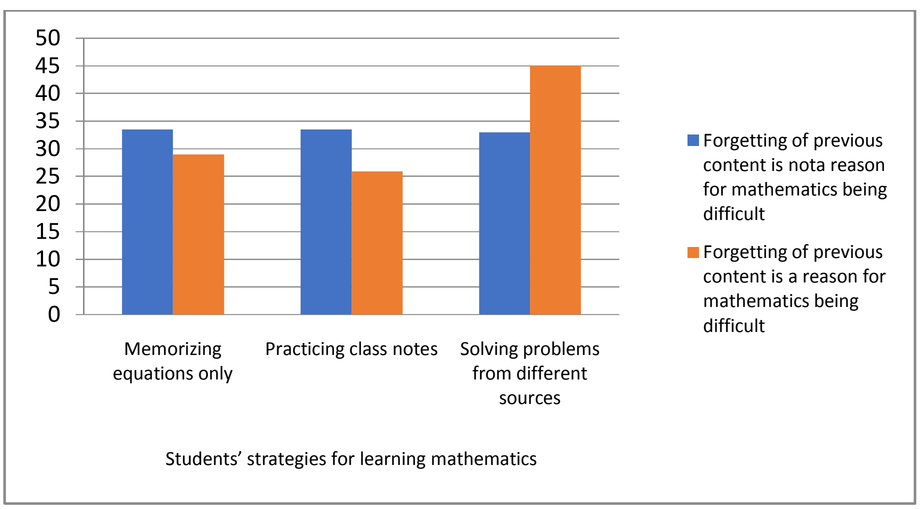

Figure 6. Bar diagram showing percentage of students reporting forgetting of previous content as a reason for mathematics being difficult by their perception of best strategy for learning mathematics

Another reason, hardness of mathematics, for mathematics being difficult also found to have influence on students' perception of best strategies for learning mathematics as in Table 27.

Table 27

χ^2 Test Using 2x3 Contingency Table of Students' Strategies for Learning Mathematics and Hardness of Mathematics

		Students' strategies for learning mathematics			Chi²
		Memorizing equations only	Practicing class notes	Solving problems from different sources	
Hardness of mathematics is a reason for mathematics being difficult	No	98	74	128	6.84*
	Yes	56	71	73	

*p<.05

Perception of hardness of mathematics as a reason for mathematics being difficult and students' perception of best learning strategy are significantly associated [χ^2 (2, N=500) =6.84, p<.05]. Among the students who perceive hardness of mathematics (n=200), significantly more students tend to prefer focusing on class notes (35.5%) than among students who do not perceive hardness of mathematics (24.7%, n=300). However, the two groups do not differ significantly on preference for doing exercise in the textbook or other sources (36.5% vs. 42.7%) and for memorizing mathematical equations (28% vs. 32.7%).This association is further demonstrated using bar diagram in Figure 7.

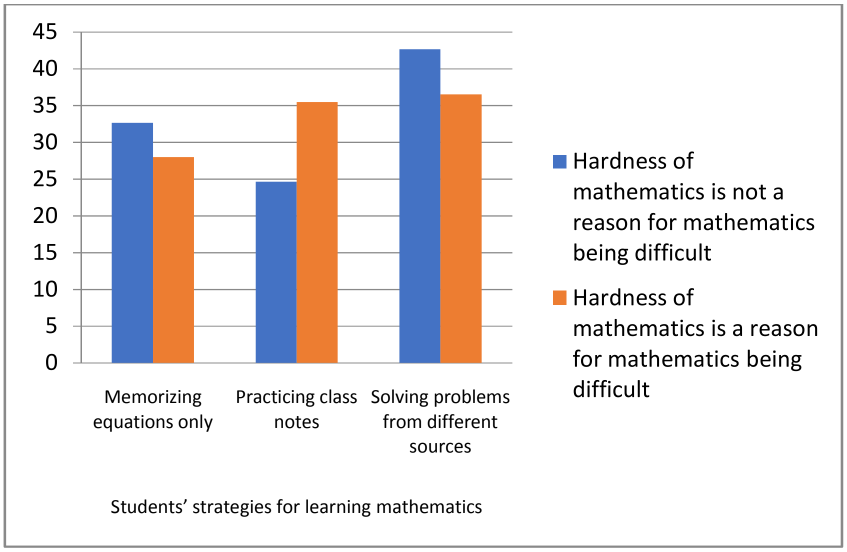

Figure 7. Bar diagram showing percentage of students reporting hardness of mathematics as a reason for mathematics being difficult by their perception of best strategy for learning mathematics

Another reason, 'don't know how to learn mathematics ' as a reason for mathematics being difficult found to have influence on students' strategy that are followed by them for preparing examinations. Results were given in Table 28.

Table 28

χ^2 Test Using 2x4 Contingency Table of Students' Strategies for Mathematics Examinations Preparations and Don't Know How to Learn Mathematics

		Students' strategies for mathematics examinations preparations				Chi^2
		Not learning	Memorizing equations only	Practicing class notes	Solving problems from different sources	
Don't know how to learn mathematics is a reason for mathematics being difficult	No	10	74	98	146	16.03**
	Yes	7	26	81	58	

**p<.01

Students' perception of 'don't know how to learn mathematics ' (n=172), and their strategy of learning for examinations are significantly associated [χ^2 (3, N=500) =16.03, p<.01]. Students who feel 'don't know how to learn mathematics ' do 'focus on class notes' (47.1%), than those who do not perceive such a feeling as reason for difficulty in mathematics (29.9%, n=328). On the contrary, students who feel 'don't know how to learn mathematics ' has less preference than those who do not have such a feeling to do 'exercise in the textbook or other sources' (33.7% vs. 44.5%) and for 'memorizing mathematical equations' (15.1% vs. 22.6%). Relatively less but nearly equal proportions of students in both groups choose not to learn (4.1% vs. 3%). This association is further demonstrated using bar diagram in Figure 8.

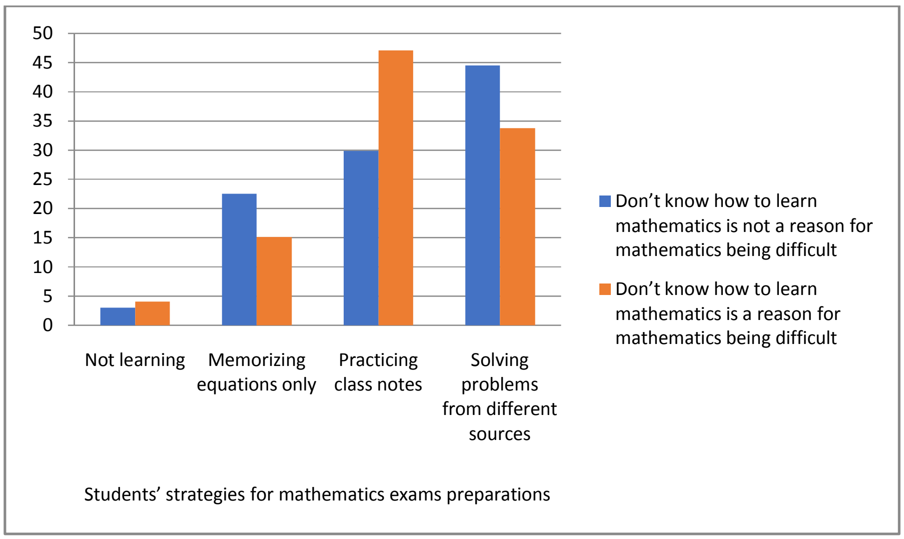

Figure 8. Bar diagram showing percentage of students reporting 'don't know how to learn mathematics' as a reason for mathematics being difficult by their strategies for mathematics examinations preparations

Among the students who are 'not learning well' (n=138), only 32.6% are working on text book problems, but more of them are learning class notes (45.7%) and or memorizing only equations (17.4%) or not at all learning for examinations (4.3%).

Students' difficulty in learning different areas of mathematics .

While the students are asked about difficult area in mathematics, 74.7% report algebra as the difficult area, 11.6% report arithmetic and 8.4% report geometry as the most difficult area of school mathematics. The remaining 3.2% of students find all areas as difficult.

Students' reasons for mathematics being easy.

Among five possible reasons, that makes mathematics learning easy, a good portion of the students identify good teaching will make mathematics learning easier (68.6%) over other reasons like easy to understand (13.6%), easiness of mathematics (13.8%), availability of tuition (22.2%), like towards mathematics (32.8%). For 8.8 percent students, mathematics is not easy by any means.

Students' Beliefs Regarding Nature and Learning of Mathematics

Students hold many false beliefs regarding the nature of mathematics and learning of it, which affect learning negatively. Table 29 briefs the students' negative beliefs regarding mathematics learning.

Table 29

Students' Negative Beliefs Regarding Learning of Mathematics by Percentage of Occurrence

Categories	Students' maladaptive motivational beliefs	% of students
Effort and ability beliefs	Only people with high intelligence can learn mathematics	56
	Ability to understand mathematics easily is more or less an inborn ability	51.6
	Mathematics can't be learned by all	49.8
	Effort will not produce better learning	28.8
	A person's chance for failing or succeeding in mathematics is fixed	23.8
Value	It is better to learn other subjects than Mathematics	70.6
	Mathematics learning will not be useful	5
Nature of mathematics	Mathematics is a difficult subject	51.8
	Mathematics should be learned by heart	51.6
	There is only one way to solve a problem in mathematics	19
	Content in mathematics are not interrelated	18.2
Interest	Mathematics is not interesting	34.4
	Mathematics is boring	30
Self-Efficacy	I never understand mathematics	48.4
	Mathematics can't be learned by myself	23.4
	I can't succeed in Mathematics	19.2

Students hold the belief, they can't succeed in mathematics (19.2%) because of difficulties they are facing in understanding, learning and remembering mathematical concepts, fear, lack of conceptual clarity, lack of others to help, lack of basics, as they don't like mathematics, as they fail most of the times and as it needs high attention.

A notable portion of students (14.4%) has a view that mathematics is not important for them because of reasons like difficulty in understanding and memorizing mathematics and the thoughts like mathematics is not essential in life, it doesn't make any improvement in life and lack of interest. Almost all students agree that mathematics learning will be useful in daily life (99.6%), but 5% of the students believe that haven't any use by learning mathematics. Only 17.8% are well aware of the use of contents that they have been learning in mathematics. Almost one by fifth of students, are experiencing fear towards mathematics. One by tenth of students (52) are trying to be always away from mathematics ; only 20% of students are willing to stay in the mathematics related situations, rest of students are keeping a midway between these two. Anyhow a good portion of students would like to continue studying mathematics after secondary school for different reasons. 69.4% of students have a goal for learning mathematics and of them 89.6% are trying well to reach their goals.

Students' learning behaviors.

Students are not well aware of the importance of acquiring prerequisites. Table 30 shows the behaviors followed by students (in percentage) while learning mathematics .

Table 30

Students' Learning Behaviors in Mathematics

Students' learning behaviors	% of students		
	Always or often	Sometimes	Not at all
Able to recall previous content	23	72.2	4.8
Able to use previous content whenever needed	39	54.6	6.4
Ensuring the acquisition of prerequisites by themselves	22.4	64.4	13.2

More than this, a remarkable portion of students (16.4%) passes over the content that they couldn't understand in the class. Barely 44.2% are trying to solve textbook exercise beyond class works; and half of the students reported that they couldn't find out the way to solve textbook exercise. Mathematics was studied only by 66.2% of students with their own interest. Students' expectancy belief affects their decision in a way that higher percentage of students (73.6) are trying well to solve only problems that they felt easy.

While considering the students' like towards their mathematics teachers, 90.2% likes their teacher, but 16.6% do not like the teaching style of their teacher.

Relation of Students' Liking of Mathematics with their Beliefs about Mathematics and Learning Strategy

Students' like towards mathematics (n= 270) had been found related to possession of many positive thoughts or beliefs regarding mathematics and vice versa. Students' like or dislike towards mathematics tends to influence their feeling of mathematics as a difficult subject. Results were given in Table 31.

Table 31

χ^2 Test Using 2x2 Contingency Table of Students' Like Towards Mathematics and Their Feeling of Mathematics as A Difficult Subject

	Mathematics is		Chi2
	Difficult	Not difficult	
Like	70	200	157.38**
Dislike	189	41	

**p<.01

Students who like mathematics tends to have feeling of mathematics as not a difficult subject (74.1%) significantly more than those who dislike mathematics (17.8 %) [$\chi^2(1, N=500) = 157.38, p<.01$].

Association of students' like or dislike towards mathematics with their feeling of mathematics as a difficult subject is demonstrated using bar diagram in Figure 9.

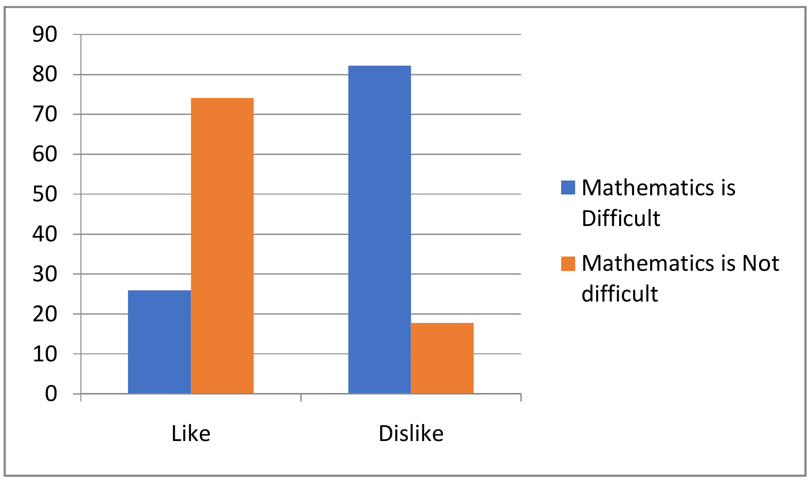

Figure 9. Bar diagram showing percentage of students reporting mathematics as a difficult subject by their like towards mathematics

Students' like towards mathematics and their interest in mathematics.

Students' like or dislike towards mathematics tends to influence their interest factors in mathematics. Results were given in Table 32.

Table 32

Relation of Students' Like with Interest in Mathematics

Interest		Like	Dislike	Chi^2
Interesting	Yes	243	85	154.85**
	No	27	145	
Boring	Yes	29	121	103.67**
	No	241	109	
Genuine interest	Yes	213	118	42.24**
	No	57	112	

** p<.01.

Significantly more number of students who like mathematics are interested in learning mathematics (90%) than the students who dislike mathematics (37%) [χ^2 (1, N=500) =154.85, p<.01]; significantly more number of students who dislike mathematics has a feeling of boredom (52.6%) than the students who like mathematics (10.7%) [χ^2 (1, N=500) =103.67, p<.01]; and students who like mathematics shows a genuine interest in learning mathematics (78.9%) than who dislike (51.3%) [χ^2 (1, N=500) =42.24, p<.01].

Association of students' like or dislike towards mathematics with their interest factors in mathematics is demonstrated using bar diagrams in Figure 10.

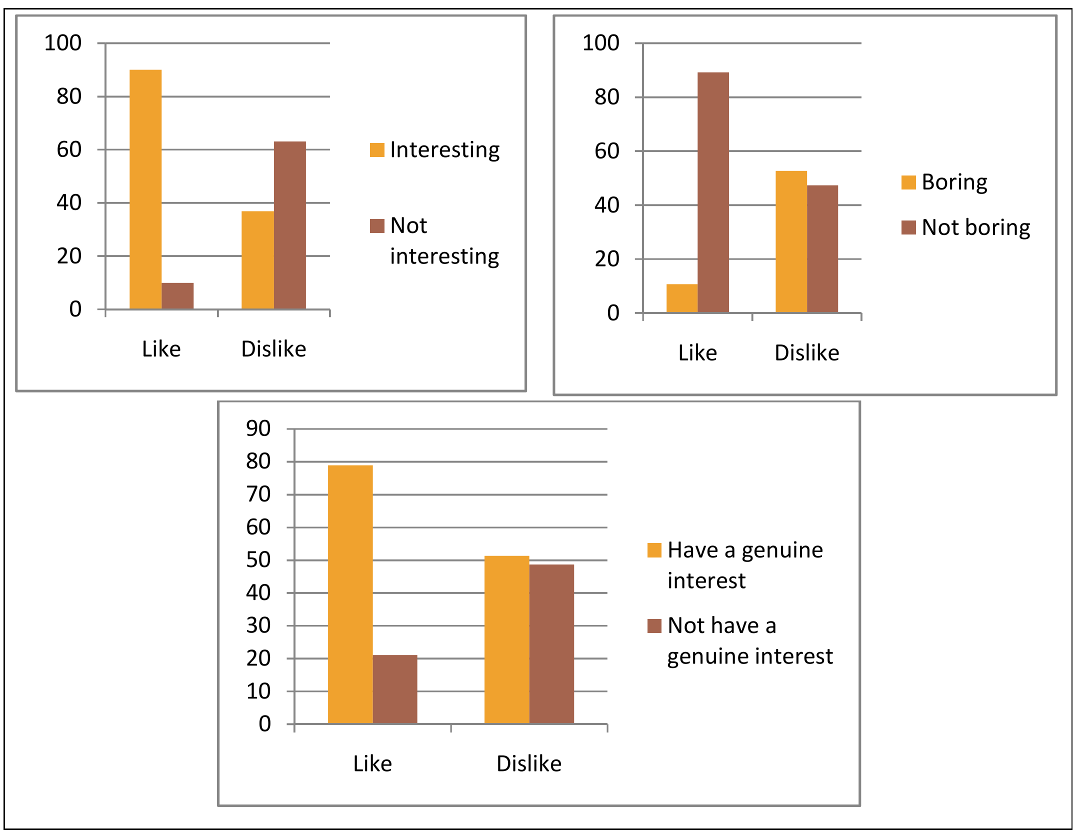

Figure 10. Bar diagrams showing percentage of students' interest factors by their like towards mathematics

Students' like towards mathematics and their values in mathematics.

Students' like or dislike towards mathematics tends to influence their values in mathematics. Results were given in Table 33.

Table 33

Relation of Students' Like with Their Values in Mathematics

Value		Like	Dislike	Chi_2
Wish to learn mathematics after high school	Yes	208	100	59.13**
	No	62	130	
Personal Value	Yes	244	184	10.84**
	No	26	46	
Prefers other subject over mathematics (Cost value)	Always	9	39	54.24**
	Sometimes	150	155	
	Not at all	111	36	

** p<.01.

Students' like is affecting decision regarding their future choices of learning mathematics ; most of the students who like mathematics, wish to continue learning mathematics after high school (77%) than those who don't like mathematics now (43.5%) [χ^2(1, N=500) =59.13, p<.01]. Students' like or dislike is significantly associated to their personal value attached to mathematics [χ^2 (1, N=500) =10.84, p<.01]. Also, more number of students, those who like, find a personal importance for learning mathematics (90.4%) than those who dislike (80%) [χ^2 (1, N=500) =10.84, p<.01]. Students' like or dislike is significantly associated to their cost value belief [χ^2 (2, N=500) =54.24, p<.01], that is more students, those who dislike mathematics, tends to believe that, it is better to learn other subjects over mathematics (17% always, 67.4% sometimes and 15.7% not at all believe) than those who like (3.3% always, 55.6% sometimes and 41.1% not at all believe).

Association of students' like or dislike towards mathematics with their values in mathematics is demonstrated using bar diagram in Figure 11.

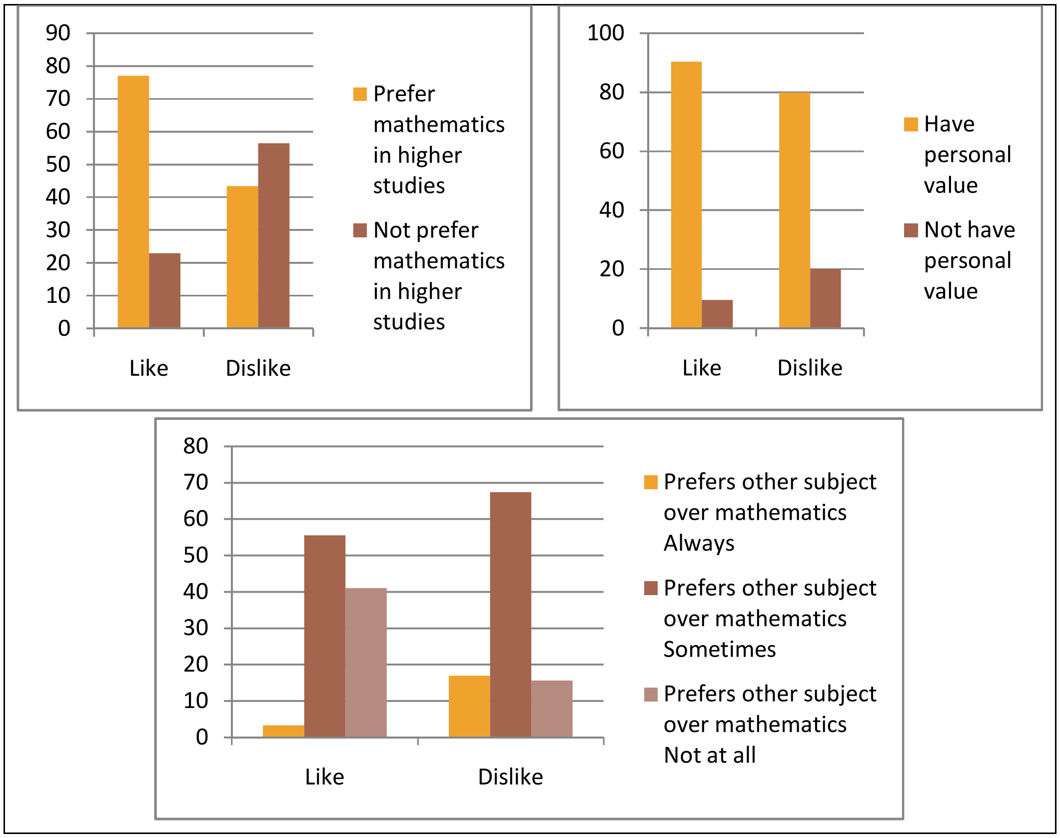

Figure 11. Bar diagrams showing percentage of students' values in mathematics by their like towards mathematics

Students' like towards mathematics and their self-efficacy in mathematics.

Students' like or dislike towards mathematics tends to influence their self-efficacy beliefs in mathematics. Results were given in Table 34.

Table 34

Relation of Students' Like with Their Self-efficacy Beliefs in Mathematics

Self-efficacy		Like	Dislike	Chi^2
Feeling of inability for learning mathematics	Yes	37	80	30.79**
	No	233	150	
I never understand mathematics	Always	15	30	70.29**
	Sometimes	69	128	
	Never	186	72	
I can succeed in mathematics	Yes	247	157	43.17**
	No	23	73	

** $p<.01$.

Students' dislike is associated to belief that they are incapable of learning mathematics [χ^2 (1, N=500) =30.79, p<.01].Among students who dislike mathematics, significantly more students tend to feel incapable of learning mathematics (34.8%) than those who like mathematics (13.7%).

Students' like or dislike is found to have significant association with their belief that "I never understand mathematics " [χ^2 (2, N=500) =70.29, p<.01]. Among students who like mathematics, significantly more students tends to perceive not to possess the belief "I never understand mathematics " (68.9%) than among students who do not like(31.3%); and even less number of students tends to possess this belief (5.6% vs. 13%) or moderately possess it (25.6% vs. 55.7%).

Students' like is significantly associated to their self-efficacy for success in mathematics [χ^2 (1, N=500) =43.17, p<.01], that is significantly more number of students who like mathematics believe that they can succeed in mathematics (91.5%) than the students who dislike mathematics (68.3%).

Association of students' like or dislike towards mathematics with their self-efficacy in mathematics is demonstrated using bar diagram in Figure 12.

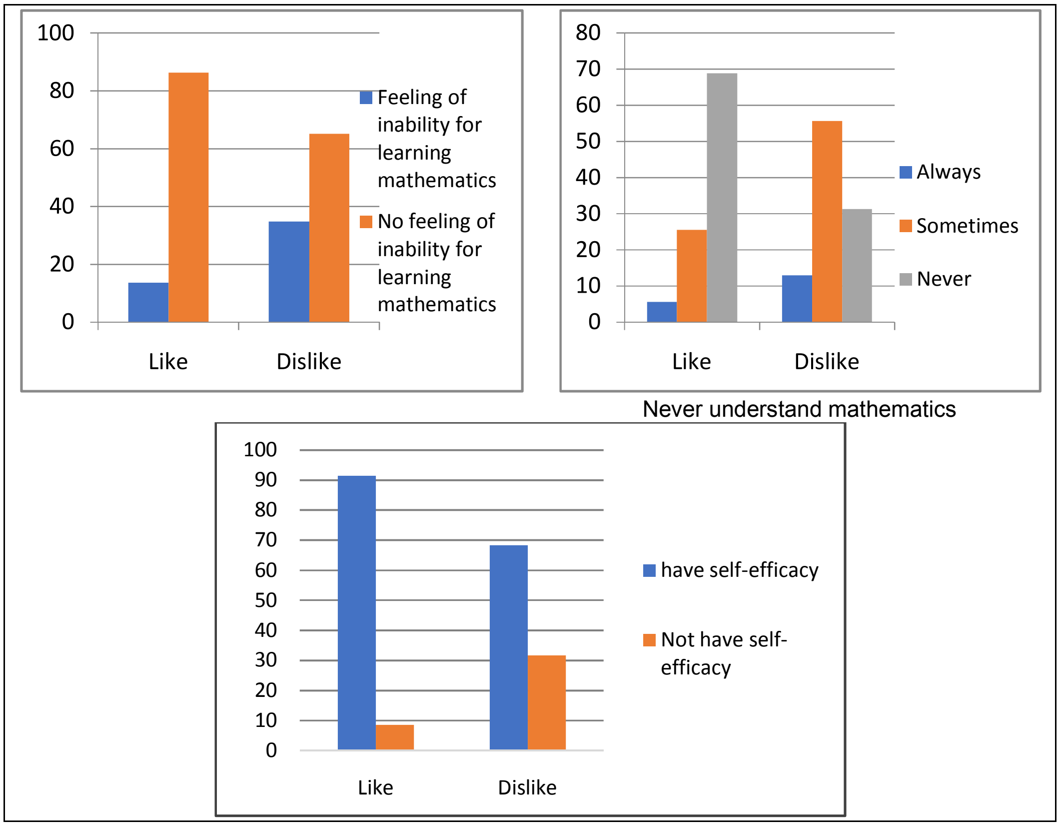

Figure 12. Bar diagrams showing percentage of students' self-efficacy in mathematics by their like towards mathematics

Students' like towards mathematics and their ability beliefs in mathematics.

Students' like or dislike towards mathematics tends to influence their ability beliefs in mathematics. Results were given in Table 35.

Table 35

Relation of Students' Like/Dislike with Their Ability Beliefs in Mathematics

Ability beliefs		Like	Dislike	Chi^2
Every one can't learn mathematics	Yes	161	90	20.88**
	No	109	140	
Effort will improve mathematics learning	Always	222	134	40.62**
	Sometimes	47	80	
	Not at all	1	16	
A person's chance for failing or succeeding in mathematics is fixed	Yes	50	69	9.03**
	No	220	161	
Agree with 'only people with high intelligence can learn mathematics '	Always	35	46	17.88**
	Sometimes	93	106	
	Never	142	78	

** p<.01.

Students' like or dislike is associated to the belief that every one can't learn mathematics [χ^2 (1, N=500) =20.88, p<.01], among students who dislike mathematics, significantly more students tend to believe that every one can't learn mathematics (60.9%) than those who like mathematics (40.4%). Students' like or dislike towards mathematics is also found significantly related to their effort belief [χ^2 (2, N=500) =40.62, p<.01], significantly more number of students from those who like mathematics, value effort (82.2% valuing very much, 17.4% to an extend and 0.4% not at all) than those who dislike (58.3% valuing very much, 34.8% to an extend and 7% not at all).

Then, students' like or dislike is found to have significant association with their belief that a person's chance for failing or succeeding in mathematics is fixed [χ^2 (1, N=500) =9.03, p<.01]. Among students who dislike mathematics, significantly more students tend to believe in fixed faith for failing or succeeding in mathematics (29.7%), than those who like mathematics (18.2%).

Students' dislike is also found to have significant association with their belief that only people with high intelligence can learn mathematics [χ^2 (2, N=500) =17.88, p<.01], among students who like mathematics, significantly more students tends to do not possess the belief that 'only people with high intelligence can learn mathematics ' (52.6%) than among students who do not like(33.9%) and less number of students tends to possess this belief (13 % vs. 20%) or moderately (34.4% vs. 46.1%).

Association of students' like or dislike towards mathematics with their ability beliefs in mathematics is demonstrated using bar diagram in Figure 13.

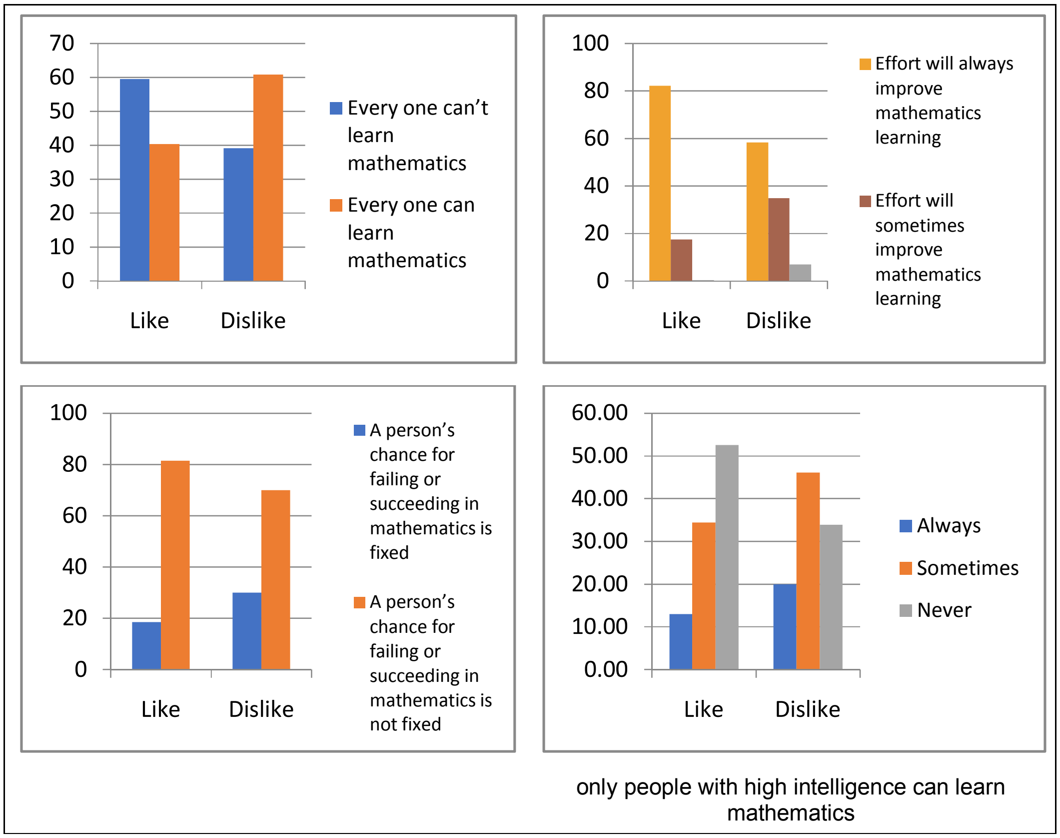

Figure 13. Bar diagrams showing percentage of students' ability beliefs in mathematics by their like towards mathematics

Students' like towards mathematics and their learning behaviors in mathematics.

Students' like or dislike towards mathematics tends to influence their learning behaviors in mathematics. Results were given in Table 36.

Table 36

Relation of Students' Like/Dislike with Their Learning Behaviors in Mathematics

Learning Behaviors		Like	Dislike	Chi2
Trying only easy problems	Yes	178	190	17.79**
	No	92	40	
Handling difficult problems	Skipping	9	12	22.18**
	Leaving after some effort	41	66	
	Leaving after long effort	51	54	
	Seeking others' help	169	98	
Best learning strategy	Memorizing mathematical equations	89	65	14.86**
	Focus on class notes	59	86	
	Do exercise from textbook or other sources	122	79	
Have a Goal	Yes	204	143	10.47**
	No	66	87	

** p<.01.

Students' like or dislike towards mathematics is found significantly related to their various learning behaviors. Significantly more number of students who dislike mathematics had a tendency to find out answer for only problems that they felt easy (82.6%) than those who like it (65.9%) [χ^2(1, N=500) =17.79, p<.01].

Students' like or dislike towards mathematics is found significantly related to their perseverance and help seeking in a difficult problem situation [χ^2 (3, N=500) =22.18, p<.01]. Students who like mathematics likely to persist and seek help (62.6%), than those who don't like mathematics (42.65%, n=230); and those who dislike mathematics are less likely to skip the problem with less effort (28.7%) than those who like (15.2%).

However, students' like and dislike do not significantly affect their choice of skipping the problem (3.3% and 5.2% respectively) and leaving the problem after long effort (18.9% and 23.5% respectively). Students' like or dislike towards mathematics is found significantly related to their perception of best learning strategy [χ^2 (2, N=500) =14.86, p<.01],among students who like mathematics, significantly more students tends to prefer for doing exercise in the textbook or other sources (45.2%) than among students who do not like (34.3%) and less tends to prefer focusing on class notes (21.9% vs. 37.4%). However, the two groups do not differ significantly on preference for memorizing mathematical equations (33% vs. 28.3%).

Also, students' like or dislike towards mathematics is found significantly related to having a goal for them for learning mathematics [χ^2 (1, N=500) =10.47, p<.01]. Significant more number of students who like mathematics have a goal while learning mathematics (75.6%) than those who dislike mathematics (62.2%).

Association of students' like or dislike towards mathematics with their learning behaviors in mathematics is demonstrated using bar diagram in Figure 14.

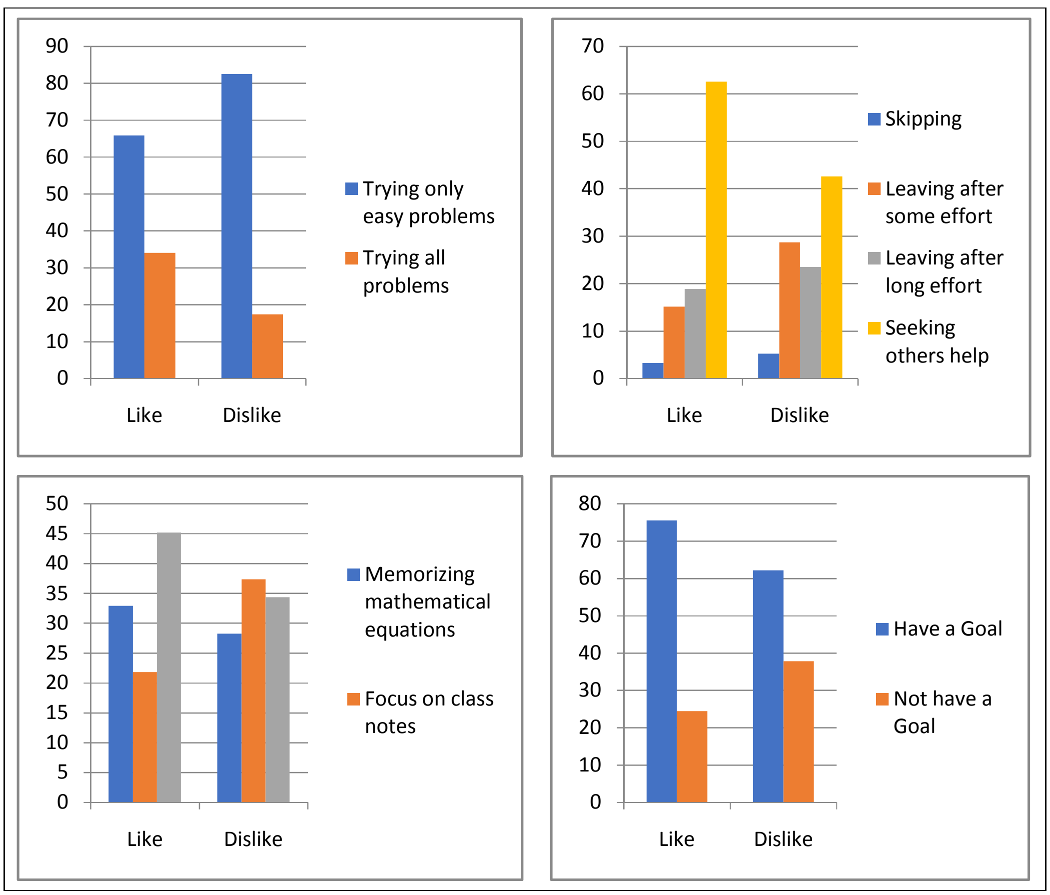

Figure 14. Bar diagrams showing percentage of students' learning behaviors by their like towards mathematics

Relation of Students' Feeling of Difficulty of Mathematics with Their Other Beliefs and Learning Strategy

More than fifty percentage of students (259) felt mathematics as a difficult subject. Mathematics has been described as a very difficult subject by 40.2% of students. Students' belief that mathematics is a difficult subject or not, had been found related to their other beliefs and behaviors.

Students' feeling of difficulty in mathematics and their interest in mathematics.

Students' feeling of difficulty in mathematics found to have relation with their interest in mathematics. Results were given in Table 37.

Table 37

Relation of Students' Feeling of Difficulty and Their Interest in Mathematics

Interest		Difficult	Not Difficult	Chi^2
interesting	Yes	113	215	114.94**
	No	146	26	
Boring	Yes	122	28	74.86**
	No	137	213	
Personal interest	Yes	143	188	28.99**
	No	116	53	

** $p<.01$.

Significantly more number of students who do not feel mathematics as a difficult subject tends to show interest in learning mathematics (89.2% vs. 43.6%)[χ^2 (1, N=500) =114.94, p<.01]. And significantly more number of students who felt mathematics as difficult subject has a feeling of boredom (47.1%) than those who do not feel mathematics as a difficult subject (11.6%) [χ^2 (1, N=500) =74.86, p<.01]. Significant more number of students who do not feel mathematics as a difficult subject is learning mathematics with their own interest (78%) than those who feel mathematics as a difficult subject (55.2%) [χ^2 (1, N=500) =28.99, p<.01].

Association of students' feeling of difficulty in mathematics with their interest in mathematics is demonstrated using bar diagram in Figure 15.

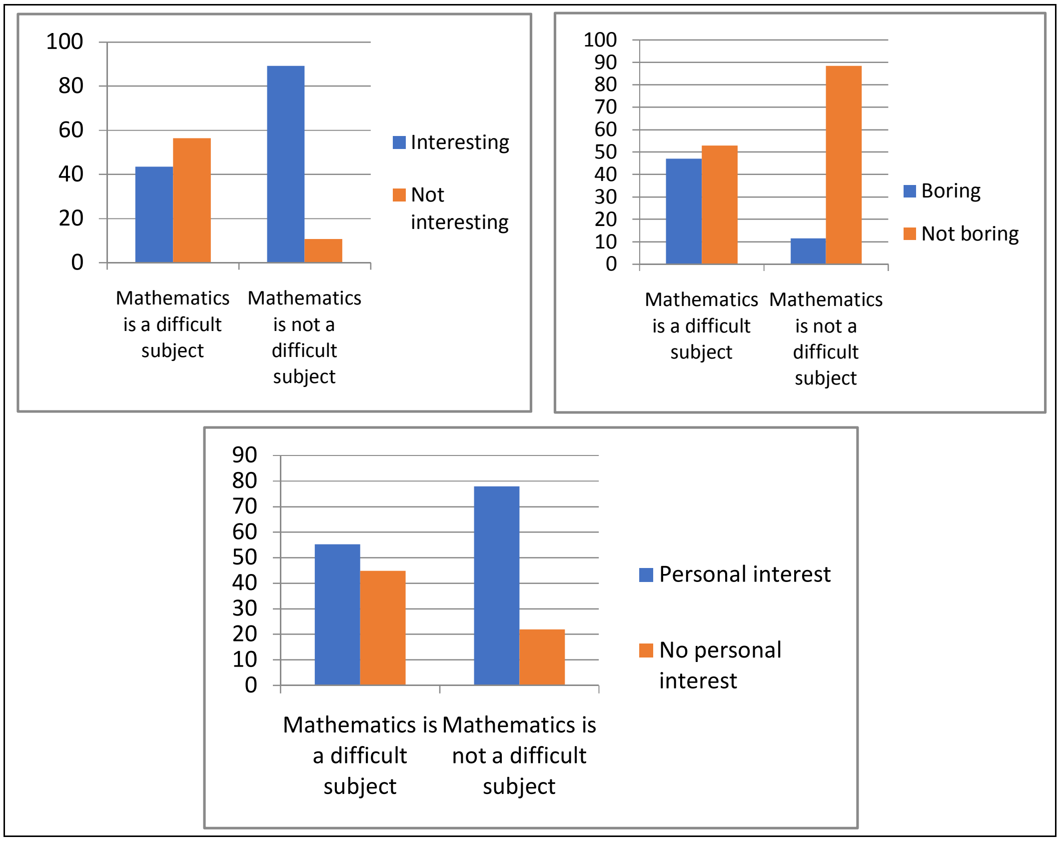

Figure 15. Bar diagrams showing percentage of students' interest factors by their feeling of difficulty in mathematics

Students' feeling of difficulty in mathematics and their values in mathematics.

Students' feeling of difficulty in mathematics found to have relation with their values in mathematics. Results were given in Table 38.

Table 38

Relation of Students' Feeling of Difficulty with their Values in Mathematics

Value		Difficult	Not Difficult	Chi^2
Wish to learn mathematics after high school	Yes	131	177	27.59**
	No	128	64	
Personal Value	Yes	209	219	10.49**
	No	50	22	
Prefers other subject over mathematics	Always	37	11	48.02**
	Sometimes	179	126	
	Not at all	43	104	

** p<.01.

Students' feeling of difficulty in mathematics found to have significant association their wish to learn mathematics after high school [χ^2 (1, N=500) =27.59, p<.01]. Among students who do not feel mathematics as a difficult subject, significantly more students tend to have a wish for learning mathematics after high school (73.4%), than those who feel mathematics as a difficult subject (50.6%).

Students' feeling of difficulty in mathematics is significantly associated to their personal value attached to mathematics [χ^2 (1, N=500) =10.49, p<.01]. More number of students, among those who do not feel mathematics as a difficult subject, find a personal importance for learning mathematics (90.9%) than those who feel mathematics as a difficult subject (80.7%).

Students' feeling of difficulty in mathematics is significantly associated to their cost value belief [χ^2 (2, N=500) =48.02, p<.01]. More students, those who dislike mathematics, tends to believe that it is better to learn other subjects over mathematics (14.3% always, 69.1% sometimes and 16.6% not at all believe) than those who do not feel mathematics as a difficult subject (4.6% always, 43.6% sometimes and 52.3% not at all believe).

Association of students' feeling of difficulty in mathematics with their values in mathematics is demonstrated using bar diagram in Figure 16.

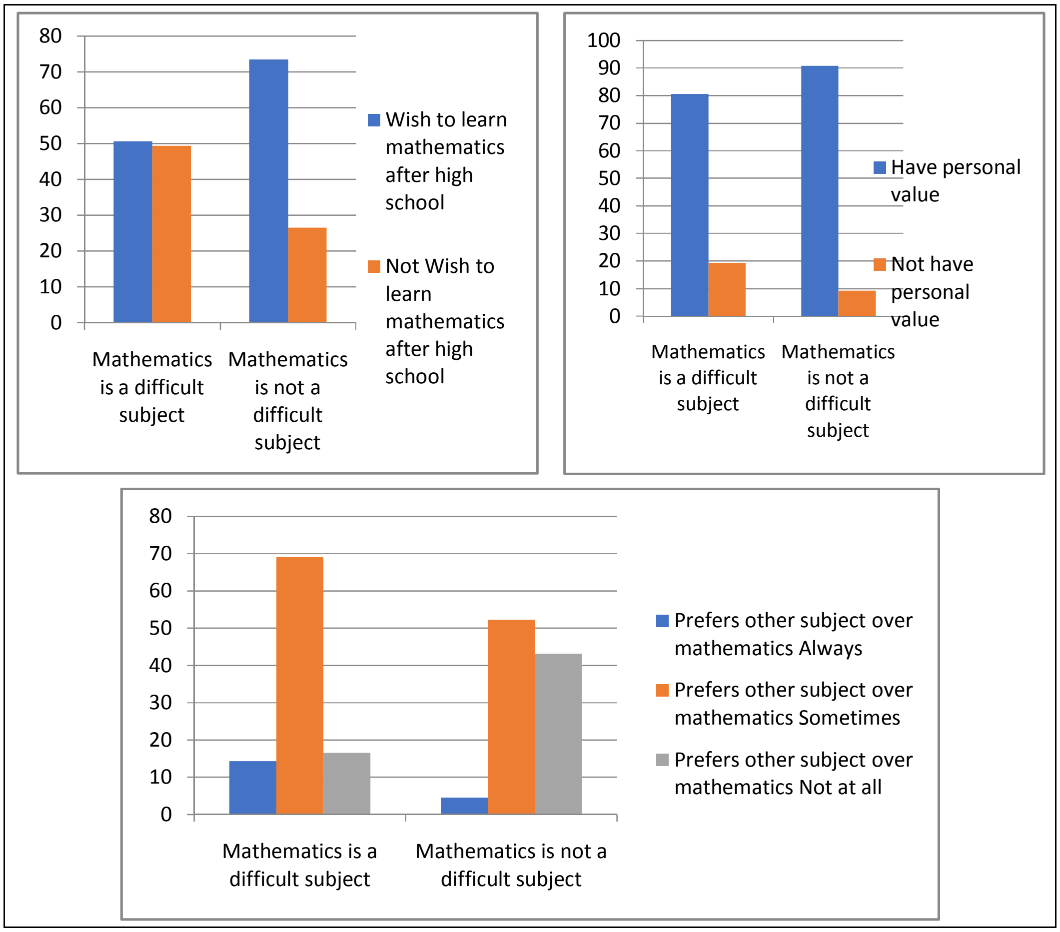

Figure 16. Bar diagrams showing percentage of students' values in mathematics by their feeling of difficulty in mathematics

Students' feeling of difficulty in mathematics and their self-efficacy in mathematics.

Students' feeling of difficulty in mathematics found to have relation with their self-efficacy in mathematics. Results were given in Table 39.

Table 39

Relation of Students' Feeling of Difficulty with Their Self-efficacy in Mathematics

Self-efficacy		Difficult	Not Difficult	Chi2
Feeling of inability for learning mathematics	Yes	85	32	26.53**
	No	174	209	
I never understand mathematics	Always	35	10	47.86**
	Sometimes	128	69	
	Never	96	162	
I can succeed in mathematics	Yes	192	212	15.40**
	No	67	29	

** p<.01.

Students' feeling of difficulty in mathematics is associated to belief that they are incapable of learning mathematics [χ^2 (1, N=500) =26.53, p<.01], among students who feel mathematics as a difficult subject, significantly more students tend to feel incapable of learning mathematics (32.8%) than those who feel mathematics as a difficult subject(13.3%).

Also, students' feeling of difficulty in mathematics is found to have significant association with their belief that "I never understand mathematics " [χ^2 (2, N=500) =47.86, p<.01]. Significant more students who felt mathematics as a difficult subject tends to believe that they never understand mathematics (13.5% always, 49.4% sometimes, 37.1% never) than those who don't felt mathematics as a difficult subject (4.1% always, 28.6% sometimes, 67.2% never).

Again, students' feeling of difficulty is significantly associated to their positive beliefs like self-efficacy for success in mathematics [χ^2 (1, N=500) =15.40, p<.01], that is significantly more number of students who do not feel mathematics as difficult has self-efficacy for success in mathematics (88%) than the students who dislike mathematics (74.1%).

Association of students' feeling of difficulty in mathematics with their self-efficacy in mathematics is demonstrated using bar diagram in Figure 17.

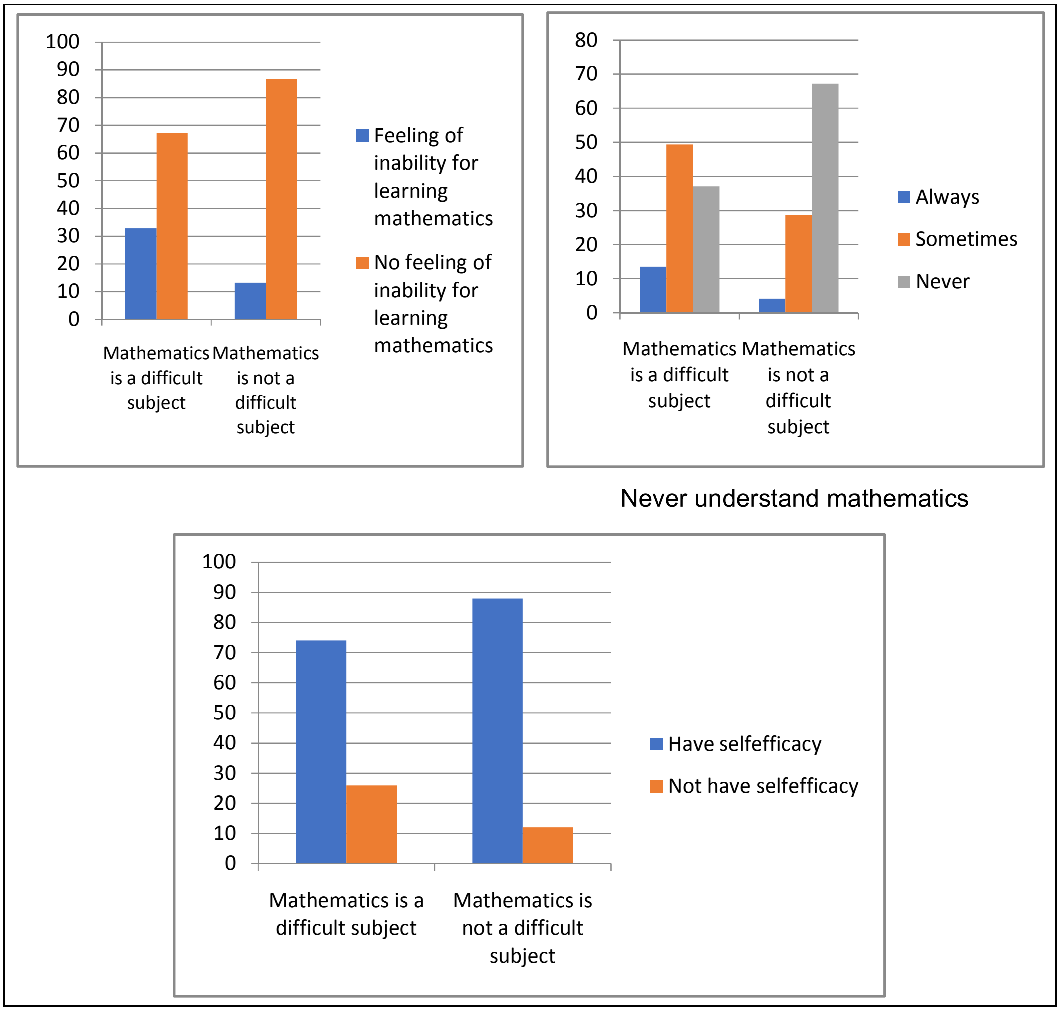

Figure 17. Bar diagrams showing percentage of students' self-efficacy in mathematics by their feeling of difficulty in mathematics

Students' feeling of difficulty in mathematics and their ability beliefs in mathematics.

Students' feeling of difficulty in mathematics tends to influence their ability beliefs in mathematics. Results were given in Table 40.

Table 40

Relation of Students' Feeling of Difficulty with Their Ability Beliefs in Mathematics

Ability beliefs		Difficult	Not Difficult	Chi^2
Every one can't learn mathematics	No	103	148	23.39**
	Yes	156	93	
Effort will improve mathematics learning	Always	156	200	32.43**
	Sometimes	89	38	
	Not at all	14	3	
A person's chance for failing or succeeding in mathematics is fixed	Yes	78	39	13.52**
	No	180	201	
Agree with 'only people with high intelligence can learn mathematics '	Always	56	25	16.78**
	Sometimes	108	91	
	Never	95	125	

** p<.01.

Students' feeling of difficulty in mathematics is associated to the belief that every one can't learn mathematics [χ^2 (1, N=500) =23.39, p<.01], among students who feel mathematics as a difficult subject, significantly more students tend to believe that every one can't learn mathematics (60.2%) than those who do not feel mathematics as a difficult subject (38.6%).

Also, students' feeling of difficulty in mathematics is found significantly related to their effort belief [χ^2 (2, N=500) =32.43, p<.01], significantly more number of students from those who do not feel mathematics as a difficult subject, value effort (83% valuing very much, 15.8% to an extend and 1.2% not at all) than those who feel mathematics as a difficult subject (60.2% valuing very much, 34.4% to an extend and 5.4% not at all).

Again, students' feeling of difficulty in mathematics is found to have significant association with their belief that a person's chance for failing or succeeding in mathematics is fixed [χ^2 (1, N=500) =13.52, p<.01]. Among students who feel mathematics as a difficult subject, significantly more students tend to believe in fixed faith for failing or succeeding in mathematics (30.2%), than those who like mathematics (16.6%).

Students' feeling of difficulty in mathematics is found to have significant association with their belief that only people with high intelligence can learn mathematics [χ^2 (2, N=500) =16.78, p<.01], among students who do not feel mathematics as a difficult subject, significantly more students tends to do not possess the belief that 'only people with high intelligence can learn mathematics ' (51.9%) than among students who feel mathematics as a difficult subject (36.7%) and less number of students tends to possess this belief (10.4 % vs. 21.6%) or moderately (37.8% vs. 41.7%).

Association of students' feeling of difficulty in mathematics with their ability beliefs in mathematics is demonstrated using bar diagram in Figure 18.

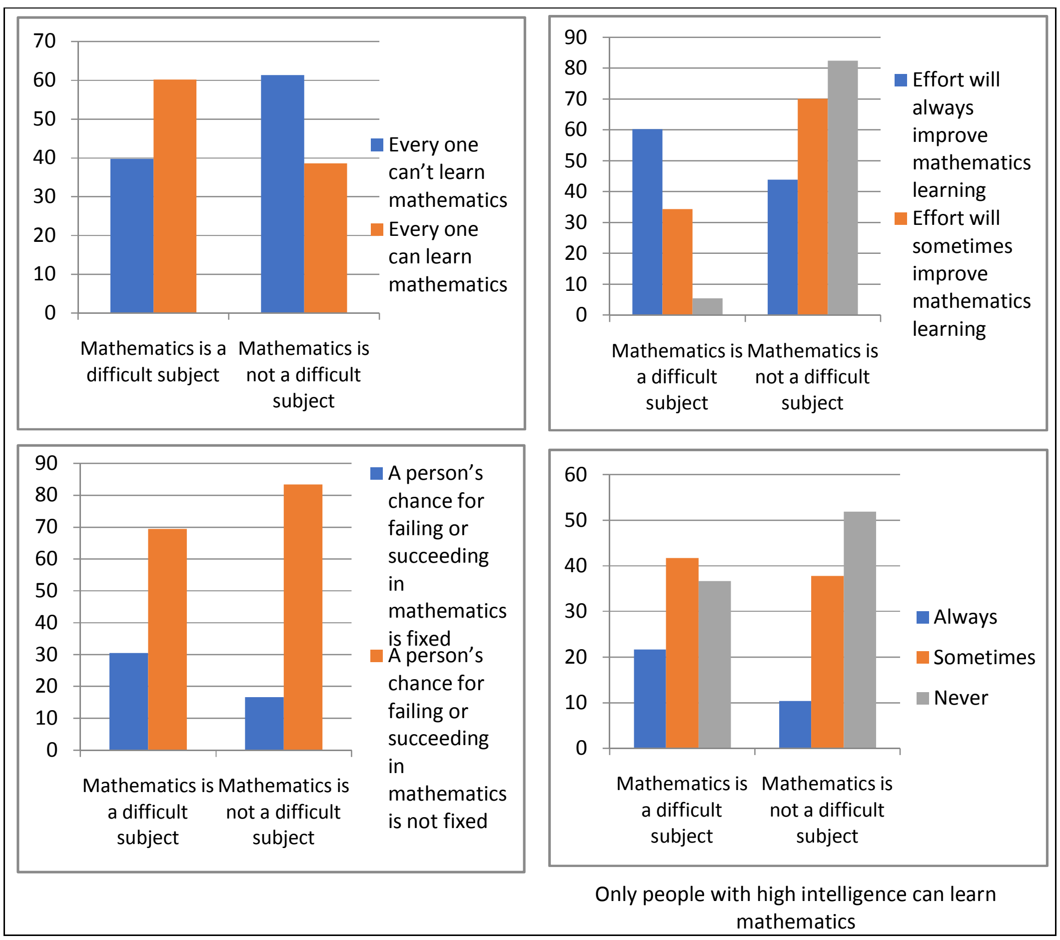

Figure 18. Bar diagrams showing percentage of students' ability beliefs in mathematics by their feeling of difficulty in mathematics

Students' feeling of difficulty in mathematics and their learning behaviors in mathematics.

Students' feeling of difficulty in mathematics tends to influence their learning behaviors in mathematics. Results were given in Table 41.

Table 41

Relation of Students' Feeling of Difficulty with Their Learning Behaviors in Mathematics

Learning Behaviors		Difficult	Not Difficult	Chi2
Trying only easy problems	Yes	215	153	24.49**
	No	44	88	
Handling difficult problems	Skipping	16	5	13.64**
	Leaving after some effort	60	47	
	Leaving after long effort	63	42	
	Seeking others' help	120	147	
Have a Goal	Yes	159	188	16.24**
	No	100	53	

** p<.01.

Significantly more number of students who feel mathematics as a difficult subject had a tendency to find out answer for only problems that they felt easy (83.01%) than those who feel mathematics as not difficult (63.49%) [χ^2(1, N=500) =24.49, p<.01]. Among the students those who feel mathematics as a difficult subject, if they felt a problem as difficult, 6.2% tends to skip the problem, 23.2% takes less effort. Only 24.3% of students wish to persist and 46.3% to seek help.

Whilst confronting with difficult problems, students who do not felt mathematics as a difficult subject, tends to show more perseverance (17.4%), and help seeking (61%) and less skipping (2.1%) or less effort (19.5%) [χ^2 (3, N=500) =13.64, p<.01].

Students' feeling of difficulty in mathematics is found significantly related to having a goal for them for learning mathematics [χ^2 (1, N=500) =16.24, p<.01]. Significant more number of students who do not feel mathematics as difficult subject have a goal while learning mathematics (78%) than those who feel mathematics as difficult subject (61.4%).

Association of students' feeling of difficulty in mathematics with their learning behaviors in mathematics is demonstrated using bar diagram in Figure 19.

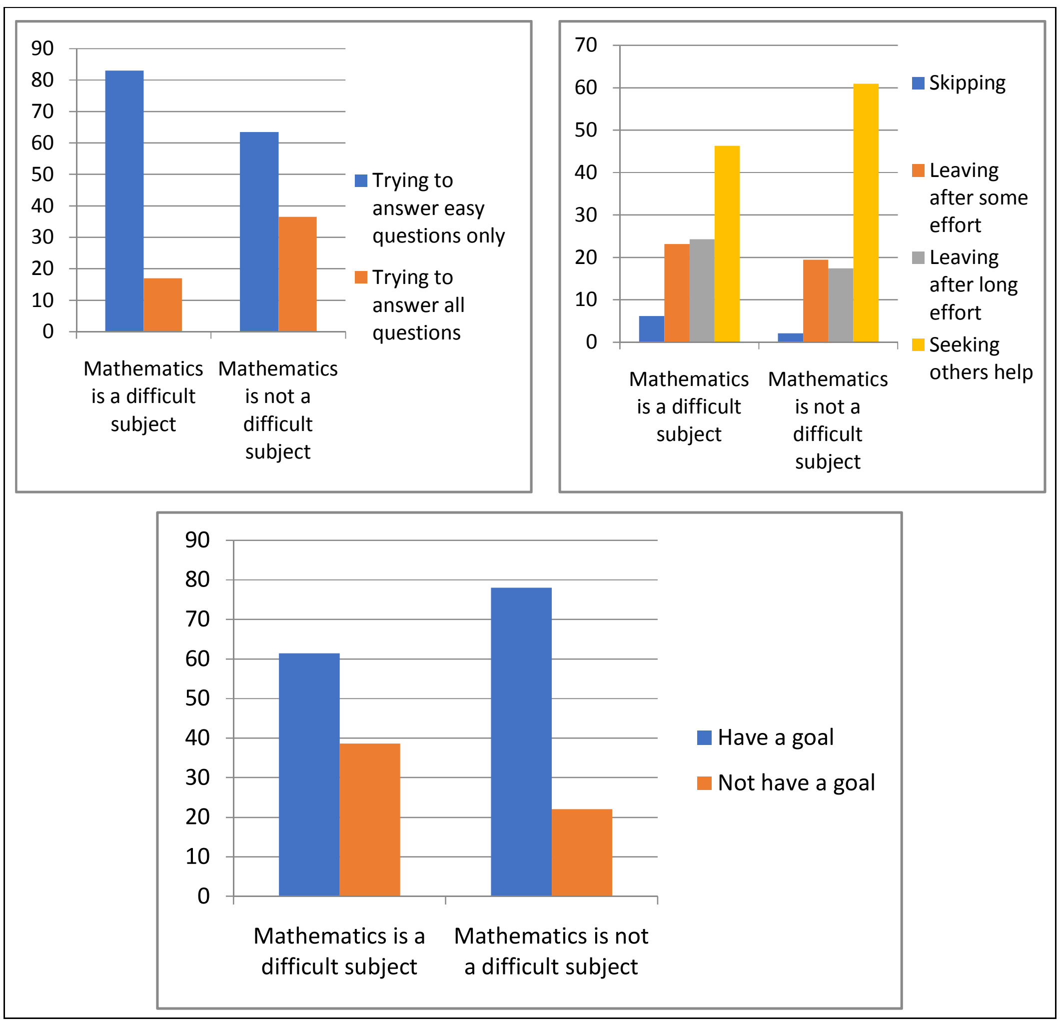

Figure 19. Bar diagrams showing percentage of students' learning behaviors by their feeling of difficulty in mathematics

Summary of Findings on Motivational Factors, Learning Strategies and Difficulties in Learning Mathematics among High School Students in Kerala

This analysis of data obtained in the survey phase of this study helped to identify the dynamics of affective and strategic factors in learning of mathematics among high school students in Kerala. Most of these findings echoes the observation of previous studies on the significance and interplay of affective, motivational and strategic factors in learning mathematics in schools students.

Mathematics is at the same time the third most liked subject in school but it is also the subject disliked by most number of students. Mathematics has been described as a very difficult subject by 40.2% of students. The like or dislike towards mathematics are gender dependent with more girls liking it and more boys disliking it. Students attribute their liking to ease of the subject, easiness to score high marks, and its value in developing higher thought processes. Students attribute their dislike to repeated failures in mathematics, regular external help needed to learn, and their ignorance of how to learn mathematics.

Among five possible reasons, that makes mathematics learning easy, a good portion of the students identify good teaching will make mathematics learning easier (68.6%) over other reasons like easy to understand (13.6%), easiness of mathematics (13.8%), availability of tuition (22.2%), and like towards mathematics (32.8%).

Students are not well aware of the importance of acquiring prerequisites. Students perceive the best strategies for learning mathematics as learning beyond class works by doing exercise in the textbook or other sources (40.2%), memorizing mathematical equations (30.8%) and focusing on class notes (29%).

And when preparing for examinations, students follow the strategies like workout exercise from textbooks or other sources (40.8%), focusing on class notes (35.8%), memorizing mathematical equations only (20%) and 3.4% students are not at all learning for examinations.

Reasons students attribute for mathematics being difficult tends to influence their perception of best strategy (memorizing mathematical equations, focusing on class notes and learning beyond class works by doing exercise in the textbook or other sources) for learning mathematics or strategy followed by them for preparing examinations.

Nearly 2/3 of students (62.2 %) perceive themselves as backward in mathematics because of difficulty in learning and understanding classroom transactions and mathematics concepts, forgetting, lack of basics, learning that demand repeated effort, and their failure to perform in examinations.

Student perception of difficulty in mathematics and like towards the subject, both, are found associated with an array of motivational and strategic factors like interest factors, values in mathematics, ability beliefs in mathematics, and their mathematics learning behaviours.

Students' like or dislike towards mathematics tends to associated with their interest factors in mathematics. It also associates with their values in mathematics like wish to learn mathematics after high school, personal value, prefers other subject over mathematics (cost value); and their self-efficacy beliefs in mathematics. Students' like or dislike towards mathematics are associated with their ability beliefs in mathematics like 'every one can't learn mathematics', 'effort will improve mathematics learning', 'a person's chance for failing or succeeding in mathematics is fixed', agree with 'only people with high intelligence can learn mathematics'. Students' like or dislike towards mathematics are associated with their learning behaviours in mathematics in handling difficult problems, choosing best learning strategy, and having a goal.

Students' feeling of difficulty in mathematics is dependent on their self-efficacy beliefs in mathematics such as feeling of inability for learning mathematics, that they never understand mathematics, or that they can succeed in mathematics. Students' feeling of difficulty in mathematics depends also on their ability beliefs in mathematics like 'every one can't learn mathematics ', 'effort will improve mathematics learning', 'a person's chance for failing or succeeding in mathematics is fixed', and 'only people with high intelligence can learn mathematics'. Students hold the beliefs, they can't succeed in mathematics (19.2%) is associated with difficulties they are facing in understanding, learning and remembering mathematical concepts, fear, lack of conceptual clarity, lack of others to help, lack of basics, as they don't like mathematics, as they fail most of the times and as it needs high attention. Students' perception of 'don't know how to learn mathematics ', and their strategy of learning for examinations are significantly associated. Hardness of mathematics as a reason for mathematics being difficult and students' perception of best learning strategy are significantly associated. Significantly more students who perceive mathematics as hard tend to prefer focusing on class notes (35.5%) than among students who do not perceive hardness of mathematics (24.7%). Moreover, students' feeling of difficulty in mathematics tends to influence their learning behaviours in mathematics such as trying only easy problems, handling difficult problems, and having a goal.

Effects of Self-regulated Learning Strategy Instruction

Effectiveness of evidence-based self-regulatory intervention (SRL strategy instruction) among standard nine students in improving their achievement in mathematics is studied using mean difference analysis. One-way and two-way analysis of variance (ANOVA) and *t*-test were used. Prior to this, to verify whether the data satisfied the assumptions of ANOVA, distribution of each dependent variable were studied using Shapiro-Wilk test of normality and Levene's test of homogeneity. Along with this, it was further verified that there was no significant difference among experimental and control groups before treatment on the dependent variables.

Distribution of Pretest Scores of Dependent Variables

The distribution of seven dependent variables are studied to verify normality, homogeneity and match between the four treatment groups. Results are presented below.

Distribution of pretest scores of achievement in Fractions among students in experimental and control groups

Statistical indices of distribution of pretest scores of achievement in fractions for the experimental and control groups are given in Table 42.

Table 42

Statistical Indices of Distributions of Pretest Scores of Achievement in Fractions in Experimental and Control Groups

	Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
							Statistics	SE	Statistics/SE	Statistics	SE	Statistics/ SE
Experimental	G1	37	4.68	5	4	2.58	0.42	0.39	1.09	-0.02	0.76	-0.03
	G2	39	3.46	4	4	1.85	0.41	0.38	1.08	-0.07	0.74	-0.09
Control	G3	37	4.24	4	3	1.94	0.10	0.39	0.25	-0.95	0.76	-1.25
	G4	38	4.18	4	4	1.93	0.30	0.38	0.78	-0.65	0.75	-0.87

Table 42 shows that, in the experimental group 1 (G1), mean (4.68), median (5), and mode (4) of pretest scores of achievement in fractions are almost equal. The indices of skewness (0.42) and kurtosis (-0.02) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (1.09), and that between kurtosis and its standard error (0.03) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2), mean (3.46), median (4), and mode (4) of pretest scores of achievement in fractions are almost equal. The indices of skewness (0.41) and kurtosis (-0.07) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (1.08), and that between kurtosis and its standard error (0.09) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3), mean (4.24), median (4), and mode (3) of pretest scores of achievement in fractions are almost equal. The indices of skewness (0.1) and kurtosis (-0.95) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.25), and that between kurtosis and its standard error (1.25) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4), mean (4.14), median (4), and mode (4) of pretest scores of achievement in fractions are almost equal. The indices of skewness (0.3) and kurtosis (-0.65) indicate slightly positively skewed and platykurtic. The ratios between skewness and its standard error (0.78), and that between kurtosis and its standard error (0.87) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of achievement in fractions. The results are given in Table 43.

Table 43

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Achievement in Fractions of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.97	37	1.42	3	147
	G2	0.96	39			
Control	G3	0.95	37			
	G4	0.95	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of achievement in fractions for all groups. Levene's test of homogeneity suggest that the variances of pretest scores of achievement in fractions of the groups were equal, [F (3, 147) =1.42, p>.05]. Therefore, pretest scores of achievement in fractions of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of achievement in fractions of the experimental and control groups. Results are in Appendix N1.

To verify the match between the groups by achievement in fractions before treatment, ANOVA was performed on pretest scores of achievement in fractions of experimental and control groups. The results are shown in Table 44.

Table 44

Comparison of Mean Pretest Scores of Achievement in Fractions in the Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	*F*
Group	29.03	3	9.68	2.21
Error	642.32	147	4.37	
Total	671.35	150		

Table 44 shows that there is no significant difference between the mean pretest scores of achievement in fractions of the four groups [F (3, 147) =2.21, p>.05]. Hence as per the data, pretest scores of achievement in fractions of the four groups were normally distributed, and the means of groups were shown no significant difference.

Distribution of Pretest scores of self-efficacy for learning fractions among students in experimental and control groups.

Statistical indices of distribution of pretest scores of self-efficacy for learning fractions for the experimental and control groups are given in Table 45.

Table 45

Statistical Indices of Distributions of Pretest Scores of Self-efficacy for Learning Fractions in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	45.89	47.0	47	9.60	-0.17	0.39	-0.45	0.19	0.76	0.25
G2	39	46.00	45.0	44	11.72	0.26	0.38	0.70	-0.17	0.74	-0.23
G3	37	42.14	43.0	44	10.60	-0.18	0.39	-0.47	-0.35	0.76	-0.47
G4	38	47.11	47.5	49	11.27	0.08	0.38	0.21	-0.28	0.75	-0.37

Table 45 shows that, in the experimental group 1 (G1), mean (45.89), median (47), and mode (47) of pretest scores of self-efficacy for learning fractions are almost equal. The indices of skewness (-0.17) and kurtosis (0.19) indicate slightly negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (0.45), and that between kurtosis and its standard error (0.25) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2), mean (46), median (45), and mode (44) of pretest scores of self-efficacy for learning fractions are almost equal. The indices of skewness (0.26) and kurtosis (-0.17) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.7), and that between kurtosis and its standard error (0.23) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3), mean (42.14), median (43), and mode (44) of pretest scores of self-efficacy for learning fractions are almost equal. The indices of skewness (-0.08) and kurtosis (-0.35) indicate slightly negatively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.47), and that between kurtosis and its standard error (0.47) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4), mean (47.11), median (47.5), and mode (49) of pretest scores of self-efficacy for learning fractions are almost equal. The indices of skewness (0.01) and kurtosis (-0.28) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.21), and that between kurtosis and its standard error (0.37) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of self-efficacy for learning fractions. The results are given in Table 46.

Table 46

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Self-efficacy for Learning Fractions of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.98	37	0.6	3	147
	G2	0.98	39			
Control	G3	0.97	37			
	G4	0.98	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of self-efficacy for learning fractions for all groups. Levene's test of homogeneity suggest that the variances of pretest scores of self-efficacy for learning fractions of the groups were equal, [F (3, 147) =0.6, p>.05]. Therefore, pretest scores of self-efficacy for learning fractions of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of self-efficacy for learning fractions of the experimental and control groups. Results are in Appendix N2.

To verify the match between the groups by self-efficacy for learning fractions before treatment, ANOVA was performed on pretest scores of self-efficacy for learning fractions of experimental and control groups. The results are shown in Table 47.

Table 47

Comparison of Mean Pretest Scores of Self-Efficacy for Learning Fractions in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	526.52	3	175.51	1.49
Error	17277.47	147	117.53	
Total	17803.99	150		

Table 47 shows that there is no significant difference between the mean pretest scores of self-efficacy for learning fractions of the four groups [F (3, 147) =1.49, p>.05]. Hence as per the data, pretest scores of self-efficacy for learning fractions of the four groups were normally distributed, and the means of groups were shown no significant difference.

Distribution of pretest scores of achievement in pairs of equations among students in experimental and control groups.

Statistical indices of distribution of pretest scores of achievement in pairs of equations for the experimental and control groups are given in Table 45.

Table 48

Statistical Indices of The Distributions of Pretest Scores of Achievement in Pairs of Equations in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	3.24	3	3	1.79	0.14	0.39	0.36	-0.59	0.76	-0.77
G2	39	3.15	3	3	1.53	-0.09	0.38	-0.23	-0.49	0.74	-0.66
G3	37	3.51	3	3	1.76	0.19	0.39	0.48	-0.66	0.76	-0.87
G4	38	3.5	3.5	4	1.80	0.13	0.38	0.35	-0.44	0.75	-0.59

Table 48 shows that, in the experimental group 1 (G1), mean (3.24), median (3), and mode (3) of pretest scores of achievement in pairs of equations are almost equal. The indices of skewness (0.14) and kurtosis (-0.59) indicate slightly positively skewed and platykurtic. The ratios between skewness and its standard error (0.36), and that between kurtosis and its standard error (0.77) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2), mean (3.15), median (3), and mode (3) of pretest scores of achievement in pairs of equations are almost equal. The indices of skewness (-0.09) and kurtosis (-0.49) indicate slightly negatively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.23), and that between kurtosis and its standard error (0.66) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3) , mean (3.51), median (3), and mode (3) of pretest scores of achievement in pairs of equations are almost equal. The indices of skewness (0.19) and kurtosis (-0.66) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.48), and that between kurtosis and its standard error (0.87) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4), mean (3.5), median (3.5), and mode (4) of pretest scores of achievement in pairs of equations are almost equal. The indices of skewness (0.13) and kurtosis (-0.44) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.35), and that between kurtosis and its standard error (0.59) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of achievement in pairs of equations. The results are given in Table 49.

Table 49

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Achievement in Pairs of Equations of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.96	37	0.56	3	147
	G2	0.95	39			
Control	G3	0.96	37			
	G4	0.95	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of achievement in pairs of equations for all groups. Levene's test of homogeneity suggest that the variances of pretest scores of achievement in pairs of equations of the groups were equal, [F (3, 147) =0.56, p>.05]. Therefore, pretest scores of achievement in pairs of equations of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of achievement in pairs of equations of the experimental and control groups. Results are in Appendix N3.

To verify the match between the groups by achievement in pairs of equations before treatment, ANOVA was performed on pretest scores of achievement in pairs of equations of experimental and control groups. The results are shown in Table 50.

Table 50

Comparison of Mean Pretest Scores of Achievement in Pairs of Equations in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	3.766	3	1.26	0.42
Error	434.631	147	2.96	
Total	438.397	150		

Table 50, shows that there is no significant difference between the mean pretest scores of achievement in pairs of equations of the four groups [F (3, 147) = 0.42, p>.05]. Hence as per the data, pretest scores of achievement in pairs of equations of the four groups were normally distributed, and the means of groups were shown no significant difference.

Distribution of pretest scores of self-efficacy for learning systems of linear equations among students in experimental and control groups.

Statistical indices of distribution of pretest scores of self-efficacy for learning systems of linear equations for the experimental and control groups are given in Table 51.

Table 51

Statistical Indices of Distributions of Pretest Scores of Self-Efficacy for Learning Systems of Linear Equations in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	13.57	13	12	3.36	0.04	0.39	0.09	-1.20	0.76	-1.58
G2	39	13.31	13	12	3.79	0.11	0.38	0.30	-0.63	0.74	-0.85
G3	37	12.92	13	13	3.56	0.07	0.39	0.18	0.20	0.76	0.26
G4	38	14.79	14.5	14	4.14	0.35	0.38	0.92	0.01	0.75	0.01

Table 51 shows that, in the experimental group 1 (G1), mean (13.57), median (13), and mode (12) of pretest scores of self-efficacy for learning systems of linear equations are almost equal. The indices of skewness (0.04) and kurtosis (-1.2) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.09), and that between kurtosis and its standard error (1.58) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2) , mean (13.31), median (13), and mode (12) of pretest scores of self-efficacy for learning systems of linear equations are almost equal. The indices of skewness (0.11) and kurtosis (-0.63) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.3), and that between kurtosis and its standard error (0.85) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3) , mean (12.92), median (13), and mode (13) of pretest scores of self-efficacy for learning systems of linear equations are almost equal. The indices of skewness (0.07) and kurtosis (0.2) indicate slightly positively skewed and leptokurtic distribution. The ratios between skewness and its standard error (0.18), and that between kurtosis and its standard error (0.26) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4) , mean (14.79), median (14.5), and mode (14) of pretest scores of self-efficacy for learning systems of linear equations are almost equal. The indices of skewness (0.35) and kurtosis (0.01) indicate slightly positively skewed and leptokurtic distribution. The ratios between skewness and its standard error (0.92), and that between kurtosis and its standard error (0.01) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of self-efficacy for learning systems of linear equations. The results are given in Table 52.

Table 52

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Self-efficacy for Learning Systems of Linear Equations of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.94	37	0.32	3	147
	G2	0.97	39			
Control	G3	0.98	37			
	G4	0.97	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of self-efficacy for learning systems of linear equations for all groups. Levene's test of homogeneity suggest that the variances of pretest scores of self-efficacy for learning systems of linear equations of the groups were equal, [F (3, 147) =0.32, p>.05]. Therefore, pretest scores of self-efficacy for learning systems of linear equations of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of self-efficacy for learning systems of linear equations of the experimental and control groups. Results are in Appendix N4.

To verify the match between the groups by self-efficacy for learning systems of linear equations before treatment, ANOVA was performed on pretest scores of self-efficacy for learning systems of linear equations of experimental and control groups. The results are shown in Table 53.

Table 53

Comparison of Mean Pretest Scores of Self-Efficacy for Learning Systems of Linear Equations in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	73.94	3	24.65	
Error	2042.46	147	13.89	1.77
Total	2116.40	150		

Table 53 shows that there is no significant difference between the mean pretest scores of self-efficacy for learning systems of linear equations of the four groups [F (3, 147) =1.77, p>.05]. Hence as per the data, pretest scores of self-efficacy for learning systems of linear equations of the four groups were normally distributed, and the means of groups were shown no significant difference.

Distribution of pretest scores of self-efficacy for learning mathematics among students in experimental and control groups.

Statistical indices of distribution of pretest scores of self-efficacy for learning mathematics for the experimental and control groups are given in Table 54.

Table 54

Statistical Indices of Distributions of Pretest Scores of Self-Efficacy for Learning Mathematics in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	64.00	63	66	9.60	0.29	0.39	0.75	-0.14	0.76	-0.19
G2	39	61.28	63	63	11.84	-0.35	0.38	-0.93	0.57	0.74	0.77
G3	37	60.16	61	63	9.45	0.13	0.39	0.34	-0.45	0.76	-0.59
G4	38	59.13	58.5	62	11.52	0.31	0.38	0.80	-0.44	0.75	-0.59

Table 54 shows that, in the experimental group 1 (G1), mean (64), median (63), and mode (66) of pretest scores of self-efficacy for learning mathematics are almost equal. The indices of skewness (0.29) and kurtosis (-0.14) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.75), and that between kurtosis and its standard error (0.19) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2), mean (61.28), median (63), and mode (63) of pretest scores of self-efficacy for learning mathematics are almost equal. The indices of skewness (-0.35) and kurtosis (0.57) indicate slightly negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (0.93), and that between kurtosis and its standard error (0.77) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3), mean (60.16), median (61), and mode (63) of pretest scores of self-efficacy for learning mathematics are almost equal. The indices of skewness (0.13) and kurtosis (-0.45) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.34), and that between kurtosis and its standard error (0.59) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4), mean (59.13), median (58.5), and mode (62) of pretest scores of self-efficacy for learning mathematics are almost equal. The indices of skewness (0.31) and kurtosis (-0.44) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.8), and that between kurtosis and its standard error (0.59) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro-Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of self-efficacy for learning mathematics. The results are given in Table 55.

Table 55

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity forPretest Scores of Self-Efficacy for Learning Mathematics of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.98	37	0.95	3	147
	G2	0.98	39			
Control	G3	0.98	37			
	G4	0.97	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of self-efficacy for learning mathematics for all groups. Levene's test of homogeneity suggests that the variances of pretest scores of self-efficacy for learning mathematics of the groups were equal, [F (3, 147) =0.95, p>.05]. Therefore, pretest scores of self-efficacy for learning mathematics of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of self-efficacy for learning mathematics of the experimental and control groups. Results are in Appendix N5.

To verify the match between the groups by self-efficacy for learning mathematics before treatment, ANOVA was performed on pretest scores of self-efficacy for learning mathematics of experimental and control groups. The results are shown in Table 56.

Table 56

Comparison of Mean Pretest Scores of Self-Efficacy for Learning Mathematics in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	492.08	3	164.03	1.44
Error	16769.27	147	114.08	
Total	17261.35	150		

Table 56 shows that there is no significant difference between the mean pretest scores of self-efficacy for learning mathematics of the four groups [F (3, 147) =1.44, p>.05]. Hence, as per the data, pretest scores of self-efficacy for learning mathematics of the four groups were normally distributed, and the means of groups were shown no significant difference.

Distribution pretest scores of task value of learning mathematics among students in experimental and control groups.

Statistical indices of distribution of pretest scores of task value of learning mathematics for the experimental and control groups are given in Table 57.

Table 57

Statistical Indices of Distributions of Pretest Scores of Task Value of Learning Mathematics in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	46.70	46	46	7.55	-0.79	0.39	-2.02	1.09	0.76	1.43
G2	39	47.64	48	44	6.65	-0.32	0.38	-0.86	-0.52	0.74	-0.70
G3	37	47.89	49	44	6.14	-1.16	0.39	-2.98	3.17	0.76	4.18
G4	38	48.53	49	48	5.76	-0.73	0.38	-1.89	0.57	0.75	0.76

Table 57 shows that, in the experimental group 1 (G1), mean (46.7), median (46), and mode (46) of pretest scores of task value of learning mathematics are almost equal. The indices of skewness (-0.79) and kurtosis (1.09) indicate slightly negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (2.02), greater than 1.96, and that between kurtosis and its standard error (1.43) is less than 1.96, indicating that this distribution deviate from normality.

In the experimental group 2 (G2), mean (47.64), median (48), and mode (44) of pretest scores of task value of learning mathematics are almost equal. The indices of skewness (-0.32) and kurtosis (-0.52) indicate slightly negatively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.86), and that between kurtosis and its standard error (0.7) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3), mean (47.89), median (49), and mode (44) of pretest scores of task value of learning mathematics are almost equal. The indices of skewness (-1.16) and kurtosis (3.17) indicate negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (2.98), and that between kurtosis and its standard error (4.18) are greater than 1.96, indicating that this distribution significantly deviates from normality.

In the control group 2 (G4), mean (48.53), median (49), and mode (48) of pretest scores of task value of learning mathematics are almost equal. The indices of skewness (-0.73) and kurtosis (0.57) indicate slightly negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (1.89), and that between kurtosis and its standard error (0.76) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of task value of learning mathematics. The results are given in Table 58.

Table 58

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Task Value of Learning Mathematics of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.95	37	1.27	3	147
	G2	0.96	39			
Control	G3	0.92**	37			
	G4	0.96	38			

** p<.01

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of task value of learning mathematics for all groups except control group 1. Levene's test of homogeneity suggest that the variances of pretest scores of task value of learning mathematics of the groups were equal, [F (3, 147) =1.27, p>.05]. Therefore, pretest scores of task value of learning mathematics of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of task value of learning mathematics of the experimental and control groups. Results are in Appendix N6.

To verify the match between the groups by task value of learning mathematics before treatment, ANOVA was performed on pretest scores of task value of learning mathematics of experimental and control groups. The results are shown in Table 59.

Table 59

Comparison of Mean Pretest Scores of Task Value of Learning Mathematics in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	64.24	3	21.41	0.50
Error	6313.75	147	42.95	
Total	6377.99	150		

Table 59 shows that there is no significant difference between the mean pretest scores of task value of learning mathematics of the four groups [F (3, 147) =0.50, p>.05]. Hence as per the data, pretest scores of task value of learning mathematics of the groups were normally distributed, except third group (control group 1) and the means of groups were shown no significant difference.

Distribution of pretest scores of self-regulated learning among students in experimental and control groups.

Statistical indices of distribution of pretest scores of self-regulated learning for the experimental and control groups are given in Table 60.

Table 60

Statistical Indices of the Distribution of Pretest Scores of Self-Regulated Learning in Experimental and Control Groups

Group	N	M	Med	Mode	SD	Skewness			Kurtosis		
						Statistics	SE	Statistics/SE	Statistics	SE	Statistics/SE
G1	37	119.43	118.0	114	18.43	0.23	0.39	0.585	-0.98	0.76	-1.29
G2	39	123.15	122.0	121	19.17	-0.32	0.38	-0.844	0.18	0.74	0.24
G3	37	122.11	121.0	124	20.56	0.56	0.39	1.430	-0.13	0.76	-0.17
G4	38	123.82	124.0	124	17.08	-0.17	0.38	-0.431	-0.66	0.75	-0.89

In the experimental group 1 (G1), mean (119.43), median (118), and mode (114) of pretest scores of self-regulated learning are almost equal. The indices of skewness (0.23) and kurtosis (-0.98) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.58), and that between kurtosis and its standard error (1.29) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the experimental group 2 (G2), mean (123.15), median (122), and mode (121) of pretest scores of self-regulated learning are almost equal. The indices of skewness (-0.32) and kurtosis (0.18) indicate slightly negatively skewed and leptokurtic distribution. The ratios between skewness and its standard error (0.84), and that between kurtosis and its standard error (0.24) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 1 (G3), mean (122.11), median (121), and mode (124) of pretest scores of self-regulated learning are almost equal. The indices of skewness (0.56) and kurtosis (-0.13) indicate slightly positively skewed and platykurtic distribution. The ratios between skewness and its standard error (1.43), and that between kurtosis and its standard error (0.17) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

In the control group 2 (G4), mean (123.82), median (124), and mode (124) of pretest scores of self-regulated learning for are almost equal. The indices of skewness (-0.17) and kurtosis (-0.66) indicate slightly negatively skewed and platykurtic distribution. The ratios between skewness and its standard error (0.43), and that between kurtosis and its standard error (0.89) are less than 1.96, indicating that this distribution does not significantly deviate from normality.

Shapiro- Wilk test of normality and Levene's test of homogeneity were performed to check the normality and homogeneity of the distribution of pretest scores of self-regulated learning. The results are given in Table 61.

Table 61

Results of Shapiro-Wilk Test of Normality and Levene's Test of Homogeneity for Pretest Scores of Self-Regulated Learning among Students of Experimental and Control Groups

Groups		Shapiro-Wilk test of normality		Levene's test of homogeneity		
		Statistic	df	Statistic	df1	df2
Experimental	G1	0.96	37	0.29	3	147
	G2	0.98	39			
Control	G3	0.96	37			
	G4	0.98	38			

Shapiro-Wilk test of normality suggests reasonable assumption of normality for the distribution of pretest scores of self-regulated learning for all groups. Levene's test of homogeneity suggest that the variances of scores of self-regulated learning of the groups were equal, [F (3, 147) =0.29, p>.05]. Therefore, pretest scores of self-regulated learning of the experimental and control groups are normal and the variances of this are homogeneous among the groups.

Further judgment of normality was performed using histograms of the distribution with normal curve for pretest scores of self-regulated learning of the experimental and control groups. Results are in Appendix N7.

To verify the match between the groups by self-regulated learning before treatment, ANOVA was performed on pretest scores of self-regulated learning of experimental and control groups. The results are shown in Table 62.

Table 62

Comparison of Mean Pretest Scores of Self-Regulated Learning in Experimental and Control Groups

Source	Type III Sum of Squares	df	Mean Square	F
Group	418.06	3	139.35	0.39
Error	52217.44	147	355.22	
Total	52635.50	150		

Table 62 shows that there is no significant difference between the mean pretest scores of self-regulated learning of the four groups [F (3, 147) =0.39, p>.05]. Hence as per the data, pretest scores of self-regulated learning of the four groups were normally distributed, and the means of groups were shown no significant difference.

Effect of Self-Regulated Learning Strategy Instruction on Dependent Variables

ANOVAs were performed to find out the effect of SRL strategy instruction on achievement in fractions, and pairs of equations, self-efficacy for learning fractions, for learning systems of linear equations, and for learning mathematics, task value of learning mathematics and students' use of self-regulated learning in mathematics. The results of after intervention status in each dependent variable are presented under distinct headings.

Effect of Self-regulated Learning Strategy Instruction on Achievement in Fraction

The effect of SRL strategy instruction on students' achievement in fractions, was studied by comparing the mean scores of achievement of experimental and control groups after intervention. The investigation contained testing the significance of difference between means of posttest scores of experimental and control groups, and calculating the effect size.

Effects were studied by comparing experimental groups(combined two experimental groups irrespective of teacher) with control groups (combined two control groups irrespective of teacher)and by comparing experimental groups, taught by experimenter against the control group taught by the experimenter, as well as experimental group taught by their mathematics teacher against the control group taught by the same teacher.

ANOVA was performed to find out the treatment effect on achievement in fractions among the experimental and control group irrespective of teacher. The results are given in Table 63.

Table 63

Main and Interaction Effect of SRL Strategy Instruction and Teacher on Achievement in Fractions

Source	Type III Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	220.30	1	220.30	29.53**	0.17
Teacher	12.07	1	12.07	1.62	
Treatment* Teacher	7.42	1	7.42	0.99	
Error	1096.68	147	7.46		
Corrected Total	1338.97	150			

** p<.01.

As shown in Table 63 , effect of treatment on achievement in fractions is significant [F, (1, 147) =29.53, p<.01; η_p^2 =.17] (experimental group M=9.84, SD=2.89; control group M=7.41, SD=2.57), but it does not vary by whether the experimenter taught the mathematics lessons or their class teacher taught that [F, (1, 147) =1.62, p>.05] (content instruction by experimenter; M=8.34, SD=2.90; Content instruction by teacher; M=8.92, SD=3.06); also it shows that there is no significant interaction effect between treatment and teacher [F, (1, 147) =0.99, p>.05]. Partial eta squared (η_p^2 =.17) shows that the effect of SRL strategy instruction on achievement in fractions of standard nine students is of medium size.

The mean scores of treatment groups and control groups were compared using *t* test to find out if there is significant effect of treatment among groups. The results are given in Table 64.

Table 64

Comparison of Mean Scores of Achievements in Fractions of Experimental and Control Groups

Treatment	N	Mean	Std. Deviation	t
Experimental Groups	76	9.84	2.89	5.46**
Control Groups	75	7.41	2.57	

** p<.01.

As shown in Table 64, mean scores of achievement in fractions differ significantly between students who received self-regulated learning strategy instruction (M=9.84, SD=2.89) and those who did not (M=7.41, SD=2.57, t=5.46, p<.01).

The mean scores of treatment groups and control groups were compared using *t* test to find out if there is significant difference in two treatment groups and in two control groups. The results are given in Table 65.

Table 65

Comparison of Mean Scores of Achievement in Fractions in Experimental and Control Groups to Reveal Teacher Effect If Any

Treatment	Content Instruction	N	Mean	Std. Deviation	*t*
Experimental treatment	Experimenter	37	9.32	3.019	1.53
	Class Teacher	39	10.33	2.708	
Control treatment	Experimenter	37	7.35	2.44	0.21
	Class Teacher	38	7.47	2.73	

As shown in Table 65 the comparison of means using *t* test shows that there is no significant difference between achievement in fractions of the two treatment groups, where content instruction done by experimenter (M=9.32, SD=3.02) and content instruction done by their teacher (M=10.33 , SD=2.71, t=1.53, p>.05). And it also shows that there is no significant difference between achievement in fractions of the two control groups (M=7.35, SD=2.44 & M=7.47, SD=2.73, t=0.21, p>.05) where mathematics instruction is handled by experimenter and class teacher respectively. It means the groups were not differed in their achievement in fractions by the teacher.

The mean scores of treatment group taught by the experimenter was compared to the respective control group and the mean scores of treatment group taught by the teacher was compared to the respective control group, using *t* test to find out if there is significant difference in the two groups by treatment. The results are given in Table 66.

Table 66

Comparison of Mean Scores of Achievement in Fractions in Between Treatment and Control Groups by the Levels of Content Instructor (Teacher/ Experimenter)

Content Instruction	Treatment	N	Mean	Std. Deviation	*t*
Experimenter	Experiment	37	9.32	3.02	3.09**
	Control treatment (control group 1)	37	7.35	2.44	
Class Teacher	Experiment	39	10.33	2.71	4.61**
	Control treatment (control group 2)	38	7.47	2.73	

** p<.01.

As shown in Table 66, the comparison of means using *t* test shows that there is significant difference between achievement in fractions of the treatment group, and control group taught by experimenter. That is the mean score of achievement fractions of treatment group, where content instruction done by experimenter (M=9.32, SD=3.02) is significantly higher than that of the control group, where also the content instruction was done by experimenter (M=7.35, SD=2.44, t=3.09, p<.01).

Table 66 also shows that there is significant difference between achievement in fractions of the treatment group and control group taught by teacher. That is the mean score of achievement fractions of treatment group, where content instruction done by class teacher (M=10.33, SD=2.71) is significantly higher than that of the control group, where also the content instruction was done by class teacher (M=7.47, SD=2.73, t=4.61, p<.01). It means, the experimental groups were significantly higher in their achievement in fractions as they got SRL strategy instruction.

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions, a line graph is plotted with error bars using mean scores of achievement in fractions of experimental and control group in Figure 20.

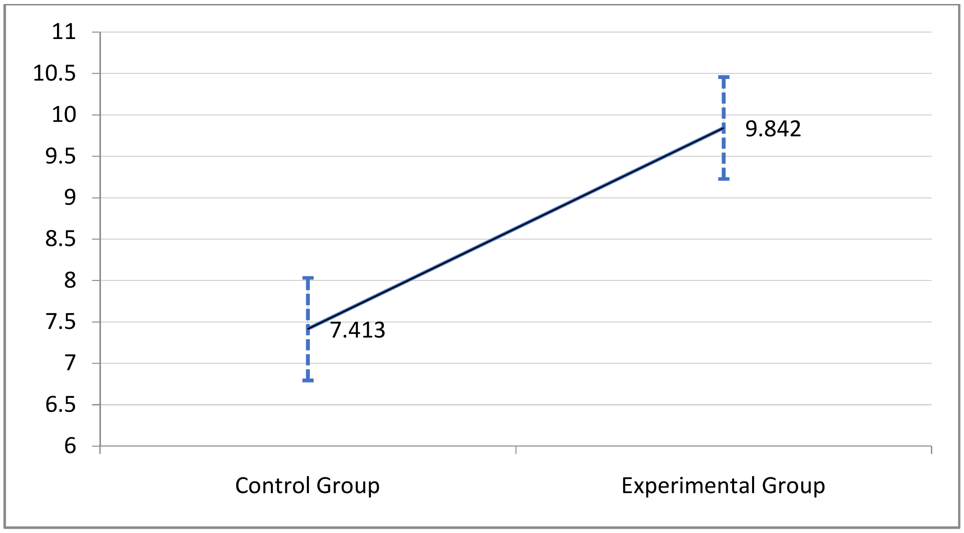

Figure 20. Line graph with error bars of achievement in fractions of experimental and control groups

The line graph (Figure 20) illustrates that the achievement in fractions among experimental group is higher than that of control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in Fractions by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics, two-way ANOVAs were performed. Results were given in the following sections.

Effect of self-regulated learning strategy instruction on achievement in Fractions by gender.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students by their gender, two-way ANOVA was performed using posttest scores of achievement in fractions. Results are given in Table 67.

Table 67

Effect of SRL Strategy Instruction on Achievement in Fractions among Standard Nine Students by Gender

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	221.44	1	221.44	30.27**	.171
Gender	30.27	1	30.27	4.14*	.027
Treatment * Gender	10.74	1	10.74	1.469	
Error	1075.22	147	7.31		
Total	1338.97	150			

** $p<.01$, * $p<.05$

As shown in Table 67, no significant interaction is observed between SRL strategy instruction and gender [$F(1, 147) = 1.47$, $p > .05$] among standard nine students. Effect of SRL strategy instruction on achievement in fractions is true for both boys and girls, that is both boys and girls in the experimental group (Boys: M=9.64, SD=3.4 and Girls: M=10, SD=2.46) improved their achievement in fractions than those in the control group (Boys: M=6.67, SD=2.12 and Girls: M=8.10, SD=2.78).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions by students' gender, a line graph is plotted with error bars using mean scores of achievement in fractions of boys and girls in experimental and control groups, and given in Figure 21.

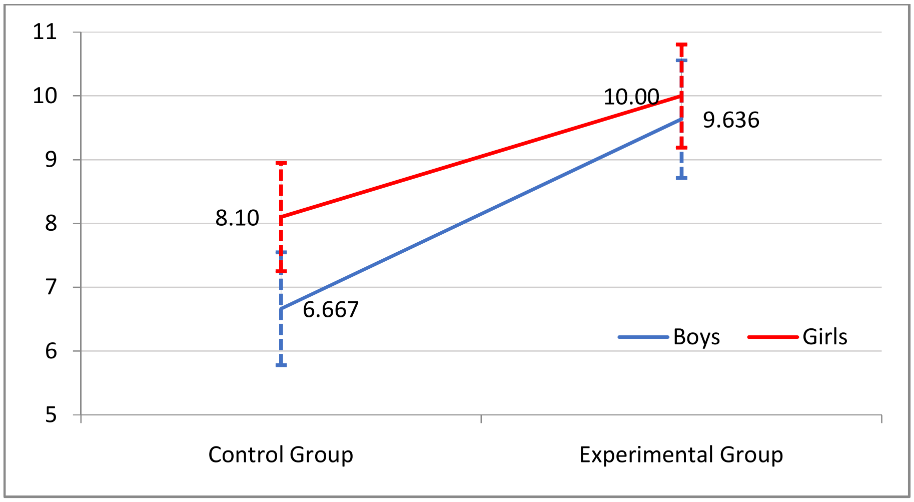

Figure 21. Line graph with error bars of achievement in fractions of the boys and girls in the experimental and control groups

The line graph (Figure 21) illustrates that the achievement in fractions of boys and girls among experimental group is higher than that of control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in fractions by their level of intelligence.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of achievement in fractions. Results are given in Table 68.

Table 68

Effect of SRL Strategy Instruction on Achievement in Fractions among Standard Nine Students by Their Level of Intelligence

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	222.70	1	222.70	34.88**	0.19
Intelligence	177.29	1	177.29	27.76**	0.16
Treatment * Intelligence	0.21	1	0.21	0.03	
Error	938.69	147	6.39		
Total	1338.97	150			

** p<.01.

As shown in Table 68, no significant interaction is observed between SRL strategy instruction and intelligence [F (1, 147) =0.03, *p*>.05] among standard nine students. Effect of SRL strategy instruction on achievement in fraction is true for students both with high and low nonverbal intelligence, that is students both with high and low nonverbal intelligence in the experimental group (High: M=10.88, SD=2.86 and Low: M=8.63, SD=2.45) improved their achievement in fractions than those in the control group (High: M=8.37, SD=2.5 and Low: M=8.10, SD=2.78).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions by students' level of intelligence, a line graph is plotted with error bars using mean scores of achievement in fractions of students with high and low nonverbal intelligence in experimental and control groups, and is given in Figure 22.

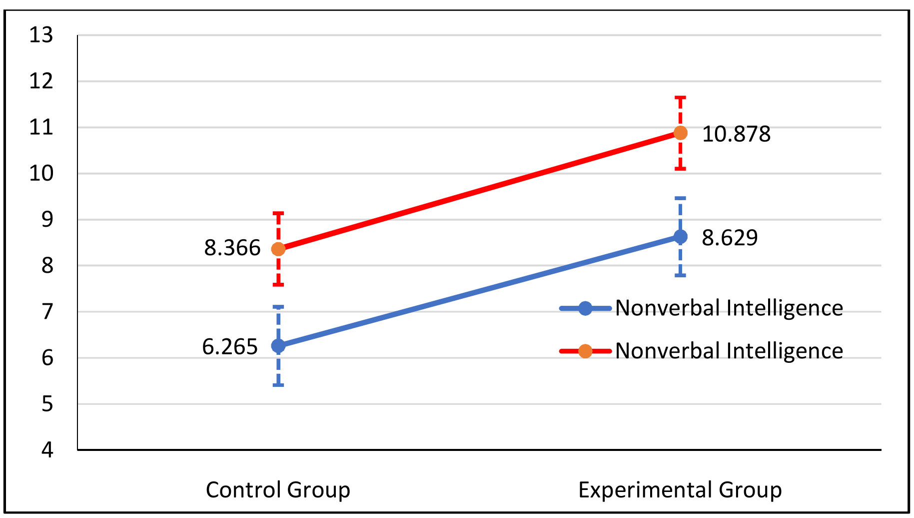

Figure 22. Line graph with error bars of achievement in fractions of students with high and low nonverbal intelligence in the experimental and control groups

The line graph (Figure 22) illustrates that the achievement in fractions of students with high and low nonverbal intelligence in experimental group is higher than that of control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in fractions by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using posttest scores of achievement in fractions. Results are given in Table 69.

Table 69

Effect of SRL Strategy Instruction on Achievement in Fractions among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	279.71	1	279.71	46.45**	0.24
Level of prerequisites in mathematics	231.02	1	231.02	38.36**	0.21
Treatment * Level of prerequisites in mathematics	0.24	1	0.24	0.04	
Error	885.18	147	6.02		
Total	1338.97	150			

** p<.01.

As shown in Table 69, no significant interaction is observed between SRL strategy instruction and prerequisites in mathematics [F (1, 147) =0.24, p>.05] among standard nine students. Effect of SRL strategy instruction on achievement in fractions is true for students both high and low prerequisites in mathematics, that is students both high and low prerequisites in mathematics in the experimental group (High: M=11.18, SD=2.81 and Low: M=8.76, SD=2.5) improved their achievement in fractions than those in the control group (High: M=8.51, SD=2.42 and Low: M=5.94, SD=1.98).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions by students' level of prerequisites, a line graph is plotted with error bars using mean scores of achievement in fractions of students with high and low prerequisites in mathematics in experimental and control groups, and is given in Figure 23.

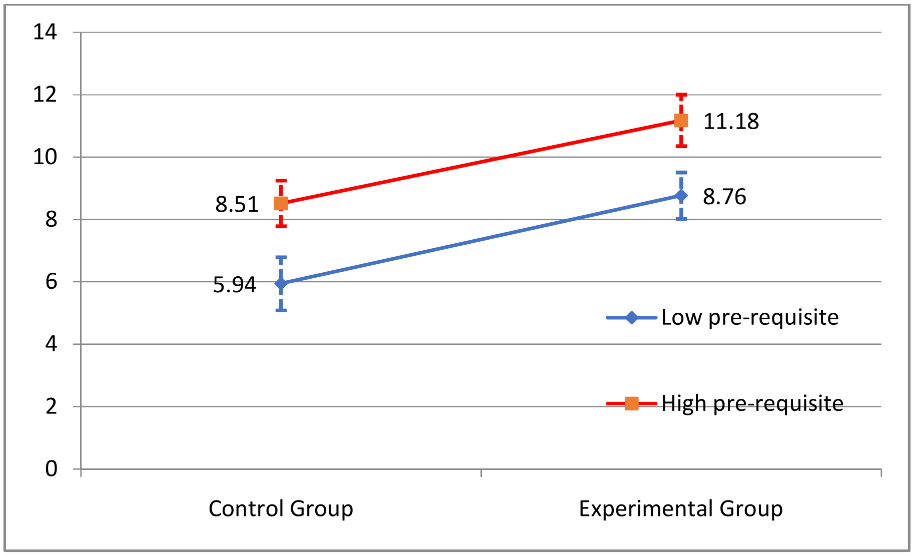

Figure 23. Line graph with error bars of achievement in fractions of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 23) illustrates that the achievement in fractions of students with high and low prerequisites in mathematics among experimental group is higher than that of corresponding control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in fractions by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of achievement in fractions. Results are given in Table 70.

Table 70

Effect of SRL Strategy Instruction on Achievement in Fractions among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	242.72	1	242.72	34.87**	0.19
Ability Conception	92.76	1	92.76	13.33**	0.08
Treatment * Ability Conception	0.49	1	0.49	0.07	
Error	1023.12	147	6.96		
Total	1338.97	150			

** p<.01.

As shown in Table 70, no significant interaction is observed between SRL strategy instruction and their mathematical ability conception [F (1, 147) =0.07, $p>.05$] among standard nine students. Effect of SRL strategy instruction on achievement in fractions is true for students both with incremental and entity beliefs in mathematics, that is students both with incremental and entity beliefs in mathematics in the experimental group (Incremental: M=10.63, SD=2.96 and Entity: M=9.17, SD=2.68) improved their achievement in fractions than those in the control group (Incremental: M=8.20, SD=2.36 and Entity: M=6.51, SD=2.55).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions by students' mathematical ability conception, a line graph is plotted with error bars using mean scores of achievement in fractions of students with incremental and entity beliefs in mathematics in experimental and control groups, and is given in Figure 24.

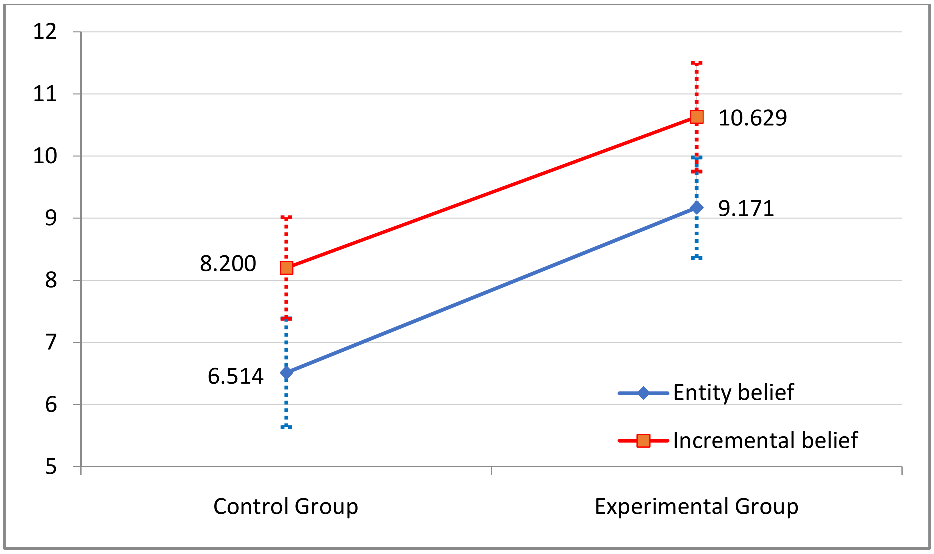

Figure 24. Line graph with error bars of achievement in fractions of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 31) illustrates that the achievement in fractions of students with incremental and entity beliefs in mathematics among experimental group is higher than that of the corresponding control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in fractions by their goal orientations in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in fractions among standard nine students by their goal orientations in mathematics, two-way ANOVA was performed using posttest scores of achievement in fractions. Results are given in Table 71.

Table 71

Effect of SRL Strategy Instruction on Achievement in Fractions among Standard Nine Students by Their Goal Orientations in Mathematics

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	213.43	1	213.43	28.15**	.16
Goal orientation in mathematics	1.60	1	1.60	0.21	
Treatment * Goal orientation in mathematics	0.00	1	0.00	0.00	
Error	1114.70	147	7.58		
Total	1338.97	150			

** p<.01.

As shown in Table 71, no significant interaction is observed between SRL strategy instruction and their goal orientation in mathematics [F (1, 147) =0, *p*>.05] among standard nine students. Effect of SRL strategy instruction on achievement in fractions is true for students both with mastery and performance approach goal orientation in mathematics, that is students both with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental group (Mastery Goal: M=9.93, SD=2.92 and Performance approach Goal: M=9.73, SD=2.89) improved their achievement in fractions than those in the control group (Mastery Goal: M=7.49, SD=2.69 and Performance approach Goal: M=7.27, SD=2.39).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in fractions by the students' goal orientation in mathematics, a line graph is plotted with error bars using mean scores of achievement in fractions of students with mastery and performance approach goal orientations in mathematics in experimental and control groups, and is given in Figure 25.

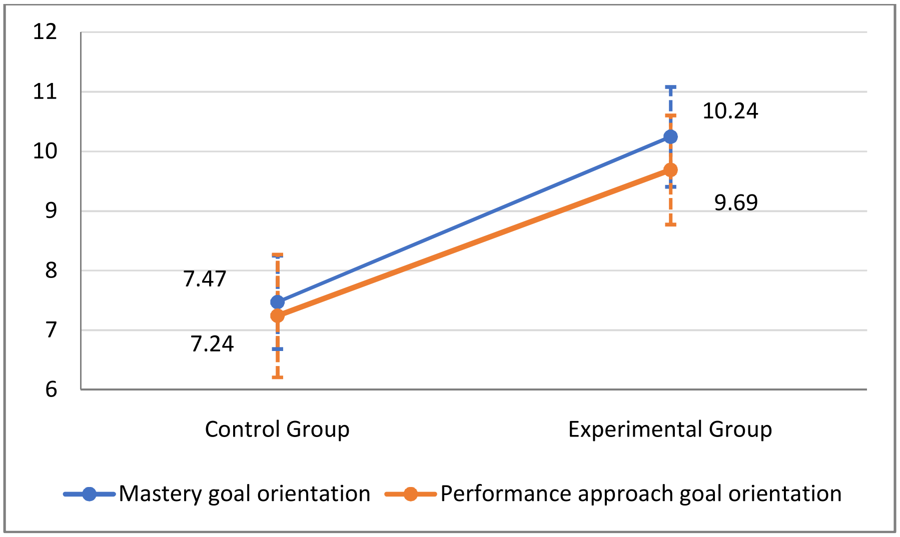

Figure 25. Line graph with error bars of achievement in fractions of students with mastery and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 25) illustrates that the achievement in fractions of students with mastery and performance approach goal orientations in mathematics among experimental group is higher than that of the corresponding control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Self-Efficacy for Learning Fractions

To check the effectiveness of SRL strategy instruction on Self-efficacy for learning fractions among standard nine students, ANOVA was performed using posttest scores of self-efficacy for learning fractions. Result of ANOVA is given in Table 72.

Table 72

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students

Source of variance	Sum of Squares	df	Mean Square	*F*
Treatment	157.20	1	157.20	1.27
Error	18410.14	149	123.56	
Total	18567.34	150		

As shown in Table 72, no significant effect of SRL strategy instruction has been observed on self-efficacy for learning fractions [F (1, 149) =1.27, p>.05]among standard nine students. That is, mean score of the self-efficacy for learning fractions in the experimental group (M=55.95, SD=10.68) do not differ from that in the control group (M=53.91, SD=11.54).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions, a line graph is plotted with error bars using mean scores of self-efficacy for learning fractions of experimental and control group in Figure 26.

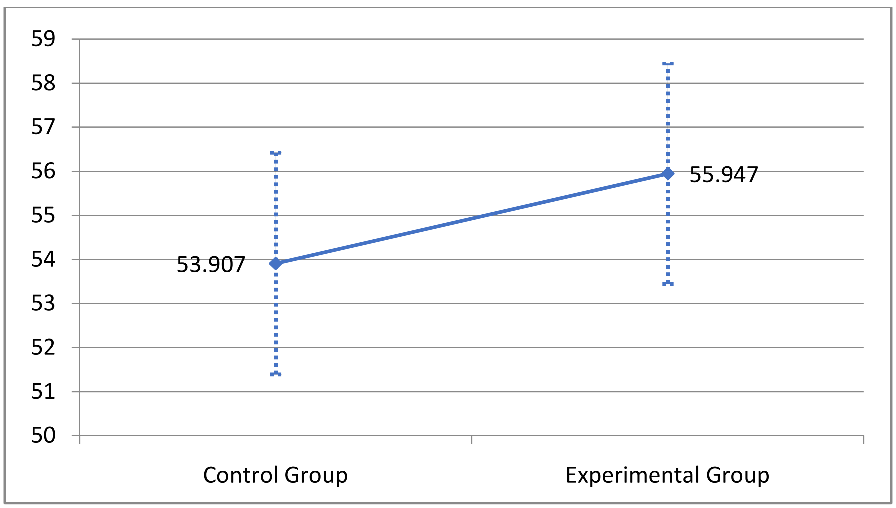

Figure 26. Line graph with error bars of self-efficacy for learning fractions of experimental and control groups

The line graph (Figure 26) illustrates that the self-efficacy for learning fraction among experimental group is higher than that of control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning Fractions by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' Self-efficacy for learning fractions among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on self-efficacy for learning fractions by their gender.

To check the effectiveness of SRL strategy instruction on Self-efficacy for learning fractions among standard nine students by gender, two-way ANOVA was performed using posttest scores of self-efficacy for learning fractions. Results are given in Table 73.

Table 73

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students by Gender

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	157.60	1	157.60	1.35	
Gender	952.95	1	952.95	8.17**	0.05
Treatment * Gender	301.24	1	301.24	2.58	
Error	17154.54	147	116.70		
Total	18567.34	150			

** p<.01.

As shown in Table 73, no significant interaction is observed between SRL strategy instruction and gender [F (1, 147) =2.58, *p*>.05] among standard nine students in their self-efficacy for learning fractions. Effect of SRL strategy instruction on self-efficacy for learning fractions is true for both boys and girls, that is both boys and girls in the experimental group (Boys: M=54.70, SD=11.89 and Girls: M=56.91, SD=9.69) do not differ in their self-efficacy for learning fractions from those in the control group (Boys: M=49.81, SD=11.54 and Girls: M=57.69, SD=10.29).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions by the students' gender, a line graph is plotted with error bars using mean score of self-efficacy for learning fractions of boys and girls in experimental and control groups, and is given in Figure 27.

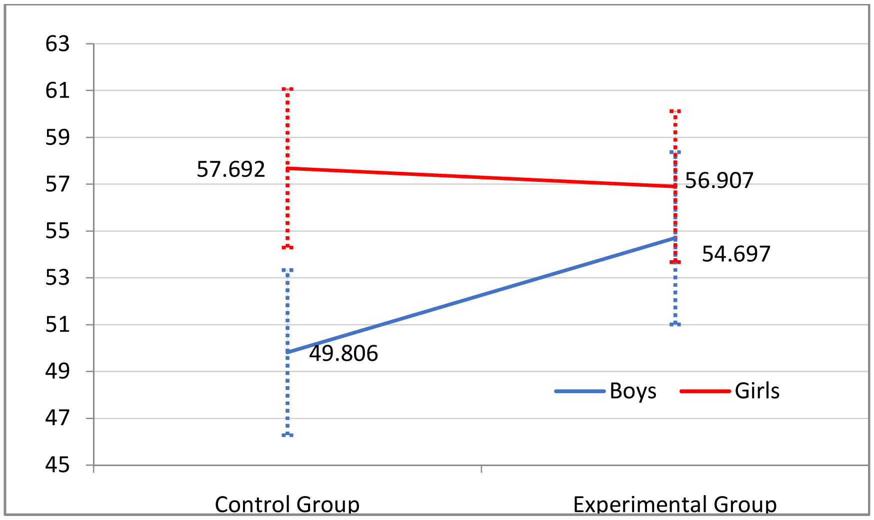

Figure 27. Line graph with error bars of self-efficacy for learning fractions of boys and girls in the experimental and control groups

The line graph (Figure 27) illustrates that the self-efficacy for learning fractions of boys and girls among experimental group is not different from control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on Self-efficacy for Learning Fractions by their level of intelligence

To check the effectiveness of SRL strategy instruction on self-efficacy for learning fractions among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of self-efficacy for learning fractions. Results are given in Table 74.

Table 74

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students by Their Level of Intelligence

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	174.97	1	174.97	1.52	
Intelligence	1502.06	1	1502.06	13.08**	0.08
Treatment * Intelligence	28.25	1	28.25	0.25	
Error	16882.97	147	114.85		
Total	18567.34	150			

** p<.01.

As shown in Table 74, no significant interaction is observed between SRL strategy instruction and intelligence [F (1, 147) =0.25, *p*>.05] among standard nine students in their self-efficacy for learning fractions. Effect of SRL strategy instruction on self-efficacy for learning fractions is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the experimental group (High: M=58.46, SD=8.64 and Low: M=53.00, SD=12.14) do not differ in their self-efficacy for learning fractions from those in the control group (High: M=57.17, SD=11.70 and Low: M=49.97, SD=10.16).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions by students' level of intelligence, a line graph is plotted with error bars using mean scores of self-efficacy for learning fractions of students with high and low nonverbal intelligence in experimental and control groups, and is given in Figure 28.

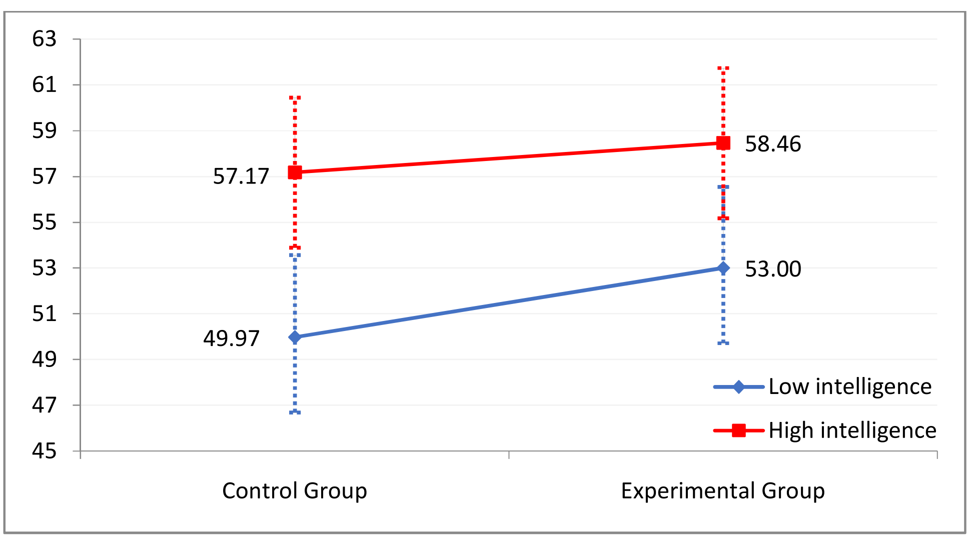

Figure 28. Line graph with error bars of self-efficacy for learning fractions of students with high and low nonverbal intelligence in the experimental and control groups.

The line graph (Figure 28) illustrates that the self-efficacy for learning fractions of students with high and low nonverbal intelligence among experimental group is not different from control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning fractions by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning fractions among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning fractions. Results are given in Table 75.

Table 75

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	339.46	1	339.46	3.13	
Level of prerequisites in mathematics	2394.05	1	2394.05	22.08**	0.13
Treatment * Level of prerequisites in mathematics	70.64	1	70.64	0.65	
Error	15935.29	147	108.40		
Total	18567.34	150			

** $p<.01$.

No significant interaction is observed between SRL strategy instruction and prerequisites in mathematics [$F(1, 147)=0.65$, $p>.05$] among standard nine students in their self-efficacy for learning fractions. Effect of SRL strategy instruction on self-efficacy for learning fractions is true for students both high and low prerequisites in mathematics, that is, students with high and low prerequisites in mathematics in the experimental group (High: M=61.15, SD=8.64 and Low: M=51.74, SD=10.4) not differ in their self-efficacy for learning fractions from those in the control group (High: M=56.74, SD=11.25 and Low: M=50.09, SD=10.96).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions by students' level of prerequisites, a line graph is plotted with error bars using mean scores of self-efficacy for learning fractions of students with high and low prerequisites in mathematics in experimental and control groups, and is given in Figure 29.

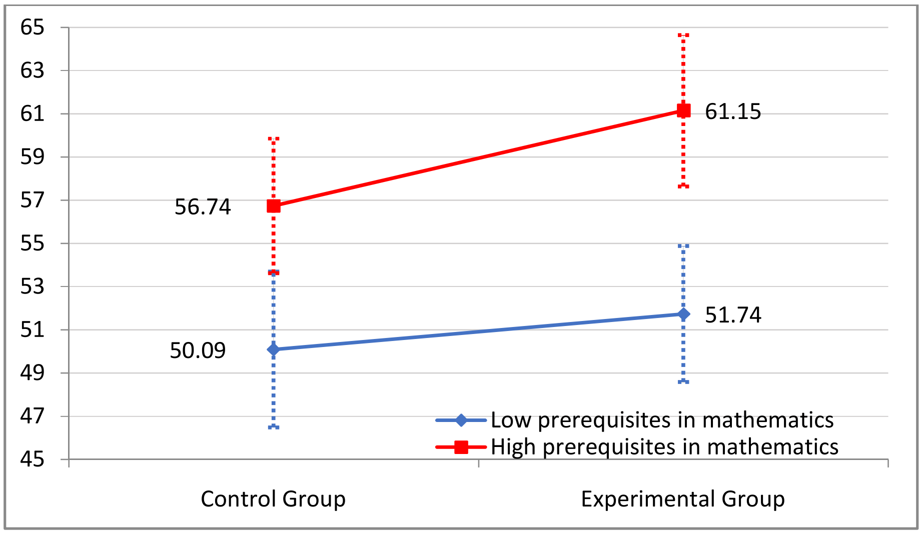

Figure 29. Line graph with error bars of self-efficacy for learning fractions of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 29) illustrates that the self-efficacy for learning fractions of students with high and low prerequisites in mathematics among experimental group is not different from control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning fractions by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on Self-efficacy for learning fractions among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of self-efficacy for learning fractions. Results are given in Table 76.

Table 76

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	226.47	1	226.47	1.96	
Ability Conception	1118.67	1	1118.67	9.69**	0.06
Treatment * Ability Conception	316.04	1	316.04	2.74	
Error	16968.58	147	115.43		
Total	18567.34	150			

** p<.01.

As shown in Table 76, no significant interaction is observed between SRL strategy instruction and mathematical ability conception [$F\ (1,\ 147) = 2.74$, $p > .05$] among standard nine students in their self-efficacy for learning fractions. Effect of SRL strategy instruction on self-efficacy for learning fractions is true for students both with incremental and entity beliefs in mathematics, that is students with incremental and entity beliefs in mathematics in the experimental group (Incremental: M=60.46, SD=8.94 and Entity: M=52.10, SD=10.63) not differ in their self-efficacy for learning fractions from those in the control group (Incremental: M=55.10, SD=12.47 and Entity: M=52.54, SD=10.38).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions by students' mathematical ability conception, a line graph is plotted with error bars using mean scores of self-efficacy for learning fractions of students with incremental and entity beliefs in mathematics in experimental and control groups, and is given in Figure 30.

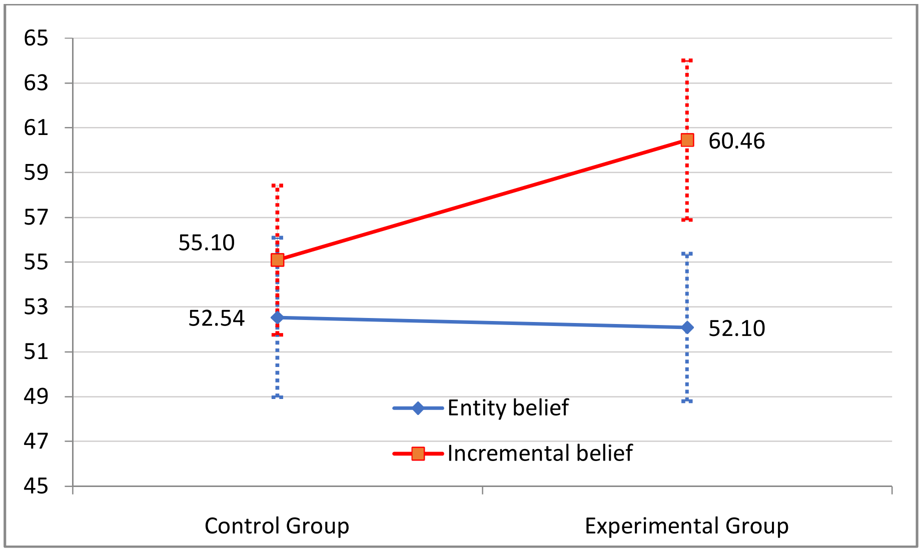

Figure 30. Line graph with error bars of self-efficacy for learning fractions of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 30) illustrates that the self-efficacy for learning fractions of students with incremental and entity beliefs in mathematics among experimental group is not different from control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning fractions by their goal orientations in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning fractions among standard nine students by their goal orientations in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning fractions. Results are given in Table 77.

Table 77

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Fractions among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*
Treatment	175.51	1	175.51	1.41
Goal orientation in mathematics	118.21	1	118.21	0.95
Treatment * Goal orientation in mathematics	0.32	1	0.32	0.00
Error	18291.92	147	124.43	
Total	18567.34	150		

As shown in Table 77, no significant interaction is observed between SRL strategy instruction and goal orientations in mathematics [F (1, 147) =0, p>.05] among standard nine students in their self-efficacy for learning fractions. Effect of SRL strategy instruction on self-efficacy for learning fractions is true for students both with mastery and performance approach goal orientation in mathematics, that is, students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental group (Mastery goal: M=56.70, SD=12.41 and Performance approach goal: M=54.97, SD=7.97) not differ in their self-efficacy for learning fractions from those in the control group (Mastery goal: M=54.57, SD=10.58 and Performance approach goal: M=52.65, SD=13.29).

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning fractions by the students' goal orientation in mathematics, a line graph is plotted with error bars using mean scores of self-efficacy for learning fractions of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental and control groups, and is given in Figure 31.

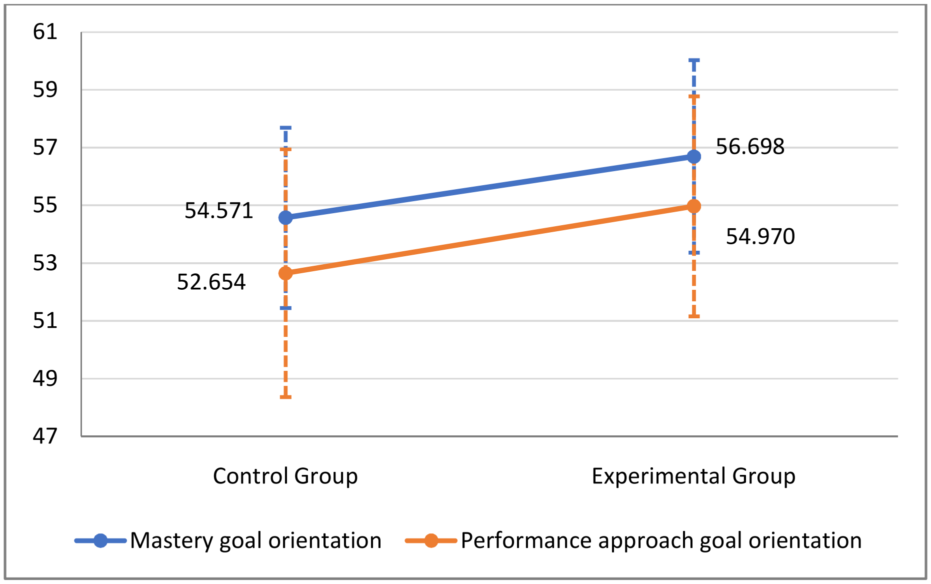

Figure 31. Line graph with error bars of self-efficacy for learning fractions of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 30) illustrates that the self-efficacy for learning fractions of students with mastery goal orientation, and performance approach goal orientation in mathematics among experimental group is not different from control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Achievement in Pairs of Equations

In this unit, there were two experimental groups, SRL strategy (Longer intervention) group, SRL strategy (Shorter intervention) group, and one control group. Teachers were interchanged in case of classroom instruction.

To analyze the effect of SRL strategy instruction on achievement in pairs of equations, ANOVA was performed to find out the treatment effect on achievement in pairs of equation irrespective of teacher. The results are given in Table 78.

Table 78

Effect of SRL Strategy Instruction and Teacher on Achievement in Pairs of Equations

Source	Type iii sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	96.635	2	48.318	4.25**	0.06
Teacher	0.009	1	0.009	0.01	
Treatment* Teacher	0	0	.	.	
Error	1670.93	147	11.367		
Total	1767.59	150			

** p<.01.

As shown in Table 78, effect of treatment on achievement in pairs of equations is significant [F, (2,147) =4.25, p<.01; η_p^2 =0.06], but effect of teacher is not significant [F, (1, 147) =.01, p>.05]; also, it shows that there is no significant interaction effect between treatment and teacher [F, (1, 147) =0, p>.05]. Partial eta squared (η_p^2 =.06) shows that the effect of SRL strategy instruction on achievement in pairs of equations of standard nine students is of small size.

The mean scores of treatment groups and control groups were compared to find out if there is significant effect of treatment among groups using *t* test. As there are two treatment group and one control group, each treatment group were compared each other.

Comparison of mean scores of achievement in pairs of equations between SRL strategy (longer intervention) and control group.

Achievement in pairs of equations of SRL strategy (Longer intervention) is compared to the control group. The results are given in Table 79.

Table 79

Comparison of Mean Scores of Achievement in Pairs of Equations among SRL Strategy (Longer Intervention) And Control Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Longer intervention)	76	10.09	3.12	2.51*
Control group	38	8.45	3.65	

*p<.05

As shown in Table 79, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of the SRL strategy (Longer intervention) (M=10.09, SD=3.12) is significantly higher than that of control group (M=8.45, SD=3.65, t=2.51, p<.05).

Comparison of mean scores of achievement in pairs of equations among SRL strategy (Shorter intervention) group and control group.

Achievement in pairs of equations of SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 80.

Table 80

Comparison of Mean Scores of Achievement in Pairs of Equations Between SRL Strategy (Shorter intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Shorter intervention)	37	8.54	3.53	0.11
Control group	38	8.45	3.65	

As shown in Table 80, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of the SRL strategy (Shorter intervention) group (M=8.54, SD=3.53) is not significantly different from that of the control group (M=8.45 , SD=3.65, t=0.11, p>.05).

Comparison of mean scores of achievement in pairs of equations among SRL strategy (Longer intervention) and SRL strategy (Shorter intervention) group,

Achievement in pairs of equations of SRL strategy (Longer intervention) group is compared to SRL strategy (Shorter intervention) group. The results are given in Table 81.

Table 81

Comparison of Mean Scores of Achievement in Pairs of Equations among SRL Strategy (Longer Intervention) Group and SRL Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Longer intervention)	76	10.09	3.12	2.38*
SRL strategy (Shorter intervention)	37	8.54	3.53	

*p<.05

As shown in Table 81, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of the SRL strategy (Longer intervention) group (M=10.09, SD=3.12) is significantly higher than that of SRL strategy (Shorter intervention) group (M=8.54, SD=3.53, t=2.38, p<.05).

Overall the three *t* test shows that the mean score of achievement in pairs of equations of the control group and SRL strategy (Shorter intervention) group is significantly lower than that of SRL strategy (Longer intervention).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations, a line graph is plotted with error bars using mean scores of achievement in pairs of equations of experimental groups and control group in Figure 32.

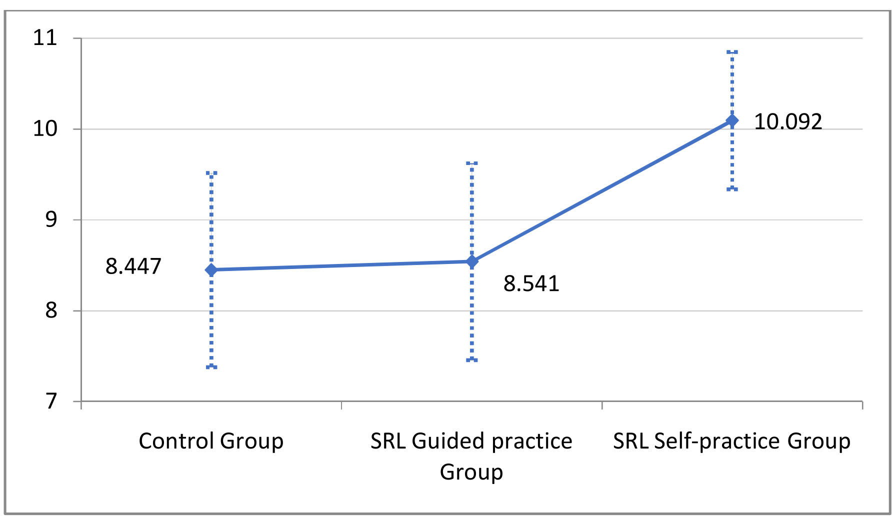

Figure 32. Line graph with error bars of achievement in pairs of equations of experimental and control groups

The line graph (Figure 32) illustrates that the achievement in pairs of equations among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in pairs of equations by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' achievement in pairs of equations among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientations in mathematics, two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on achievement in pairs of equations by gender.

To check the effectiveness of SRL strategy instruction on achievement in pairs of equations among standard nine students by gender, two-way ANOVA was performed using posttest scores of achievement in pairs of equations. Results are given in Table 82.

Table 82

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations among Standard Nine Students by Gender

Source	Sum of squares	df	Mean square	F	Partial eta squared
Treatment	93.69	2	46.84	4.34*	0.06
Gender	51.68	1	51.68	4.79*	0.03
Treatment * Gender	74.69	2	37.34	3.46*	0.05
Error	1565.86	145	10.80		
Total	1767.59	150			

*p<.05

As shown in Table 82, there is a significant interaction is observed between SRL strategy instruction and gender [F (2, 145) =3.46, p<.05, η_p^2 =.05] among standard nine students in their achievement in pairs of equations. That is effect of SRL strategy instruction on achievement in pairs of equations vary by gender.

To check the interaction of gender with effectiveness of SRL strategy instruction on students' achievement in pairs of equations among standard nine students, one-way ANOVAs were performed in boys and girls. Results are given in the following sections.

Table 83

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations among Standard Nine Students in Boys and Girls

Source		Sum of squares	df	Mean square	*F*	Partial eta squared
Boys	Treatment	141.14	2	70.57	7.93**	0.19
	Error	587.15	66	8.90		
	Total	728.29	68			
Girls	Treatment	24.91	2	12.45	1.01	
	Error	978.71	79	12.39		
	Total	1003.62	81			

**p<.01

As shown in Table 83, effect of treatment on achievement in pairs of equations is significant among boys [F (2,66) =7.93, p<.01; η_p^2 =0.19], but not among girls [F (2, 79) =1.01, p>.05]. Partial eta squared (η_p^2 =.19) shows that the effect of SRL strategy instruction on achievement in pairs of equations of standard nine boys is of medium size.

Among boys, mean scores of treatment groups and control groups were compared to find out if there is significant effect of treatment among groups, using t test. As there are two treatment groups and one control group, each treatment group were compared each other and to control group in case of boys.

Comparison of mean scores of achievement in pairs of equations of boys among SRL strategy (Longer intervention) group and control group.

Achievement in pairs of equations of boys among SRL strategy (Longer intervention) group is compared to the control group. The results are given in Table 84.

Table 84

Comparison of Mean Scores of Achievement in Pairs of Equations of Boys among SRL strategy (Longer intervention) group and Control Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Longer intervention)	33	10.18	3.22	3.80**
Control group	20	6.90	2.73	

**p<.01

As shown in Table 84, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of boys among the SRL strategy (Longer intervention) group (M=10.18, SD=3.22) is significantly higher than that of control group (M=6.90, SD=2.73, t=3.80, p<.01).

Comparison of mean scores of achievement in pairs of equations of boys among SRL strategy (Shorter intervention) group and control group.

Achievement in pairs of equations of boys among SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 85.

Table 85

Comparison of Mean Scores of Achievement in Pairs of Equations of Boys among SRL Strategy (Shorter intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Shorter intervention)	16	8.19	2.76	1.40
Control group	20	6.90	2.73	

As shown in Table 85, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of boys among the SRL strategy (Shorter intervention) group (M=8.19, SD=2.76) is not significantly different from the control group (M=6.90, SD=2.73, t=1.40, p>.05).

Comparison of mean scores of achievement in pairs of equations of boys among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group.

Achievement in pairs of equations of boys among SRL strategy (Longer intervention) group is compared to SRL strategy (Shorter intervention) group. The results are given in Table 86.

Table 86

Comparison of Mean Scores of Achievement in Pairs of Equations of Boys among SRL Strategy (Longer Intervention) Group and SRL Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	33	10.18	3.22	2.13*
SRL strategy (Shorter intervention)	16	8.19	2.76	

*p<.05

As shown in Table 86, the comparison of means using *t* test shows that mean score of achievement in pairs of equations of boys in SRL strategy (Longer intervention) group (M=10.18, SD=3.22) is significantly higher than that of boys in SRL strategy (Shorter intervention) group (M=8.19, SD=2.76, t=2.13, p<.05).

Overall, the three *t* tests show that the mean score of achievement in pairs of equations of boys in SRL strategy (Longer intervention) group is higher than that of control group and SRL strategy (Shorter intervention) group.

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations by the students' gender, line graph is plotted with error bars using mean score of achievement in pairs of equations of boys and girls in the two experimental and control groups, and is given in Figure 33.

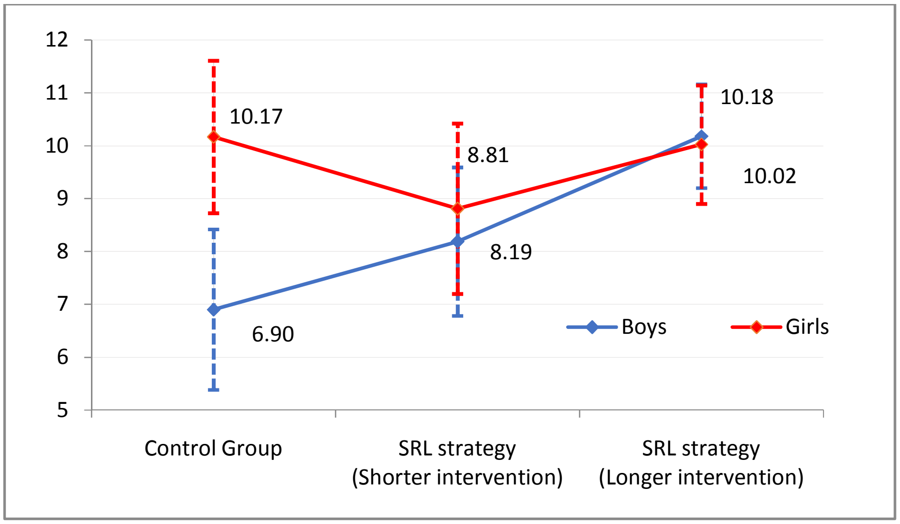

Figure 33. Line graph with error bars of achievement in pairs of equations of the boys and girls in the experimental and control groups

The line graph (Figure 33) illustrates that the SRL strategy (Longer intervention) is effective in case of boys.

Effect of self-regulated learning strategy instruction on achievement in pairs of equations by their level of intelligence.

To check the effectiveness of SRL strategy instruction on achievement in pairs of equations among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of achievement in pairs of equations. Results are given in Table 87.

Table 87

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations among Standard Nine Students by Their Level of Intelligence

Source	Sum of squares	df	Mean square	F	Partial eta squared
Treatment	96.94	2	48.47	4.60**	0.06
Intelligence	94.10	1	94.10	8.92**	0.06
Treatment * intelligence	17.76	2	8.88	0.84	
Error	1529.10	145	10.55		
Total	1767.59	150			

**p<.01

As shown in Table 87, no significant interaction is observed between SRL strategy instruction and intelligence [F (2, 145) =0.84, *p*>.05] among standard nine students in their achievement in pairs of equations. Effect of SRL strategy instruction on achievement in pairs of equations is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=11.12, SD=3.21 and Low: M=8.89, SD=2.55) improved their achievement in pairs of equations than those in the SRL strategy (Shorter intervention) group (High: M=8.84, SD=4.19 and M=Low: 8.22, SD=2.76) and in control group (High: M=9.36, SD=11.70 and Low: M=7.19, SD=3.91).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations by students' level of intelligence, a line graph is plotted with error bars using mean scores of achievement in pairs of equations of students with high and low nonverbal intelligence in experimental groups and control groups, and is given in Figure 34.

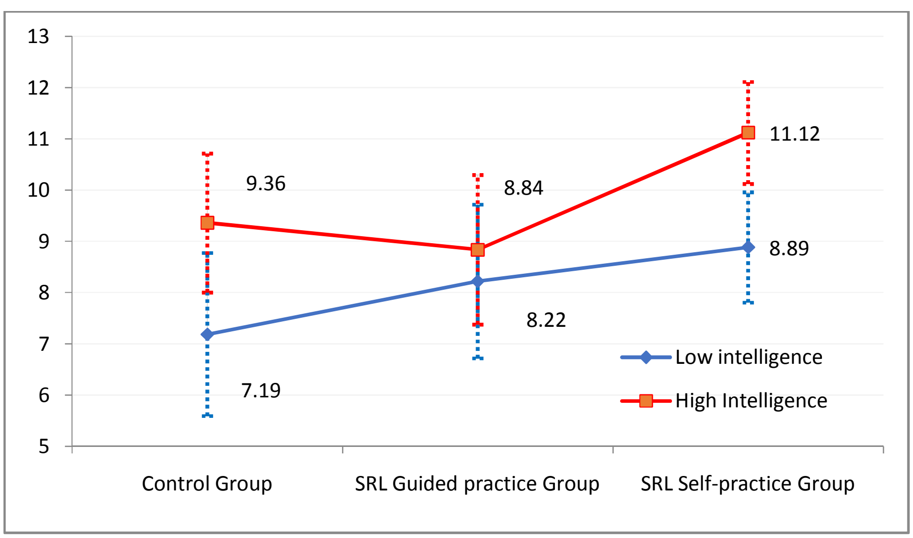

Figure 34. Line graph with error bars of achievement in pairs of equations of students with high and low nonverbal intelligence in the experimental and control groups

The line graph (Figure 34) illustrates that the achievement in pairs of equations of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in pairs of equations by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in pairs of equations among standard nine students by their Level of prerequisites in Mathematics , two-way ANOVA was performed using posttest scores of achievement in pairs of equations. Results are given in Table 88.

Table 88

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations Among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	140.76	2	70.38	7.36**	0.09
Level of prerequisites in mathematics	273.78	1	273.78	28.65**	0.16
Treatment * Level of prerequisites in mathematics	7.06	2	3.53	0.37	
Error	1385.77	145	9.56		
Total	1767.59	150			

**p<.01

As shown in Table 88, no significant interaction was observed between SRL strategy instruction and their prerequisites in mathematics [F (2, 145) =0.37, *p*>.05] among standard nine students in their achievement in pairs of equations. Effect of SRL strategy instruction on achievement in pairs of equations is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=11.38, SD=3.28 and Low: M=9.05, SD=2.57) improved their achievement in pairs of equations than those in the SRL strategy (Shorter intervention) group (High: M=9.73, SD=3.68 and Low: M=6.80, SD=2.51) and in the control group (High: M=9.95, SD=3.76 and Low: M=6.59, SD=2.55).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations by students' level of prerequisites, a line graph is plotted with error bars using mean scores of achievement in pairs of equations of students with high and low prerequisites in mathematics in experimental groups and control groups, and is given in Figure 35.

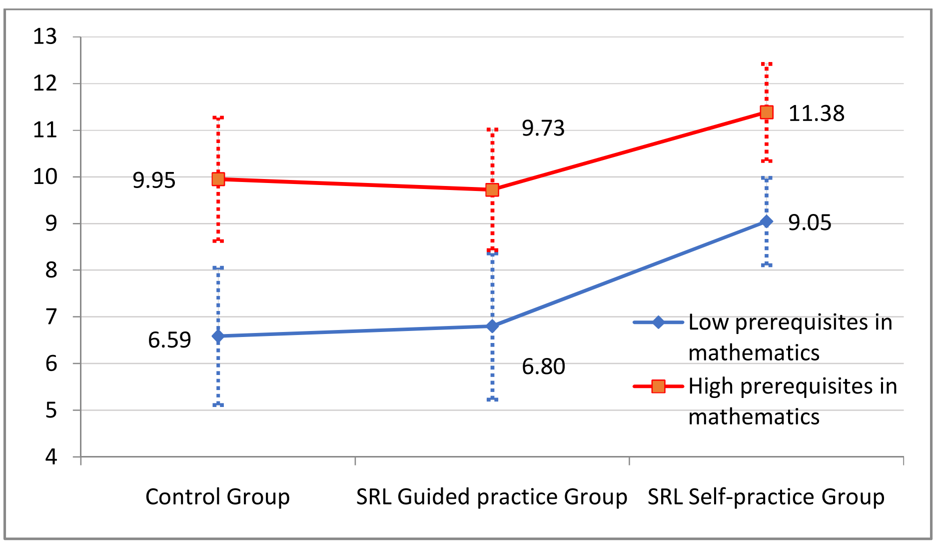

Figure 35. Line graph with error bars of achievement in pairs of equations of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 35) illustrates that the achievement in pairs of equations of students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on achievement in pairs of equations by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on achievement in pairs of equations among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of achievement in pairs of equations. Results are given in Table 89.

Table 89

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations Among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	113.72	2	56.86	5.39**	0.07
Ability Conception	116.81	1	116.81	11.08**	0.07
Treatment * Ability Conception	11.55	2	5.77	0.55	
Error	1528.81	145	10.54		
Total	1767.59	150			

**p<.01

As shown in Table 89, no significant interaction is observed between SRL strategy instruction and their mathematical ability conception [$F(2, 145) = 0.55$, $p > .05$] among standard nine students in their achievement in pairs of equations. Effect of SRL strategy instruction on achievement in pairs of equations is true for students both with incremental and entity beliefs in mathematics, that is students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) group (Incremental: M=11.11, SD=3.59 and Entity: M=9.22, SD=2.36) improved their achievement in pairs of equations than those in the SRL strategy (Shorter intervention) group (Incremental: M=9.75, SD=3.57 and Entity: M=7.12, SD=3) and in the control group (Incremental: M=8.95, SD=3.76 and Entity: M=7.89, SD=3.55).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations by students' mathematical ability conception, a line graph is plotted with error bars using mean scores of achievement in pairs of equations of students with incremental and entity beliefs in mathematics in experimental groups and control group, and is given in Figure 36.

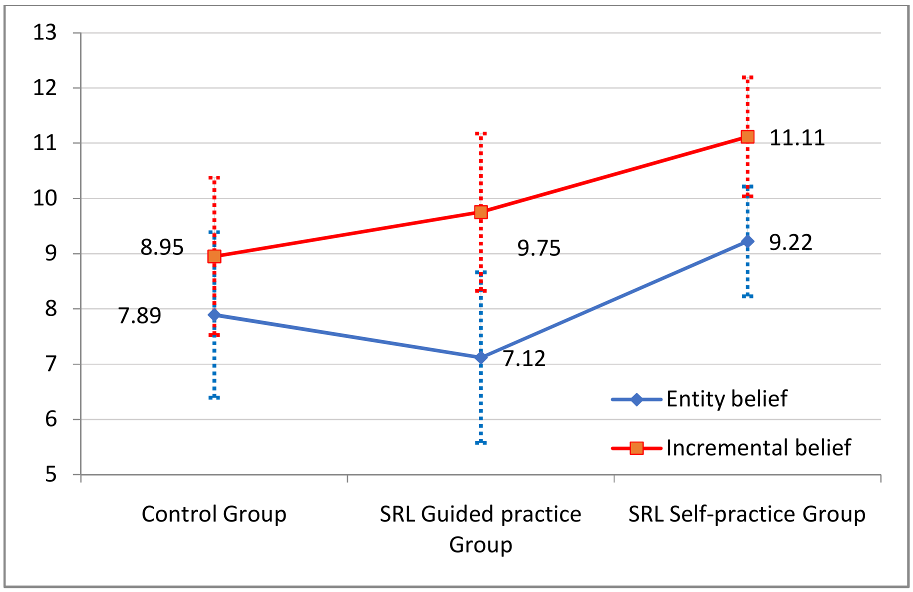

Figure 36. Line graph with error bars of achievement in pairs of equations of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 36) illustrates that the achievement in pairs of equations of students with incremental and entity beliefs in mathematics in SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on achievement in pairs of equations by their goal orientation in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in pairs of equations among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using posttest scores of achievement in pairs of equations. Results are given in Table 90.

Table 90

Effect of SRL Strategy Instruction on Achievement in Pairs of Equations among Standard Nine Students by Their Goal Orientation In Mathematics

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	97.50	2	48.75	4.25*	0.06
Goal orientation in mathematics	6.93	1	6.93	0.60	
Treatment * Goal orientation in mathematics	0.39	2	0.20	0.02	
Error	1663.60	145	11.47		
Total	1767.59	150			

*p<.05

As shown in Table 90, no significant interaction is observed between SRL strategy instruction and their goal orientation in mathematics [F (2, 145) =0.02, *p*>.05] among standard nine students in their achievement in pairs of equations. Effect of SRL strategy instruction on achievement in pairs of equations is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics; that is students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery goal: M=10.26, SD=3.39 and Performance approach goal: M=9.88, SD=2.76) improved their achievement in pairs of equations than those in the SRL strategy (Shorter intervention) group (Mastery goal: M=8.73, SD=3.72 and Performance approach goal: M=8.09, SD=3.18) and in the control group (Mastery goal: M=8.61, SD=3.45 and Performance approach goal: M=8.20, SD=4.06).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in pairs of equations by students' goal orientation in mathematics, a line graph is plotted with error bars using mean scores of achievement in pairs of equations of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental groups and control groups, and is given in Figure 37.

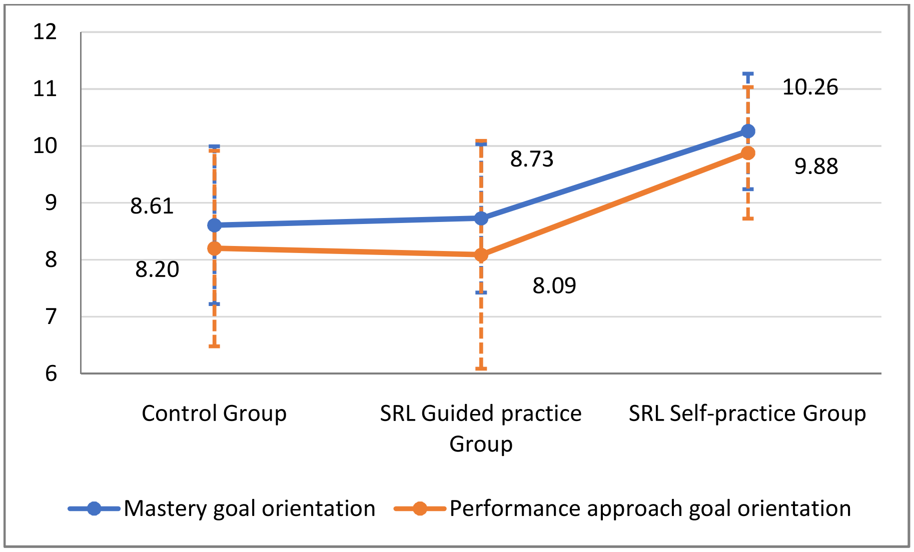

Figure 37. Line graph with error bars of achievement in pairs of equations of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 37) illustrates that achievement in pairs of equations of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Achievement in Mathematics

ANOVA was performed to find out the treatment effect of SRL strategy instruction on achievement in mathematics among standard nine students. The results are given in Table 91.

Table 91

Effect of SRL Strategy Instruction on Achievement in Mathematics Among Standard Nine Students

Source of variance	Sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	7077.77	2	3538.88	12.36**	.143
Error	42379.54	148	286.35		
Total	49457.312	150			

**p<.01

As shown in Table 91, significant effect of SRL strategy instruction has been observed on achievement in mathematics [F (2, 148) =12.36, $p<.01$; η_p^2 =.14] among standard nine students. Partial eta squared (η_p^2 =.14) shows that the effect of SRL strategy instruction on achievement in mathematics of standard nine students is of medium size.

The mean scores of treatment groups and control group were compared to find out if there is significant effect of treatment among groups using *t* test.

Comparison of mean scores of achievement in mathematics among SRL strategy(Longer intervention) group and control group.

Achievement in mathematics of SRL strategy (Longer intervention) group is compared to the control group. The results are given in Table 92.

Table 92

Comparison of Mean Scores of Achievement in Mathematics among SRL Strategy (Longer Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy(Longer intervention)	76	63.31	17.16	3.97**
Control group	38	49.78	17.22	

**p<.01

As shown in Table 92, the comparison of means using *t* test shows that mean score of achievement in mathematics of the SRL strategy (Longer intervention) group(M=63.31, SD=17.16) is significantly higher than that of control group (M=49.78, SD=17.23, t=3.97, p<.01).

Comparison of mean scores of achievement in mathematics among SRL strategy (Shorter intervention) group and control group.

Achievement in mathematics of SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 93.

Table 93

Comparison of Mean Scores of Achievement in Mathematics among SRL Strategy (Shorter Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Shorter intervention)	37	49.46	16.09	0.81
Control group	38	49.78	17.22	

As shown in Table 93, comparison of means using t test shows that there is no significant difference between mean scores of achievement in mathematics of the SRL strategy (Shorter intervention) group (M=49.46, SD=16.09) and control group (M=49.78 , SD=17.23, t= 0.81, p>.05).

Comparison of mean scores of achievement in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group.

Achievement in mathematics of SRL strategy (Longer intervention) group is compared to SRL strategy (Shorter intervention) group. The results are given in Table 94.

Table 94

Comparison of Mean Scores of Achievement in Mathematics among SRL Strategy (Longer Intervention) Group and SRL Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Longer intervention)	76	63.31	17.16	4.11**
SRL strategy (Shorter intervention)	37	49.46	16.09	

**p<.01

As shown in Table 94, the comparison of means using *t* test shows that mean score of achievement in mathematics of the SRL strategy (Longer intervention) group (M=63.31, SD=17.16) is significantly higher than that of SRL strategy (Shorter intervention) group (M=49.46, SD=16.09, t=4.11, p<.01).

Overall the three *t* test shows that the mean score of achievement in mathematics of the control group and SRL strategy (Shorter intervention) group is significantly lower than that of SRL strategy (Longer intervention) groups.

In order to demonstrate the effect of SRL strategy instruction on achievement in mathematics graphically, a line graph is plotted with error bars using mean scores of achievement in mathematics of experimental groups and control group in Figure 38.

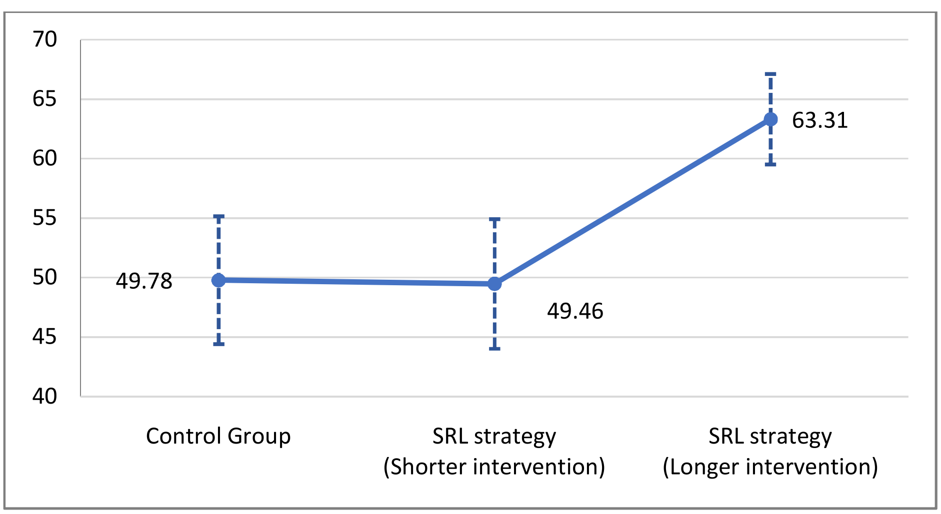

Figure 38. Line graph with error bars of achievement in mathematics of experimental and control groups

The line graph (Figure 38) illustrates that the achievement in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in mathematics by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' achievement in mathematics among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics, two-way ANOVAs were performed. Results are given in the following sections.

Effect of Self-regulated learning Strategy instruction on achievement in mathematics by gender.

To check the effectiveness of SRL strategy instruction on achievement in mathematics among standard nine students by gender, two-way ANOVA was performed using posttest scores of achievement in mathematics. Results are given in Table 95.

Table 95

Effect of SRL Strategy Instruction on Achievement in Mathematics among Standard Nine Students by Gender

Source	Sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	7092.65	2	3546.33	12.75**	0.15
Gender	1797.03	1	1797.03	6.46*	0.04
Treatment * Gender	808.33	2	404.17	1.45	
Error	40322.91	145	278.09		
Total	49457.31	150			

**p<.01, *p<.05

As shown in Table 95, no significant interaction is observed between SRL strategy instruction and gender [F (2, 145) =1.45, *p*>.05] among standard nine students in their achievement in mathematics. Effect of SRL strategy instruction on achievement in mathematics is true for both boys and girls, that is both boys and girls in SRL strategy (Longer intervention) group (Boys: M=62.64, SD=19.33 and Girls: M=63.83, SD=15.50) improved their achievement in mathematics than those in the SRL strategy (Shorter intervention) group (Boys: M=44.06, SD=11.90 and Girls: M=53.58, SD=17.86) and control group (Boys: M=44.43, SD=13.45 and Girls: M=55.72, SD=19.3).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in mathematics by the students' gender, a line graph is plotted with error bars using mean score of achievement in mathematics of boys and girls in the two experimental and control groups, and is given in Figure 39.

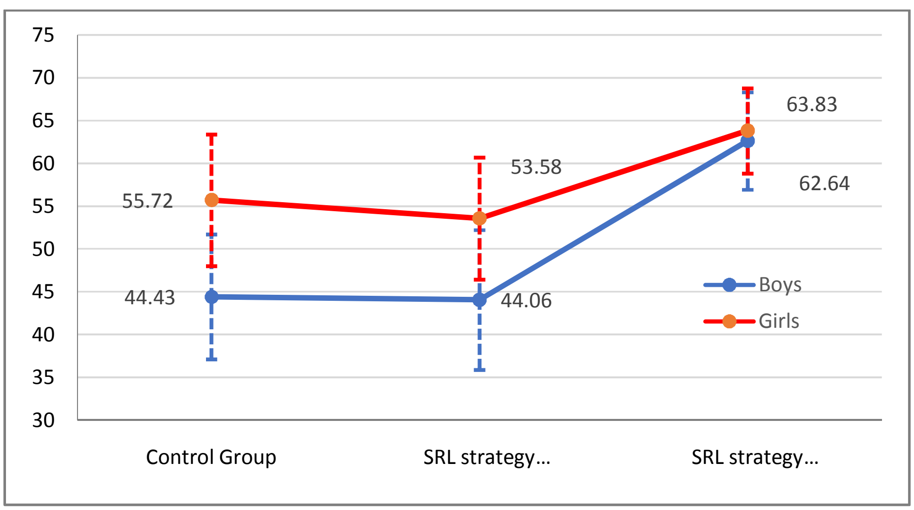

Figure 39. Line graph with error bars of achievement in mathematics of the boys and girls in the experimental and control groups

The line graph (Figure 39) illustrates that the achievement in mathematics of boys and girls among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in mathematics by their level of intelligence.

To check the effectiveness of SRL strategy instruction on achievement in mathematics among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of achievement in mathematics. Results are given in Table 96.

Table 96

Effect of SRL Strategy Instruction on Achievement in Mathematics among Standard Nine Students by Their Level of Intelligence

Source	Sum of squares	df	Mean square	F	Partial eta squared
Treatment	7124.94	2	3562.47	14.48**	0.17
Intelligence	5387.34	1	5387.34	21.90**	0.13
Treatment * intelligence	289.29	2	144.64	0.59	
Error	35661.87	145	245.94		
Total	49457.31	150			

**p<.01

As shown in Table 96, no significant interaction is observed between SRL strategy instruction and intelligence [$F\ (2, 145) = 0.59$, $p > .05$] among standard nine students in their achievement in mathematics. Effect of SRL strategy instruction on achievement in mathematics is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=69.90, SD=17.36 and Low: M=55.58, SD=13.45) improved their achievement in mathematics than those in the SRL strategy (Shorter intervention) group (High: M=53.51, SD=18.78 and Low: M=45.18, SD=11.72) and in the control group (High: M=56.27, SD=16.56 and Low: M=40.84, SD=14.18).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in mathematics by students' level of intelligence, a line graph is plotted with error bars using mean scores of achievement in mathematics of students with high and low nonverbal intelligence in experimental groups and control groups, and is given in Figure 40.

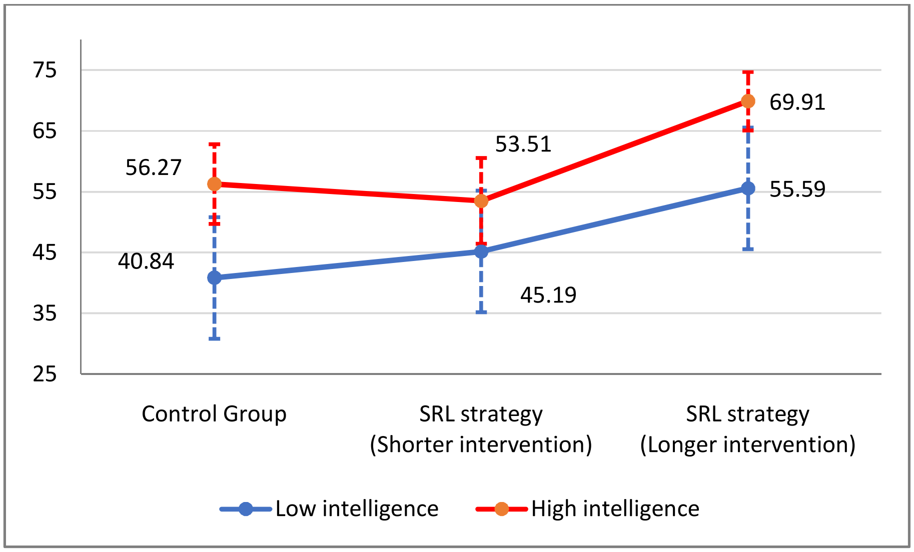

Figure 40. Line graph with error bars of achievement in mathematics of students with high and low nonverbal intelligence in the experimental and control groups

The line graph (Figure 40) illustrates that the achievement in mathematics of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in mathematics by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in mathematics among standard nine students by their Level of prerequisites in Mathematics, two-way ANOVA was performed using posttest scores of achievement in mathematics. Results are given in Table 97.

Table 97

Effect of SRL Strategy Instruction on Achievement in Mathematics among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	9198.42	2	4599.21	20.72**	0.22
Level of prerequisites in mathematics	9394.83	1	9394.83	42.32**	0.23
Treatment * Level of prerequisites in mathematics	146.66	2	73.33	0.33	
Error	32190.08	145	222.00		
Total	49457.31	150			

**p<.01

As shown in Table 97, no significant interaction was observed between SRL strategy instruction and their prerequisites in mathematics [F (2, 145) =0.33, *p*>.05] among standard nine students in their achievement in mathematics. Effect of SRL strategy instruction on achievement in mathematics is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=71.73, SD=17.67 and Low: M=40.28, SD=10.50) improved their achievement in mathematics than those in the SRL strategy (Shorter intervention) group (High: M=55.72, SD=16.40 and Low: M=40.28, SD=10.50) and in the control group (High: M=58.66, SD=15.94 and Low: M=38.8, SD=11.69).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in mathematics by students' level of prerequisites, a line graph is plotted with error bars using mean scores of achievement in mathematics of students with high and low prerequisites in mathematics in experimental groups and control groups, and is given in Figure 41.

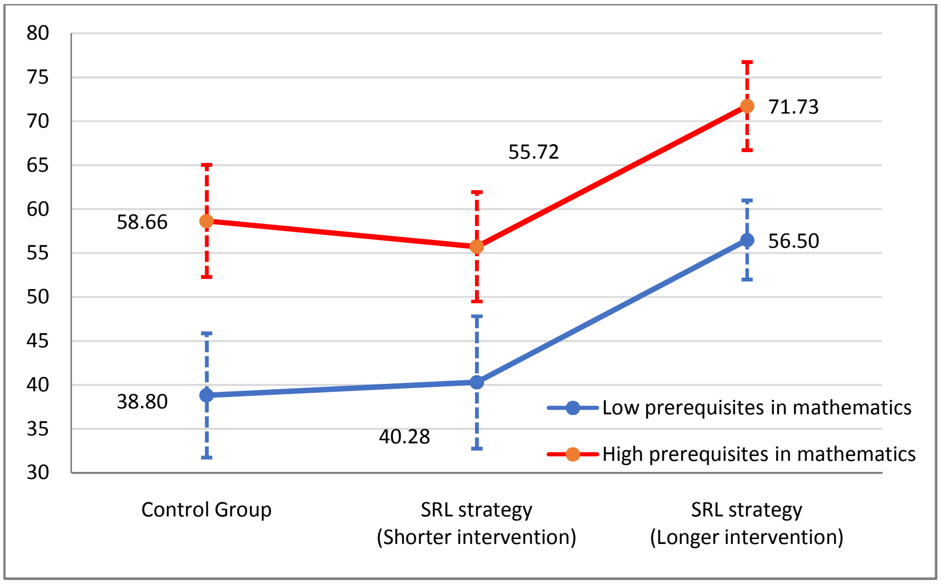

Figure 41. Line graph with error bars of achievement in mathematics of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 41) illustrates that the achievement in mathematics of students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in mathematics by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction achievement in mathematics among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of achievement in mathematics. Results are given in Table 98.

Table 98

Effect of SRL Strategy Instruction on Achievement in Mathematics among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	7856.04	2	3928.02	14.95**	0.17
Ability Conception	3926.60	1	3926.60	14.94**	0.09
Treatment * Ability Conception	8.81	2	4.41	0.02	
Error	38103.34	145	262.78		
Total	49457.31	150			

**p<.01

As shown in Table 98, no significant interaction is observed between SRL strategy instruction and their mathematical ability conception [F (2, 145) =0.02, *p*>.05] among standard nine students in their achievement in mathematics. Effect of SRL strategy instruction on achievement in mathematics is true for students both with incremental and entity beliefs in mathematics, that is students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) group (Incremental: M=68.84, SD=18.96 and Entity: M=58.59, SD=14.03) improved their achievement in mathematics than those in the SRL strategy (Shorter intervention) group (Incremental: M=54.39, SD=14.8 and Entity: M=43.66, SD=16.02) and in the control group (Incremental: M=55.18, SD=16.52 and Entity: M=43.76, SD=16.37).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in mathematics by the students' mathematical ability conception, a line graph is plotted with error bars using mean scores of achievement in mathematics of students with incremental and entity beliefs in mathematics in experimental groups and control groups, and is given in Figure 42.

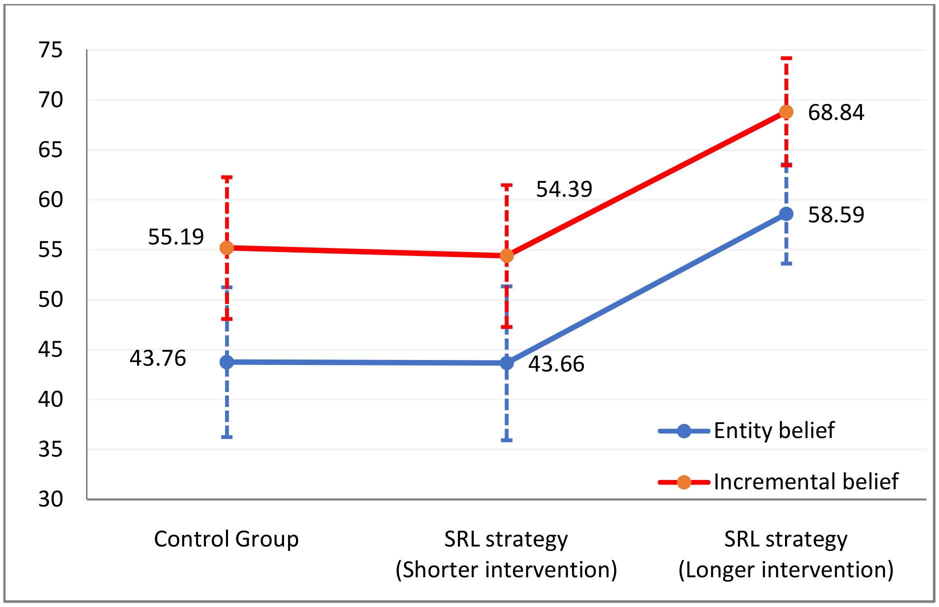

Figure 42. Line graph with error bars of achievement in mathematics of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 42) illustrates that the achievement in mathematics of students with incremental and entity beliefs in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on achievement in mathematics by their goal orientation in mathematics.

To check the effectiveness of SRL strategy instruction on achievement in mathematics among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using posttest scores of achievement in mathematics. Results are given in Table 99.

Table 99

Effect of SRL Strategy Instruction on Achievement in Mathematics among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	6717.84	2	3358.92	11.55**	0.14
Goal orientation in mathematics	104.40	1	104.40	0.36	
Treatment * Goal orientation in mathematics	86.33	2	43.16	0.15	
Error	42167.87	145	290.81		
Total	49457.31	150			

**p<.01

As shown in Table 99, no significant interaction is observed between SRL strategy instruction and their goal orientation in mathematics [F (2, 145) =0.15, p>.05] among standard nine students in their achievement in mathematics. Effect of SRL strategy instruction on achievement in mathematics is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics, that is students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery goal: M=64.04, SD=18.27 and Performance approach goal: M=62.37, SD=15.81) improved their achievement in mathematics than those in the SRL strategy (Shorter intervention) group (Mastery goal: M=49.3, SD=15.22 and Performance approach goal: M=49.69, SD=18.79) and in the control group (Mastery goal: M=51.42, SD=18.40 and Performance approach goal: M=47.24, SD=15.51).

In order to graphically demonstrate the effect of SRL strategy instruction on achievement in mathematics by the students' goal orientation in mathematics, a line graph is plotted with error bars using mean scores of achievement in mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental groups and control groups, and is given in Figure 43.

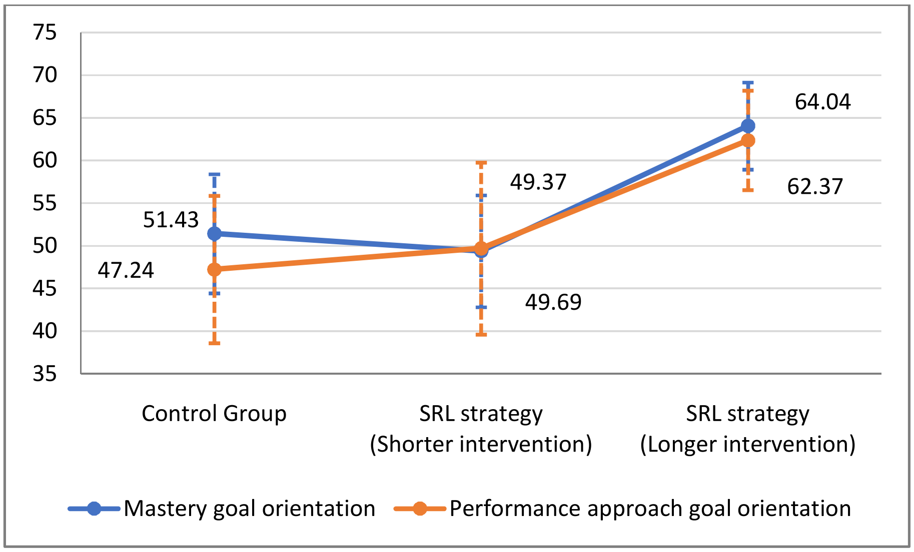

Figure 43. Line graph with error bars of achievement in mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 43) illustrates that the achievement in mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy(Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of Self-regulated Learning Strategy Instruction on Self-efficacy for Learning Systems of Linear Equations

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students, ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Result of ANOVA were given in Table 100.

Table 100

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students

Source of variance	Sum of squares	df	Mean square	*F*
Treatment	31.04	2	15.52	1.85
Error	1241.15	148	8.39	
Total	1272.19	150		

As shown in Table 100, no significant effect of SRL strategy instruction has been observed on self-efficacy for learning systems of linear equations [F (2, 148) =1.85, p>.05] among standard nine students. That is, mean score of the self-efficacy for learning systems of linear equations in the in SRL strategy (Longer intervention) group (M=17.28, SD=2.47) SRL strategy (Shorter intervention) group (M=16.57, SD=3.03) and control group (M=16.24, SD=3.5) are not different from each other.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of experimental groups and control group in Figure 44.

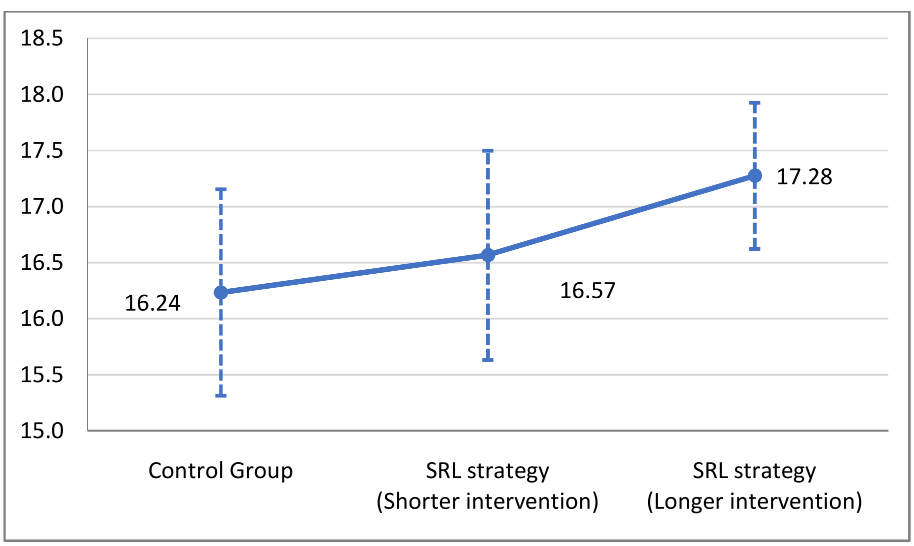

Figure 44. Line graph with error bars of self-efficacy for learning systems of linear equations of experimental and control groups

The line graph (Figure 44) illustrates that the self-efficacy for learning systems of linear equations among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning systems of linear equations by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' self-efficacy for learning systems of linear equations among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on self-efficacy for learning systems of linear equations by gender.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students by gender, two-way ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Results are given in Table 101.

Table 101

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students by Gender

Source	Sum of squares	df	Mean square	*F*
Treatment	31.68	2	15.84	1.86
Gender	5.74	1	5.74	0.68
Treatment * Gender	5.64	2	2.82	0.33
Error	1231.68	145	8.49	
Total	1272.19	150		

As shown in Table 101, no significant interaction is observed between SRL strategy instruction and gender [F (2, 145) =0.33, *p*>.05] among standard nine students in their self-efficacy for learning systems of linear equations. Effect of SRL strategy instruction on self-efficacy for learning systems of linear equations is true for both boys and girls, that is boys and girls in SRL strategy (Longer intervention) group (Boys: M=17.24, SD=2.83 and Girls: M=17.30, SD=2.19), SRL strategy (Shorter intervention) group (Boys: M=16, SD=3.18 and Girls: M=17, SD=2.92)and control group (Boys: M=16.15, SD=3.94 and Girls: M=16.33, SD=3.05) do not differ in their self-efficacy for learning systems of linear equations.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations by the students' gender graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of experimental groups and control group in Figure 45.

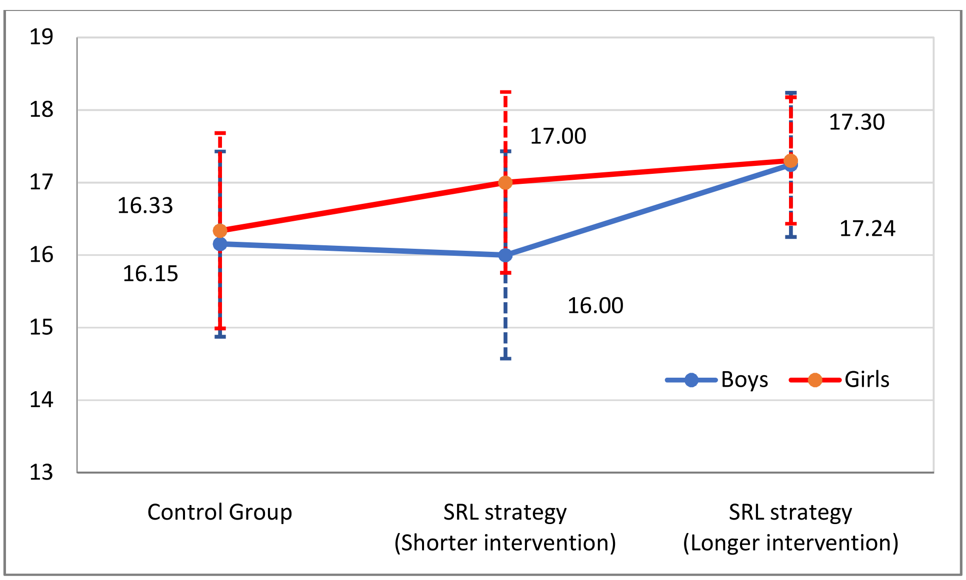

Figure 45. Line graph with error bars of self-efficacy for learning systems of linear equations of the boys and girls in the of experimental and control groups

The line graph (Figure 45) illustrates that the self-efficacy for learning systems of linear equations of boys and girls among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on self-efficacy for learning systems of linear equations by their level of intelligence.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Results are given in Table 102.

Table 102

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students by Their Level of Intelligence

Source	Sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	31.06	2	15.53	1.88	
Intelligence	33.34	1	33.34	4.03*	0.03
Treatment * intelligence	8.66	2	4.33	0.52	
Error	1200.32	145	8.28		
Total	1272.19	150			

*p<.05

As shown in Table 102, no significant interaction is observed between SRL strategy instruction and intelligence [F (2, 145) =0.52, $p>.05$] among standard nine students in their self-efficacy for learning systems of linear equations. Effect of SRL strategy instruction on self-efficacy for learning systems of linear equations is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=17.61, SD=2.33 and Low: M=16.89, SD=2.6), in the SRL strategy (Shorter intervention) group (High:

M=17.42, SD=3.24 and Low: M=15.67, SD=2.59) and in the control group (High: M=16.45, SD=3.42 and Low: M=15.94, SD=3.7) do not differ in their self-efficacy for learning systems of linear equations.

In order to graphically demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations by students' level of intelligence, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of students with high and low nonverbal intelligence in the experimental groups and control group in Figure 46.

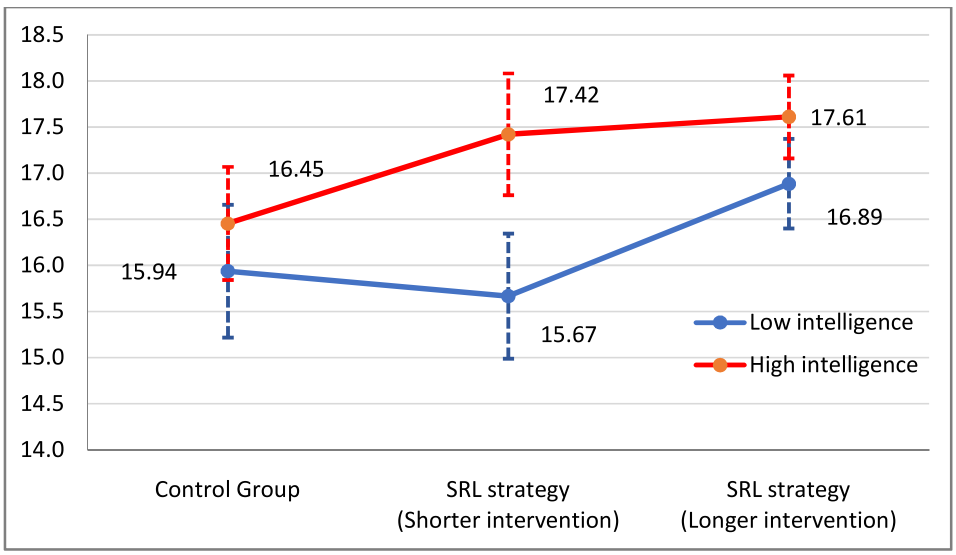

Figure 46. Line graph with error bars of self-efficacy for learning systems of linear equations of students with high and low nonverbal intelligence in the of experimental and control groups

The line graph (Figure 46) illustrates that self-efficacy for learning systems of linear equations of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning systems of linear equations by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Results are given in Table 103.

Table 103

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	F
Treatment	35.72	2	17.86	2.18
Level of prerequisites in mathematics	8.12	1	8.12	0.99
Treatment * Level of prerequisites in mathematics	38.07	2	19.03	2.33
Error	1186.04	145	8.18	
Total	1272.19	150		

As shown in Table 103, no significant interaction is observed between SRL strategy instruction and prerequisites in mathematics [F (2, 145)=2.33, p>.05] among standard nine students in their self-efficacy for learning systems of linear equations. Effect of SRL strategy instruction on self-efficacy for learning systems of linear equations is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=17.97, SD=2.37 and Low: M=16.71, SD=2.43), in the SRL strategy (Shorter intervention) group (High: M=17.09, SD=3.25 and Low: M=15.80, SD=2.6) and in the control group (High: M=15.76, SD=3.51 and Low: M=16.82, SD=3.50) do not differ in their self-efficacy for learning systems of linear equations.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations by students' level of prerequisites in mathematics graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of students with high and low prerequisites in mathematics in the experimental groups and control group in Figure 47.

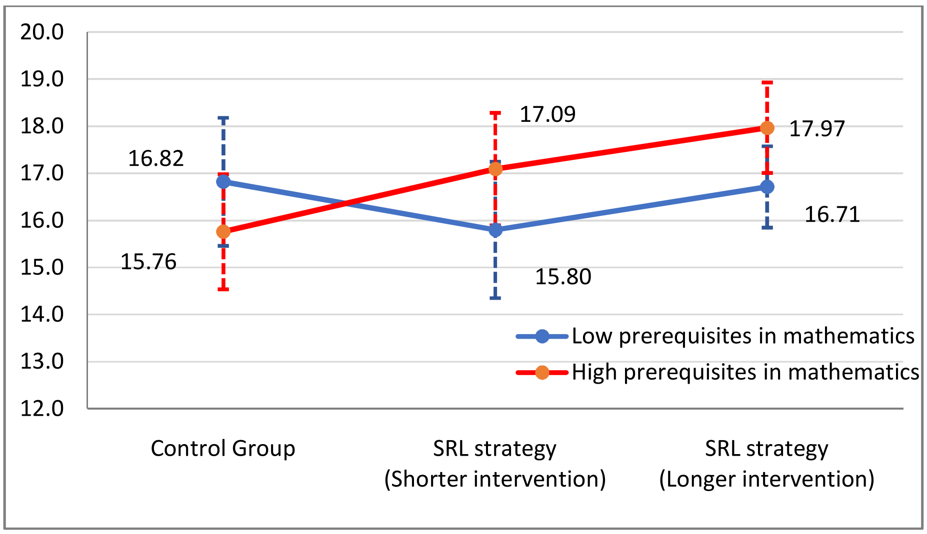

Figure 47. Line graph with error bars of self-efficacy for learning systems of linear equations of students with high and low prerequisites in mathematics in the of experimental and control groups

The line graph (Figure 47) illustrates that the self-efficacy for learning systems of linear equations students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on Self-efficacy for Learning Systems of linear equations by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Results are given in Table 104.

Table 104

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	*F*
Treatment	33.21	2	16.61	2.01
Ability Conception	3.58	1	3.58	0.43
Treatment * Ability Conception	37.75	2	18.88	2.28
Error	1198.72	145	8.27	
Total	1272.19	150		

As shown in Table 104, no significant interaction was observed between SRL strategy instruction and mathematical ability conception [F (2, 145) =2.28, p>.05] among standard nine students in their self-efficacy for learning systems of linear equations. Effect of SRL strategy instruction on self-efficacy for learning systems of linear equations is true for students both with incremental and entity beliefs in mathematics, that is students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) group (Incremental: M=17.49, SD=2.29 and Entity: M=17.10, SD=2.62), in the SRL strategy (Shorter intervention) group (Incremental: M=16.05, SD=3.30 and Entity: M=17.18, SD=2.65) and in the control group (Incremental: M=17.05, SD=3.32 and Entity: M=15.33, SD=3.56) do not differ in their self-efficacy for learning systems of linear equations.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations by the students' mathematical ability conception graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of students with incremental and entity beliefs in mathematics in experimental groups and control groups, and is given in Figure 48.

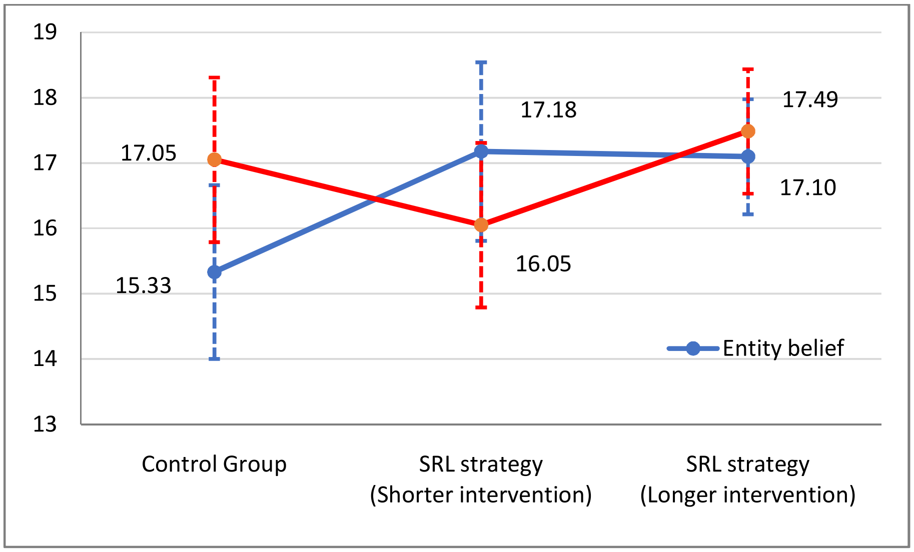

Figure 48. Line graph with error bars of self-efficacy for learning systems of linear equations of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 48) illustrates that the self-efficacy for learning systems of linear equations of students with incremental and entity beliefs in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group are not differ from that of control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning systems of linear equations by their goal orientation in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning systems of linear equations among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning systems of linear equations. Results are given in Table 105.

Table 105

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Systems of Linear Equations among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*
Treatment	23.62	2	11.81	1.40
Goal orientation in mathematics	2.04	1	2.04	0.24
Treatment * Goal orientation in mathematics	16.17	2	8.08	0.96
Error	1224.51	145	8.44	
Total	1272.19	150		

As shown in Table 105, no significant interaction was observed between SRL strategy instruction and goal orientation in mathematics [F (2, 145) =0.96, *p*>.05] among standard nine students in their self-efficacy for learning systems of linear equations. Effect of SRL strategy instruction on self-efficacy for learning systems of linear equations is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics, that is students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery goal: M=17.42, SD=2.88 and Performance Approach goal: M=17.09, SD=1.83), in the SRL strategy (Shorter intervention) group (Mastery goal: M=16.62, SD=2.87 and Performance Approach goal: M=16.45, SD=3.53) and in the control group (Mastery goal: M=15.74, SD=3.21 and Performance Approach goal: M=17, SD=3.89) do not differ in their self-efficacy for learning systems of linear equations.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning systems of linear equations by the students' goal orientation in mathematics graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning systems of linear equations of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental groups and control groups, and is given in Figure 49.

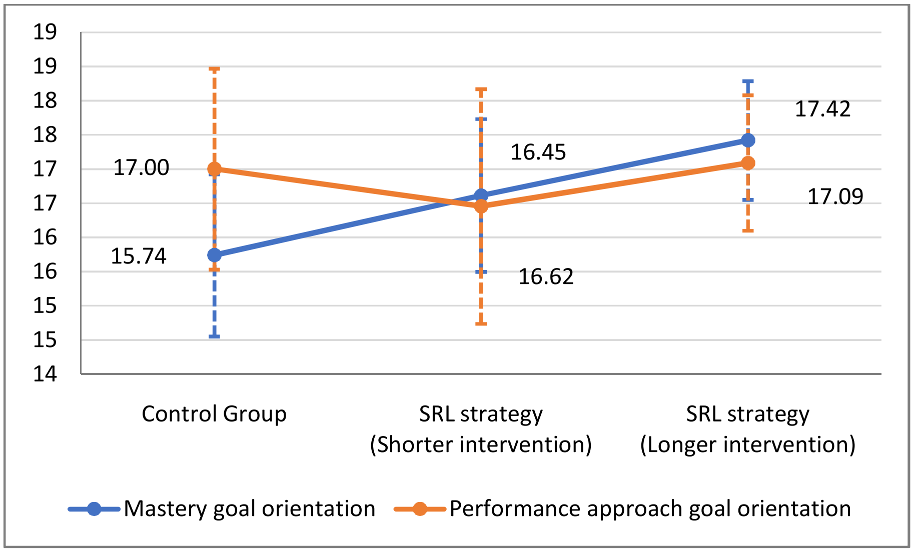

Figure 49. Line graph with error bars of self-efficacy for learning systems of linear equations of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 49) illustrates that the self-efficacy for learning systems of linear equations of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group are not different from that of control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Self-Efficacy for Learning Mathematics

To check the effectiveness of SRL strategy instruction on self-efficacy for learning mathematics among standard nine students, ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Result of ANOVA was given in Table 106.

Table 106

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics Among Standard Nine Students

Source of variance	Sum of squares	Df	Mean square	*F*
Treatment	143.91	2	71.95	0.70
Error	15191.06	148	102.64	
Total	15334.97	150		

As shown in Table 106, no significant effect of SRL strategy instruction has been observed on self-efficacy for learning mathematics [F (2, 148) =0.70, p>.05] among standard nine students. That is mean score of the self-efficacy for learning mathematics in the in SRL strategy (Longer intervention) group (M=69.18, SD=9.42), SRL strategy (Shorter intervention) group (M=66.78, SD=10.21) and control group (M=68.26, SD=11.38) are not different from each other.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of experimental groups and control group in Figure 50.

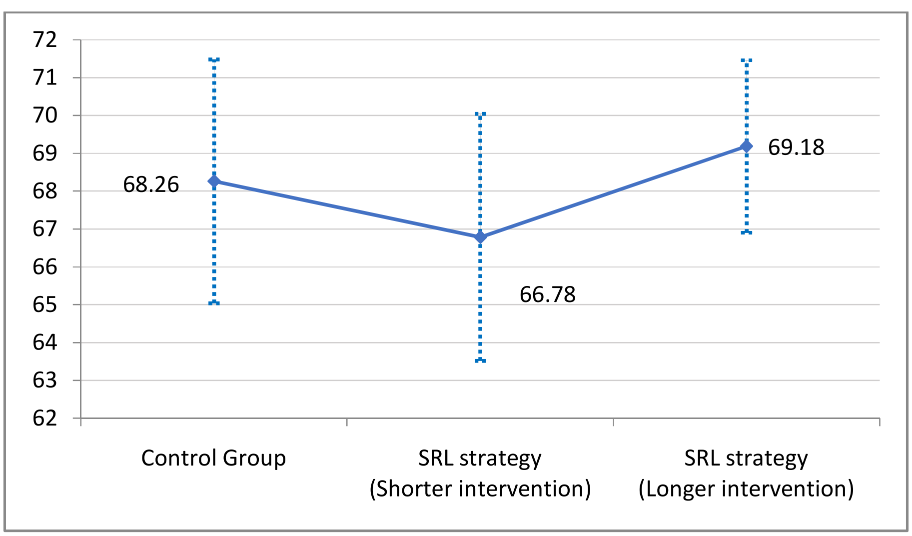

Figure 50. Line graph with error bars of self-efficacy for learning mathematics of experimental and control groups

The line graph (Figure 50) illustrates that the self-efficacy for learning mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning mathematics by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' self-efficacy for learning mathematics among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics, two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on self-efficacy for learning mathematics by gender

To check the effectiveness of SRL strategy instruction on self-efficacy for learning mathematics among standard nine students by gender, two-way ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Results are given in Table 107.

Table 107

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics among Standard Nine Students by Gender

Source	Sum of squares	df	Mean square	*F*
Treatment	203.58	2	101.79	1.00
Gender	126.68	1	126.68	1.25
Treatment * Gender	429.55	2	214.77	2.11
Error	14737.53	145	101.64	
Total	15334.97	150		

As shown in Table 107, no significant interaction is observed between SRL strategy instruction and gender [F (2, 145) =2.11, p>.05] among standard nine students in their self-efficacy for learning mathematics. Effect of SRL strategy instruction on self-efficacy for learning mathematics is true for both boys and girls, that is, boys and girls in SRL strategy (Longer intervention) group (Boys: M=70.64, SD=10.41 and Girls: M=68.07, SD=8.54), SRL strategy (Shorter intervention) group (Boys: M=64.13, SD=7.85 and Girls: M=68.81, SD=11.47) and control group (Boys: M=66.50, SD=11.86 and Girls: M=70.22, SD=10.81) do not differ in their self-efficacy for learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics by the students' gender graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of boys and girls in the experimental groups and control group in Figure 51.

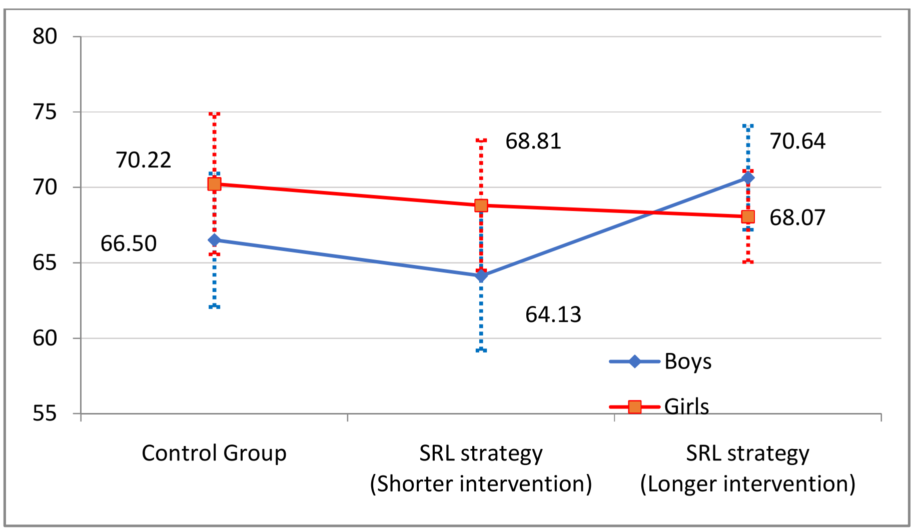

Figure 51. Line graph with error bars of self-efficacy for learning mathematics of the boys and girls in the of experimental and control groups

The line graph (Figure 51) illustrates that the self-efficacy for learning mathematics of boys and girls among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning mathematics by their level of intelligence.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning mathematics among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Results are given in Table 108.

Table 108

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics Among Standard Nine Students by Their Level of Intelligence

Source	Sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	139.29	2	69.64	0.69	
Intelligence	544.08	1	544.08	5.40**	0.04
Treatment * intelligence	40.65	2	20.32	0.20	
Error	14605.26	145	100.73		
Total	15334.97	150			

**p<.01

As shown in Table 108, no significant interaction is observed between SRL strategy instruction and intelligence [F (2, 145) =0.20, *p*>.05] among standard nine students in their self-efficacy for learning mathematics. Effect of SRL strategy instruction on self-efficacy for learning mathematics is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=70.66, SD=8.66 and Low: M=67.46, SD=10.08), in the SRL strategy (Shorter intervention) group (High: M=69.53, SD=11.92 and Low: M=63.89, SD=7.29) and in the control group (High: M=69.64, SD=10.14 and Low: M=66.38, SD=12.99) do not differ in their self-efficacy for learning mathematics

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In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics by students' level of intelligence graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of students with high and low nonverbal intelligence in the experimental groups and control group in Figure 52.

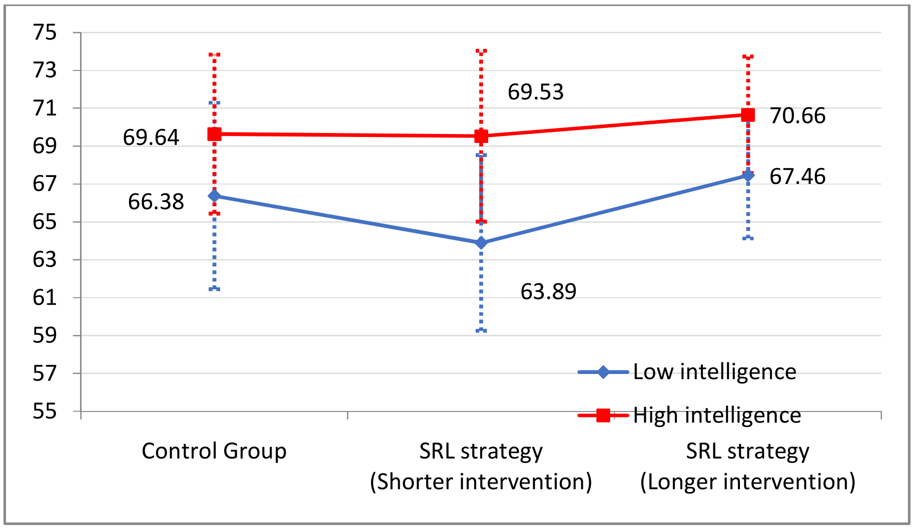

Figure 52. Line graph with error bars of self-efficacy for learning mathematics of students with high and low nonverbal intelligence in the of experimental and control groups

The line graph (Figure 52) illustrates that the self-efficacy for learning mathematics of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning mathematics by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning mathematics among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Results are given in Table 109.

Table 109

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	266.88	2	133.44	1.38	
Level of prerequisites in mathematics	815.44	1	815.44	8.45**	0.06
Treatment * Level of prerequisites in mathematics	117.80	2	58.90	0.61	
Error	13995.54	145	96.52		
Total	15334.97	150			

**p<.01

As shown in Table 109, no significant interaction is observed between SRL strategy instruction and prerequisites in mathematics [F (2, 145) =0.61, p>.05] among standard nine students in their self-efficacy for learning mathematics. Effect of SRL strategy instruction on self-efficacy for learning mathematics is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=72.88, SD=8.78 and Low: M=66.19, SD=8.92), in the SRL strategy (Shorter intervention) group (High: M=69.14, SD=11.31 and Low: M=63.33, SD=7.40) and in the control group (High: M=69.33, SD=10.58 and Low: M=66.94, SD=12.48) do not differ in their self-efficacy for learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics by students' level of prerequisites in mathematics graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of students with high and low prerequisites in mathematics in the experimental groups and control group in Figure 53.

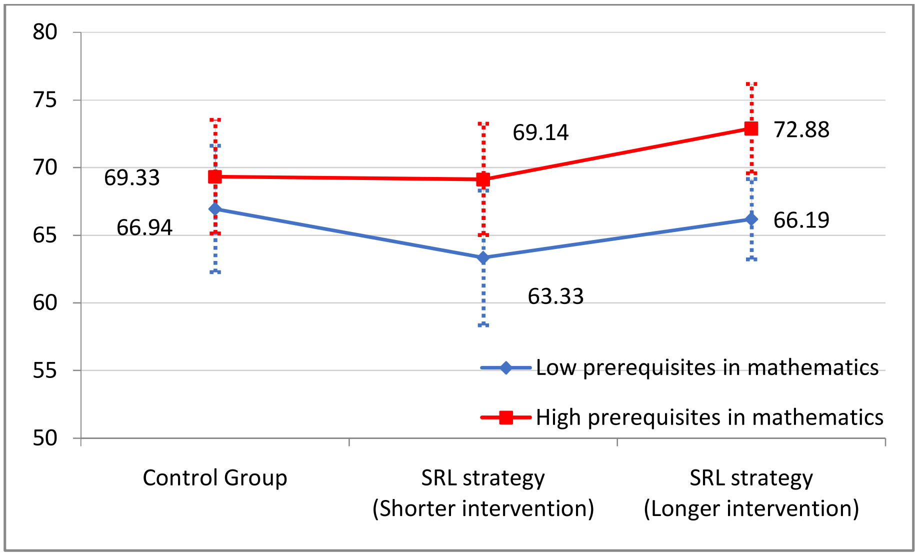

Figure 53. Line graph with error bars of self-efficacy for learning mathematics of students with high and low prerequisites in mathematics in the of experimental and control groups

The line graph (Figure 53) illustrates that the self-efficacy for learning mathematics of students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on self-efficacy for learning mathematics by their mathematical ability conception.

To check the effectiveness of self-regulated learning strategy instruction on self-efficacy for learning mathematics among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Results are given in Table 110.

Table 110

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics among Standard Nine Students by Their Mathematical ability conception

Source	Sum of Squares	df	Mean Square	*F*	Partial Eta Squared
Treatment	162.03	2	81.02	0.84	
Ability Conception	389.20	1	389.20	4.05*	0.03
Treatment * Ability Conception	645.04	2	322.52	3.35*	0.04
Error	13941.82	145	96.15		
Total	15334.97	150			

*p<.05

As shown in Table 110, significant interaction is observed between SRL strategy instruction and mathematical ability conception [F (2, 145) =3.35, $p<.05$, $\eta_p^2=0.04$] among standard nine students in their self-efficacy for learning mathematics. Effect of SRL strategy instruction on self-efficacy for learning mathematics vary by mathematical ability conception, between students with incremental or entity beliefs in mathematics.

To check the interaction of mathematical ability conception with effectiveness of SRL strategy instruction on students' self-efficacy for learning mathematics among standard nine students, one-way ANOVAs were performed. Results are given in Table 111.

Table 111

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics Among Standard Nine Students by Their Incremental and Entity Beliefs in Mathematics

<table>
<tr><th colspan="2">Source</th><th>Sum of squares</th><th>df</th><th>Mean square</th><th>F</th><th>Partial eta squared</th></tr>
<tr><td rowspan="3">Entity beliefs</td><td>Treatment</td><td>159.49</td><td>2</td><td>79.75</td><td rowspan="2">0.84</td><td rowspan="6">0.09</td></tr>
<tr><td>Error</td><td>6937.30</td><td>73</td><td>95.03</td></tr>
<tr><td>Total</td><td>7096.79</td><td>75</td><td></td><td></td></tr>
<tr><td rowspan="3">Incremental beliefs</td><td>Treatment</td><td>671.43</td><td>2</td><td>335.71</td><td rowspan="2">3.45*</td></tr>
<tr><td>Error</td><td>7004.52</td><td>72</td><td>97.29</td></tr>
<tr><td>Total</td><td>7675.95</td><td>74</td><td></td><td></td></tr>
</table>

*p<.05

As shown in Table 111, effect of treatment on self-efficacy for learning mathematics is significant among students with incremental beliefs [F (2,72) =3.45, p<.05; η_p^2 =.09], but not among students with entity beliefs [F (2, 73) =0.84, p>.05]. Partial eta squared (η_p^2 =.09) shows that the effect of SRL strategy instruction on self-efficacy for learning mathematics of standard nine students with incremental beliefs is of small size.

Among students with incremental beliefs, mean scores of treatment groups and control groups were compared to find out if there is significant effect of treatment among groups, using t test. As there are two treatment group and one control group, each treatment group were compared each other in case of students with incremental beliefs.

Comparison of mean scores of self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Longer intervention) group and control group.

Self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Longer intervention) group is compared to the control group. The results are given in Table 112.

Table 112

Comparison of Mean Scores of Self-Efficacy for Learning Mathematics of Students with Incremental Beliefs among SRL Strategy (Longer Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	35	72.23	9.53	.13
Control	20	71.90	8.55	

As shown in Table 112, the comparison of means using t test shows that mean score of self-efficacy for learning mathematics of students with incremental belief among the SRL strategy (Longer intervention) group

(M=72.23, SD=9.53) is not significantly differ from control group (M=71.90, SD=8.55, *t*=0.13, *p*>.05).

Comparison of mean scores of self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Shorter intervention) group and control group.

Self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 113.

Table 113

Comparison of Mean Scores of Self-Efficacy for Learning Mathematics of Students with Incremental Belief among SRL Strategy (Shorter Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Shorter intervention)	20	65.35	11.53	2.04*
Control	20	71.90	8.55	

*p<.05

As shown in Table 113, the comparison of means using *t* test shows that mean score of self-efficacy for learning mathematics of students with incremental belief among the SRL strategy (Shorter intervention) group (M=65.35, SD=11.53) is significantly lower than control group (M=71.90, SD=8.55, *t*=2.04, *p*<.05).

Comparison of mean scores of self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group.

Self-efficacy for learning mathematics of students with incremental belief among SRL strategy (Longer intervention) group is compared to SRL strategy (Shorter intervention) group. The results are given in Table 114.

Table 114

Comparison of Mean Scores of Self-Efficacy for Learning Mathematics of Students with Incremental Beliefs Among SRL Strategy (Longer Intervention) Group and SRL Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	35	72.23	9.53	2.38*
SRL strategy (Shorter intervention)	20	65.35	11.53	

*p<.05

As shown in Table 114, the comparison of means using *t* test shows that mean score of self-efficacy for learning mathematics of students with incremental belief among the SRL strategy (Longer intervention) group (M=72.23, SD=9.53) is significantly higher than that of SRL strategy (Shorter intervention) group (M=65.35, SD=11.53, t=2.38, p<.05).

Overall, the three *t* tests show that the mean score of self-efficacy for learning mathematics of students with incremental belief in the SRL strategy (Shorter intervention) group is lower than that of control group and SRL strategy (Longer intervention) group.

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics by the students' mathematical ability conception graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of students with incremental and entity beliefs in mathematics in experimental groups and control groups, and is given in Figure 54.

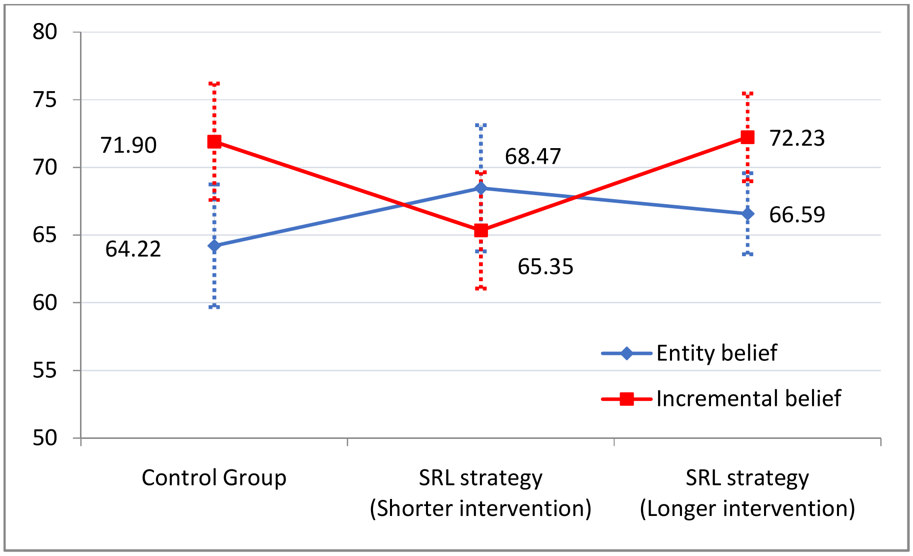

Figure 54. Line graph with error bars of self-efficacy for learning mathematics of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 54) illustrates that the self-efficacy for learning mathematics of students with incremental beliefs in the SRL strategy (Shorter intervention) group is lower than that of SRL strategy (Longer intervention) group and control group.

Effect of self-regulated learning strategy instruction on Self-efficacy for learning mathematics by their goal orientation in mathematics.

To check the effectiveness of SRL strategy instruction on self-efficacy for learning mathematics among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using posttest scores of self-efficacy for learning mathematics. Results are given in Table 115.

Table 115

Effect of SRL Strategy Instruction on Self-Efficacy for Learning Mathematics Among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*
Treatment	220.97	2	110.48	1.07
Goal orientation in mathematics	107.67	1	107.67	1.04
Treatment * Goal orientation in mathematics	73.75	2	36.88	0.36
Error	15026.86	145	103.63	
Total	15334.97	150		

As shown in Table 115, no significant interaction is observed between SRL strategy instruction and goal orientation in mathematics [F (2, 145) =0.36, p>.05] among standard nine students in their self-efficacy for learning mathematics. Effect of SRL strategy instruction on self-efficacy for learning mathematics is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics. That is, students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery Goal: M=69.70, SD=9.65 and Performance approach goal: M=68.52, SD=9.20), in the SRL strategy (Shorter intervention) group (Mastery Goal: M=68.04, SD=10.27 and Performance approach goal: M=63.82, SD=9.91) and in the control group (Mastery Goal: M=68.35, SD=10.55 and Performance approach goal: M=68.13, SD=12.92) do not differ in their self-efficacy for learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on self-efficacy for learning mathematics by the students' goal orientation in mathematics graphically, a line graph is plotted with error bars using mean scores of self-efficacy for learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental groups and control groups, and is given in Figure 55.

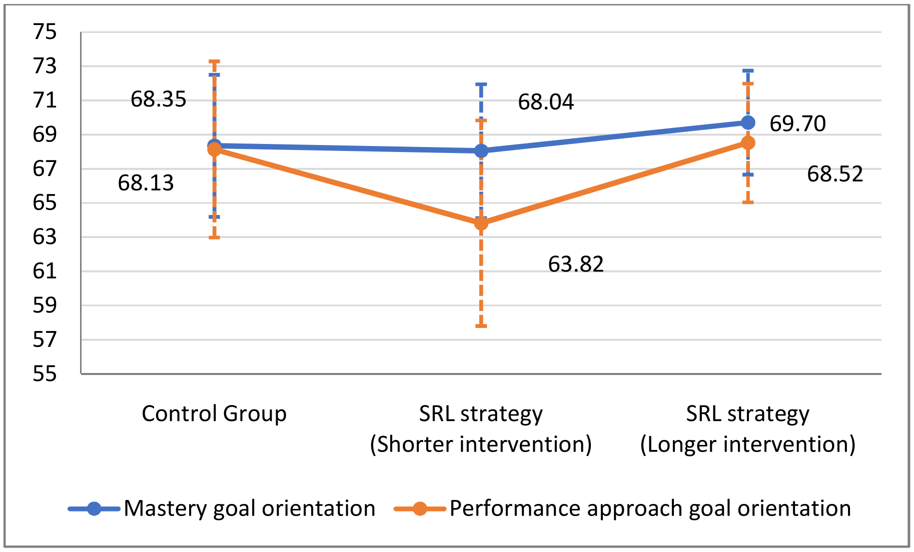

Figure 55. Line graph with error bars of self-efficacy for learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 55) illustrates that self-efficacy for learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group are not different from that of control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Task Value of Learning Mathematics

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students, ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 116.

Table 116

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students

Source of variance	Sum of squares	df	Mean square	*F*
Treatment	17.16	2	8.58	0.39
Error	3295.71	148	22.27	
Total	3312.86093	150		

As shown in Table 116, no significant effect of SRL strategy instruction has been observed on students' task value of learning mathematics [F (2, 148) =.39, *p*>.05] among standard nine students. That is, mean score of the task value of learning mathematics in the SRL strategy (Longer intervention) group (M=52.13, SD=3.75) SRL strategy (Shorter intervention) group (M=51.76, SD=4.72) and control group (M=51.32, SD=6.23) are not different from each other.

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of experimental groups and control group in Figure 56.

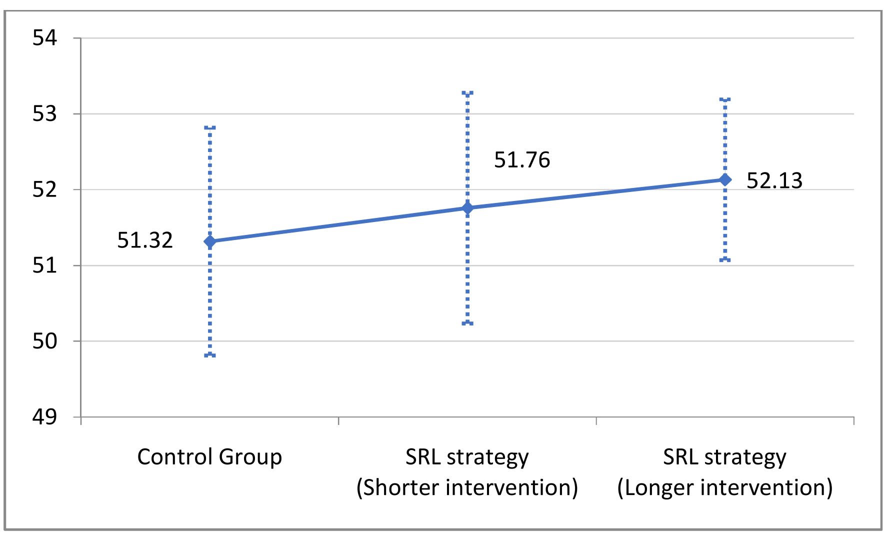

Figure 56. Line graph with error bars of task value of learning mathematics of experimental and control groups

The line graph (Figure 56) illustrates that the task value of learning mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on task value of learning mathematics by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' task value of learning mathematics among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on task value of learning mathematics by gender.

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students by gender, two-way ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 117.

Table 117

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students by Gender

Source	Sum of squares	df	Mean square	F	Partial eta squared
Treatment	9.25	2	4.62	0.24	
Gender	414.62	1	414.62	21.08**	0.13
Treatment * Gender	71.14	2	35.57	1.81	
Error	2852.01	145	19.67		
Total	3312.86	150			

**p<.01

As shown in Table 117, no significant interaction is observed between SRL strategy instruction and gender [F (2, 145) =1.81, *p*>.05] among standard nine students in their task value of learning mathematics. Effect of SRL strategy instruction on task value of learning mathematics is true for both boys and girls, that is boys and girls in SRL strategy (Longer intervention) group (Boys: M=50.97, SD=3.75 and Girls: M=53.02, SD=3.55), SRL strategy (Shorter intervention) group (Boys: M=50, SD=4.56 and Girls: M=53.10, SD=4.49) and control group (Boys: M=48.75, SD=6.77 and Girls: M=54.17, SD=4.12) do not differ in their task value of learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics by the students' gender graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of experimental groups and control group in Figure 57.

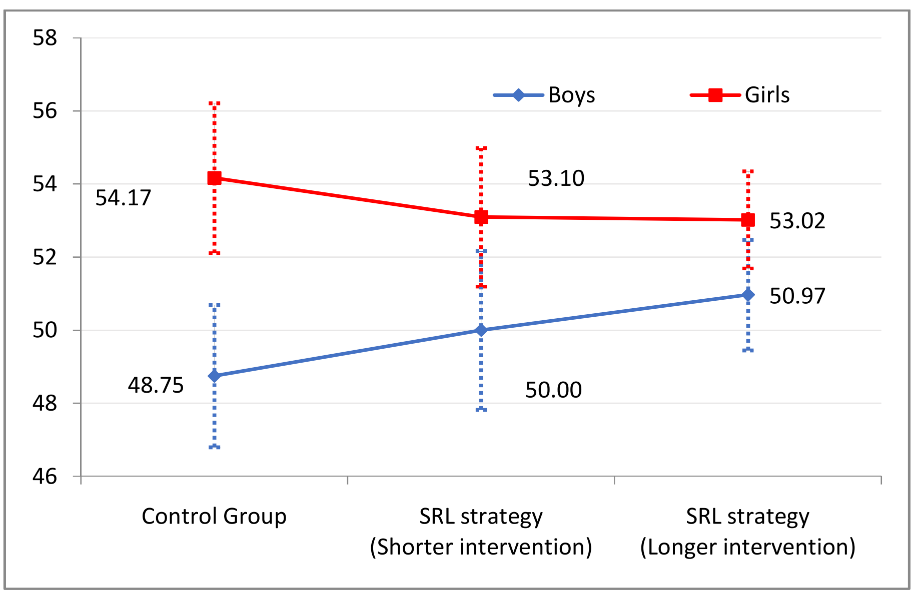

Figure 57. Line graph with error bars of task value of learning mathematics of the boys and girls in experimental and control groups

The line graph (Figure 57) illustrates that the task value of learning mathematics of boys and girls among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on task value of learning mathematics by their level of intelligence.

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students by their level of intelligence, two-way ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 118.

Table 118

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students by Their Level of Intelligence

Source	Sum of squares	df	Mean square	F	Partial eta squared
Treatment	19.02	2	9.51	0.44	
Intelligence	159.87	1	159.87	7.44**	0.05
Treatment * intelligence	23.48	2	11.74	0.55	
Error	3116.60	145	21.49		
Total	3312.86	150			

**p<.01

As shown in Table 118, no significant interaction is observed between SRL strategy instruction and intelligence [F (2, 145)=0.55, *p*>.05]among standard nine students in their task value of learning mathematics. Effect of SRL strategy instruction on task value of learning mathematics is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=52.88, SD=3.6 and Low: M=51.26, SD=3.73), in the SRL strategy (Shorter intervention) group (High: M=53.42, SD=4.75 and Low: M=50, SD=4.12) and in the control group (High: M=51.95, SD=6.52 and Low: M=50.44, SD=5.9) do not differ in their task value of learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics by students' level of intelligence graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of students with high and low nonverbal intelligence in the experimental groups and control group in Figure 58.

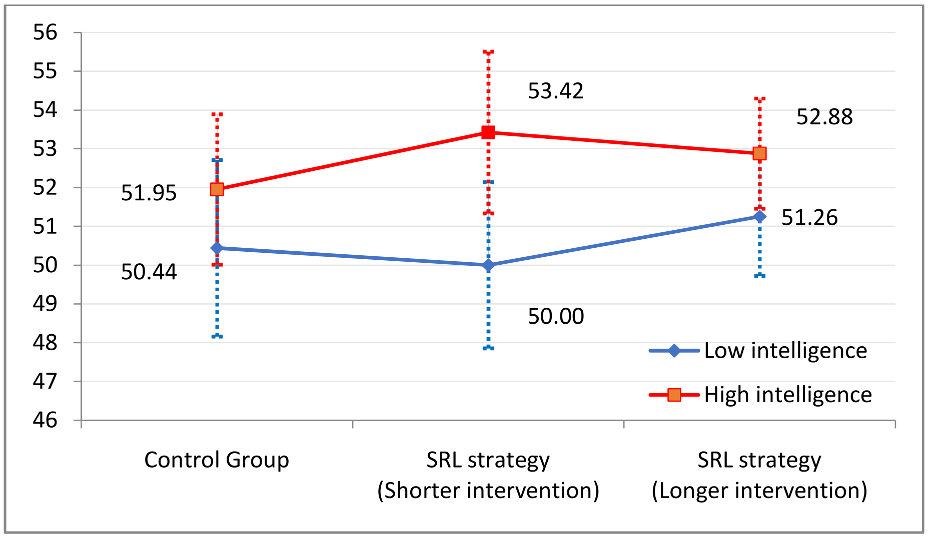

Figure 58. Line graph with error bars of task value of learning mathematics of students with high and low nonverbal intelligence in the experimental and control groups

The line graph (Figure 58) illustrates that the task value of learning mathematics of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on task value of learning mathematics by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 119.

Table 119

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	F	Partial Eta Squared
Treatment	38.15	2	19.07	0.95	
Level of prerequisites in mathematics	255.37	1	255.37	12.69**	
Treatment * Level of prerequisites in mathematics	95.80	2	47.90	2.38	0.08
Error	2918.15	145	20.13		
Total	3312.86	150			

**p<.01

As shown in Table 119, no significant interaction is observed between SRL strategy instruction and their prerequisites in mathematics [F (2, 145) =2.38, *p*>.05]among standard nine students in their task value of learning mathematics. Effect of SRL strategy instruction on task value of learning mathematics is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=53.56, SD=3.3 and Low: M=50.98, SD=3.74), in the SRL strategy (Shorter intervention) group (High: M=52.00, SD=5.23 and Low: M=51.40, SD=4.01)and in the control group (High: M=53.62, SD=4.64 and Low: M=48.47, SD=6.88) do not differ in their task value of learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics by students' level of prerequisites in mathematics graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of students with high and low prerequisites in mathematics in the experimental groups and control group in Figure 59.

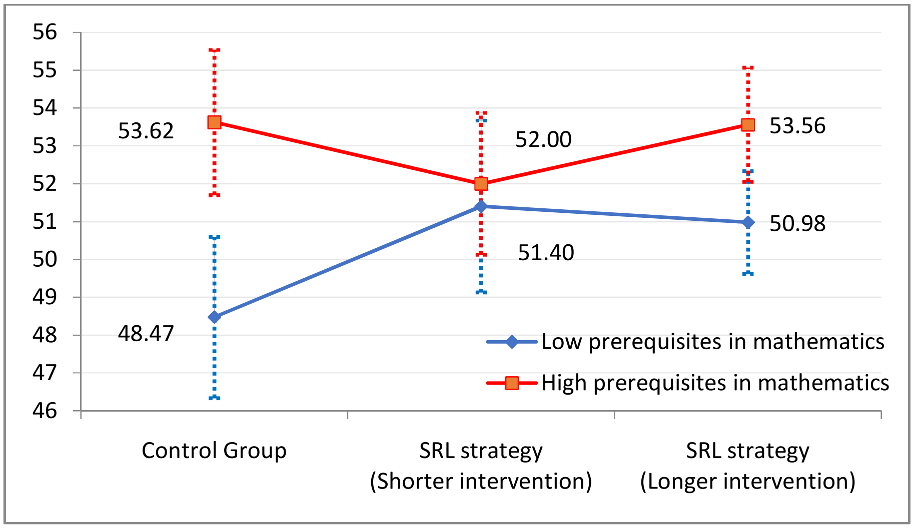

Figure 59. Line graph with error bars of task value of learning mathematics of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 59) illustrates that task value of learning mathematics of students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on task value of learning mathematics by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students by their mathematical ability conception, two-way ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 120.

Table 120

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	*F*
Treatment	22.43	2	11.21	0.52
Ability Conception	32.50	1	32.50	1.50
Treatment * Ability Conception	68.96	2	34.48	1.59
Error	3149.24	145	21.72	
Total	3312.86	150		

As shown in Table 120, no significant interaction is observed between SRL strategy instruction and their mathematical ability conception [F (2, 145) =1.59, p>.05] among standard nine students in their task value of learning mathematics. Effect of SRL strategy instruction on task value of learning mathematics is true for students both with incremental and entity beliefs in mathematics, that is, students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) group (Incremental: M=53.63, SD=3.46 and Entity: M=50.85, SD=3.55), in the SRL strategy (Shorter intervention) group (Incremental: M=51.90, SD=4.77 and Entity: M=51.59, SD=4.81) and in the control group (Incremental: M=51.25, SD=6.82 and Entity: M=51.39, SD=5.70) do not differ in their task value of learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics by the students' mathematical ability conception graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of students with incremental and entity beliefs in mathematics in experimental groups and control groups, and is given in Figure 60.

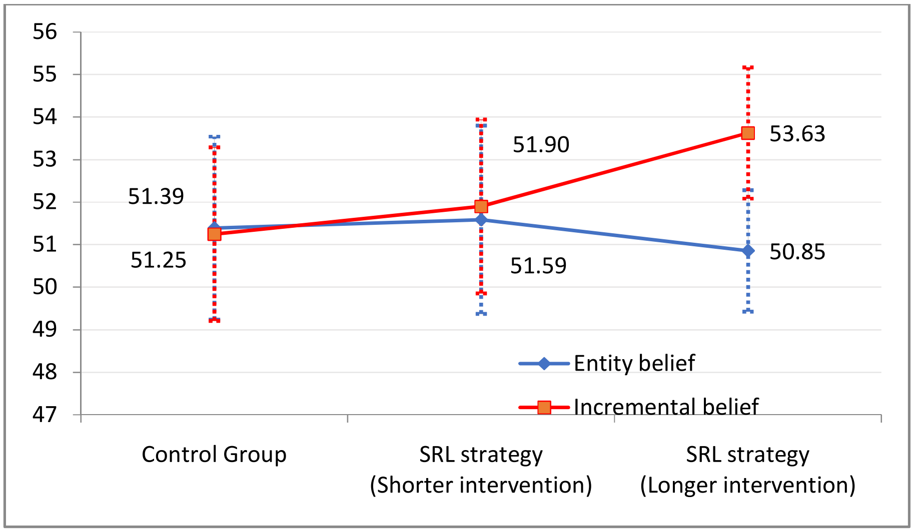

Figure 60. Line graph with error bars of task value of learning mathematics of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 60) illustrates that the task value of learning mathematics of students with incremental and entity beliefs in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group is not different from that of the control group after SRL strategy instruction.

Effect of Self-regulated learning Strategy instruction on task value of learning mathematics by their goal orientation in mathematics.

To check the effectiveness of SRL strategy instruction on task value of learning mathematics among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using posttest scores of task value of learning mathematics. Results are given in Table 121.

Table 121

Effect of SRL Strategy Instruction on Task Value of Learning Mathematics among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*
Treatment	7.91	2	3.96	0.18
Goal orientation in mathematics	5.15	1	5.15	0.23
Treatment * Goal orientation in mathematics	71.64	2	35.82	1.61
Error	3223.52	145	22.23	
Total	3312.86	150		

As shown in Table 121, no significant interaction is observed between SRL strategy instruction and their goal orientation in mathematics [F (2, 145) =1.61, p>.05] among standard nine students in their task value of learning mathematics. Effect of SRL strategy instruction on task value of learning mathematics is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics, that is students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery goal: M=52.77, SD=3.46 and Performance approach goal: M=51.30, SD=4.01), in the SRL strategy (Shorter intervention) group (Mastery goal: M=51.42, SD=5.08 and Performance approach goal: M=52.55, SD=3.83) and in the control group (Mastery goal: M=50.70, SD=6.97 and Performance approach goal: M=52.27, SD=4.96) do not differ in their task value of learning mathematics .

In order to demonstrate the effect of SRL strategy instruction on task value of learning mathematics by the students' goal orientation in mathematics graphically, a line graph is plotted with error bars using mean scores of task value of learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in experimental groups and control groups, and is given in Figure 61.

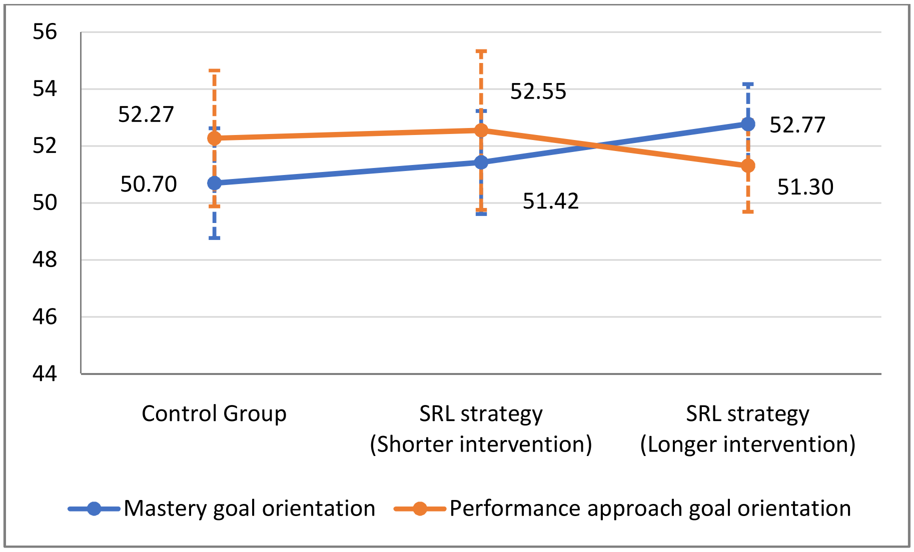

Figure 61. Line graph with error bars of task value of learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 61) illustrates that the task value of learning mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group are not different from that of control group after SRL strategy instruction.

Effect of Self-Regulated Learning Strategy Instruction on Self-Regulated Learning

To check the effectiveness of SRL strategy instruction on self-regulated learning among standard nine students, firstly ANOVA were performed using posttest scores of self-regulated learning, and then on gain scores of self-regulated learning. Results of ANOVA while checked the effectiveness of SRL strategy instruction using post test scores of self-regulated learning strategy are given in Table 122.

Table 122

Effect of SRL Strategy Instruction on Self-Regulated Learning among Standard Nine Students

Source of variance	Sum of squares	df	Mean square	*F*
Treatment	219.62	2	109.81	0.44
Error	36717.81	148	248.09	
Total	36937.43	150		

As shown in Table 122, no significant effect of SRL strategy instruction has been observed on students' self-regulated learning [F (2, 148) =.44, p>.05] among standard nine students.

Then ANOVA is performed again on the gain scores of self-regulated learning. Results of ANOVA among the groups with respect to gain score of self-regulated learning use were given in Table 123.

Table 123

Effect of SRL Strategy Instruction on Self-Regulated Learning (Gain Score) among Standard Nine Students

Source of variance	Sum of squares	df	Mean square	*F*	Partial eta squared
Treatment	724.97	2	362.48	3.34*	0.04
Error	16041.13	148	108.39		
Total	16766.09	150			

*p<.05

As shown in Table 123, significant effect of SRL strategy instruction has been observed on gain scores of self-regulated learning [F (2, 148) =3.34, p<.05; η_p^2 =.04] among standard nine students.

The mean gain scores of treatment groups and control groups were compared using *t* test to find out if there is significant effect of treatment on gain scores of self-regulated learning among groups.

Comparison of mean of gain scores of self-regulated learning among SRL strategy (Longer intervention) group and control group.

Gain scores of self-regulated learning of SRL strategy (Longer intervention) group is compared to that of control group. The results are given in Table 124.

Table 124

Comparison of Mean Gain Scores of Self-Regulated Learning among SRL Strategy (Longer Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	76	13.61	10.62	2.49*
Control	38	8.32	10.85	

*P<0.05

As shown in Table 124, the comparison of means using *t* test shows that mean gain scores of self-regulated learning of the SRL strategy (Longer intervention) group (M=13.61, SD=10.62) is significantly higher than that of control group (M=8.32, SD=10.85, t=2.49, p<.05).

Comparison of mean gain scores of self-regulated learning among SRL strategy (Shorter intervention) group and control group.

Gain scores of self-regulated learning of SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 125.

Table 125

Comparison of Mean Gain Scores of Self-Regulated Learning among SRL Strategy (Shorter Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Shorter intervention)	37	11.08	9.46	1.18
Control	38	8.32	10.85	

As shown in Table 125, the comparison of means using *t* test shows that there is no significant difference between the mean gain scores of self-regulated learning of the SRL strategy (Shorter intervention) group (M=11.08, SD=9.46) and control group (M=8.32, SD=10.85, *t*=1.18, *p*>.05).

Comparison of mean gain scores of self-regulated learning among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group.

Gain scores of self-regulated learning of SRL strategy (Longer intervention) group is compared to that of SRL strategy (Shorter intervention) group. The results are given in Table 126.

Table 126

Comparison of Mean Gain Scores of Self-Regulated Learning among SRL Strategy (Longer Intervention) Group SRL and Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention) group	76	13.61	10.62	1.23
SRL strategy (Shorter intervention) group	37	11.08	9.46	

As shown in Table 126, the comparison of means using *t* test shows that there is no significant difference between the mean gain scores of self-regulated learning of the SRL strategy (Longer intervention) group (M=13.61, SD=10.62) and SRL strategy (Shorter intervention) group (M=11.08, SD=9.46, *t*=1.23, *p*>.05).

Overall, the three *t* tests show that, the mean gain scores of self-regulated learning of the control group and SRL strategy (Shorter intervention) group is significantly lower than that of SRL strategy (Longer intervention) group.

In order to demonstrate the effect of SRL strategy instruction on gain scores of self-regulated learning graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning of experimental groups and control group in Figure 62.

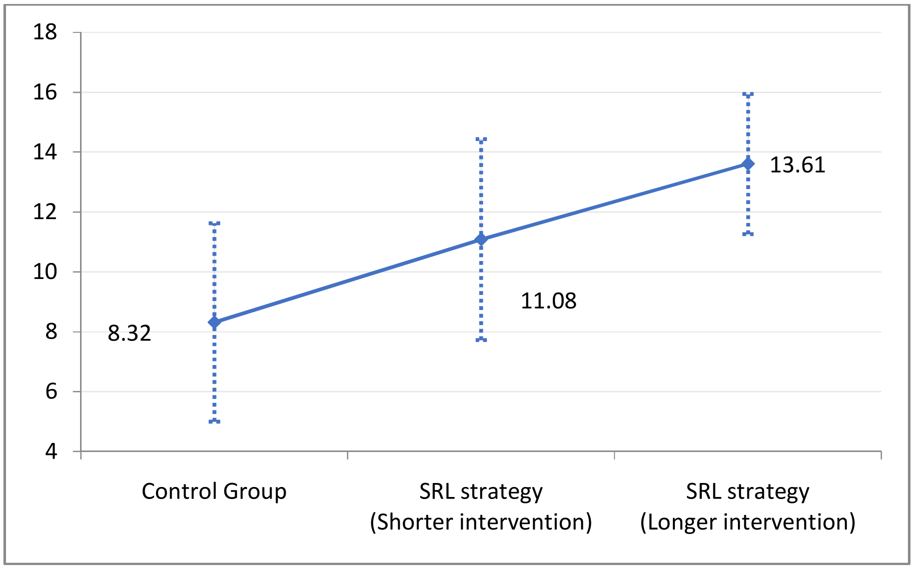

Figure 62. Line graph with error bars of gain scores of self-regulated learning of experimental and control groups

The line graph (Figure 62) illustrates that the self-regulated learning among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on Self-regulated learning by level of control and moderator variables.

To check the effectiveness of SRL strategy instruction on students' Self-regulated learning among standard nine students, with respect to their gender, level of intelligence, level of prerequisites in mathematics, mathematical ability conception and goal orientation in mathematics, two-way ANOVAs were performed. Results are given in the following sections.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning by gender.

To check the effectiveness of SRL strategy instruction on self-regulated learning among standard nine students by gender, two-way ANOVA was performed using gain scores of self-regulated learning. Results are given in Table 127.

Table 127

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning among Standard Nine Students by Gender

Source	Sum of Squares	df	Mean Square	*F*	Partial eta squared
Treatment	848.15	2	424.07	4.05*	0.05
Gender	127.71	1	127.71	1.22	
Treatment * Gender	671.78	2	335.89	3.21*	0.04
Error	15168.76	145	104.61		
Total	16766.09	150			

*p<.05

As shown in Table 127, there is significant interaction between SRL strategy instruction and gender [F (2, 145) =3.21, $p<.05$; η_p^2 =.04] among standard nine students in their gain in self-regulated learning. Effect of SRL strategy instruction on gain in self-regulated learning in mathematics vary by gender.

To check the interaction of gender with effectiveness of SRL strategy instruction on students' gain in self-regulated learning among standard nine students, one-way ANOVAs were performed. Results are given in following three sections.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning among boys and girls.

To check the effectiveness of SRL strategy instruction on gain of self-regulated learning among boys and girls in standard nine one-way ANOVA was performed. Results are given in Table 128.

Table 128

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning among Boys and Girls in Standard Nine

Source		Sum of squares	df	Mean square	*F*	Partial eta squared
Boys	Treatment	539.68	2	269.84	2.55	0.10
	Error	6985.63	66	105.84		
	Total	7525.30	68			
Girls	Treatment	908.50	2	454.25	4.39*	
	Error	8183.13	79	103.58		
	Total	9091.62	81			

*p<.05

As shown in Table 128, effect of treatment on gain in self-regulated learning in mathematics is significant among girls [F (2,79) =4.39, p<.05; η_p^2 =0.10], but not among boys [F (2, 66) =2.55, p>.05]. Partial eta squared (η_p^2 =.10) shows that the effect of SRL strategy instruction on gain in self-regulated learning in mathematics of standard nine girl students is of small size.

Among girls, mean scores of treatment groups and control groups were compared using *t* test to find out if there is significant effect of treatment among groups. As there are two treatment groups and one control group, each treatment group were compared each other in case of girls.

Comparison of mean gain scores of self-regulated learning in mathematics of girls among SRL strategy (Longer intervention) group and control group.

Gain in self-regulated learning in mathematics of girls among SRL strategy (Longer intervention) group is compared to the control group. The results are given in Table 129.

Table 129

Comparison of Mean Gain Scores of Self-Regulated Learning in Mathematics of Girls among SRL Strategy (Longer Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	43	12.23	10.12	2.77**
Control	18	4.50	9.49	

**p<.01

As shown in Table 129, the comparison of means using *t* test shows that mean gain score of self-regulated learning in mathematics of girls among the SRL strategy (Longer intervention) group (M=12.23, SD=10.12) is significantly higher than that of control group (M=4.50, SD=9.49, *t*= 2.77, *p*<.01).

Comparison of mean gain scores of self-regulated learning in mathematics of girls among SRL strategy (Shorter intervention) group and control group.

Gain in self-regulated learning in mathematics of girls among SRL strategy (Shorter intervention) group is compared to that of control group. The results are given in Table 130.

Table 130

Comparison of Mean Gain Scores of Self-Regulated Learning in Mathematics of Girls among SRL Strategy (Shorter Intervention) Group and Control Group

Treatment	N	Mean	Std. Deviation	t
SRL strategy (Shorter intervention)	21	13.05	10.84	2.60**
Control	18	4.50	9.49	

**p<.01

As shown in Table 130, the comparison of means using *t* test shows that mean gain score of self-regulated learning in mathematics of girls among the SRL strategy (Shorter intervention) group (M=13.05, SD=10.84) is significantly higher than that of the control group (M=4.50, SD=9.49, *t*= 2.60, *p*<.01).

Comparison of mean gain scores of self-regulated learning in mathematics of girls among SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group.

Gain in self-regulated learning in mathematics of girls among SRL strategy (Longer intervention) group is compared to SRL strategy (Shorter intervention) group. The results are given in Table 131.

Table 131

Comparison of Mean Gain Scores of Self-Regulated Learning in Mathematics of Girls among SRL Strategy (Longer Intervention) Group and SRL Strategy (Shorter Intervention) Group

Treatment	N	Mean	Std. Deviation	*t*
SRL strategy (Longer intervention)	43	12.23	10.12	.30
SRL strategy (Shorter intervention)	21	13.05	10.84	

As shown in Table 131, the comparison of means using *t* test shows that mean gain score of self-regulated learning in mathematics of girls among the SRL strategy (Longer intervention) group (M=12.23, SD=10.12) is not significantly differ from SRL strategy (Shorter intervention) group (M=13.05, SD=10.84, t= .30, p>.05).

Overall, the three *t* tests show that the mean gain in self-regulated learning in mathematics of girls the SRL strategy (Longer intervention) group and SRL strategy (Shorter intervention) group are significantly higher than that of control group.

In order to demonstrate the effect of SRL strategy instruction on self-regulated learning in mathematics by the students' gender graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning of boys and girls in the two experimental groups and control group, and given in Figure 63.

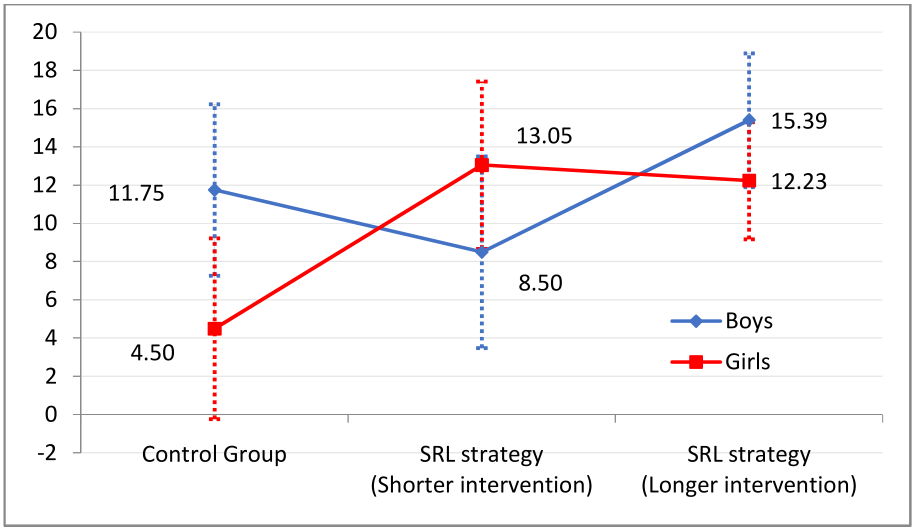

Figure 63. Line graph with error bars of self-regulated learning in mathematics of the boys and girls in the experimental and control groups.

The line graph (Figure 63) illustrates that the SRL strategy instruction is effective for improving self-regulated learning in mathematics of girls of SRL strategy (Longer intervention) group, and SRL strategy (Shorter intervention) group.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning by their level of intelligence.

To check the effectiveness of SRL strategy instruction on self-regulated learning in mathematics among standard nine students by their level of intelligence, two-way ANOVA was performed using gain scores of self-regulated learning in mathematics. Results are given in Table 132.

Table 132

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning Among Standard Nine Students by Their Level of Intelligence

Source	Sum of Squares	df	Mean Square	*F*	Partial eta squared
Treatment	600.61	2	300.31	2.79*	0.04
Intelligence	301.34	1	301.34	2.80	
Treatment * Intelligence	214.63	2	107.31	1.00	
Error	15631.87	145	107.81		
Total	16766.09	150			

*p<.05

As shown in Table 132, no significant interaction is observed between SRL strategy instruction and intelligence [F (2, 145) =1, *p*>.05] among standard nine students in their gain of self-regulated learning in mathematics. Effect of SRL strategy instruction on gain of self-regulated learning is true for students both high and low on nonverbal intelligence, that is students with high and low nonverbal intelligence in the SRL strategy (Longer intervention) group (High: M=13.51, SD=10.36 and Low: M=13.71, SD=11.07) improved their use of self-regulated learning in mathematics than those in the SRL strategy (Shorter intervention) group (High: M=9.74, SD=10.15 and Low: M=9.74, SD=8.82) and in the control group (High: M=5.77, SD=9.72 and Low: M=11.81, SD=11.64).

In order to demonstrate the effect of SRL strategy instruction on self-regulated learning in mathematics by students' level of intelligence graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning in mathematics of students with high and low nonverbal intelligence in experimental groups and control groups, and is given in Figure 64.

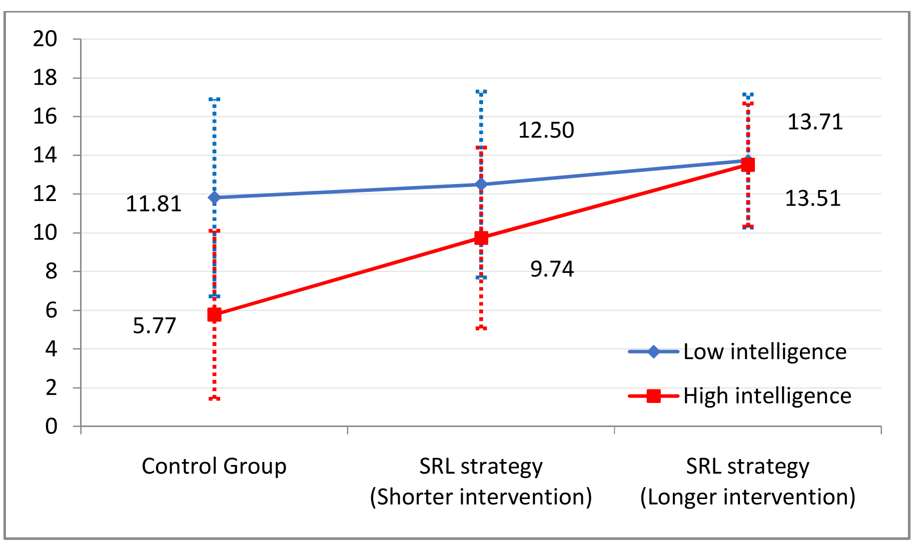

Figure 64. Line graph with error bars of self-regulated learning in mathematics of students with high and low nonverbal intelligence in the experimental and control groups

The line graph (Figure 64) illustrates that self-regulated learning in mathematics of students with high and low nonverbal intelligence among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning by their level of prerequisites in mathematics.

To check the effectiveness of SRL strategy instruction on self-regulated learning among standard nine students by their level of prerequisites in mathematics, two-way ANOVA was performed using gain scores of self-regulated learning in mathematics. Results are given in Table 133.

Table 133

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning among Standard Nine Students by Their Level of Prerequisites in Mathematics

Source	Sum of Squares	df	Mean Square	*F*	Partial eta squared
Treatment	649.77	2	324.88	2.97*	0.04
Level of prerequisites in mathematics	153.63	1	153.63	1.40	
Treatment * Level of prerequisites in mathematics	7.67	2	3.84	0.04	
Error	15881.87	145	109.53		
Total	16766.09	150			

*p<.05

As shown in Table 133, no significant interaction was observed between SRL strategy instruction and prerequisites in mathematics [F (2, 145) =0.04, p>.05] among standard nine students in their gain of self-regulated learning. Effect of SRL strategy instruction on gain of self-regulated learning is true for students both high and low prerequisites in mathematics, that is students with high and low prerequisites in mathematics in the SRL strategy (Longer intervention) group (High: M=12.70, SD=11.23 and Low: M=14.33, SD=10.18) improved their use of self-regulated learning in mathematics than those in the SRL strategy (Shorter intervention) group (High: M=10.23, SD=10.15 and Low: M=12.33, SD=8.53) and in the control group (High: M=7.1, SD=11.95 and Low: M=9.82, SD=9.46).

In order to demonstrate the effect of SRL strategy instruction on self-regulated learning in mathematics by students' level of prerequisites graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning in mathematics of students with high and low prerequisites in mathematics in experimental groups and control groups, and is given in Figure 65.

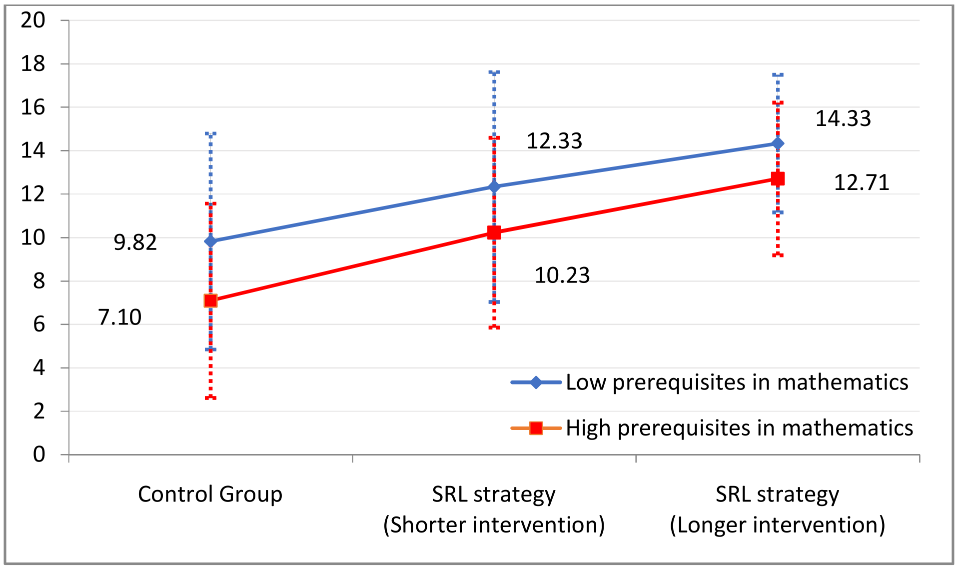

Figure 65. Line graph with error bars of self-regulated learning in mathematics of students with high and low prerequisites in mathematics in the experimental and control groups

The line graph (Figure 65) illustrates that the self-regulated learning of students with high and low prerequisites in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning by their mathematical ability conception.

To check the effectiveness of SRL strategy instruction on self-regulated learning among standard nine students by their mathematical ability conception, two-way ANOVA was performed using gain scores of self-regulated learning. Results are given in Table 134.

Table 134

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning among Standard Nine Students by Their Mathematical Ability Conception

Source	Sum of Squares	df	Mean Square	*F*	Partial eta squared
Treatment	766.32	2	383.16	3.54*	0.05
Ability Conception	6.59	1	6.59	0.06	
Treatment * Ability Conception	302.01	2	151.00	1.40	
Error	15683.06	145	108.16		
Total	16766.09	150			

*p<.05

As shown in Table 134, no significant interaction is observed between SRL strategy instruction and their mathematical ability conception [F (2, 145) =1.40, *p*>.05] among standard nine students in their gain of self-regulated learning. Effect of SRL strategy instruction on gain of self-regulated learning is true for students both with incremental and entity beliefs in mathematics, that is students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) group (Incremental: M=15.46, SD=12.25 and Entity: M=12.02, SD=8.85) improved their use of self-regulated learning in mathematics than those in the SRL strategy (Shorter intervention) group (Incremental: M=9.45, SD=8.94 and Entity: M=13, SD=9.96) and in the control group (Incremental: M=9, SD=12.60 and Entity: M=7.56, SD=8.81).

In order to demonstrate the effect of SRL strategy instruction on self-regulated learning in mathematics by the students' mathematical ability conception graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning of students with incremental and entity beliefs in mathematics in experimental groups and control groups, and is given in Figure 66.

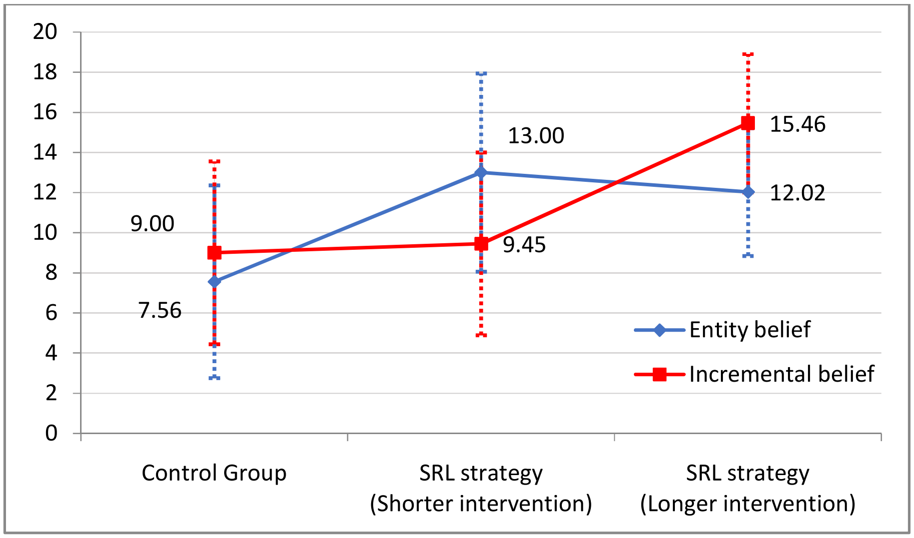

Figure 66. Line graph with error bars of self-regulated learning in mathematics of students with incremental and entity beliefs in mathematics in the experimental and control groups

The line graph (Figure 66) illustrates that the self-regulated learning in mathematics of students with incremental and entity beliefs in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Effect of self-regulated learning strategy instruction on students' gain in self-regulated learning by their goal orientation in mathematics

To check the effectiveness of SRL strategy instruction on self-regulated learning among standard nine students by their goal orientation in mathematics, two-way ANOVA was performed using gain scores of self-regulated learning. Results are given in Table 135.

Table 135

Effect of SRL Strategy Instruction on Gain of Self-Regulated Learning among Standard Nine Students by Their Goal Orientation in Mathematics

Source	Sum of Squares	df	Mean Square	*F*
Treatment	611.16	2	305.58	2.85
Goal orientation in mathematics	9.56	1	9.56	0.09
Treatment * Goal orientation in mathematics	454.25	2	227.13	2.12
Error	15563.81	145	107.34	
Total	16766.09	150		

As shown in Table 135, no significant interaction is observed between SRL strategy instruction and their goal orientation in mathematics [F (2, 145) =2.12, *p*>.05] among standard nine students in their gain of self-regulated learning in mathematics. Effect of SRL strategy instruction on gain of self-regulated learning is true for students both with mastery goal orientation, and performance approach goal orientation in mathematics, that is students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) group (Mastery goal: M=15.28, SD=11.25 and Performance approach goal: M=11.42, SD=9.46) improved their use of self-regulated learning in mathematics than those in the SRL strategy (Shorter intervention) group (Mastery goal: M=9.57, SD=8.46 and Performance approach goal: M=14.63, SD=11.11) and in the control group (Mastery goal: M=8.13, SD=11.25 and Performance approach goal: M=8.60, SD=10.59).

In order to demonstrate the effect of SRL strategy instruction on self-regulated learning in mathematics by the students' goal orientation in mathematics graphically, a line graph is plotted with error bars using mean gain scores of self-regulated learning of students with mastery goal orientation, and performance approach goal orientation in experimental groups and control groups, and is given in Figure 67.

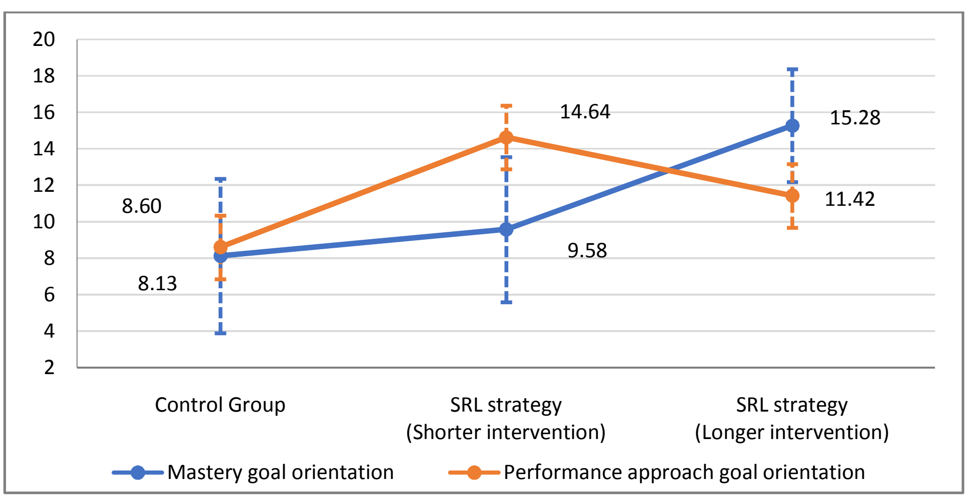

Figure 67. Line graph with error bars of self-regulated learning in mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental and control groups

The line graph (Figure 67) illustrates that self-regulated learning in mathematics of students with mastery goal orientation, and performance approach goal orientation in mathematics among SRL strategy (Longer intervention) group is higher than that of SRL strategy (Shorter intervention) group and control group after SRL strategy instruction.

Summary of Findings on Effect of Self-Regulated Learning Strategy Intervention on Achievement in Mathematics among High School Students in Kerala

SRL strategy instruction (Longer intervention) improve students' achievement in cognitive domain, such as achievement in mathematics, fractions, and pairs of equations. It enhanced use of SRL strategies by students in their learning process. But SRL strategy instruction (Longer intervention) failed to improve affective domain achievements such as task value and self-efficacy in learning mathematics. This was generally true for boys and girls, students with high and low on intelligence, high and low prerequisites incremental and entity beliefs, mastery and performance approach goal orientations. However use of SRL strategies in their learning process could not be enhanced among boys. Self-efficacy for learning mathematics could not be enhanced among students with entity beliefs. Notably SRL strategy (Shorter intervention) did not enhance neither cognitive nor affective or strategic outcomes of learning mathematics in high schools.

Chapter V

SUMMARY, MAJOR FINDINGS, AND SUGGESTIONS

- *Restatement of the Problem*
- *Variables of the Study*
- *Hypotheses of the Study*
- *Methodology in Brief*
- *Major Findings of the study*
- *Tenability of the Hypotheses*
- *Limitations of the Study*
- *Discussion of Findings*
- *Educational Implications*
- *Conclusion*
- *Suggestions for Further Research*

This chapter presents an overview of the important aspects of the study, procedure of the study, summary of results and findings, implications of the study and suggestions for further research.

Restatement of the Problem

This study entitled as "Enhancing Achievement through Evidence Based Self-Regulatory Intervention on Student Difficulties in High School Mathematics"

It probed the affective and strategic difficulties in learning mathematics among high school students in Kerala to develop a self-regulatory learning intervention that was imparted through guided and self-practice in classroom. The study verified the impact of this SRL instruction on achievement and self-efficacy in the chapters namely fractions and pairs of linear equations of standard 9 mathematics. It further verified whether the SRL instruction provided for two differing durations impacts the extent of task values, self-efficacy in learning mathematics and self-regulated leaning in mathematics of these students. The effect of self-regulatory learning instruction on the above variables were studied by the levels of nonverbal intelligence, prerequisites in mathematics, ability conceptions, goal orientations and gender.

Variables of the Study

The independent and dependent variables of the study were as follows:

1. Independent variable in the study is self-regulated learning strategy intervention.
2. Dependent variables of the study are achievement in mathematics in terms of,

a. *Achievement in mathematics*
b. *Achievement in fractions*
c. *Achievement in pairs of equations*
d. *Self-efficacy for learning mathematics*
e. *Self-efficacy for learning fractions*
f. *Self-efficacy for learning systems of linear equations*
g. *Task value of learning mathematics*
h. *Self-regulated learning*

3. Control variables of the study are nonverbal intelligence, prerequisites in mathematics, gender and teacher.
4. Moderator variable considered in the study are mathematical ability conception and mathematical goal orientation.

Hypotheses of the Study

Hypotheses of this study were the following:

1. Students' feeling of difficulty in mathematics is significantly dependent on their
   i. Motivational factors
   ii. Learning strategies
2. Intervention on Self-Regulatory Learning significantly enhances high school students'
   i. Achievement in fractions
   ii. Self-efficacy for learning fractions
3. Intervention on Self-Regulatory Learning significantly enhances high school students'
   (i) Achievement in pairs of equations

(ii) Achievement in mathematics

(iii) Self-efficacy for learning systems of linear equations

(iv) Self-efficacy for learning mathematics

(v) Task value of learning mathematics

(vi) Use of self-regulated learning

4. Intervention on Self-Regulatory Learning significantly enhances high school students'

    (i) Achievement in fractions

    (ii) Self-efficacy for learning fractions

    equally for

    a) Boys and girls
    b) High and low levels of nonverbal intelligence
    c) High and low levels of prerequisites in mathematics
    d) Mathematical ability conceptions
    e) Goal orientations in mathematics

5. Intervention on self-regulatory learning significantly enhances high school students'

    (i) Achievement in pairs of equations

    (ii) Achievement in mathematics

    (iii) Self-efficacy for learning systems of linear equations

    (iv) Self-efficacy for learning mathematics

    (v) Task value of learning mathematics

    (vi) Use of self-regulated learning

    equally for

    a) Short and long interventions
    b) Boys and girls
    c) High and low levels of nonverbal intelligence

d) High and low levels of prerequisites in mathematics

e) Mathematical ability conceptions

f) Goal orientations in mathematics

Methodology in Brief

A mixed method involving qualitative and quantitative phases in an embedded sequential design was used. Accordingly, it had two phases. First was a survey phase, the latter being an experimental phase.

Phase I: Survey phase.

This exploratory phase using a Questionnaire on student perception of mathematics administered in a semi structured focus group interview among five hundred high school students from Malappuram, and Kozhikode district identified and categorized causal factors that make mathematics learning difficult. Based on these factors, a self-regulated learning strategy focusing on helping students solve their difficulties is developed,after this phase.

Phase II: Experimental phase.

This phase followed a pretest-posttest-control group design.

1. Four intact classes were selected for the experiment, after matching them in prior achievement and nonverbal intelligence.
2. Then they were randomly assigned to two experimental groups and two control groups.
3. The evidence based self-regulatory intervention is done by two stages along with content instruction of two chapters (1. Fractions and 2. Pairs of equations). Content instruction of the two chapters in all groups were done using constructivist instructional strategy.

i. In the first stage, two experimental groups were given self-regulated learning strategy instruction along with content instruction of the chapter fractions.

ii. In the second stage one more group from the previously control groups also was given self-regulated learning strategy instruction (the stage one experimental groups continued self-regulated learning strategy as self-practice along with the content instruction of chapter pairs of equations.)

4. Effectiveness of the intervention is checked afterwards with respect to all dependent variables.

Sample

The survey is conducted on a random sample of 500 ninth standard students from twelve schools of Malappuram and Kozhikode districts.

For the standardization of the tools developed for the study, sample was 370 ninth standard students.

For the experimental study, students in four intact ninth standard classrooms, from Oriental Higher Secondary School, Tirurangadi, Malappuram were the sample. There were total 151 students. These groups were matched on nonverbal intelligence and test of prerequisites in Mathematics.

Tools used for the Study

As the study focused on the difficulties, tools used for the study are:

1. Questionnaire on student perception of mathematics
2. Raven's standard progressive matrices
3. Test of prerequisites in mathematics
4. Mathematical goal orientation inventory (Middleton & Midgley, 1997)

5. Achievement test in fractions
6. Achievement test in pairs of equations
7. Scale of self-efficacy for learning mathematics
8. Scale of self-efficacy for learning fractions
9. Scale of self-efficacy for learning systems of linear equations
10. Scale of mathematical ability conception
11. Scale of task value of learning mathematics
12. Self-regulated learning strategy questionnaire
13. Lesson plans for self-regulatory intervention.
14. Lesson plans based on constructivism (for chapters on fractions and linear equations).

Design of the Quasi-experiment Used

The pretest posttest control group design used in the study can be denoted as follows.

		Stage 1		Stage 2	
G_1	O_1	$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$	O_5	$X_{SRL\text{-}SP\text{-}C(T)}$	O_9
G_2	O_2	$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$	O_6	$X_{SRL\text{-}SP\text{-}C(E)}$	O_{10}
G_3	O_3	$C_{(E)}$	O_7	$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$	O_{11}
G_4	O_4	$C_{(T)}$	O_8	$C_{(E)}$	O_{12}

G_1, G_2, G_3, G_4– are intact groups matched on Nonverbal intelligence and Prerequisites in mathematics.

$X_{SRL\text{-}GP\text{-}L\text{-}C(E)}$ - SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by experimenter)

$X_{SRL\text{-}GP\text{-}L\text{-}C(T)}$ - SRL strategy instruction (Guided Practice-Longer intervention) + Content instruction (by teacher)

$C_{(E)}$ - Content instruction (by experimenter)

$C_{(T)}$ -	Content instruction (by teacher)
$X_{SRL\text{-}SP\text{-}C(T)}$ -	SRL strategy self-practice + Content instruction (by teacher)
$X_{SRL\text{-}SP\text{-}C(E)}$ -	SRL strategy self-practice + Content instruction (by experimenter)
$X_{SRL\text{-}GP\text{-}S\text{-}C(T)}$ -	SRL strategy instruction (Guided Practice-Shorter intervention) + Content instruction (by teacher)
$C_{(E)}$ -	Content instruction (by experimenter)
O_1, O_2, O_3, O_4 -	Pretests on mathematical ability conception, goal orientation in mathematics, achievement in fractions, achievement in pairs of equation, self-efficacy for learning fractions, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value for learning mathematics, use of self-regulatory learning.
O_5, O_6, O_7, O_8 -	Posttests on achievement in fractions and Self-efficacy for learning fractions
O_9, O_{10}, O_{11}, O_{12} -	Posttests on achievement in pairs of equation, self-efficacy for learning systems of linear equations, self-efficacy for learning mathematics, task value for learning mathematics, use of self-regulatory learning.

Statistical Techniques Used

In addition to the basic descriptive statistics, the following statistical techniques were used.

1) Chi-square test of association
2) Z test for comparing two population proportions
3) Shapiro-Wilk test of normality

4) Levene's test of homogeneity of variances
5) One-way and two-way analyses of variance (ANOVA)
6) Kruskal–Wallis test
7) Test of significance of difference between means
8) Estimation of effect size, partial eta-squared

Major Findings of the Study

The findings of the study can be summarized as follows.

1) Perception of mathematics as difficult and disliked subject among significant share of students in Kerala is dependent on the affective and strategic deficits in learning it

Mathematics is at the same time the third most liked subject in school and the subject disliked by most number of students in Kerala. Mathematics has been described as a very difficult subject by 40.2% of students. The like or dislike towards mathematics are gender dependent, that is, with more girls liking it and more boys disliking it. Students attribute their liking to ease of the subject, easiness to score high marks, and its value in developing higher thought processes. Students attribute their dislike to repeated failures in mathematics, regular external help needed to learn, and their ignorance of how to learn mathematics.

Among five possible reasons, that makes mathematics learning easy, a good portion of the students identify good teaching will make mathematics learning easier (68.6%) over other reasons like easy to understand (13.6%), easiness of mathematics (13.8%), availability of tuition (22.2%), and like towards mathematics (32.8%).

2) Students have less than required prerequisite knowledge and they use surface strategies and these impacts their perception of mathematics as difficult

Students are not well aware of the importance of acquiring prerequisites. Students perceive the best strategies for learning mathematics as learning beyond class works by doing exercise in the textbook or other sources (40.2%), memorizing mathematical equations (30.8%) and focusing on class notes (29%). And when preparing for exams, students follow the strategies like workout exercise from textbooks or other sources (40.8%), focusing on class notes (35.8%), memorizing mathematical equations only (20%) and 3.4% students are not at all learning for examinations.

Reasons students attribute for mathematics being difficult tends to influence their perception of best strategy (memorizing mathematical equations, focusing on class notes and learning beyond class works by doing exercise in the textbook or other sources) for learning mathematics or strategy followed by them in preparing for examinations.

Nearly 2/3 of students (62.2%) perceive themselves as backward in mathematics because of difficulty in learning and understanding classroom transactions and mathematics concepts, forgetting, lack of basics, learning that demand extensive practices, and their failure to perform well in examinations.

3) Secondary school students' feeling of difficulty in mathematics is significantly associated to their motivational factors like interest, values, self-efficacy and ability beliefs, and their learning strategies

a. Students' feeling of difficulty in mathematics has relation with their interest factors{interest [χ^2 (1, N=500) =114.94, p<.01], feeling of boredom [χ^2 (1, N=500) =74.86, p<.01], and personal interest [χ^2 (1, N=500) =28.99, p<.01]}; values {wish to learn mathematics after high school [χ^2 (1, N=500) =27.59, p<.01], personal value [χ^2 (1, N=500) =10.49, p<.01], and cost value belief [χ^2(2, N=500) =48.02, p<.01]}; self-efficacy in mathematics {incapable of learning mathematics [χ^2 (1, N=500) =26.53, p<.01], belief that "I never understand mathematics" [χ^2 (2, N=500) =47.86, p<.01], and self-efficacy for success in mathematics [χ^2 (1, N=500) =15.40, p<.01]}; and ability beliefs {every one can't learn mathematics [χ^2 (1, N=500) =23.39, p<.01], effort belief [χ^2 (2, N=500) =32.43, p<.01], a person's chance for failing or succeeding in mathematics is fixed[χ^2 (1, N=500) =13.52, p<.01] and only people with high intelligence can learn mathematics [χ^2 (2, N=500) =16.78, p<.01]}.

b. Students' feeling of difficulty in mathematics has relation with their learning strategies {handling difficult problems [χ^2 (3, N=500) =13.64, p<.01], trying only easy problems [χ^2(1, N=500) =24.49, p<.01], and having a goal for learning mathematics [χ^2(1, N=500) =16.24, p<.01]}.

4) **Self-regulated learning strategy intervention, for relatively longer duration, enhances high school students' achievements in mathematics (fractions and pairs of equations) with small to medium effect, irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, mathematical ability conception, and goal orientation in mathematics. However, short SRL intervention did not enhance achievement in pairs of equation in girls**

a. Mean scores of achievement in mathematics after self-regulated learning strategy intervention is significantly higher for SRL strategy (Longer intervention) (M=63.31, SD=17.16) than that of SRL strategy (Shorter intervention)(M=49.46, SD=16.09) and control group (M=49.78, SD=17.23) [F (2, 148) =12.36, p<.01; η_p^2 =.14] among secondary school students.

i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =1.45, p>.05] on achievement in mathematics among standard nine students. Mean score of achievement in mathematics after self-regulated learning strategy intervention of both boys and girls in the SRL strategy (Longer intervention) (M=62.64, SD=19.33 and M=63.83, SD=15.50 respectively) is higher than that of SRL strategy (Shorter intervention) (M=44.06, SD=11.90 and M=53.58, SD=17.86 respectively) and control group (M=44.43, SD=13.45 and M=55.72, SD=19.3 respectively).

ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (2, 145) =0.59, p>.05] on achievement in mathematics among standard nine students. Mean score of achievement in mathematics after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the SRL strategy (Longer intervention) (M=69.90, SD=17.36 and M=55.58, SD=13.45 respectively) is higher than that of SRL strategy (Shorter intervention) (M=53.51, SD=18.78 and M=45.18, SD=11.72 respectively) and control group (M=56.27, SD=16.56 and M=40.84, SD=14.18 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (2, 145) =0.33, p>.05] on achievement in mathematics among standard nine students. Mean score of achievement in mathematics after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the SRL strategy (Longer intervention) (M=71.73, SD=17.67 and M=40.28, SD=10.50 respectively) is higher than that of SRL strategy (Shorter intervention) (M=55.72, SD=16.40 and M=40.28, SD=10.50 respectively) and control group (M=58.66, SD=15.94 and M=38.8, SD=11.69 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [$F(2, 145) = 0.02$, $p > .05$] on achievement in mathematics among standard nine students. Mean score of achievement in mathematics after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) (M=68.84, SD=18.96 and M=58.59, SD=14.03 respectively) is higher than that of SRL strategy (Shorter intervention) (M=54.39, SD=14.8 and M=43.66, SD=16.02 respectively) and control group (M=55.18, SD=16.52 and M=43.76, SD=16.37 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [$F(2, 145) = 0.15$, $p > .05$] on achievement in mathematics among standard nine students. Mean score of achievement in mathematics after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=64.04, SD=18.27 and M=62.37, SD=15.81 respectively) is higher than that of SRL strategy (Shorter intervention) (M=49.3, SD=15.22 and M=49.69, SD=18.79 respectively) and control group (M=51.42, SD=18.40 and M=47.24, SD=15.51 respectively).

b. Mean score of achievement in fractions after self-regulated learning strategy intervention is significantly higher for (M=9.84, SD=2.89) than that of control group (M=7.41, SD=2.57, t=5.46, $p<.01$) [F, (1, 147) =29.53, $p<.01$; $\eta_p^2=.17$] among secondary school students.

   i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (1, 147) =1.47, $p>.05$] on achievement in fractions among standard nine students. Mean score of achievement in fractions after self-regulated learning strategy intervention of both boys and girls in the experimental group (M=9.64, SD=3.4 and M=10, SD=2.46 respectively) improved their achievement in fractions than those in the control group (M=6.67, SD=2.12 and M=8.10, SD=2.78 respectively).

   ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (1, 147) =0.03, $p>.05$] on achievement in fractions among standard nine students. That is, mean score of achievement in fractions after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the experimental group (M=10.88, SD=2.86 and M=8.63, SD=2.45 respectively) improved their achievement in fractions than those in the control group (M=8.37, SD=2.5and M=8.10, SD=2.78 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (1, 147) =0.24, p>.05] on achievement in fractions among standard nine students. That is, mean score of achievement in fractions after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the experimental group (M=11.18, SD=2.81 and M=8.76, SD=2.5 respectively) improved their achievement in fractions than those in the control group (M=8.51, SD=2.42 and M=5.94, SD=1.98 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (1, 147) =0.07, p>.05] on achievement in fractions among standard nine students. That is, mean score of achievement in fractions after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the experimental group (M=10.63, SD=2.96 and M=9.17, SD=2.68 respectively) improved their achievement in fractions than those in the control group (M=8.20, SD=2.36 and M=6.51, SD=2.55 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and their goal orientation in mathematics [F (1, 147) =0, p>.05] on achievement in fractions among standard nine students. That is, mean score of achievement in fractions after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental group (M=9.93, SD=2.92 and M=9.73, SD=2.89 respectively) improved their achievement in fractions than those in the control group (M=7.49, SD=2.69 and M=7.27, SD=2.39 respectively).

c. Mean scores of achievement in pairs of equations after self-regulated learning strategy intervention is significantly higher for SRL strategy (Longer intervention) (M=10.09, SD=3.12) than that of SRL strategy (Shorter intervention) (M=8.54, SD=3.53) and control group (M=8.45, SD=3.65) [F, (2,147) =4.25, p<.01; η_p^2 =0.06] among secondary school students.

   i. A significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =3.46, p<.05, ηp2 =.05] on achievement in pairs of equations among standard nine students. Mean score of achievement in pairs of equations after self-regulated learning strategy intervention of boys in the SRL strategy (Longer intervention) (M=10.18, SD=3.22) is higher than that of SRL strategy (Shorter intervention) (M=6.90, SD=2.73) and control group (M=6.90, SD=2.73).

   ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (2, 145) =0.84, p>.05] on achievement in pairs of equations among standard nine students. Mean score of achievement in pairs of equations after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the SRL strategy (Longer intervention) (M=11.12, SD=3.21 and M=8.89, SD=2.55 respectively) is higher than that of SRL strategy (Shorter intervention) (M=8.84, SD=4.19 and M=8.22, SD=2.76 respectively) and control group (M=9.36, SD=11.70 and M=7.19, SD=3.91 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (2, 145) =0.37, p>.05] on achievement in pairs of equations among standard nine students. Mean score of achievement in pairs of equations after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the SRL strategy (Longer intervention) (M=11.38, SD=3.28 and M=9.05, SD=2.57 respectively) is higher than that of SRL strategy (Shorter intervention) (M=9.73, SD=3.68 and M=6.80, SD=2.51 respectively) and control group (M=9.95, SD=3.76 and M=6.59, SD=2.55 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (2, 145) =0.55, p>.05] on achievement in pairs of equations among standard nine students. Mean score of achievement in pairs of equations after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) (M=11.11, SD=3.59 and M=9.22, SD=2.36 respectively) is higher than that of SRL strategy (Shorter intervention) group (M=9.75, SD=3.57 and M=7.12, SD=3 respectively) and control group (M=8.95, SD=3.76 and M=7.89, SD=3.55 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (2, 145) =0.02, p>.05] on achievement in pairs of equations among standard nine students. Mean score of achievement in pairs of equations after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=10.26, SD=3.39 and M=9.88, SD=2.76 respectively) is higher than that of SRL strategy (Shorter intervention) (M=8.73, SD=3.72 and M=8.09, SD=3.18 respectively) and in the control group (M=8.61, SD=3.45 and M=8.20, SD=4.06 respectively).

5) **Self-regulated learning strategy intervention do not enhance high school students' Self-efficacy for learning mathematics, in general and fractions and systems of linear equations in specific,irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, and goal orientation in mathematics. However, self-efficacy for learning mathematics after the longer self-regulated learning strategy intervention was significantly higher than that after shorter intervention among students with incremental beliefs**

   a. Mean scores of self-efficacy for learning mathematics after self-regulated learning strategy intervention is not differ between SRL strategy (Longer intervention) (M=69.18, SD=9.42) SRL strategy (Shorter intervention) (M=66.78, SD=10.21) and control group (M=68.26, SD=11.38) [F (2, 148) =0.70, p>.05] among secondary school students.

      i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =2.11, p>.05] on self-efficacy for learning mathematics among standard nine students. Mean score of self-efficacy for learning mathematics after self-regulated learning strategy intervention of boys and girls in the SRL strategy (Longer intervention) (M=70.64, SD=10.41 and M=68.07, SD=8.54 respectively) and SRL strategy (Shorter intervention) (M=64.13, SD=7.85 and M=68.81, SD=11.47 respectively) not differ from control group (M=66.50, SD=11.86 and M=70.22, SD=10.81 respectively).

ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [$F(2, 145) = 0.20$, $p > .05$] on self-efficacy for learning mathematics among standard nine students. Mean score of self-efficacy for learning mathematics after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the SRL strategy (Longer intervention) (M=70.66, SD=8.66 and M=67.46, SD=10.08 respectively) and SRL strategy (Shorter intervention) (M=69.53, SD=11.92 and M=63.89, SD=7.29 respectively) not differ from control group (M=69.64, SD=10.14 and M=66.38, SD=12.99 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [$F(2, 145) = 0.61$, $p > .05$] on self-efficacy for learning mathematics among standard nine students. Mean score of self-efficacy for learning mathematics after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the SRL strategy (Longer intervention) (M=72.88, SD=8.78 and M=66.19, SD=8.92 respectively) and SRL strategy (Shorter intervention) (M=69.14, SD=11.31 and M=63.33, SD=7.40 respectively) not differ from control group (M=69.33, SD=10.58 and M=66.94, SD=12.48 respectively).

iv. A significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [$F(2, 145) = 3.35$, $p < .05$, $\eta p2 = 0.04$] on self-efficacy for learning mathematics among standard nine students. Mean score of self-efficacy for learning mathematics after self-regulated learning strategy intervention of students with incremental beliefs in mathematics in the SRL strategy (Longer intervention) (M=49.35, SD=13.26) and control group (M=60.85, SD=8.59) are higher than that of SRL strategy (Shorter intervention) (M=49.35, SD=13.26).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (2, 145) =0.36, p>.05] on self-efficacy for learning mathematics among standard nine students. Mean score of self-efficacy for learning mathematics after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=69.70, SD=9.65 and M=68.52, SD=9.20 respectively) and SRL strategy (Shorter intervention) (M=68.04, SD=10.27 and M=63.82, SD=9.91 respectively) not differ from control group (M=68.35, SD=10.55 and M=68.13, SD=12.92 respectively).

b. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of experimental group (M=55.95, SD=10.68) is not differ from that of control group (M=53.91, SD=11.54) [F (1, 149) =1.27, p>.05] among secondary school students.

i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (1, 147) =2.58, p>.05] on self-efficacy for learning fractions among standard nine students. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of both boys and girls in the experimental group (M=54.70, SD=11.89 and M=56.91, SD=9.69

respectively) not differ in their self-efficacy for learning fractions from those in the control group (M=49.81, SD=11.54 and M=57.69, SD=10.29 respectively).

ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (1, 147) =0.25, p>.05] on self-efficacy for learning fractions among standard nine students. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the experimental group (M=58.46, SD=8.64 and M=53.00, SD=12.14 respectively) not differ in their self-efficacy for learning fractions from those in the control group (M=57.17, SD=11.70 and M=49.97, SD=10.16 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (1, 147) =0.65, p>.05] on self-efficacy for learning fractions among standard nine students. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the experimental group (M=61.15, SD=8.64 and M=51.74, SD=10.4 respectively) not differ in their self-efficacy for learning fractions from those in the control group (M=56.74, SD=11.25 and M=50.09, SD=10.96 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (1, 147) =0.65, p>.05] on self-efficacy for learning fractions among standard nine students. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the experimental group

(M=60.46, SD=8.94 and M=52.10, SD=10.63 respectively) not differ in their self-efficacy for learning fractions from those in the control group (M=55.10, SD=12.47 and M=52.54, SD=10.38 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (1, 147) =0, p>.05] on self-efficacy for learning fractions among standard nine students. Mean score of self-efficacy for learning fractions after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the experimental group (M=56.70, SD=12.41 and M=54.97, SD=7.97 respectively) not differ in their self-efficacy for learning fractions from those in the control group (M=54.57, SD=10.58 and M=52.65, SD=13.29 respectively).

c. Mean scores of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention is not differ between SRL strategy (Longer intervention) (M=17.28, SD=2.47), SRL strategy (Shorter intervention) (M=16.57,SD=3.03), and control group (M=16.24, SD=3.5) [F (2, 148) =1.85, p>.05] among secondary school students.

i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =0.33, p>.05] on self-efficacy for learning systems of linear equations among standard nine students. Mean score of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention of boys and girls in the SRL strategy (Longer intervention) (M=17.24, SD=2.83 and M=17.30, SD=2.19 respectively) and SRL strategy (Shorter intervention) (M=16, SD=3.18 and M=17, SD=2.92 respectively) not differ from control group (M=16.15, SD=3.94 and M=16.33, SD=3.05 respectively).

ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (2, 145) =0.52, p>.05] on self-efficacy for learning systems of linear equations among standard nine students. Mean score of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the SRL strategy (Longer intervention) (M=17.61, SD=2.33 and M=16.89, SD=2.6 respectively) and SRL strategy (Shorter intervention) (M=17.42, SD=3.24 and M=15.67, SD=2.59 respectively) not differ from control group (M=16.45, SD=3.42 and M=15.94, SD=3.7 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (2, 145) =2.33, p>.05] on self-efficacy for learning systems of linear equations among standard nine students. Mean score of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the SRL strategy (Longer intervention) (M=17.97, SD=2.37 and M=16.71, SD=2.43 respectively) and SRL strategy (Shorter intervention) (M=17.09, SD=3.25 and M=15.80, SD=2.6 respectively) not differ from control group (M=15.76, SD=3.51 and M=16.82, SD=3.50 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (2, 145) =2.28, p>.05] on self-efficacy for learning systems of linear equations among standard nine students. Mean score of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) (M=17.49, SD=2.29 and M=17.10, SD=2.62 respectively) and SRL strategy (Shorter intervention) (M=16.05, SD=3.30 and M=17.18, SD=2.65 respectively) not differ from control group (M=17.05, SD=3.32 and M=15.33, SD=3.56 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (2, 145) =0.96, $p>.05$] on self-efficacy for learning systems of linear equations among standard nine students. Mean score of self-efficacy for learning systems of linear equations after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=17.42, SD=2.88 and M=17.09, SD=1.83 respectively) and SRL strategy (Shorter intervention) (M=16.62, SD=2.87 and M=16.45, SD=3.53 respectively) not differ from control group (M=15.74, SD=3.21 and M=17, SD=3.89 respectively).

6) ***Self-regulated learning strategy intervention do not enhance standard nine students' task value of learning mathematics, irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, mathematical ability conception, and goal orientation in mathematics***

a. Mean scores of task value of learning mathematics after self-regulated learning strategy intervention is not differ between SRL strategy (Longer intervention) (M=52.13, SD=3.75) SRL strategy (Shorter intervention) (M=51.76, SD=4.72) and control group (M=51.32, SD=6.23) [F (2, 148) =.39, p>.05] among secondary school students.

i. No significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =1.81, p>.05] on task value of learning mathematics. Mean score of task value of learning mathematics after self-regulated learning strategy intervention of boys and girls in the SRL strategy (Longer intervention) (M=50.97, SD=3.75 and M=53.02, SD=3.55 respectively) and SRL strategy (Shorter intervention) (M=50, SD=4.56 and M=53.10, SD=4.49 respectively) not differ from control group (M=48.75, SD=6.77 and M=54.17, SD=4.12 respectively).

ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (2, 145) =0.55, p>.05] on task value of learning mathematics. Mean score of task value of learning mathematics after self-regulated learning strategy intervention of both students high and low on nonverbal intelligence in the SRL strategy (Longer intervention) (M=52.88, SD=3.6 and M=51.26, SD=3.73 respectively) and SRL strategy (Shorter intervention) (M=53.42, SD=4.75 and M=50, SD=4.12 respectively) not differ from control group (M=51.95, SD=6.52 and M=50.44, SD=5.9 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (2, 145) =2.38, p>.05] on task value of learning mathematics. Mean score of task value of learning mathematics after self-regulated learning strategy intervention of both students high and low on prerequisites in mathematics in the SRL strategy (Longer intervention) (M=53.56, SD=3.3 and M=50.98, SD=3.74 respectively) and SRL strategy (Shorter intervention) (M=52.00, SD=5.23 and M=51.40, SD=4.01 respectively) not differ from control group (M=53.62, SD=4.64 and M=48.47, SD=6.88 respectively).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (2, 145) =1.59, p>.05] on task value of learning mathematics. Mean score of task value of learning mathematics after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) (M=53.63, SD=3.46 and M=50.85, SD=3.55 respectively) and SRL strategy (Shorter intervention) (M=51.90, SD=4.77 and M=51.59, SD=4.81 respectively) not differ from control group (M=51.25, SD=6.82 and M=51.39, SD=5.70 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (2, 145) =1.61, p>.05] on task value of learning mathematics. Mean score of task value of learning mathematics after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=52.77, SD=3.46 and M=51.30, SD=4.01

respectively) and SRL strategy (Shorter intervention) (M=51.42, SD=5.08 and M=52.55, SD=3.83 respectively) not differ from control group (M=50.70, SD=6.97 and M=52.27, SD=4.96 respectively).

7) ***Self-regulated learning strategy intervention, of relatively long duration, significantly enhances standard ninestudents' use of self-regulated learning with medium effect, in girls (but not boys), irrespective of high-low levels of nonverbal intelligence or prerequisite knowledge, mathematical ability conception, and goal orientation in mathematics***

   a. Mean scores of use of self-regulated learning in mathematics after self-regulated learning strategy intervention is significantly higher for SRL strategy (Longer intervention) (M=13.61, SD=10.62) than that of SRL strategy (Shorter intervention) (M=11.08, SD=9.46) and control group (M=8.32, SD=10.85) [F (2, 148) =3.34, p<.05; η_p^2 =.04] among standard 9 students.

      i. A significant interaction is observed between self-regulated learning strategy instruction and gender [F (2, 145) =3.21, p<.05; ηp2 =.04] on use of self-regulated learning. Mean gain score of use of self-regulated learning after self-regulated learning strategy intervention, only of girls in the SRL strategy (Longer intervention) (M=12.23, SD=10.12) and SRL strategy (Shorter intervention) (M=13.05, SD=10.84) are higher than that of control group (M=4.50, SD=9.49).

      ii. No significant interaction is observed between self-regulated learning strategy instruction and nonverbal intelligence [F (2, 145)

=1, p>.05] on use of self-regulated learning. Mean gain score of use of self-regulated learning after self-regulated learning strategy intervention of students both high and low nonverbal intelligence in the SRL strategy (Longer intervention) (M=13.51, SD=10.36 and M=13.71, SD=11.07 respectively) is higher than that of SRL strategy (Shorter intervention) (M=9.74, SD=10.15 and M=9.74, SD=8.82 respectively) and control group (M=5.77, SD=9.72 and M=11.81, SD=11.64 respectively).

iii. No significant interaction is observed between self-regulated learning strategy instruction and prerequisites in mathematics [F (2, 145) =0.04, p>.05] on use of self-regulated learning. Mean gain score of use of self-regulated learning after self-regulated learning strategy intervention of students both high and low prerequisites in mathematics in the SRL strategy (Longer intervention) (High: M=12.70, SD=11.23 and Low: M=14.33, SD=10.18 respectively) is higher than that of SRL strategy (Shorter intervention) (high: M=10.23, SD=10.15 and Low: M=12.33, SD=8.53 respectively) and control group (high: M=7.1, SD=11.95 and Low: M=9.82, SD=9.46).

iv. No significant interaction is observed between self-regulated learning strategy instruction and mathematical ability conception [F (2, 145) =1.40, p>.05] on use of self-regulated learning.Mean gain score of use of self-regulated learning after self-regulated learning strategy intervention of both students with incremental and entity beliefs in mathematics in the SRL strategy (Longer intervention) (M=15.46, SD=12.25 and M=12.02, SD=8.85

respectively) is higher than that of SRL strategy (Shorter intervention) (M=9.45, SD=8.94 and M=13, SD=9.96 respectively) and control group (M=9, SD=12.60 and M=7.56, SD=8.81 respectively).

v. No significant interaction is observed between self-regulated learning strategy instruction and goal orientation in mathematics [F (2, 145) =2.12, $p>.05$] on use of self-regulated learning. Mean gain score of use of self-regulated learning after self-regulated learning strategy intervention of both students with mastery goal orientation, and performance approach goal orientation in mathematics in the SRL strategy (Longer intervention) (M=15.28, SD=11.25 and M=11.42, SD=9.46 respectively) is higher than that of SRL strategy (Shorter intervention) (M=9.57, SD=8.46 and M=14.63, SD=11.11 respectively) and control group (M=8.13, SD=11.25 and M=8.60, SD=10.59 respectively).

Thus the study findings can be summed up as follows. Mathematics is high among both most liked and most disliked school subjects. Students find strategic and affective difficulties in learning mathematics as well as cognitive difficulties. The evidence based self-regulatory intervention enhanced students' cognitive achievement and use of self-regulated learning in mathematics but not enhanced affective achievement such as self-efficacy and task value. However, a limited self-regulated intervention for only three weeks did not significantly enhanced achievement. This was generally true for boys and girls, students with high and low on intelligence, high and low prerequisites incremental and entity beliefs, mastery and performance approach goal orientations. However, self-regulated learning intervention failed to impact among girls in case of achievement in pairs of equations, boys in case of self-regulated learning and students with entity beliefs in case of self-efficacy for learning mathematics.

Tenability of the Hypotheses

Tenability of the hypotheses formulated for the study are verified on the basis of the findings are mentioned in Table 136.

Table 136

Tenability of the Hypotheses

Hypothesis		Status	Supporting finding
1.i.	Students' feeling of difficulty in mathematics is significantly dependent on their motivational factors	Accepted	3.a
1.ii.	Students' feeling of difficulty in mathematics is significantly dependent on their learning strategies	Accepted	3.b
2.i.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions	Accepted	4.b
2.ii.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions	Rejected	5.b
3.i.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations	Accepted	4.c
3.ii.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics	Accepted	4.a
3.iii.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations	Rejected	5.c
3.iv.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning mathematics	Rejected	5.a
3.v.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics	Rejected	6.a
3.vi.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning	Rejected	7.a
4.i.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions equally for boys and girls	Accepted	4.b.i
4.i.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions equally for high and low levels of nonverbal intelligence	Accepted	4.b.ii

Hypothesis		Status	Supporting finding
4.i.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions equally for high and low levels of prerequisites in mathematics	Accepted	4.b.iii
4.i.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions equally for mathematical ability conceptions	Accepted	4.b.iv
4.i.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in fractions equally for mastery and performance approach goal orientations in mathematics	Accepted	4.b.v
4.ii.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions equally for boys and girls	Rejected	5.b.i
4.ii.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions equally for high and low levels of nonverbal intelligence	Rejected	5.b.ii
4.ii.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions equally for high and low levels of prerequisites in mathematics	Rejected	5.b.iii
4.ii.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions equally for mathematical ability conceptions	Rejected	5.b.iv
4.ii.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning fractions equally for mastery and performance approach goal orientations in mathematics	Rejected	5.b.v
5.i.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for short and long Interventions	Accepted	4.c
5.i.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for boys and girls	Rejected	4.c.i
5.i.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for high and low levels of nonverbal intelligence	Accepted	4.c.ii
5.i.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for high and low levels of prerequisites in mathematics	Accepted	4.c.iii
5.i.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for mathematical ability conceptions	Accepted	4.c.iv

Hypothesis		Status	Supporting finding
5.i.f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in pairs of equations equally for mastery and performance approach goal orientations in mathematics	Accepted	4.c.v
5.ii.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for short and long interventions	Rejected	4.a
5.ii.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for boys and girls	Accepted	4.a.i
5.ii.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for high and low levels of nonverbal intelligence	Accepted	4.a.ii
5.ii.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for High and low levels of Prerequisites in mathematics	Accepted	4.a.iii
5.ii.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for mathematical ability conceptions	Accepted	4.a.iv
5.ii.f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' achievement in mathematics equally for mastery and performance approach goal orientations in mathematics	Accepted	4.a.v
5.iii. a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for short and long interventions	Rejected	5.c
5.iii. b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for boys and girls	Rejected	5.c.i
5.iii. c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for high and low levels of nonverbal intelligence	Rejected	5.c.ii
5.iii. d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for High and low levels of Prerequisites in mathematics	Rejected	5.c.iii
5.iii. e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for mathematical ability conceptions	Rejected	5.c.iv
5.iii. f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning systems of linear equations equally for mastery and performance approach goal orientations in mathematics	Rejected	5.c.v

Hypothesis		Status	Supporting finding
5.iv.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning mathematics equally for short and long Interventions	Rejected	5.a
5.iv.b.	Intervention on Self-Regulatory Learning significantly enhances standard 9 students' self-efficacy for learning mathematics equally for boys and girls	Rejected	5.a.i
5.iv.c.	Intervention on Self-Regulatory Learning significantly enhances standard 9 students' self-efficacy for learning mathematics equally for high and low levels of nonverbal intelligence	Rejected	5.a.ii
5.iv.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning mathematics equally for high and low levels of prerequisites in mathematics	Rejected	5.a.iii
5.iv.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning mathematics equally for mathematical ability conceptions	Rejected	5.a.iv
5.iv.f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' self-efficacy for learning mathematics equally for mastery and performance approach goal orientations in mathematics	Rejected	5.a.v
5.v.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for short and long Interventions	Rejected	6.a
5.v.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for boys and girls	Rejected	6.a.i
5.v.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for high and low levels of nonverbal intelligence	Rejected	6.a.ii
5.v.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for high and low levels of prerequisites in mathematics	Rejected	6.a.iii
5.v.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for mathematical ability conceptions	Rejected	6.a.iv
5.v.f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' task value of learning mathematics equally for mastery and performance approach goal orientations in mathematics	Rejected	6.a.v
5.vi.a.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for short and long Interventions	Rejected	7.a
5.vi.b.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for boys and girls	Rejected	7.a.i

Hypothesis		Status	Supporting finding
5.vi.c.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for High and low levels of nonverbal intelligence	Accepted	7.a.ii
5.vi.d.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for High and low levels of prerequisites in mathematics	Accepted	7.a.iii
5.vi.e.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for mathematical ability conceptions	Accepted	7.a.iv
5.vi.f.	Intervention on Self-Regulatory Learning significantly enhances standard nine students' use of self-regulated learning equally for mastery and performance approach goal orientations in mathematics	Accepted	7.a.v

Limitations of the Study

The main limitations of the study are the following.

Usually experimental studies control variables through making them constants, sampling, through building them into designs, or through statistical means. Keeping this tradition, gender was built in to the study design as a factor. It was also ensured that self-regulation was matched among the treatment groups. However, attempt was not made to match extent of self-regulation between boys and girls, as it is beyond practicality to match even a few most relevant variables among the subgroups of the samples. But, as the study progressed to analysis phase, it came to notice that, before intervention, boys were low on self-regulated learning than girls. This might have caused only boys to have benefited by self-regulated learning strategy instruction. Likewise, though the groups were matched on self-regulation in total, initially, control group was significantly higher in help seeking component of self-regulated learning strategy and slightly high on motivational variable such as self-efficacy for learning fractions, self-efficacy for learning systems of linear equations, task value of learning mathematics, and self-regulated learning in mathematics. This might have interacted with treatment. However, resolving these issues by manipulating the experimental sample actually would have further reduced the generalizability of the findings from this study.

The study did not measure task value belief specifically connected with the topics fractions and pairs of equations and measured only task value beliefs of mathematics in general as the attempt was to gauge the effect of SRL interventions on affective and motivational factors relevant for further learning of mathematics. But, it turned out that task value in mathematics as a whole could not impact even in any of the subgroups of students. This engendered an afterthought that the task value of learning the specific topic could have also been studied as was done for self-efficacy beliefs in the topics. However, this might also would not have helped, as neither self-efficacies in the topics could have been enhanced.

Intervening variables, other than intelligence and prerequisites in mathematics, were not considered. There may have extraneous variables such as institutional environment and parental influence; but they are not taken in to consideration

Discussion of Findings

The findings reveal that perception of mathematics as difficult and disliked subject among significant share of students in Kerala is dependent on the affective and strategic deficits in learning it. Affective experiences are important as, such feelings from previous tasks are mediating development of task value among students (Eccles, 1984). Moreover, the findings will contribute to provide a context to support their growing awareness for students of themselves as agents in the learning process by supporting their strategic behaviors (Pape, Bell, & Yetkin, 2003).

Students have less than required prerequisite knowledge and they use surface strategies, and these impacts their perception of mathematics as difficult. This match with observation that in comparison to surface strategies, deeper strategies facilitate encoding and recall (Murayama, Pekrun, Lichtenfeld & VomHofe, 2013). One area that needs further attention of researchers in Kerala is how mathematical goal orientation mediates learning approaches? The findings, read along with previous researches (Azar, Lavasani, Malahmadi, and Amani 2010) indicate needs for inculcating mastery goals that will positively influence deep approaches in learning mathematics.

Secondary school students' feeling of difficulty in mathematics is significantly associated to their motivational factors like interest, values, self-efficacy, and ability beliefs and their learning strategies. This one is more reiterates observation of Wigfield and Eccles (1992) that individuals' perception of their own ability and expectancies for success on particular task has important role in their motivation to accomplish the task well. This goes along with the observation by Schunk (2001) that young children will have difficulty in forethought phase than older children because of their limited ability to attend and follow a model, and in formulating and maintaining well-defined long-term goals. This also suggest the need for encouraging learners to write learning diaries, journal and logbooks are examples for self-recording that helps the learner to be in line with goals. Self-recording help the learner to understand his desirable and undesirable behavioral pattern in relation to learning. It creates the thought of how well they proceed to their goal, what difficulties are being faced by them and how can they overcome those. These self-recording process leads to self-experimentation. Through self-experimentation, learner might try new techniques or behavior to overcome undesirable behavioral patterns, so as to achieve better results. Blackwell, Trzesniewski and Dweck (2007) also studied the relation between implicit theories of intelligence and mathematics achievement, and observed their trajectory of grades through a longitudinal study among seventh graders. They found that incremental theories of intelligence had a positive association with low helpless response, high effort belief, and positive strategies. Result showed that the effect of implicit theories of intelligence is more prevalent as they approach to junior high school; and it is not evident in their previous grades. In the same study they experimented the effect of eight session teaching incremental theory intervention, and found that it improves the achievement and changes the theories of intelligence of entity believers.

Self-regulated learning strategy intervention, for relatively longer duration, enhances high school students' achievements in mathematics (fractions and pairs of equations) with small to medium effect, irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, mathematical ability conception, and goal orientation in mathematics. However, short SRL intervention did not enhance achievement in pairs of equation in girls. This finding goes along with observation of Perels, Gurtler, and Schmitz (2005) among eighth graders in Germany that is possible to improve self-regulation competence through kind of short training but seems to be more difficult to train self-regulatory compared to problem-solving competencies. The study by Perels, Dignath and Schmitz (2009) also repeated this result that SRL intervention improve mathematical achievement but not motivation and problem solving in sixth grade students. This adds to the need for self-regulatory intervention to be part of daily teaching- learning acts rather than remedial type of interventions, which many a research in education currently are.

Self-regulated learning strategy intervention do not enhance high school students' self-efficacy for learning mathematics, in general and, in fractions and systems of linear equations in specific, irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, and goal orientation in mathematics. The study by Perels, Dignath and Schmitz (2009) also found the same that self-efficacy is not improved through a regular class room intervention. However, self-efficacy for learning mathematics after the longer self-regulated learning strategy intervention was significantly higher than that after shorter intervention among students with incremental beliefs.

Self-regulated learning strategy intervention do not enhance standard nine students' task value of learning mathematics, irrespective of gender, high-low levels of nonverbal intelligence or prerequisite knowledge, mathematical ability conception, and goal orientation in mathematics. Gray (2014) found that students' task values are changing according to task. In this study, strategies are given to improve students' task value in the chapter fractions and pairs of equations, not for general mathematics learning; but then measured students' task value for learning mathematics, and found no change. It indicates that task value on topics of mathematics may not improve the general task value of learning mathematics, or it may take more time to observe a significant difference.

Educational Implications

The analysis of data obtained in the survey phase of this study helped to identify the dynamics of affective and strategic factors in learning of mathematics among high school students in Kerala. Most of these findings echoes the observation of previous studies on the significance and interplay of affective, motivational and strategic factors in learning mathematics in school students.

1. Educators should recognize the importance of self-regulated learning

Importance of self-regulation, especially for subjects like mathematics in which students have feeling of difficulty, needs to be recognized by educators, teachers, school administraters and curriculum planners. Individuals' perception of their own ability and expectancies for success on particular task have important role in their motivation to accomplish the task well (Wigfield & Eccles, 1992).

2. ***Students should be self-regulated learners to overcome their difficulties in learning***

There is need to develop effective strategic and regulatory patterns of thinking and action to overcome low motivation, poor self-awareness, deficient strategic skills, and below average academic performance.

For practicing self-regulated learning, students need ability to set their own goal, ability to plan their learning or behavior with the available time and resources, ability to determine discrepancy between goal and target behavior, knowledge of different strategies for learning different content, above all students need knowledge of themselves, their strength and weaknesses.

3. ***Teachers should help students to analyze their learning behaviors***

Analysis of students' learning behavior and feedback on this, support students' self-regulated learning strategy use, through improving their calibration of self-monitoring and regulation of behavior.

4. ***Students are to be trained on individual or combined self-regulated learning strategies***

Strategy training through methods including computer-based instruction, semi-structured guidance, and face-to-face discussion enhances SRL in mathematics.

External feedback can enhance self-regulation as it provides calibration and hence increases learner's effective engagement in the task. Without external feedback students with little knowledge of self-regulation can't have an optimal performance. So external feedback is proposed as a way to make students self-regulated.

An integral part of developing students' SRL was to provide a context to support their growing awareness of themselves as agents in the learning process by supporting their strategic behaviours and to attribute outcomes to these behaviors (Pape, Bell & Yetkin, 2003).

To promote the use of self-regulated learning strategies among students, teachers can follow different strategies individually or in combinations, such as use of different learning strategies (Marée, Van Bruggen & Jochems, 2013; Lim, Lee & Grabowski, 2008), goal setting strategies (Clarke, 2013; Kitsantas, Robert & Doster, 2004; Butler, 1997; Schunk, 1990), self-monitoring strategies (Kitsantas, Robert, & Doster, 2004; Butler & Winne, 1995), volitional control strategies (Boekaerts & Corno, 2005), developing metacognitive knowledge (Pintrich, 1999), and organizational strategies (Pintrich, 1999; Weinstein & Mayer, 1986).

5. ***Goal setting and self-monitoring can be used to promote self-regulated learning***

Students' attitudes, interests, feelings, beliefs and dispositions collectively contribute to effective goals. Goals works as a standard for self-regulated learning process. As Zimmerman (2004) suggested, setting short term goals to learning process will improve students' self-regulated learning.

Self-monitoring is important during the early periods of learning, but as it become routine, they needed less intentional monitoring. Writing learning diaries, journals and logbooks, are examples for self-recording that helps the learner to be in line with goals. Self-recording helps the learner to understand his desirable and undesirable behavioural pattern in relation to learning.

6. Students should write learning protocol to enhance self-regulated learning

This study reinforces the observation of many others that writing learning protocols is a powerful tool that helps the students to monitor and regulate their learning behavior (Nückles, Hübner & Renkl, 2009). Several studies have demonstrated that writing learning protocol is enhancing learning outcomes (Nückles, Hübner & Renkl, 2009; Wong, Kuperis, Jamieson, Keller & Cull-Hewitt, 2002; Connor-Greene, 2000).

It is not easy to follow sophisticated learning strategies even though they are writing learning protocol. Hence, it can not guarantee students' use of metacognitive and cognitive strategies (Nu¨ckles, Schwonke, Berthold & Renkl, 2004). So, it is suggested that for an optimal result through writing learning protocol, provide systematic prompts for writing learning protocol (Berthold, Nu¨ckles & Renkl,2007). Prompts can be questions or hints regarding their use of cognitive and metacognitive strategies used or their understanding of the contents.

7. Learning contents should be organized to enhance understanding

Organization of the learned materials is a cognitive strategy that enhance self-regulated learning (Pintrich, 1999). Organization of learning contents through the identification of main ideas and interlinking of concepts is found to be effective in students' use of cognitive strategies and hence in improving self-regulated learning (Pintrich, 1999; Weinstein & Mayer, 1986). Engaging in concept mapping activities helps the learners to organize their learning.

Self-regulated learning intervention improved students' mathematical achievement, but if it is to enhance self-regulated learning competencies they need to be comparatively longer and guided along with content instruction.

8. ***Textbook can be an aid to enhance self-regulated learning***

Textbooks, workbooks, and curricular materials needs to further improve the ways in which they support self-regulation of learning among students.

Textbook should be useful in enhancing self-learning of the students. Besides the content descriptions, this should explain how to and where to use it. Content of the textbook should be organized in a way that it connects between prerequisite of that area and its use in the advanced levels of that content and in daily life.

Providing brief descriptions about what the lessons are, how the contents are organized, and where to use it, will improve the memory and understanding of students. The list of desired prerequisites can be listed in the initial section of the chapters. A printed booklet with all prerequisites for the chapter with related questions can be given to students before introducing each chapter, hence, students can learn this with the help of their peers or others. This would be helpful for smooth understanding of the particular chapter. Also, this can be helpful in overriding their belief that mathematics is a difficult subject.

9. ***Teachers have to be incremental theorists***

Content related beliefs are gradually developed in students over a long period of time. So it is not easy to change their mindset quickly. Teachers who are in constant interaction with the students, can gradually cause a change by giving opportunity to make the students belief that it is effort not ability rides the achievement.

10. Teachers need to be trained on self-regulatory learning strategies

The findings support the suggestion that there is need of training for teachers on self-regulated learning strategies (Clyde, 2015) and so that they can provide these strategies to students.

- Teachers need to help the students to set the goals for each unit.
- Content organization in the textbook should facilitate deep level processing.
- Steps need to be taken to ensure prerequisite knowledge for every new topic.
- Connect the material to be learnt to the previous knowledge.
- In textbooks or support materials, provide the list of necessary prerequisites to students while introducing the new lesson. Students can learn these with the help of peers or others.
- Introduction to units need to communicate why should students learn the topic, will help the students to develop task value in them.
- Teacher can suggest effective strategies to learn the topics by considering students' difficulties and nature of content.

Conclusion

This study probed the affective and strategic difficulties in learning mathematics among high school students in Kerala to develop a self-regulatory learning intervention that was imparted through guided and self-practice in classroom and verified the impact of this SRL instruction on achievement and self-efficacy in the chapters namely fractions and pairs of equations of standard nine mathematics. Perception of mathematics as difficult and disliked subject among significant share of students in Kerala is dependent on the affective and strategic deficits in learning it. The need and importance of self-regulatory intervention is evidenced from the finding that students have less than required prerequisite knowledge and they use surface strategies and these impacts their perception of mathematics as difficult. It was further revealed that secondary school students' feeling of difficulty in mathematics is significantly associated to their motivational factors like interest, values, self-efficacy, and ability beliefs, and their learning strategies.

This evidence-based intervention to develop self-regulated learning, enhances student achievement in mathematics. Self-regulated learning interventions will be effective if they are practicing at least for a fortnight or longer. Self-regulated learning interventions results in significant and measurable increase of self-regulated learning practices of girls. Self-regulated learning interventions enhances self-efficacy in mathematics especially of students with incremental belief in ability to learn mathematics. Self-regulated learning intervention enhance mathematics achievement and self-efficacy irrespective of students' nonverbal intelligence and level of prerequisites in mathematics. Effectiveness of self-regulated learning interventions in enhancing achievements vary by motivational beliefs of students.

Each one's beliefs and likes influences their thoughts and actions. Everyone likes to do what they like. Those who find mathematics as enjoyable tends to take effort and hard work in mathematics than those who do not like it. Mathematics is a disliked subject for many students with belief that it is a difficult subject and can't be learned by all. It may result in taking less effort and which in turn brings low achievement. These beliefs are not formed as all of a sudden and it can't be changed quickly. Also, it is difficult to change these beliefs themselves without any intervention. Hence, especially for subjects like mathematics in which students have feeling of difficulty, need regular and systematic evidence based support for effective strategic and regulatory patterns, analysis of students learning behaviors, providing prompts to goal setting and self-monitoring including through writing learning protocols, strategy training with conventional and emerging technologies, helping students organizing learned materials, supportive curriculum and text book development, and emphasizing all these in teacher development be given thrust than is presently done by educators, teachers, school administration and curriculum planners.

Suggestions for Further Research

- While self-regulation is important in mathematics learning, it does not explain the intense negative affect towards mathematics, in spite of the task value for it among students. Future studies need to focus further on reasons behind negative perception of mathematics among students.
- There is need for developing appropriate instruments to overcome the limitations of students' self-reports on self-regulated learning.
- There is need to develop effective strategic and regulatory patterns of thinking and action to overcome low motivation, poor self-awareness, deficient strategic skills, and below-average academic performance.
- Many of the intervention studies, including this one, fails to enhance students' academic self-regulation, at the same time improving the cognitive outcomes. The factors that interplay between the developed strategies and measurement of self-regulated strategies needs further research attention.
- The task value instruction on the topics or SRL intervention did not improved task value of learning mathematics. Task value is an important determinant of SRL and achievement, hence it is necessary to identify steps for improving task value of learning mathematics.
- Students motivational beliefs such as self-efficacy and task value are not improved through six week long self-regulated learning intervention. Further research can be done to check effectiveness of an intervention with more duration in changing motivational variables.

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APPENDICES

Appendix -A1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

QUESTIONNAIRE ON STUDENT PERCEPTION OF MATHEMATICS

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

പേര്:..; ആൺ/പെൺ

സ്ക്കൂൾ:...ക്ലാസ്സ്...........................

നിർദ്ദേശങ്ങൾ

പ്രിയ വിദ്യാർത്ഥികളെ, ഗണിത പഠനത്തെക്കുറിച്ചുള്ള ഒരു അവലോകനം നടത്താനാണ് ഈ അഭിമുഖത്തിലൂടെ ഉദ്ദേശിക്കുന്നത്. ചിലർക്ക് ഗണിത പഠനം രസകരമായൊരു അനുഭവമാണ്, എന്നാൽ മറ്റു ചിലർക്ക് നേരെ തിരിച്ചും. ചിലർക്ക് അത് വേഗത്തിൽ മനസ്സിലാവുന്നു, ചിലർ അതിനായി കൂടുതൽ സമയം എടുക്കുന്നു. ചിലരെ സംബന്ധിച്ച് ഗണിതമായിരിക്കും ഏറ്റവും എളുപ്പമുള്ള വിഷയം, മറ്റെല്ലാ വിഷയങ്ങൾക്കും മുൻപന്തിയിൽ നിൽക്കുമ്പോഴും ചിലർ ഗണിതത്തിൽ മാത്രം പുറകോട്ട് നിൽക്കുന്നു. ഗണിതം പഠിക്കുമ്പോഴുള്ള ലക്ഷ്യങ്ങൾ, നിങ്ങളുടെ താത്പര്യങ്ങൾ, പഠനരീതി, ഇങ്ങിനെ ഗണിത പഠനവുമായി ബന്ധപ്പെട്ട കാര്യങ്ങളുടെ ഒരു അവലോകനമാണ് ഇവിടെ ഉദ്ദേശിക്കുന്നത്. നിങ്ങൾ ഒരോരുത്തരും ഈ വിഷയം ഗ്രൂപ്പിൽ ചർച്ച ചെയ്ത് വ്യക്തവും കൃത്യവുമായ പ്രതികരണങ്ങൾ തരാൻ താത്പര്യപ്പെടുന്നു. നിങ്ങൾ ഇവിടെതരുന്ന മറുപടികൾ, ഗവേഷണ ആവശ്യങ്ങൾക്കല്ലാതെ യാതൊരു കാരണവശാലും മറ്റൊരാളുമായി പങ്കുവെക്കില്ല. സൂചനകൾ തന്നിട്ടുള്ളവയിൽ ഏറ്റവും യോജിക്കുന്നത് ശരി (✓) അടയാളപ്പെടുത്തുക.

	വിഷയം	ഇഷ്ടപ്പെട്ട വിഷയം (✓)	വെറുപ്പുള്ള വിഷയം (✓)	ഇഷ്ടപ്പെടാനുള്ള കാരണം	വെറുപ്പ് തോന്നുവാനുള്ള കാരണം
1.	മലയാളം				
	ഇംഗ്ലീഷ്				
	ഹിന്ദി				
	സോഷ്യൽ സ്റ്റഡീസ്(SS)				
	ഫിസിക്സ്				
	കെമിസ്ട്രി				
	ബയോളജി				
	മാത്തമാറ്റിക്സ്				
	ഐ. ടി.				

2	ഗണിത ശാസ്ത്രം നിങ്ങൾക്ക് ഇഷ്ടമാണൊ?	അതെ	അല്ല
	ഇഷ്ടപ്പെടാനുള്ള/ഇഷ്ടപ്പെടാതിരിക്കാനുള്ള കാരണം?		
3	ഗണിത പഠനത്തിൽ നിങ്ങൾ മുൻപന്തിയിലാണൊ?	അതെ	അല്ല
	നിങ്ങളുടെ അഭിപ്രായത്തിൽ അതിന്റെ കാരണം എന്താണ്?		
4	ഏതെല്ലാം കാര്യങ്ങളാണ് നിങ്ങളുടെ ഗണിത പഠനത്തിന് ബുദ്ധിമുട്ടുണ്ടാക്കുന്നത്? ശരി (✓) അടയാളപ്പെടുത്തുക • കണക്ക് വളരെ കടുപ്പമുള്ളവിഷയമായത് കൊണ്ട് ☐ • മുൻ ക്ലാസ്സിലേത്തത് മറന്ന് പോകന്നത് കൊണ്ട് ☐ • വീട്ടിൽ പറഞ്ഞ് തരാൻ ആളില്ലാത്തത് കൊണ്ട് ☐ • കണക്ക് എങ്ങിനെ പഠിക്കണമെന്ന് അറിയാത്തത് ☐ • എനിക്ക് ഗണിതം പഠിക്കാൻ കഴിവ് കുറവാണ് ☐ • ക്ലാസ്സ് മനസ്സിലാകാത്തത് ☐ • നന്നായി പഠിക്കാത്തത് ☐ • കണക്ക് മനസ്സിലാവാത്തത് ☐ • പെട്ടെന്ന്മറന്ന് പോകുന്നത് ☐		
5	ഏതെല്ലാം കാര്യങ്ങളാണ് ഗണിത പഠനം എളുപ്പമാക്കുന്നത്? ശരി (✓) അടയാളപ്പെടുത്തുക • വേഗത്തിൽ മനസ്സിലാക്കാൻ സാധിക്കുന്നത് ☐ • എളുപ്പമുള്ള വിഷയമാണ് ☐ • ട്യൂഷൻ ഉള്ളത് കൊണ്ട് ☐ • കണക്ക് ഇഷ്ടമുള്ളത് കൊണ്ട് ☐ • ടീച്ചർ നന്നായി പഠിപ്പിക്കുന്നത് കൊണ്ട് ☐ •		
6	ഗണിതം ഒരു ബുദ്ധിമുട്ടുള്ള വിഷയമായി നിങ്ങൾ കരുതുന്നുണ്ടൊ?	ഉണ്ട്	ഇല്ല
7	നിങ്ങൾക്ക് എളുപ്പമാണെന്ന് ഉറപ്പുള്ള ചോദ്യങ്ങൾക്ക് മാത്രം ഉത്തരം കണ്ടെത്താനുള്ള ശ്രമം നടത്താറുണ്ടോ?	ഉണ്ട്	ഇല്ല
8	വിജയപ്രതീക്ഷ ഇല്ലെങ്കിൽ ഗണിതത്തിലെ ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കാറുണ്ടോ?	ഉണ്ട്	ഇല്ല
	നിങ്ങളെ സംബന്ധിച്ച് ഏറ്റവും യോജിക്കുന്നത് ശരി (✓) അടയാളപ്പെടുത്തുക		
9	ഗണിതം • വളരെവിഷമം പിടിച്ച വിഷയമാണ് ☐ • താരതമ്യേന വിഷമമാണ് ☐ • വളരെഎളുപ്പമാണ് ☐		
10	ഒരു പ്രശ്നം ബുദ്ധിമുട്ടുള്ളതാണെന്ന് തോന്നിയാൽ • വിട്ട്കളയും ☐ • കുറച്ചൊക്കെ ശ്രമിച്ച ശേഷം ഉപേക്ഷിക്കും ☐ • കുറേയേറെ ശ്രമിച്ച ശേഷം ഉപേക്ഷിക്കും ☐ • ഏറെസമയം ശ്രമിച്ചിട്ടും കണ്ടെത്താനായില്ലെങ്കിൽ ആരുടെയെങ്കിലും സഹായം തേടും ☐		

11	മുൻ ക്ലാസ്സുകളിൽ പഠിച്ച കാര്യങ്ങൾ നിങ്ങൾക്ക് ഓർമയുണ്ടാവാറുണ്ടൊ?	എല്ലായ്പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
	ആവശ്യസമയത്ത് അവ ഉപയോഗിക്കാൻ കഴിയാറുണ്ടൊ?	എല്ലായ്പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
12	ടെക്സ്റ്റ് ബുക്കിലെ ഒരു ചോദ്യം കണ്ടാൽ അതിന്റെ ഉത്തരം കണ്ടുപിടിക്കാൻ ഏതു വഴിയിലൂടെ പോകണമെന്ന് നിങ്ങൾക്ക് മനസ്സിലാവാറുണ്ടൊ?			ഉണ്ട്	ഇല്ല
13	ടീച്ചർ ക്ലാസ്സിൽ പഠിപ്പിക്കുന്നതിനപുറമെടെക്സ്റ്റ് ബുക്കിലെ എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം കണ്ടെത്താൻ നോക്കാറുണ്ടൊ?			ഉണ്ട്	ഇല്ല
14	ഗണിത പഠനം രസകരമാണൊ?			അതെ	അല്ല
15	ഗണിതം ബോറിംഗ് ആണൊ?			അതെ	അല്ല
16	സ്വയം താത്പര്യപ്പെട്ട് ഗണിതം പഠിക്കാറുണ്ടൊ?			ഉണ്ട്	ഇല്ല
17	നിങ്ങളുടെ ഗണിത അധ്യാപകനെ/അധ്യാപികയെ നിങ്ങൾക്ക് ഇഷ്ടമാണൊ?			അതെ	അല്ല
18	ടീച്ചർ പഠിപ്പിക്കുന്ന രീതി നിങ്ങൾക്ക് ഇഷ്ടമാണൊ?			അതെ	അല്ല
19	ടീച്ചർ നിങ്ങൾക്കായി ശ്രദ്ധ തരാറുണ്ടൊ?		ഇല്ല	എപ്പോഴെങ്കിലും /കുറച്ചൊക്കെ	ഉണ്ട്
20	ഗണിതത്തിലെഏത് ഭാഗത്താണ് നിങ്ങൾക്ക്ഏറ്റവുംകൂടുതൽ ബുദ്ധിമുട്ട് അനുഭവപ്പെടുന്നത്? • ജ്യോമെട്രി (ജ്യാമിതി) ☐ • ആൾജിബ്ര (ബീജഗണിതം) ☐ • അരിത്തമെറ്റിക് (അങ്കഗണിതം) ☐ •				
21	ഗണിതം നിങ്ങളെക്കൊണ്ട് പഠിച്ചെടുക്കാൻ പറ്റാത്തതാണെന്ന് നിങ്ങൾ കരുതുന്നുണ്ടൊ?			ഉണ്ട്	ഇല്ല
22	ഗണിതത്തിൽ നിങ്ങൾക്ക് വിജയിക്കാൻ കഴിയുമെന്ന് നിങ്ങൾ കരുതുന്നുണ്ടോ?			ഉണ്ട്	ഇല്ല
	ഇല്ലെങ്കിൽ അതിന്റെ കാരണം?				
23	മുൻ ക്ലാസ്സുകളിൽ നിങ്ങൾ ഗണിതത്തിൽ വിജയിക്കാറുണ്ടായിരുന്നൊ?	എല്ലായ്പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	ഒരിക്കലുമില്ല
24	ഗണിതം പഠിക്കേണ്ട ആവശ്യമുണ്ടൊ?			ഉണ്ട്	ഇല്ല
	എന്തുകൊണ്ട്?				
25	**നിങ്ങളെ സംബന്ധിച്ച്** ഗണിതം ഒരു സുപ്രധാന വിഷയമാണൊ?			അതെ	അല്ല
	എന്തുകൊണ്ട്?				

26	ഗണിതപഠനം നിങ്ങൾക്കുപകരിക്കുമെന്ന് നിങ്ങൾ കരുതുന്നുണ്ടോ?	ഉണ്ട്	ഇല്ല		
27	ഗണിതം പഠിക്കുന്നത് കൊണ്ട് നിത്യജീവിത ത്തിൽ എന്തെങ്കിലും ഉപയോഗമുണ്ടോ?	എല്ലായ് പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോഴൊ ക്കെ	ഒരിക്കലുമില്ല
28	ഗണിതപഠനം അത്രയേറെ ആവശ്യമുള്ളതാ ണെന്ന് നിങ്ങൾക്ക് തോന്നിയിട്ടുണ്ടോ?	എല്ലായ് പ്പോഴും	മിക്കപ്പോഴും	ചിലപ്പോഴൊ ക്കെ	ഒരിക്കലുമില്ല
29	ഗണിത ക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന കാര്യങ്ങളുടെ ഉപയോഗംഎന്താണെന്ന് നിങ്ങൾക്കറിയാമൊ?	അറിയില്ല	കുറച്ചൊക്കെ അറിയാം	അറിയാം	
30	ഗണിതത്തിൽ നിങ്ങൾ പഠിക്കുന്ന കാര്യങ്ങൾ എത്രത്തോളം ഉപകാരപ്രദമാണ്?	ഒരു ഉപകാരവുമില്ല	കുറച്ചൊക്കെ	വളരെ അധികം ഉപകാരമുണ്ട്	
31	ഗണിതം പഠിക്കുന്നതിനേക്കാൾ നല്ലത്˘വേറെ വിഷയങ്ങൾ പഠിക്കുന്നതാണെന്ന് തോന്നാറുണ്ടോ?	എല്ലായ്പ്പോഴും	ചിലപ്പൊ ഴൊക്കെ	ഒരിക്കലുമില്ല	
32	ചെറിയ ക്ലാസ്സുകളിലെ ഗണിതം എളുപ്പമുള്ളതാണൊ?	അതെ	അല്ല		
33	ചെറിയ ക്ലാസ്സുകളിലെ ഗണിതം എളുപ്പമുള്ളതും മുന്നോട്ട് പോകുംതോറും പ്രയാസമേറിയതും ആണെന്ന് നിങ്ങൾ കരുതുന്നുണ്ടോ?	ഉണ്ട്	ഇല്ല		
34	ചെറിയ ക്ലാസ്സുകളിൽ നിങ്ങൾ ഗണിതം ഇഷ്ടപ്പെട്ടിരുന്നോ?	ഉണ്ട്	ഇല്ല		
35	എല്ലാവർക്കും പഠിക്കാൻ കഴിയുന്ന ഒരു വിഷയമാണ് ഗണിതമെന്ന് നിങ്ങൾക്ക് വിശ്വാസമുണ്ടോ?	ഉണ്ട്	ഇല്ല		
36	ഗണിതംപെട്ടെന്ന് മനസ്സിലാക്കാനുള്ളകഴിവ് ജന്മനാ ലഭിക്കുന്നതാണെന്ന് നിങ്ങൾകരുതുന്നുണ്ടോ?	തീർച്ചയായും	കുറേയൊക്കെ	ഇല്ല	
37	നന്നായി പരിശ്രമിക്കുകയാണെങ്കിൽ നിങ്ങൾക്ക് ഗണിതം പഠിച്ചെടുക്കാൻ കഴിയുമെന്ന് സ്വയം കരുതുന്നുണ്ടോ?	തീർച്ചയായും	കുറേയൊക്കെ	ഇല്ല	
38	ഗണിതം മന:പാഠമാക്കേണ്ട വിഷയമാണെന്ന് നിങ്ങൾ കരുതുന്നുണ്ടോ?	ഉണ്ട്	ഇല്ല		
39	''എനിക്കൊരിക്കലും കണക്ക് മനസ്സിലാവില്ല'' എന്നൊരു ചിന്ത നിങ്ങൾക്കുണ്ടോ?	തീർച്ചയായും	കുറേയൊക്കെ	ഇല്ല	
40	ഗണിതത്തിൽ പഠിക്കുന്ന കാര്യങ്ങൾ പരസ്പരം ബന്ധമുള്ളതാണൊ?	അതെ	അല്ല		
41	കണക്കിലെ ഒരു പ്രശ്നത്തിന് ഉത്തരം കണ്ടെത്താൻ ഒന്നിൽ കൂടുതൽ വഴികൾ ഉണ്ടാവുമെന്ന് നിങ്ങൾ ധരിക്കുന്നുണ്ടോ?	ഉണ്ട്	ഇല്ല		
42	കണക്കിലെ ഒരു പ്രശ്നത്തിന് ഒന്നിൽ കൂടുതൽ ഉത്തരങ്ങൾ ഉണ്ടാകാമൊ?	ഉണ്ട്	ഇല്ല		
43	''കണക്കിൽ തോൽക്കുന്നവർ തോറ്റുകൊണ്ടേയിരിക്കും അല്ലെങ്കിൽ വിജയിക്കുന്നവർ വിജയിച്ചുകൊണ്ടേയിരിക്കും'' എന്നത് ശരിയാണൊ?	അതെ	അല്ല		
44	''കൂടുതൽ ബുദ്ധിയുള്ളവർക്കേ ഗണിതം പഠിക്കാൻ സാധിക്കൂ'' എന്ന് പറയുന്നത് ശരിയാണൊ?	തീർച്ചയായും	കുറേയൊക്കെ	ഇല്ല	
45	ഗണിതം പഠിക്കാൻ ഏറ്റവും നല്ലരീതിഏതാണ്? • സമവാക്യങ്ങൾകാണാതെ പഠിക്കും ☐ • ടീച്ചർ ക്ലാസ്സിൽചെയ്തകണക്കുകൾ മാത്രം പഠിക്കും ☐ • ടെക്സ്റ്റ്ബുക്കിലെഎല്ലാ പ്രശ്നങ്ങൾക്കുംഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കും ☐ •				
46	ഒരു കണക്ക് പരീക്ഷക്ക് നിങ്ങൾ ഏത് രീതിയിലൂടെയാണ് (എങ്ങിനെയാണ്) പഠിക്കുന്നത്? • സമവാക്യങ്ങൾകാണാതെ പഠിക്കും ☐ • ടീച്ചർ ക്ലാസ്സിൽ ചെയ്ത കണക്കുകൾ മാത്രം പഠിക്കും ☐ • ടെക്സ്റ്റ്ബുക്കിലെ എല്ലാ പ്രശ്നങ്ങൾക്കും ഉത്തരം കണ്ടെത്താൻ ശ്രമിക്കും ☐ •				

47	ഗണിതത്തിലെ പാഠഭാഗങ്ങൾക്കനുസരിച്ച് പഠനരീതി മാറ്റാറുണ്ടോ?	ഉണ്ട്	ഇല്ല				
48	ഗണിതം പഠിക്കാനായി ഒരു ദിവസം ഏകദേശം എത്ര സമയം ചിലവഴിക്കാറുണ്ട്?						
	പഠിക്കാറില്ല	5 മിനുട്ട്	10 മിനുട്ട്	15 മിനുട്ട്	30 മിനുട്ട്	45 മിനുട്ട്	ഒരു മണിക്കൂർ
49	ഒരു ആശയം പഠിക്കുന്നതിന് മുൻപ് അതിന്റെ മുന്നറിവുകൾ മനസ്സിലാക്കിയെന്ന് ഉറപ്പിക്കാറുണ്ടോ?	തീർച്ചയായും	കുറേ യൊക്കെ	ഇല്ല			
50	മനസ്സിലാകാത്ത ഭാഗങ്ങൾ പിന്നീട് ആരോടെങ്കിലും ചോദിച്ച് മനസ്സിലാക്കാറു ണ്ടോ?	ഉണ്ട്	ഇല്ല				
51	ഗണിതത്തെ നിങ്ങൾക്ക് പേടിയുണ്ടോ?	വളരെകൂടുതൽ	അതെ	ഇല്ല			
	ചെറുപ്പം മുതലേ അങ്ങിനെയാണൊ?	അതെ	അല്ല				
52	ഗണിതവുമായി ബന്ധപ്പെട്ട സാഹചര്യങ്ങളിൽ നിന്ന് ഒഴിഞ്ഞ് മാറാൻ ശ്രമിക്കാറുണ്ടോ?	എല്ലായ്പ്പോഴും	ചിലപ്പൊഴൊക്കെ	ഒരിക്കലുമില്ല			
53	പേടികാരണം നിങ്ങൾ ഗണിതസമവാക്യങ്ങൾ മറന്നു പോകാറുണ്ടോ?	മിക്കപ്പോഴും	ചിലപ്പൊഴൊക്കെ	ഒരിക്കലുമില്ല			
54	പത്താം ക്ലാസ്സിന് ശേഷം നിങ്ങൾഗണിതം പഠിക്കാൻ ഇഷ്ടപ്പെടുന്നുണ്ടോ?	ഉണ്ട്	ഇല്ല				
55	ഗണിതം പഠിക്കുന്നതിന് നിങ്ങൾക്കൊരുലക്ഷ്യമുണ്ടൊ?	ഉണ്ട്	ഇല്ല				
56	ഗണിതം പഠിക്കുമ്പോൾ എന്താണ് നിങ്ങളുടെലക്ഷ്യം?						
57	ലക്ഷ്യം നേടാനായി പരിശ്രമിക്കാറുണ്ടോ?	ഉണ്ട്	ഇല്ല				
58	കണക്കിൽവിജയിക്കുകഎന്നത്കൊണ്ട്**നിങ്ങൾ**എന്താണ്ഉദ്ദേശിക്കുന്നത്? • കഷ്ടിച്ച് പാസ്സാവുക ☐ • ക്ലാസ്സിലെഒന്നാമനാവുക ☐ • നിത്യജീവിതത്തിൽ അത്യാവശ്യം വേണ്ടി വരുന്ന ഗണിതം നന്നായി പഠിക്കുക ☐ • നിത്യജീവിതത്തിലും മറ്റും ഉപയോഗിക്കാൻ ഉതകുന്ന തരത്തിൽ ആഴത്തിൽ മനസ്സിലാക്കുക ☐						
59	എത്ര പഠിച്ചാലും ഒന്നാമതെത്താൻ പോകുന്നില്ല എന്ന ചിന്തയിൽ എപ്പൊഴെങ്കിലും നിങ്ങൾകണക്ക് പഠിക്കാതിരുന്നിട്ടുണ്ടോ?	ഉണ്ട്	ഇല്ല				
60	ഏത് തരം ഗണിത പ്രശനങ്ങളാണ് നിങ്ങൾ കൂടുതൽ ഇഷ്ടപ്പെടുന്നത്? • ഏറ്റവുംഎളുപ്പമുള്ളത് ☐ • ശരാശരി ബുദ്ധിമുട്ടുള്ളത് ☐ • വിഷമകരമായത് ☐						

Appendix -A2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

QUESTIONNAIRE ON STUDENT PERCEPTION OF MATHEMATICS

Dr. Abdul Gafoor. K — Professor

AbidhaKurukkan — Research Scholar

Name: ……………………………………………………………; Male/Female

School: ……………………. ……………………. Class ……………………

Directions:

Dear students, the purpose of this interview is to make a review on learning of mathematics. Learning mathematics is an interesting experience for some people, whereas it is entirely opposite to others. Some of them understand mathematical concepts quickly; others spend more time to understand them. Mathematics is the easiest subject for some people, nevertheless, others do not do well in mathematics despite the fact that they excel in all other subjects areas. This examination deals with various dimensions related to learning mathematics such as the goals that set when learning mathematics, your interests, and learning style. Discuss these dimensions within your group and provide clear and accurate responses. Your responses will not be used for any other purpose other than using for the research requirements. Indicate the most accurate responses from those given to you.

1.	**Subject**	**Most favorite subject (✓)**	**Least Favorite Subject (✓)**	**Reason for like**	**Reason for dislike**
	Malayalam				
	English				
	Hindi				
	S.S				
	Physics				
	Chemistry				
	Biology				
	Mathematics				
	I.T.				

<table>
<tr><td rowspan="2">2</td><td colspan="3">Do you like mathematical sciences?</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="5">Reason for like/dislike?</td></tr>
<tr><td rowspan="2">3</td><td colspan="3">Do you excel in learning mathematics?</td><td>Yes</td><td>No</td></tr>
<tr><td colspan="5">Justify your response</td></tr>
<tr><td rowspan="7">4</td><td colspan="5">What reasons make your mathematical learning difficult? Indicate the right one (✓)</td></tr>
<tr><td>• Mathematics is a tough subject</td><td>☐</td><td colspan="2">• Do not understand the materials covered in class</td><td>☐</td></tr>
<tr><td>• Forgetting the materials learned previously</td><td>☐</td><td colspan="2">• Do not study well</td><td>☐</td></tr>
<tr><td>• Do not have anyone to help at home</td><td>☐</td><td colspan="2">• Do not understand mathematics</td><td>☐</td></tr>
<tr><td>• Do not know how to learn mathematics</td><td>☐</td><td colspan="2">• Forget learned materials easily</td><td>☐</td></tr>
<tr><td>• I lack the ability to learn mathematics</td><td>☐</td><td colspan="2">•</td><td></td></tr>
<tr><td>•</td><td></td><td colspan="2"></td><td></td></tr>
<tr><td>5</td><td colspan="5">What reasons make your mathematical learning easy? Indicate the right one (✓)
Can understand mathematics easily ☐
Mathematics is an easy subject ☐
I receive tuition in mathematics ☐
I like mathematics ☐
My teacher teaches mathematics thoroughly ☐</td></tr>
<tr><td>6</td><td colspan="3">Do you feel mathematics as a tough subject?</td><td>Yes</td><td>No</td></tr>
<tr><td>7</td><td colspan="3">Do you try to find answers only to those questions that you find easy to answer?</td><td>Yes</td><td>No</td></tr>
<tr><td>8</td><td colspan="3">Do you try to answer any mathematics questions if you do not have hope of being successful?</td><td>Yes</td><td>No</td></tr>
<tr><td></td><td colspan="5">Mark the most appropriate about you (✓)</td></tr>
<tr><td>9</td><td colspan="5">Mathematics is
An extremely hard subject ☐
A moderately hard subject ☐
An easy subject ☐</td></tr>
</table>

10	If I find a mathematical problem difficult to solve I will leave that problem ☐ I will try a bit and then leave ☐ I will try my best and then leave ☐ I will seek help even after I cannot solve it after trying my best ☐				
11	Do you remember materials learned in your previous classes?	Always	Often	Sometimes	Never
	Are you able to use them whenever required?	Always	Often	Sometimes	Never
12	Do you understand how to proceed with solving a problem in your textbook?			Yes	No
13	Do you try to find answers of all questions in your textbook in addition to the ones solved in class by your teacher?			Yes	No
14	Is learning mathematics interesting?			Yes	No
15	Is learning mathematics boring?			Yes	No
16	Do you learn mathematics at your own interest?			Yes	No
17	Do you like your mathematics teacher?			Yes	No
18	Do you like the way of teaching by your teacher?			Yes	No
19	Does your teacher pay attention to you?		No	Some times	Yes
20	Which topic in mathematics do you find hard? Geometry ☐ Algebra ☐ Arithmetic ☐				
21	Do you think that you are not capable in learning mathematics?			Yes	No
22	Do you think that you can be successful in mathematics?			Yes	No
	If you do not, Why?				
23	Were you successful in mathematics in previous grade levels?	Always	Often	Sometimes	Never
24	Is learning mathematics a requirement?			Yes	No
	Why?				

25	Is mathematics a very important subject to you?	Yes	No		
	Why?				
26	Do you think learning mathematics is useful to you?	Yes	No		
27	Is learning mathematics useful in daily life?	Always	Often	Sometimes	Never
28	Do you think that learning mathematics is necessary?	Always	Often	Sometimes	Never
29	Do you know the use of mathematics topics taught in class?	Don’t Know	Know a Little	Yes	
30	To what extent are the topics in mathematics that you learn useful?	Not at all useful	Some use	Very Useful	
31	Do you think that it is better to learn other subjects over mathematics?	Always	Sometimes	Never	
32	Is mathematics in lower grade levels easy?	Yes	No		
33	Do you think that mathematics in lower grade levels is easy and then becomes difficult as you proceed to higher grade levels?	Yes	No		
34	Did you like mathematics in lower grade levels?	Yes	No		
35	Do you believe that everyone can learn mathematics?	Yes	No		
36	Do you think that the ability to learn mathematics is inborn?	Always	Sometimes	Never	
37	Do you think that you can learn mathematics yourself by trying very hard?	Always	Sometimes	Never	
38	Do you think that mathematics is a matter of memorization?	Yes	No		
39	Do you have a belief that “I will never understand mathematics”?	Always	Sometimes	Nev er	
40	Are topics learned in mathematics interrelated to one another?	Yes	No		
41	Do you believe that there is more than one way to solve a problem in mathematics?	Yes	No		
42	Can there be more than one answer for a mathematical problem?	Yes	No		
43	Do you agree with the statement that “those who fail in mathematics continue to fail, whereas those who are successful continue to be successful”?	Yes	No		
44	Do you agree with the statement that “only people with high intelligence can learn mathematics”?	Always	Sometimes	Never	

45	Which is the best method to learn mathematics? Memorize equations ☐ Study the problems solved in class by teacher ☐ Try to find answers to all problems in the textbook ☐			
46	How do you learn (using what method) for a mathematics test? Memorize equations ☐ Study the problems solved in class by teacher ☐ Try to find answers to all problems in the textbook ☐			
47	Do you make changes in learning strategies with respect to different topics in mathematics?	Yes	No	
48	How much time do you spend daily to learn mathematics? Not Learning | 5 Minutes | 10 Minutes | 15 Minutes | 30 Minutes | 45 Minutes | 1 Hour			
49	Do you make sure that you understood related previous concepts prior to learn a concept?	Always	Sometimes	Never
50	Do you ask others and make sure you understood the topics that you did not understand previously?	Yes	No	
51	Are you afraid of mathematics?	Much more	A little	No
	Is it true since your younger age?	Yes	No	
52	Do you try to keep away from situations related to mathematics?	Always	Sometimes	Never
53	Do you forget mathematics equations due to fear?	Often	Sometimes	Never
54	Do you like to learn mathematics after grade ten?	Yes	No	
55	Do you have a goal in learning mathematics?	Yes	No	
56	What is your goal in learning mathematics?			
57	Do you make efforts to achieve your goal?	Yes	No	
58	What do you mean by being successful in mathematics? Barely pass ☐ Be the top most in class ☐ Learn mathematical concepts well that are used in daily life ☐ To have a profound understanding of mathematical concepts and apply them in daily life ☐			
59	Have you ever avoided learning mathematics thinking that you would never become the top most in the subject?	Yes	No	
60	Which type of mathematical problems are you interested in? Very easy ☐ Moderately difficult ☐ Hard ☐			

Appendix –B1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF PREREQUISITES IN MATHEMATICS

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Time: 40 minute

Marks: 60

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്...

നിർദ്ദേശങ്ങൾ:

താഴെ തന്നിട്ടുള്ള ചോദ്യങ്ങളോരോന്നും നിങ്ങൾ മുൻ ക്ലാസ്സുകളിൽ പഠിച്ച കാര്യങ്ങളാണ്. ഓരോ ചോദ്യത്തിനും a, b, c, d എന്നിങ്ങനെ നാല് ഉത്തരങ്ങൾ തന്നിട്ടുണ്ട്, ഒന്ന് മാത്രമെ ശരിയായത് ഒള്ളു; ഉത്തരങ്ങൾ തന്നിട്ടുള്ള ഉത്തര ക്കടലാസിൽ അനുയോജ്യമായ കോളത്തിൽ രേഖപ്പെടുത്തുക (ശരി അടയാളം ഇടുക). എല്ലാ ചോദ്യത്തിനും ഉത്തരം എഴുതാൻ ശ്രമിക്കുക. എന്തെങ്കിലും ക്രിയ ചെയ്തു നോക്കണമെങ്കിൽ കൂടുതലായി തന്നിട്ടുള്ള പേപ്പർ ഉപയോഗിക്കാം

SECTION 1

1) താഴെതന്നിട്ടുള്ളവയിൽഭിന്നസംഖ്യയായിഎഴുതിയിട്ടുള്ളത്ഏത്?

a) 7.6 b)$\frac{7}{6}$ c)7^2 d) $7 \div 6$

2) $\frac{50}{100}$ൽ അംശംഏത്?,ഛേദം ഏത്?

a)അംശം5, ഛേദം 10

b)അംശം 50, ഛേദം 100

c)അംശം 100, ഛേദം 50

d)അംശം 10, ഛേദം 5

3) തന്നിട്ടുള്ളവയിൽഏതിനെയാണ്കാൽഭാഗംഎന്ന് പറയുന്നത്?

a)$\frac{1}{4}$ b)$\frac{2}{4}$ c)$\frac{4}{1}$ d)$\frac{3}{4}$

4) പകുതിയെ ഭിന്നസംഖ്യ ഉപയോഗിച്ച്എങ്ങിനെ സൂചിപ്പിക്കാം?

a)$\frac{1}{2}$ b)$\frac{1}{8}$ c)$\frac{1}{3}$ d)$\frac{1}{4}$

5) തന്നിട്ടുള്ളവയിൽഏതാണ്മുക്കാൽഭാഗത്തെ സൂചിപ്പിക്കുന്നത്?

a)$\frac{1}{4}$ b)$\frac{1}{8}$ c)$\frac{1}{3}$ d)$\frac{3}{4}$

6) $5\frac{1}{4}$ =......... ?

a)$\frac{5}{4}$ b)$\frac{6}{4}$ c)$\frac{21}{4}$ d)$\frac{10}{4}$

7) $\frac{47}{7}$ = ...?

a)$6\frac{5}{7}$ b) 41 c)$5\frac{6}{7}$ d)$38\frac{2}{7}$

8) $\frac{21}{56}$ ന്റെ ലഘുരൂപം

a)$\frac{8}{3}$ b)$\frac{1}{35}$ c)$\frac{3}{8}$ d)$\frac{3}{7}$

9) തന്നിട്ടുള്ളവയിൽനിന്ന് $\frac{8}{11}$ന്ത്തുല്യമായ ഭിന്നംകണ്ടെത്തുക.

a)$\frac{24}{33}$ b)$\frac{10}{13}$ c)$\frac{11}{8}$ d)$\frac{4}{22}$

10) $\frac{3}{5}$ന്റെ രൂപമല്ലാത്തത് ഏത്?

a)$\frac{21}{35}$ b)$\frac{6}{13}$ c)$\frac{30}{50}$ d)$\frac{12}{20}$

11) $\frac{7}{11}$ന്റെ വ്യുൽക്രമം എന്ത്?

a)11 b)$\frac{11}{7}$ c)$7 \div 11$ d)$\frac{1}{11}$

12) 9 ന്റെ വ്യുൽക്രമം എന്ത്?

a)-9 b)$\frac{1}{9}$ c)9^2 d)3

13) $\frac{x}{y}$യുടെവ്യുൽക്രമംഎന്ത്?

a)x b) y c)$\frac{y}{x}$ d)xy

14) $\frac{1}{2}$ന്റെ വ്യുൽക്രമം എന്ത്?

a)1 b)2 c)$\frac{1}{2}$ d)2^2

15) $\frac{6}{17}+\frac{7}{17}$ = ...?

a)$\frac{13}{34}$ b)$\frac{1}{17}$ c)$\frac{13}{17}$ d)$\frac{23}{24}$

16) $\frac{3}{5}+\frac{8}{5}$ = ...?

a)$2\frac{1}{5}$ b)$\frac{11}{10}$ c)$\frac{8}{5}$ d)$\frac{8}{13}$

17) $\frac{7}{12}+\frac{3}{10}$ = ...?

a)$\frac{12}{12}$ b)$\frac{53}{60}$ c)$\frac{10}{22}$ d)$\frac{10}{30}$

18) $\frac{21}{7}-\frac{10}{7}$ = ...?

a)$\frac{2}{7}$ b)$\frac{11}{14}$ c)11 d)$\frac{11}{7}$

19) $\frac{14}{45} - \frac{3}{35}$ = …………..?

a)$\frac{11}{10}$ b)$\frac{11}{45}$ c)$\frac{71}{315}$ d)$\frac{11}{315}$

20) ഒരു ഭിന്നസംഖ്യക്ക് തുല്യമായ മററൊരു ഭിന്നസംഖ്യ ഉണ്ടാക്കണമെങ്കിൽ എന്തു ചെയ്യണം?

a)അംശത്തേയും ഛേദത്തേയും ഒരേ സംഖ്യകൊണ്ട് ഗുണിക്കണം

b)ഒരേ സംഖ്യ അംശത്തിലേക്കും ഛേദത്തിലേക്കും കൂട്ടണം

c)ഒരേ സംഖ്യ അംശത്തിൽനിന്നും ഛേദത്തിൽനിന്നും കുറക്കണം

d)അതേ സംഖ്യകൊണ്ട് ഗുണിക്കണം

21) $\frac{3}{4} \times \frac{2}{3}$ = ……….?

a)$\frac{9}{8}$ b)$\frac{6}{7}$ c)$\frac{6}{12}$ d)$\frac{32}{43}$

22) $\frac{3}{2} \div \frac{4}{3}$ = ……….?

a)$\frac{4}{2}$ b)$\frac{9}{4}$ c)$\frac{18}{4}$ d)$\frac{9}{8}$

23) $\frac{5}{3} \div \frac{7}{3}$ = ……….?

a)$\frac{5}{7}$ b)$\frac{35}{9}$ c)$\frac{7}{5}$ d)$\frac{9}{35}$

24) $\frac{84}{5}$ന്റെ ദശാംശരൂപം

a)8.4 b)16.8 c)$16\frac{4}{5}$ d)16.5

25) 7.9നെ ഭിന്നമായി എങ്ങിനെ എഴുതാം?

a)$7 \times \frac{9}{10}$ b)$7\frac{9}{10}$ c)$\frac{79}{100}$ d)$\frac{7}{9}$

26) 13.1 നെ ഭിന്നമായി എങ്ങിനെ എഴുതാം?

a)$\frac{131}{10}$ b)$13 \times \frac{1}{10}$ c)$\frac{131}{100}$ d)$\frac{13}{1}$

27) 'a' എന്ന സംഖ്യയെക്കാൾ ചെറുതാണ് 'b' എന്ന സംഖ്യ, ഇതിനെ ചിഹ്നം ഉപയോഗിച്ച് എങ്ങിനെ എഴുതാം?

a)$a < b$ b) $b < a$ c) $a \neq b$ d) $a = b$

28) $\frac{a}{b} = 1$എന്നതിൽ നിന്ന്എത്തിചേരാവുന്ന നിഗമനം?

a)a=b+1 b)$a < b$ c) $a = b$ d) $a \times b=1$

29) a=b എങ്കിൽ താഴെ തന്നവയിൽ ശരിയായത് ഏത്?

a) $a=\frac{1}{b}$ b)$\frac{a}{b} = 1$ c) $a + b =1$ d) $a - b=1$

30) $a \times b=$ ________?

a)ba b)a+b c)b+a d) $a \div b$

31) a യുടെ വർഗ്ഗം?

a)a^2 b)a^3 c)1 d) a

32) a^2 ന്റെവർഗ്ഗം?

a)1 b) a c)2 d)a^4

33) a+b= 2c ആയാൽ, തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a)$a = \frac{2c}{b}$ b)$\frac{a}{c} + b = 2$ c)$a + \frac{b}{c} = 2$ d)$\frac{a+b}{c} = 2$

34) $\frac{a}{b} = 2$എങ്കിൽ, a = _________?

a)$2b$ b)$\frac{2}{b}$ c)$2 + b$ d)2- b

35) $\frac{n(n+1)}{n}$ =?

a)n b)2 c)$n + 1$ d)n^2

36) $\frac{n^2}{n} =$?

a)1 b)2 c)n d)n^3

37) $\frac{n+n}{n}$ =?

a)$\frac{1+n}{n}$ b)$\frac{2}{n}$ c)2 d)1

38) $x^2 + x$= ?

a)x^3 b)$2x^2$ c)$x(x+1)$ d)$3x$

39) $\frac{a \times b \times c}{a \times c}$ =?

a)ac b)$b + 1$ c)$b - c$ d)b

40) $\frac{a+b+c}{a+c}$ =?

a)1 b)a c)$1 + \frac{b}{a+c}$ d)3

41) a+b= 2cആയാൽ, a = ________?

a)$2c - b$ b)$2c + b$ c)$\frac{2c}{b}$ d)$2bc$

42) x-y = y^2 ആയാൽ, x = ______?

a)y^3 b)$y^2 + y$ c)$2y^2$ d)y

43) xy= zഎങ്കിൽx = ______?

a)$z + y$ b)$z - y$ c)yz d)$\frac{z}{y}$

44) $\frac{x}{y} = z$ എങ്കിൽ, x = ______?

a) $z + y$ b) $z - y$ c) $\frac{z}{y}$ d) zy

45) $\frac{x}{y} = z$ എങ്കിൽ, y = ______?

a) $\frac{z}{x}$ b) $\frac{x}{z}$ c) $x - z$ d) $x + z$

SECTION 2

46 മുതൽ 60 വരെയുള്ള ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക. ക്രിയ ചെയ്യാനായി ചോദ്യത്തിന് താഴെ തന്നിട്ടുള്ള ഭാഗം ഉപയോഗിക്കുക

46)	$9\,\overline{)\,6885}$
47)	42 ന്റെ അഭാജ്യ ഘടകങ്ങൾ ഏതെല്ലാം?
48)	$\frac{3}{7}$, $\frac{4}{5}$ഇവയെഒരേഛേദമുള്ള ഭിന്നമായിഎഴുതുക.
49)	$\frac{11}{12}$, $\frac{5}{18}$ ഇവയെ ഒരേ ഛേദമുള്ള ഭിന്നമായി എഴുതുക.

50)	$\frac{a}{b}$, $\frac{c}{d}$ ഇവയെ ഒരേ ഛേദമുള്ള ഭിന്നമായി എഴുതുക.
51)	$\frac{3}{7}$, $\frac{4}{7}$ ഇവയിൽ വലുത് ഏത്?
52)	$\frac{6}{a}$, $\frac{7}{a}$ ഇവയിൽ വലുത് ഏത്?
53)	$\frac{a}{6}$, $\frac{a}{8}$ ഇവയിൽ ചെറുത് ഏത്?
54)	$\frac{8}{6}$, $\frac{8}{7}$ഇവയിൽചെറുത്ഏത്?
55)	$\frac{373}{100}$ നെ ദശാംശരൂപമാക്കി എഴുതുക.

56)	$\frac{5}{4}$ നെ ദശാംശരൂപമാക്കി എഴുതുക.
57)	''ഒരു സംഖ്യയുടെ രണ്ട് മടങ്ങും മൂന്നു മടങ്ങും കൂട്ടിയാൽ സംഖ്യയുടെ അഞ്ച് മടങ്ങ് കിട്ടും'' ഇതിനെ ബീജ ഗണിത രൂപത്തിൽ എഴുതുക.
58)	''ഒരു സംഖ്യയുടെ വർഗ്ഗത്തോട് ആ സംഖ്യ കൂട്ടുക'', ഇതിനെ ബീജ ഗണിത രൂപത്തിൽ എഴുതുക.
59)	''തുടർച്ചയായ മൂന്ന് എണ്ണൽ സംഖ്യകളുടെ തുക നടുവിലത്തെ സംഖ്യയുടെ മൂന്നിരട്ടി ആയിരിക്കും'', ഇതിനെ ബീജഗണിത രൂപത്തിൽ എഴുതുക.
60)	$47.39 = (4 \times 10) + (7 \times 1) + \left(3 \times \frac{1}{10}\right) + (9 \times \frac{1}{100})$ തന്നിട്ടുള്ള രൂപത്തിൽ 356.542 നെ സ്ഥാനവില നോക്കി പിരിച്ചെഴുതുക.

Appendix –B2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF PREREQUISITES IN MATHEMATICS (FINAL)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Time: 40 minute | Marks: 60

Name: ……………………………………………… ………………; Male/Female

Age: …………………….. Class ……………………………………………………

Directions:

You have learned each of the following questions in previous standards. Four choices such as ‘a’, ‘b’, ‘c’, and ‘d’ are given of which there is only one right answer. Give a tick mark for right choice for each question. Make an attempt to answer all questions. You may use additional paper provided for performing more calculations.

SECTION 1

1) In the given numbers which one is written in the form of fraction

   a) 7.6 b) $\frac{7}{6}$ c) 7^2 d) $7 \div 6$

2) What are the numerator and denominator in the fraction $\frac{50}{100}$?

   a) Numerator 5, Denominator 10
   b) Numerator 50, Denominator 100
   c) Numerator 100, Denominator 50
   d) Numerator 10, Denominator 5

3) In the given fraction which one is known as ‘Quarter’?

   a) $\frac{1}{4}$ b) $\frac{2}{4}$ c) $\frac{4}{1}$ d) $\frac{3}{4}$

4) How can we represent half using fraction?

   a) $\frac{1}{2}$ b) $\frac{1}{8}$ c) $\frac{1}{3}$ d) $\frac{1}{4}$

5) In the given fraction which one is known as ‘three quarter’?

   a) $\frac{1}{4}$ b) $\frac{1}{8}$ c) $\frac{1}{3}$ d) $\frac{3}{4}$

6) $5\frac{1}{4}$ =……… ?

a)$\frac{5}{4}$ b)$\frac{6}{4}$ c)$\frac{21}{4}$ d)$\frac{10}{4}$

7) $\frac{47}{7}$ = ……….?

a)$6\frac{5}{7}$ b) 41 c)$5\frac{6}{7}$ d)$38\frac{2}{7}$

8) Simplest form of $\frac{21}{56}$

a)$\frac{8}{3}$ b)$\frac{1}{35}$ c)$\frac{3}{8}$ d)$\frac{3}{7}$

9) From the given, find out the equal fraction for $\frac{8}{11}$.

a)$\frac{24}{33}$ b)$\frac{10}{13}$ c)$\frac{11}{8}$ d)$\frac{4}{22}$

10) Which one is not a form of $\frac{3}{5}$?

a)$\frac{21}{35}$ b)$\frac{6}{13}$ c)$\frac{30}{50}$ d)$\frac{12}{20}$

11) What is the reciprocal of $\frac{7}{11}$?

a)11 b)$\frac{11}{7}$ c) $7 \div 11$ d)$\frac{1}{11}$

12) What is the reciprocal of 9?

a)-9 b)$\frac{1}{9}$ c)9^2 d)3

13) What is the reciprocal of $\frac{x}{y}$?

a)x b) y c)$\frac{y}{x}$ d)xy

14) What is the reciprocal of $\frac{1}{2}$?

a)1 b)2 c)$\frac{1}{2}$ d)2^2

15) $\frac{6}{17}+\frac{7}{17}$ = ………?

a)$\frac{13}{34}$ b)$\frac{1}{17}$ c)$\frac{13}{17}$ d)$\frac{23}{24}$

16) $\frac{3}{5}+\frac{8}{5}$ = ………..?

a)$2\frac{1}{5}$ b)$\frac{11}{10}$ c)$\frac{8}{5}$ d)$\frac{8}{13}$

17) $\frac{7}{12}+\frac{3}{10}$ = …………?

a)$\frac{12}{12}$ b)$\frac{53}{60}$ c)$\frac{10}{22}$ d)$\frac{10}{30}$

18) $\frac{21}{7}$-—$\frac{10}{7}$ = ……………?

a)$\frac{2}{7}$ b)$\frac{11}{14}$ c)11 d)$\frac{11}{7}$

19) $\frac{14}{45}$-—$\frac{3}{35}$ = …………?

a)$\frac{11}{10}$ b)$\frac{11}{45}$ c)$\frac{71}{315}$ d)$\frac{11}{315}$

20) What to do to make an equal fraction for a given fraction?

a)Multiply numerator and denominator with same number

b)Add same number to numerator and denominator

c)Subtract same number from numerator and denominator

d)Multiply with the same fraction

21) $\frac{3}{4}$-×$\frac{2}{3}$ = ……….?

a)$\frac{9}{8}$ b)$\frac{6}{7}$ c)$\frac{6}{12}$ d)$\frac{32}{43}$

22) $\frac{3}{2}$-÷$\frac{4}{3}$ = ……….?

a)$\frac{4}{2}$ b)$\frac{9}{4}$ c)$\frac{18}{4}$ d)$\frac{9}{8}$

23) $\frac{5}{3}$÷$\frac{7}{3}$ = ……….?

a)$\frac{5}{7}$ b)$\frac{35}{9}$ c)$\frac{7}{5}$ d)$\frac{9}{35}$

24) Decimal form of $\frac{84}{5}$

a)8.4 b)16.8 c)$16\frac{4}{5}$ d)16.5

25) How to write7.9as a fraction?

a)$7 \times \frac{9}{10}$ b)$7\frac{9}{10}$ c)$\frac{79}{100}$ d)$\frac{7}{9}$

26) How to write13.1as a fraction?

a)$\frac{131}{10}$ b)$13 \times \frac{1}{10}$ c)$\frac{131}{100}$ d)$\frac{13}{1}$

27) How to write using symbol that ‘b’is less than ‘a’?

a)a < b b) b < a c) a ≠ b d) a = b

28) $\frac{a}{b} = 1$means that?

a)a=b+1 b) a < b c) a = b d) a × b=1

29) If a=b, which one is correct in the following?

a) a=$\frac{1}{b}$ b)$\frac{a}{b} = 1$ c) a + b =1 d) a - b=1

30) a × b= ________?

a)ba b)a+b c)b+a d) a ÷ b

31) Square of 'a'?

a)a^2 b)a^3 c)1 d) a

32) Square of 'a^2' ?

a)1 b) a c)2 d)a^4

33) If a+b= 2c, which of the following is correct?

a)$a = \frac{2c}{b}$ b)$\frac{a}{c} + b = 2$ c)$a + \frac{b}{c} = 2$ d)$\frac{a+b}{c} = 2$

34) $\frac{a}{b} = 2$Then,a = ________?

a)$2b$ b)$\frac{2}{b}$ c)$2 + b$ d)2- b

35) $\frac{n(n+1)}{n}$ =?

a)n b)2 c)$n + 1$ d)n^2

36) $\frac{n^2}{n} =$?

a)1 b)2 c)n d)n^3

37) $\frac{n+n}{n}$ =?

a)$\frac{1+n}{n}$ b)$\frac{2}{n}$ c)2 d)1

38) $x^2 + x$= ?

a)x^3 b)$2x^2$ c)$x(x + 1)$ d)$3x$

39) $\frac{a \times b \times c}{a \times c}$ =?

a)ac b)$b + 1$ c)$b - c$ d)b

40) $\frac{a+b+c}{a+c}$ =?

a)1 b)a c)$1 + \frac{b}{a+c}$ d)3

41) a+b= 2c Then,a = _______?

a)$2c - b$ b)$2c + b$ c)$\frac{2c}{b}$ d)$2bc$

42) x-y = y^2Then,x $=$ ______?

a)y^3 b)$y^2 + y$ c)$2y^2$ d)y

43) xy= z Then, x = ______?

a)$z + y$ b)$z - y$ c)yz d)$\frac{z}{y}$

44) $\frac{x}{y} = z$ F¦nÂ, x = ______?

a)$z + y$ b)$z - y$ c)$\frac{z}{y}$ d)zy

45) $\frac{x}{y} = z$ Then,y = ______?

a)$\frac{z}{x}$ b)$\frac{x}{z}$ c)x$-z$ d)x +z

SECTION 2

Find out answers for questions from 46 to 60. Please use the Given space for calculations

46)

$9 \overline{\smash{)}6885}$

47) What are the factors of 42?

48) Write $\frac{3}{7}, \frac{4}{5}$ as fractions with same denominator.

49) Write $\frac{11}{12}, \frac{5}{18}$ as fractions with same denominator.

50) Write $\frac{a}{b}, \frac{c}{d}$ as fractions with same denominator.

51) Which is the larger one in$\frac{3}{7}, \frac{4}{7}$?

52) Which is the larger one in $\frac{6}{a}, \frac{7}{a}$?

53) Which is the smaller one in $\frac{a}{6}, \frac{a}{8}$?

54) Which is the smaller one in $\frac{8}{6}, \frac{8}{7}$?

55) Write in the decimal form $\frac{373}{100}$

56) Write in the decimal form $\frac{5}{4}$

57) Write the algebraic form of "sum of two times of a number and three times of the number would be five times of that number"

58) Write the algebraic form of "Sum of a number and its square"

59) Write the algebraic form of "Sum of three consecutive integers would be 3 times of the middle integer".

60) $47.39 = (4 \times 10) + (7 \times 1) + \left(3 \times \frac{1}{10}\right) + (9 \times \frac{1}{100})$
on the basis of place value, write down '356.542' like the given example

Appendix -B3

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Response sheet for

TEST OF PREREQUISITES IN MATHEMATICS (Section 1)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: ………………………………….......…………… …………………………

Class ……………………..Roll Number:………………..…

Sl. No.	a	b	c	d
1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d
9	a	b	c	d
10	a	b	c	d
11	a	b	c	d
12	a	b	c	d
13	a	b	c	d
14	a	b	c	d
15	a	b	c	d
16	a	b	c	d
17	a	b	c	d
18	a	b	c	d
19	a	b	c	d
20	a	b	c	d
21	a	b	c	d
22	a	b	c	d
23	a	b	c	d

Sl. No.	a	b	c	d
24	a	b	c	d
25	a	b	c	d
26	a	b	c	d
27	a	b	c	d
28	a	b	c	d
29	a	b	c	d
30	a	b	c	d
31	a	b	c	d
32	a	b	c	d
33	a	b	c	d
34	a	b	c	d
35	a	b	c	d
36	a	b	c	d
37	a	b	c	d
38	a	b	c	d
39	a	b	c	d
40	a	b	c	d
41	a	b	c	d
42	a	b	c	d
43	a	b	c	d
44	a	b	c	d
45	a	b	c	d

Appendix –B4

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Scoring Key for

TEST OF PREREQUISITES IN MATHEMATICS

Dr. Abdul Gafoor. K Professor

Abidha Kurukkan Research Scholar

SECTION 1

Question Number	Answer
1	b
2	b
3	a
4	a
5	d
6	c
7	a
8	c
9	a
10	b
11	b
12	b
13	c
14	b
15	c
16	a
17	b
18	d
19	c
20	a
21	c
22	d

23	a
24	b
25	b
26	a
27	b
28	c
29	b
30	a
31	a
32	d
33	d
34	a
35	c
36	c
37	c
38	c
39	d
40	c
41	a
42	b
43	d
44	d
45	b

SECTION 2

Question Number	Answer
46	765
47	1,2,3,6,7,
48	$\frac{15}{35}, \frac{28}{35}$
49	$\frac{33}{36}, \frac{10}{36}$
50	$\frac{ad}{bd}, \frac{cb}{bd}$
51	$\frac{4}{7}$
52	$\frac{7}{a}$
53	$\frac{a}{8}$
54	$\frac{8}{7}$
55	3.73
56	1.25
57	$2x + 3x = 5x$
58	$x^2 + x$
59	$(a - 1) + a + (a + 1) = 3a$
60	$356.542 = (3 \times 100) + (5 \times 10) + (6 \times 1) + \left(5 \times \frac{1}{10}\right) + \left(4 \times \frac{1}{100}\right) + \left(2 \times \frac{1}{1000}\right)$

Appendix –C1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF MATHEMATICAL ABILITY CONCEPTION
(DRAFT)

Dr. Abdul Gafoor. K — Professor
Abidha Kurukkan — Research Scholar

പേര്:………………………………………………………………………………; ആൺ/പെൺ

വയസ്സ്: ……………………...ക്ലാസ്സ്…………………………………………………

നിർദ്ദേശങ്ങൾ:

ഗണിത പഠനവുമായി ബന്ധപ്പെട്ട് ഉണ്ടാകാവുന്ന ചില വിശ്വാസങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഈ പ്രസ്താവനകളോട് നിങ്ങൾ എത്രമാത്രം യോജിക്കുന്നു /വിയോജിക്കുന്നു എന്ന് തന്നിട്ടുള്ള സൂചനകൾ പ്രകാരം അടയാളപ്പെടുത്തുക (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക

1	2	3	4	5
തീർത്തും വിയോജിക്കുന്നു	**ഏറെക്കുറെ വിയോജിക്കുന്നു**	**യോജിപ്പോ വിയോജിപ്പോ ഇല്ല**	**ഏറെക്കുറെ യോജിക്കുന്നു**	**തീർത്തും യോജിക്കുന്നു**

1	കണക്കിലെ എന്റെ നേട്ടം എനിക്ക് ജന്മനാ എത്ര ബുദ്ധിയുണ്ടെന്നുള്ളതിനെ ആശ്രയിച്ചിരിക്കും	1 2 3 4 5
2	കണക്കിൽ വിജയിക്കണമെങ്കിൽ ഞാൻ വളരെ മിടുക്കനായിരിക്കണം	1 2 3 4 5
3	ഗണിതവൈദഗ്ധ്യം നിരന്തരാഭ്യാസത്തിലൂടെ ഉണ്ടാക്കിയെടുക്കുന്നതാണ്	1 2 3 4 5
4	ഗണിതവൈദഗ്ധ്യം ജന്മനാ ലഭിക്കുന്നതാണ്	1 2 3 4 5
5	മിടുക്ക്/കഴിവ് കുറവാണെങ്കിൽ പിന്നെ എത്ര പരിശ്രമിച്ചിട്ടും കാര്യമില്ല	1 2 3 4 5
6	പരിശ്രമം കഴിവിനെക്കൂട്ടും	1 2 3 4 5
7	പരിശ്രമം കൂട്ടാൻ പററും പക്ഷെ ജന്മനാ കിട്ടുന്ന കഴിവ് കൂട്ടാൻ പററില്ല	1 2 3 4 5
8	ഗണിതം എല്ലാവർക്കും പഠിക്കാൻ കഴിയുന്ന വിഷയമാണ്	1 2 3 4 5
9	കണക്കിൽ തോൽക്കുന്നവർ തോററുകൊണ്ടേയിരിക്കും വിജയിക്കുന്നവർ വിജയിച്ചു കൊണ്ടേയിരിക്കും	1 2 3 4 5
10	മാർക്ക് കുറയുന്നത് എന്റെ കഴിവ്കുറവിനെ സൂചിപ്പിക്കുന്നു	1 2 3 4 5
11	തെററുകൾ എന്റെ കഴിവില്ലായ്മയുടെ അടയാളമാണ്	1 2 3 4 5
12	കണക്കിൽ മാർക്ക് കുറയുന്നതിന്റെ കാരണം നന്നായി പരിശ്രമിക്കാത്തതാണ്	1 2 3 4 5
13	കണക്കിൽ കൂടുതൽ മാർക്ക് വാങ്ങുന്നവർ കൂടുതൽ കഴിവുള്ളവരാണ്	1 2 3 4 5
14	കണക്കിലെ എന്റെ പ്രകടനം ഞാൻ ഉദ്ദേശിച്ചാലും മെച്ചപ്പെടുത്താനാവില്ല	1 2 3 4 5
15	എനിക്കൊരിക്കലും കണക്ക് മനസ്സിലാവില്ല	1 2 3 4 5

Appendix -C2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF MATHEMATICAL ABILITY CONCEPTION
(DRAFT)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Name: ……………………………………………………………; Male/Female

School: …………………………………………… Class ……………………

Directions:

Given below are a few beliefs related to mathematics learning. Circle the right indicator to show how much you agree/disagree with each of the statements. Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

1	My achievement in mathematics depends on my innate talent.	1	2	3	4	5
2	I need to be brilliant in order to be successful in mathematics.	1	2	3	4	5
3	Mathematics skills is developed through continuous effort.	1	2	3	4	5
4	Proficiency in mathematics is an inborn talent.	1	2	3	4	5
5	Making effort is meaningless if you are not smart/talented.	1	2	3	4	5
6	Effort enhances competence.	1	2	3	4	5
7	One can put more effort, but it is not possible to enhance the inborn talent.	1	2	3	4	5
8	Mathematics is a subject that anyone can learn.	1	2	3	4	5
9	Those who fail in mathematics keep on failing, whereas those who pass keep on passing.	1	2	3	4	5
10	Scoring low indicates lack of my ability.	1	2	3	4	5
11	Mistakes are indicators of my incompetence.	1	2	3	4	5
12	Lack of hard work is the reason behind getting low scores in mathematics.	1	2	3	4	5
13	Those who score high in mathematics are smart.	1	2	3	4	5
14	I would not be able to improve my performance in mathematics even if I contemplate enough to do so.	1	2	3	4	5
15	I never understand mathematics.	1	2	3	4	5

Appendix –C3

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF MATHEMATICAL ABILITY CONCEPTION
(FINAL)

Dr. Abdul Gafoor. K Professor

Abidha Kurukkan Research Scholar

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്..

നിർദ്ദേശങ്ങൾ:

ഗണിത പഠനവുമായി ബന്ധപ്പെട്ട് ഉണ്ടാകാവുന്ന ചില വിശ്വാസങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഈ പ്രസ്താവനകളോട് നിങ്ങൾ എത്രമാത്രം യോജിക്കുന്നു /വിയോജിക്കുന്നു എന്ന് തന്നിട്ടുള്ള സൂചനകൾ പ്രകാരം അടയാളപ്പെടുത്തുക (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക

1	2	3	4	5
തീർത്തും വിയോജിക്കുന്നു	**ഏറെക്കുറെ വിയോജിക്കുന്നു**	**യോജിപ്പോ വിയോജിപ്പോ ഇല്ല**	**ഏറെക്കുറെ യോജിക്കുന്നു**	**തീർത്തും യോജിക്കുന്നു**

1	കണക്കിലെ എന്റെ നേട്ടം എനിക്ക് ജന്മനാ എത്ര ബുദ്ധിയുണ്ടെന്നുള്ളതിനെ ആശ്രയിച്ചിരിക്കും	1 2 3 4 5
2	ഗണിതവൈദഗ്ധ്യം നിരന്തരാഭ്യാസത്തിലൂടെ ഉണ്ടാക്കിയെടുക്കുന്നതാണ്	1 2 3 4 5
3	ഗണിതവൈദഗ്ധ്യം ജന്മനാ ലഭിക്കുന്നതാണ്	1 2 3 4 5
4	മിടുക്ക്/കഴിവ് കുറവാണെങ്കിൽ പിന്നെ എത്ര പരിശ്രമിച്ചിട്ടും കാര്യമില്ല	1 2 3 4 5
5	പരിശ്രമം കഴിവിനെക്കൂട്ടും	1 2 3 4 5
6	പരിശ്രമം കൂട്ടാൻപററും പക്ഷെ ജന്മനാ കിട്ടുന്ന കഴിവ് കൂട്ടാൻ പററില്ല	1 2 3 4 5
7	ഗണിതം എല്ലാവർക്കും പഠിക്കാൻ കഴിയുന്ന വിഷയമാണ്	1 2 3 4 5
8	കണക്കിൽ തോൽക്കുന്നവർ തോററുകൊണ്ടേയിരിക്കും വിജയിക്കുന്നവർ വിജയിച്ചുകൊണ്ടേയിരിക്കും	1 2 3 4 5
9	മാർക്ക് കുറയുന്നത് എന്റെ കഴിവ് കുറവിനെ സൂചിപ്പിക്കുന്നു	1 2 3 4 5
10	തെററുകൾ എന്റെ കഴിവില്ലായ്മയുടെ അടയാളമാണ്	1 2 3 4 5
11	കണക്കിലെ എന്റെ പ്രകടനം ഞാൻ ഉദ്ദേശിച്ചാലും മെച്ചപ്പെടുത്താനാവില്ല	1 2 3 4 5
12	എനിക്കൊരിക്കലും കണക്ക് മനസ്സിലാവില്ല	1 2 3 4 5

Appendix –C4

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF MATHEMATICAL ABILITY CONCEPTION
(FINAL)

Dr. Abdul Gafoor. K **Abidha Kurukkan**
Professor Research Scholar

Name: ……………………………………………………; Male/Female
School: ………………………………………… Class ……………………

Directions:

Given below are a few beliefs related to mathematics learning. Circle the right indicator to show how much you agree/disagree with each of the statements. Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

1	2	3	4	5
Strongly Disagree	Disagree	Neither Agree Nor Disagree	Agree	Strongly Agree

1	My achievement in mathematics depends on my innate talent.	1	2	3	4	5
2	Mathematics skills is developed through continuous effort.	1	2	3	4	5
3	Proficiency in mathematics is an inborn talent.	1	2	3	4	5
4	Making effort is meaningless if you are not smart/talented.	1	2	3	4	5
5	Effort enhances competence.	1	2	3	4	5
6	One can put more effort, but it is not possible to enhance the inborn talent.	1	2	3	4	5
7	Mathematics is a subject that anyone can learn.	1	2	3	4	5
8	Those who fail in mathematics keep on failing, whereas those who pass keep on passing.	1	2	3	4	5
9	Scoring low indicates lack of my ability.	1	2	3	4	5
10	Mistakes are indicators of my incompetence.	1	2	3	4	5
11	I would not be able to improve my performance in mathematics even if I contemplate enough to do so.	1	2	3	4	5
12	I never understand mathematics.	1	2	3	4	5

Appendix -D1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN FRACTIONS (DRAFT)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Time: 45 minute | Marks: 25

നിർദ്ദേശങ്ങൾ:

ഭിന്നസംഖ്യകൾ എന്ന അദ്ധ്യായത്തിൽ നിന്നുള്ള 25 ചോദ്യങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഓരോ ചോദ്യത്തിനും a, b, c, d എന്നിങ്ങനെ നാല് ഉത്തരങ്ങൾ തന്നിട്ടുണ്ട്, ഒന്ന് മാത്രമെ ശരിയായത് ഒള്ളു; ഉത്തരങ്ങൾ തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ അനുയോജ്യമായ കോളത്തിൽ രേഖപ്പെടുത്തുക (ഉത്തരത്തെ സൂചിപ്പിക്കുന്ന അക്ഷരത്തിനു ചുററും വട്ടം വരക്കുക. ഉദാ: a, b, c, d). എല്ലാ ചോദ്യത്തിനും ഉത്തരം എഴുതാൻ ശ്രമിക്കുക. എന്തെങ്കിലും ക്രിയ ചെയ്തു നോക്കണമെങ്കിൽ കൂടുതലായി തന്നിട്ടുള്ള പേപ്പർ ഉപയോഗിക്കാം.

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1) താഴെ തന്നിട്ടുള്ളവയിൽ $\frac{p}{q}$ ന് തുല്യമായ ഭിന്നം ഏത്?

a) $\frac{q}{p}$ b) $\frac{p}{q}$ c) $\frac{p^2}{q^2}$ d) $\frac{pq}{p}$

2) തന്നിട്ടുള്ളവയിൽ $\frac{3}{5}$ ന് തുല്യമല്ലാത്ത ഭിന്നം ഏത്?

a) $\frac{30}{50}$ b) $\frac{51}{85}$ c) $\frac{42}{71}$ d) $\frac{33}{55}$

3) താഴെ തന്നിട്ടുള്ളവയിൽ $\frac{a}{b}$ ക്ക് തുല്യമായ ഭിന്നം ഏത്?

a) $\frac{an}{bm}$ b) $\frac{a^2}{ab}$ c) $\frac{a^2}{b^2}$ d) $\frac{ab}{ab}$

4) $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ ശരിയാകുന്നത് ഏത്?

a) $aq = pb$ b) $ap = bq$ c) $ab = pq$ d) $a = p$

5) $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ $\frac{b}{a} =$ ________?

a) $\frac{p}{q}$ b) $\frac{q}{p}$ c) pq d) 1

6) $\frac{a}{b} - \frac{p}{q} =$ ________?

a) $\frac{ap-bp}{bq}$ b) $\frac{aq-bp}{bq}$ c) $\frac{aq-bp}{ap}$ d) $\frac{ab-pq}{bq}$

7) $\frac{n^2-1}{n+1} =$ _____?

a) $n-1$ b) $\frac{n-1}{2}$ c) n d) $\frac{n-1}{n+1}$

8) $\frac{a}{b}$ യിൽ $a < b$ ആണെങ്കിൽ തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a)$\frac{a}{b} > 1$ b)$\frac{a}{b} < 1$ c)$\frac{a}{b} = 1$ d)$a = b$

9) $\frac{a}{b} = \frac{p}{q}$ ഇതിൽ നിന്ന് എത്തിച്ചേരാവുന്ന നിഗമനം

a)$\frac{a}{b} = \frac{a+b}{a-b}$ b)$\frac{a}{b} = \frac{p+q}{p-q}$ c)$\frac{a}{b} = \frac{a+p}{b+q}$ d)$\frac{a}{b} = \frac{a+1}{b+1}$

10) $\frac{1}{x} + \frac{1}{y} =$ _______?

a)$\frac{2xy}{x}$ b)$\frac{xy}{x+y}$ c)$\frac{x+y}{xy}$ d)$\frac{x}{y}$

11) $\frac{3}{2y} - \frac{1}{y} =$ _______?

a)$\frac{1}{2y}$ b)$\frac{2}{2y}$ c)$\frac{1}{y}$ d)$\frac{3-2y}{2y}$

12) $\frac{x}{y} \times \frac{y}{x} =$ _______?

a)0 b)$\frac{x}{y}$ c)$\frac{y}{x}$ d)1

13) $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, എങ്കിൽ അഞ്ചാം പദം ഏത്?

a)$\frac{5^2-1}{4} = 6$ b)$\frac{7^2-1}{8} = 5$ c)$\frac{5^2-1}{5} = 4$ d)$\frac{6^2-1}{7} = 5$

14) $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, ഈ ക്രമത്തിലെ ഒരു പദമാണ് $\frac{x^2-1}{y} = 9$ എങ്കിൽ x ന്റെ വില എത്ര?

a)1 b)11 c) 10 d) 9

15) $\frac{c}{d} = \frac{x}{y}$ എങ്കിൽ തന്നിട്ടുള്ളവയിൽ $\frac{c}{d}$ ക്ക് തുല്യമാകുന്നത്ഏത്?

a)$\frac{c+2x}{d+2y}$ b)$\frac{c+x}{d+2y}$ c)$\frac{c+2x}{d+y}$ d)$\frac{y}{x}$

16) $\frac{a}{b} = \frac{p}{q}$ ആണ്, എങ്കിൽ $\frac{a+p}{b+nq}$എന്നത് $\frac{a}{b}$ക്ക് തുല്യമാകണമെങ്കിൽ $\frac{a+p}{b+nq}$വിൽ നിന്ന് ഏത് ചരം ഒഴിവാക്കണം?

a)p b)b c)n d) q

17) $\frac{a}{b}$ യിൽ $a < b$ ആണെങ്കിൽ തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a)$\frac{a}{b} > \frac{a+1}{b+1}$ b)$\frac{a}{b} < \frac{a+1}{b+1}$ c)$\frac{a}{b} = \frac{a+1}{b+1}$ d) $\frac{a}{b} < \frac{a-1}{b-1}$

18) $cd < xy$ആണെങ്കിൽതന്നിട്ടുള്ളതിൽശരിയായത്ഏത്?

a)$\frac{c}{x} < \frac{y}{d}$ b)$\frac{c}{d} < \frac{x}{y}$ c)$\frac{c}{x} = \frac{y}{d}$ d) $\frac{c}{x} > \frac{y}{d}$

19) $\frac{7}{8} > \frac{x}{5}$എങ്കിൽ തന്നിട്ടുള്ളയിൽ $'x'$ ന്റെ വില ആകാവുന്നത് ഏത്?

a)4 b)5 c) 6 d) 7

20) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$ ഇവയെ ആരോഹണക്രമത്തിൽ എഴുതുക.

a) $\frac{13}{15}, \frac{12}{14}, \frac{11}{13}$ b) $\frac{11}{13}, \frac{12}{14}, \frac{13}{15}$

c) $\frac{11}{13}, \frac{13}{15}, \frac{12}{14}$ d) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$

21) $\frac{a}{b} = \frac{p}{q}$ വിൽ $a < b$ ആവണമെങ്കിൽ p യും q വും തമ്മിലുള്ള ബന്ധം തന്നിട്ടുള്ളവയിൽ ഏതായിരിക്കണം?

a) $p > q$ b) $q < p$ c) $p = q$ d) $p < q$

22) $\frac{a}{b} = \frac{p}{q}$ യും $a < b$ യും ആണെങ്കിൽ തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a) $q < p$ b) $aq < bp$ c) $ap < bq$ d) $p = q$

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23 മുതൽ 25 വരെ ചോദ്യങ്ങൾക്ക് തന്നിട്ടുള്ള സമവാക്യം അപഗ്രഥിച്ച് ഉത്തരം കണ്ടെത്തുക

$\frac{3}{7} = \frac{a}{10} + \frac{b}{100} + c$ എങ്കിൽ

23) a യുടെ വില a) 7 b) $\frac{7}{10}$ c) 10 d) 4

24) b യുടെ വില a) 2 b) $\frac{7}{10}$ c) 14 d) 1

25) c യുടെവില a) 3 b) $\frac{6}{700}$ c) $\frac{1}{700}$ d) 4

Appendix –D2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN FRACTIONS (DRAFT)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Time: 45 minute | Marks: 25

Directions:

Given below are twenty-five questions from the chapter of Fractions. Four choices such as a, b, c, and d are given of which there is only one right answer. Circle the right choice for each question as shown (Eg: a, b, c, d). Make an attempt to answer all questions. You may use additional paper provided for performing more calculations.

1) Which of the following is an equivalent fraction of $\frac{p}{q}$?

a) $\frac{q}{p}$ b) $\frac{p}{q}$ c) $\frac{p^2}{q^2}$ d) $\frac{pq}{p}$

2) Which of the following is a fraction not an equivalent as $\frac{3}{5}$?

a) $\frac{30}{50}$ b) $\frac{51}{85}$ c) $\frac{42}{71}$ d) $\frac{33}{55}$

3) Which of the following is an equivalent fraction of $\frac{a}{b}$?

a) $\frac{an}{bm}$ b) $\frac{a^2}{ab}$ c) $\frac{a^2}{b^2}$ d) $\frac{ab}{ab}$

4) If $\frac{a}{b} = \frac{p}{q}$, then which of these equations is true?

a) $aq = pb$ b) $ap = bq$ c) $ab = pq$ d) $a = p$

5) If $\frac{a}{b} = \frac{p}{q}$, then what is $\frac{b}{a} =$ _______?

a) $\frac{p}{q}$ b) $\frac{q}{p}$ c) pq d) 1

6) $\frac{a}{b} - \frac{p}{q} =$ _______?

a) $\frac{ap-bp}{bq}$ b) $\frac{aq-bp}{bq}$ c) $\frac{aq-bp}{ap}$ d) $\frac{ab-pq}{bq}$

7) $\frac{n^2-1}{n+1} =$ _____?

a) $n-1$ b) $\frac{n-1}{2}$ c) n d) $\frac{n-1}{n+1}$

8) If $a < b$ in the fraction $\frac{a}{b}$, then which of the following is true?

a)$\frac{a}{b} > 1$ b) $\frac{a}{b} < 1$ c)$\frac{a}{b} = 1$ d)$a = b$

9) If $\frac{a}{b} = \frac{p}{q}$, then what is your assumption?

a)$\frac{a}{b} = \frac{a+b}{a-b}$ b) $\frac{a}{b} = \frac{p+q}{p-q}$ c)$\frac{a}{b} = \frac{a+p}{b+q}$ d)$\frac{a}{b} = \frac{a+1}{b+1}$

10) $\frac{1}{x} + \frac{1}{y} =$ _______?

a)$\frac{2xy}{x}$ b) $\frac{xy}{x+y}$ c)$\frac{x+y}{xy}$ d)$\frac{x}{y}$

11) $\frac{3}{2y} - \frac{1}{y} =$ _______?

a)$\frac{1}{2y}$ b) $\frac{2}{2y}$ c)$\frac{1}{y}$ d)$\frac{3-2y}{2y}$

12) $\frac{x}{y} \times \frac{y}{x} =$ _______?

a)0 b) $\frac{x}{y}$ c)$\frac{y}{x}$ d)1

13) If$\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, then what is the 5th term?

a)$\frac{5^2-1}{4} = 6$ b) $\frac{7^2-1}{8} = 5$ c)$\frac{5^2-1}{5} = 4$ d)$\frac{6^2-1}{7} = 5$

14) If $\frac{x^2-1}{y} = 9$ is a term in the series of $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, ….
then what is the value of x?

a)1 b)11 c) 10 d) 9

15) If $\frac{c}{d} = \frac{x}{y}$, then which fraction of the following is equivalent to $\frac{c}{d}$?

a)$\frac{c+2x}{d+2y}$ b) $\frac{c+x}{d+2y}$ c)$\frac{c+2x}{d+y}$ d)$\frac{y}{x}$

16) If $\frac{a}{b} = \frac{p}{q}$, then which of the variables in $\frac{a+p}{b+nq}$ must be avoided to make it equal to $\frac{a}{b}$?

a)p b)b c)n d) q

17) If $a < b$ in the fraction $\frac{a}{b}$, then which of the following is true?

a)$\frac{a}{b} > \frac{a+1}{b+1}$ b) $\frac{a}{b} < \frac{a+1}{b+1}$ c)$\frac{a}{b} = \frac{a+1}{b+1}$ d) $\frac{a}{b} < \frac{a-1}{b-1}$

18) If $cd < xy$, then which of the following is true?

a)$\frac{c}{x} < \frac{y}{d}$ b) $\frac{c}{d} < \frac{x}{y}$ c)$\frac{c}{x} = \frac{y}{d}$ d) $\frac{c}{x} > \frac{y}{d}$

19) If $\frac{7}{8} > \frac{x}{5}$, then which of the following can be the value of $'x'$?

a)4 b)5 c) 6 d) 7

20) Write $\frac{12}{14}, \frac{11}{13}$, and $\frac{13}{15}$ in the ascending order.

a)$\frac{13}{15}, \frac{12}{14}, \frac{11}{13}$ b) $\frac{11}{13}, \frac{12}{14}, \frac{13}{15}$

c)$\frac{11}{13}, \frac{13}{15}, \frac{12}{14}$ d) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$

21) If $\frac{a}{b} = \frac{p}{q}$ and $a < b$, then which of the following shows the relationship between p and q?

a)$p > q$ b)$q < p$ c)$p = q$ d)$p < q$

22) If $\frac{a}{b} = \frac{p}{q}$ and $a < b$, then which of the following is accurate?

a)$q < p$ b)$aq < bp$ c)$ap < bq$ d)$p = q$

Find answers for 23 to 25 by analyzing the given equation

If $\frac{3}{7} = \frac{a}{10} + \frac{b}{100} + c$ then

23) The value of a is-- ----….a)7 b) $\frac{7}{10}$ c)10 d)4

24) The value of b is-- ----….a)2 b) $\frac{7}{10}$ c)14 d)1

25) The value of c is-- ----….a)3 b) $\frac{6}{700}$ c)$\frac{1}{700}$ d)4

Appendix -D3

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Response sheet for

TEST OF ACHIEVEMENT IN FRACTIONS (DRAFT)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Name: …………………………………........…………… …………………………

Class ……………………..Roll Number:………………..…

Sl. No.	a	b	c	d
1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d
9	a	b	c	d
10	a	b	c	d
11	a	b	c	d
12	a	b	c	d
13	a	b	c	d
14	a	b	c	d
15	a	b	c	d
16	a	b	c	d
17	a	b	c	d
18	a	b	c	d
19	a	b	c	d
20	a	b	c	d
21	a	b	c	d
22	a	b	c	d
23	a	b	c	d
24	a	b	c	d
25	a	b	c	d

Appendix –D4

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Scoring Key for

TEST OF ACHIEVEMENT IN FRACTIONS (DRAFT)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Question Number	Answer
1	b
2	c
3	b
4	a
5	b
6	b
7	a
8	b
9	c
10	c
11	a
12	d
13	d
14	c
15	a
16	c
17	b
18	a
19	a
20	b
21	d
22	c
23	d
24	a
25	b

Appendix –D5

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN FRACTIONS (FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Time: 35 minute

Marks: 15

നിർദ്ദേശങ്ങൾ:

ഭിന്നസംഖ്യകൾ എന്ന അദ്ധ്യായത്തിൽ നിന്നുള്ള 25 ചോദ്യങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഓരോ ചോദ്യത്തിനും a, b, c, d എന്നിങ്ങനെ നാല് ഉത്തരങ്ങൾ തന്നിട്ടുണ്ട്, ഒന്ന് മാത്രമെ ശരിയായത് ഒള്ളു; ഉത്തരങ്ങൾ തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ അനുയോജ്യമായ കോളത്തിൽ രേഖപ്പെടുത്തുക (ഉത്തരത്തെ സൂചിപ്പിക്കുന്ന അക്ഷരത്തിനു ചുററും വട്ടം വരക്കുക. ഉദാ: a, b, c, d). എല്ലാ ചോദ്യത്തിനും ഉത്തരം എഴുതാൻ ശ്രമിക്കുക. എന്തെങ്കിലും ക്രിയ ചെയ്തു നോക്കണമെങ്കിൽ കൂടുതലായി തന്നിട്ടുള്ള പേപ്പർ ഉപയോഗിക്കാം.

---

1) തന്നിട്ടുള്ളവയിൽ $\frac{3}{5}$ ന് തുല്യമല്ലാത്ത ഭിന്നം ഏത്?

a)$\frac{30}{50}$ b)$\frac{51}{85}$ c)$\frac{42}{71}$ d)$\frac{33}{55}$

2) $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ ശരിയാകുന്നത് ഏത്?

a)$aq = pb$ b)$ap = bq$ c)$ab = pq$ d) $a = p$

3) $\frac{a}{b} - \frac{p}{q} =$ ________?

a)$\frac{ap-bp}{bq}$ b)$\frac{aq-bp}{bq}$ c)$\frac{aq-bp}{ap}$ d)$\frac{ab-pq}{bq}$

4) $\frac{a}{b}$യിൽ$a < b$ ആണെങ്കിൽ തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a)$\frac{a}{b} > 1$ b)$\frac{a}{b} < 1$ c)$\frac{a}{b} = 1$ d)$a = b$

5) $\frac{1}{x} + \frac{1}{y} =$ _______?

a)$\frac{2xy}{x}$ b)$\frac{xy}{x+y}$ c)$\frac{x+y}{xy}$ d)$\frac{x}{y}$

6) $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, എങ്കിൽ അഞ്ചാം പദം ഏത്?

a)$\frac{5^2-1}{4} = 6$ b)$\frac{7^2-1}{8} = 5$ c)$\frac{5^2-1}{5} = 4$ d)$\frac{6^2-1}{7} = 5$

7) $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, ഈ ക്രമത്തിലെരു പദമാണ് $\frac{x^2-1}{y} = 9$ എങ്കിൽ x ന്റെ വില എത്ര?

a)1 b)11 c) 10 d) 9

8) $\frac{c}{d} = \frac{x}{y}$എങ്കിൽ തന്നിട്ടുള്ളവയിൽ $\frac{c}{d}$ ക്ക് തുല്യമാകുന്നത് ഏത്?

a)$\frac{c+2x}{d+2y}$ b)$\frac{c+x}{d+2y}$ c)$\frac{c+2x}{d+y}$ d)$\frac{y}{x}$

9) $\frac{a}{b}$യിൽ$a < b$ ആണെങ്കിൽ തന്നിട്ടുള്ളതിൽ ശരിയായത് ഏത്?

a)$\frac{a}{b} > \frac{a+1}{b+1}$ b)$\frac{a}{b} < \frac{a+1}{b+1}$ c)$\frac{a}{b} = \frac{a+1}{b+1}$ d) $\frac{a}{b} < \frac{a-1}{b-1}$

10) $\frac{7}{8} > \frac{x}{5}$എങ്കിൽ തന്നിട്ടുള്ളയിൽ $'x'$ ന്റെ വില ആകാവുന്നത് ഏത്?

a)4 b)5 c) 6 d) 7

11) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$ഇവയെ ആരോഹണക്രമത്തിൽ എഴുതുക.

a)$\frac{13}{15}, \frac{12}{14}, \frac{11}{13}$ b)$\frac{11}{13}, \frac{12}{14}, \frac{13}{15}$

c)$\frac{11}{13}, \frac{13}{15}, \frac{12}{14}$ d) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$

12) $\frac{a}{b} = \frac{p}{q}$വിൽ $a < b$ ആവണമെങ്കിൽ p യും q വും തമ്മിലുള്ള ബന്ധം തന്നിട്ടുള്ളവയിൽ ഏതായിരിക്കണം?

a)$p > q$ b)$q < p$ c)$p = q$ d)$p < q$

---

13 മുതൽ15 വരെ ചോദ്യങ്ങൾക്ക് തന്നിട്ടുള്ള സമവാക്യം അപഗ്രഥിച്ച് ഉത്തരം കണ്ടെത്തുക

$\frac{3}{7} = \frac{a}{10} + \frac{b}{100} + c$ എങ്കിൽ

13) a യുടെ വില a)7 b)$\frac{7}{10}$ c)10 d)4

14) b യുടെ വില a)2 b)$\frac{7}{10}$ c)14 d)1

15) cയുടെവില a)3 b)$\frac{6}{700}$ c)$\frac{1}{700}$ d)4

Appendix –D6

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN FRACTIONS (FINAL)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Time: 35 minute | Marks: 15

Directions:

Given below are twenty-five questions from the chapter of Fractions. Four choices such as a, b, c, and d are given of which there is only one right answer. Circle the right choice for each question as shown (Eg: a, b, c, d). Make an attempt to answer all questions. You may use additional paper provided for performing more calculations.

1) Which of the following is a fraction not an equivalent as $\frac{3}{5}$?

a) $\frac{30}{50}$ b) $\frac{51}{85}$ c) $\frac{42}{71}$ d) $\frac{33}{55}$

2) If $\frac{a}{b} = \frac{p}{q}$, then which of these equations is true?

a) $aq = pb$ b) $ap = bq$ c) $ab = pq$ d) $a = p$

3) $\frac{a}{b} - \frac{p}{q} =$ _______?

a) $\frac{ap-bp}{bq}$ b) $\frac{aq-bp}{bq}$ c) $\frac{aq-bp}{ap}$ d) $\frac{ab-pq}{bq}$

4) If $a < b$ in the fraction $\frac{a}{b}$, then which of the following is true?

a) $\frac{a}{b} > 1$ b) $\frac{a}{b} < 1$ c) $\frac{a}{b} = 1$ d) $a = b$

5) $\frac{1}{x} + \frac{1}{y} =$ _______?

a) $\frac{2xy}{x}$ b) $\frac{xy}{x+y}$ c) $\frac{x+y}{xy}$ d) $\frac{x}{y}$

6) If $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, then what is the 5th term?

a) $\frac{5^2-1}{4} = 6$ b) $\frac{7^2-1}{8} = 5$ c) $\frac{5^2-1}{5} = 4$ d) $\frac{6^2-1}{7} = 5$

7) If $\frac{x^2-1}{y} = 9$ is a term in the series of $\frac{2^2-1}{3} = 1$, $\frac{3^2-1}{4} = 2$, $\frac{4^2-1}{5} = 3$, …. then what is the value of x?

a) 1 b) 11 c) 10 d) 9

8) If $\frac{c}{d} = \frac{x}{y}$, then which fraction of the following is equivalent to $\frac{c}{d}$?

a) $\frac{c+2x}{d+2y}$ b) $\frac{c+x}{d+2y}$ c) $\frac{c+2x}{d+y}$ d) $\frac{y}{x}$

9) If $a < b$ in the fraction $\frac{a}{b}$, then which of the following is true?

a) $\frac{a}{b} > \frac{a+1}{b+1}$ b) $\frac{a}{b} < \frac{a+1}{b+1}$ c) $\frac{a}{b} = \frac{a+1}{b+1}$ d) $\frac{a}{b} < \frac{a-1}{b-1}$

10) If $\frac{7}{8} > \frac{x}{5}$, then which of the following can be the value of $'x'$?

a) 4 b) 5 c) 6 d) 7

11) Write $\frac{12}{14}, \frac{11}{13}$, and $\frac{13}{15}$ in the ascending order.

a) $\frac{13}{15}, \frac{12}{14}, \frac{11}{13}$ b) $\frac{11}{13}, \frac{12}{14}, \frac{13}{15}$ c) $\frac{11}{13}, \frac{13}{15}, \frac{12}{14}$ d) $\frac{12}{14}, \frac{11}{13}, \frac{13}{15}$

12) If $\frac{a}{b} = \frac{p}{q}$ and $a < b$, then which of the following shows the relationship between p and q?

a) $p > q$ b) $q < p$ c) $p = q$ d) $p < q$

Find answers for 13to15 by analyzing the given equation

If $\frac{3}{7} = \frac{a}{10} + \frac{b}{100} + c$ then

13) The value of a is-- ----…. a) 7 b) $\frac{7}{10}$ c) 10 d) 4

14) The value of b is-- ----…. a) 2 b) $\frac{7}{10}$ c) 14 d) 1

15) The value of c is-- ----…. a) 3 b) $\frac{6}{700}$ c) $\frac{1}{700}$ d) 4

Appendix -D7

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Response sheet for

TEST OF ACHIEVEMENT IN FRACTIONS (FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: ……………………………………………..................…………………………

Class ……………………………………..Roll Number:……......……..................……..…

Sl. No.	a	b	c	d
1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d
9	a	b	c	d
10	a	b	c	d
11	a	b	c	d
12	a	b	c	d
13	a	b	c	d
14	a	b	c	d
15	a	b	c	d

Appendix –D8

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Scoring Key for

TEST OF ACHIEVEMENT IN FRACTIONS (FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Question Number	Answer
1	c
2	a
3	b
4	b
5	c
6	d
7	c
8	a
9	b
10	a
11	b
12	d
13	d
14	a
15	b

Appendix –E1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (DRAFT)

Dr. Abdul Gafoor. K **Abidha Kurukkan**
Professor Research Scholar

Time: 45 minute Marks: 20

നിർദ്ദേശങ്ങൾ:

സമവാക്യജോടികൾ എന്ന അദ്ധ്യായത്തിൽ നിന്നുള്ള 20 ചോദ്യങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഓരോ ചോദ്യത്തിനും a, b, c, d എന്നിങ്ങനെ നാല് ഉത്തരങ്ങൾ തന്നിട്ടുണ്ട്, ഒന്ന് മാത്രമെ ശരിയായത് ഉള്ളു; ഉത്തരങ്ങൾ തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ അനുയോജ്യമായ കോളത്തിൽ രേഖപ്പെടുത്തുക (ഉത്തരത്തെ സൂചിപ്പിക്കുന്ന അക്ഷര ത്തിനു ചുററും വട്ടം വരക്കുക. ഉദാ: a, b, c, d). എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതാൻ ശ്രമിക്കുക. എന്തെങ്കിലും ക്രിയചെയ്തു നോക്കണമെങ്കിൽ കൂടുതലായി തന്നിട്ടുള്ള പേപ്പർ ഉപയോഗിക്കാം.

---

1) $2t + 4.5 = 16.5$, എങ്കിൽ $t =$ _____?

a)14 **b)**11.5 **c)**6 **d)** 12

2) $\frac{y+12}{2} = 15$, എങ്കിൽ $y =$ _____?

a)42 **b)**5 **c)**25 **d)** 18

3) $\frac{x}{5} = y$, എങ്കിൽ $x =$ _____?

a)$y + 5$ **b)**$5y$ **c)**$y - 5$ **d)** $\frac{y}{5}$

4) $\frac{k}{4} + 4 = 6$, എങ്കിൽ $k - 1 =$ _____?

a)8 **b)**14 **c)**7 **d)** $\frac{2}{4}$

5) $4(y + 1) = 20$ എങ്കിൽ $y + 1 =$ _____?

a)16 **b)**5 **c)**6 **d)** 80

6) തന്നിട്ടുള്ളവയിൽ $x^2 - y^2$നു തുല്യമായത് ഏത്?

a)$(x + y)(x + y)$ **b)**$(x - y)^2$

c)$(x - y)(x - y)$ **d)** $(x + y)(x - y)$

7) ഒരു രണ്ടക്ക സംഖ്യയുടെ അക്കങ്ങളുടെ തുകയെ 7 കൊണ്ട് ഗുണിച്ച് 3 കൂട്ടിയാലും , അക്കങ്ങളുടെ വ്യത്യാസത്തെ 20 കൊണ്ട്ഗുണിച്ച് 8 കുറച്ചാലും ആ സംഖ്യ തന്നെ കിട്ടും, സംഖ്യ ഏത്?

a)52 **b)** 25 **c)**42 **d)** 24

8) അക്കങ്ങൽ തമ്മിലുള്ള വ്യത്യാസം 4 ഉം അവയുടെ വർഗ്ഗങ്ങൾ തമ്മിലുള്ള വ്യത്യാസം 64 ഉം ആകുന്നതരത്തിൽ രണ്ട് സംഖ്യകൾ കണ്ടെത്തുക.

a)10, 6 **b)** 8, 4 **c)**12, 8 **d)** 11, 7

9) $\frac{y+4}{3} = 2$, എങ്കിൽ $2y - 1 =$ _____?

a)6 **b)** 4 **c)**3 **d)** 19

10) $u + 2t = 24$ എന്ന സമവാക്യത്തിൽ t യുടെ വില 6 ആണെങ്കിൽ uഎത്ര?

a)36 **b)** 9 **c)**18 **d)** 12

11) $7x + 3y = 23$ആണ്, x ന്റെ വില എത്രയായാലാണ് y യുടെ വില 3 ആവുക?

a)3 **b)** 2 **c)**1 **d)** 5

12) ഒരു രണ്ടക്ക സംഖ്യയിലെ അക്കങ്ങളുടെ തുക 8 ആണ്, പത്തുകളുടെ സ്ഥാനത്തെ അക്കത്തിന്റെ 2 മടങ്ങിനെക്കാൾ 2 കൂടുതലാണ് ഒന്നുകളുടെ സ്ഥാനത്തെ അക്കം. സംഖ്യയേത്?

ഈ ചോദ്യത്തിന് ഉത്തരം കണ്ടെത്താൻ വേണ്ടി, പത്തിന്റെ സ്ഥാനത്തെ അക്കം x എന്നും ഒന്നിന്റെ സ്ഥാനത്തെ അക്കം y എന്നും എടുത്ത് സലിമും റാഫിയും എഴുതിയ സമവാക്യങ്ങൾ താഴെ കൊടുത്തിരിക്കുന്നു.

സലിം എഴുതിയ സമവാക്യങ്ങൾ

$10x + y = 8 \quad --(1)$

$2x + 2 = y \quad --(2)$

റാഫിഎഴുതിയസമവാക്യങ്ങൾ

$x + y = 8 \quad --(1)$

$2x + 2 = y \quad --(2)$

എങ്കിൽ

a)സലിംഎഴുതിയ രണ്ട് സമവാക്യങ്ങളുംശരിയാണ്

b)റാഫിഎഴുതിയ രണ്ട് സമവാക്യങ്ങളുംശരിയാണ്

c)സലിംഎഴുതിയഒന്നാംസമവാക്യംശരിയാണ്

d) റാഫിഎഴുതിയരണ്ടാംസമവാക്യംതെററാണ്

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് 13, 14 എന്നീ ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

$x + y = 18$ഉം$x - y = 12$ ഉംആണെങ്കിൽ

13) x ന്റെ വില എത്ര? **a)**12 **b)** 14 **c)**15 **d)** 16

14) y യുടെ വില എത്ര? **a)**6 **b)** 4 **c)**3 **d)** 2

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് $15, 16$ എന്നീ ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

രണ്ട് പേനക്കും ഒരു നോട്ട്ബുക്കിനും കൂടി 20 രൂപ, 4പേനക്കും 3 നോട്ട്ബുക്കിനും കൂടി 50 രൂപ; പേനയുടെ വില xആയും നോട്ട്ബുക്കിന്റെ വില y ആയും എടുത്ത് ബീജഗണിത സമവാക്യങ്ങളാക്കിയാൽ കിട്ടുന്നസമവാക്യങ്ങൾ ഏതെല്ലാം?

15) ഒന്നാംവാചകത്തിൽനിന്ന്കിട്ടുന്ന സമവാക്യം

a)$2x + y = 20$ **b)**$x + 2y = 20$

c)$x + y = 20$ **d)** $2x + 2y = 20$

16) രണ്ടാംവാചകത്തിൽനിന്ന്കിട്ടുന്ന സമവാക്യം

a)$3x + 4y = 50$ **b)**$4x + 2y = 50$

c)$4x + 3y = 50$ **d)** $x + 3y = 50$

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് 17മുതൽ 20 വരെയുള്ള ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

ഒരു സംഖ്യയുടെ രണ്ട് മടങ്ങുംമറ്റൊരുസംഖ്യയുടെമൂന്ന്മടങ്ങുംകൂട്ടിയപ്പോൾ34 കിട്ടി. ആദ്യ സംഖ്യയുടെ അഞ്ച് മടങ്ങിൽനിന്ന് രണ്ടാമത്തെ സംഖ്യയുടെ നാല് മടങ്ങ് കുറച്ചപ്പോൾ 16 കിട്ടി.

ആദ്യസംഖ്യ x എന്നും രണ്ടാമത്തെ സംഖ്യ y എന്നും എടുത്തു എന്ന് കരുതിയാൽ;

17) ഒന്നാമത്തെ വാചകത്തിൽനിന്ന്കിട്ടുന്ന സമവാക്യം?

a)$x^2 + y^3 = 34$ **b)**$2x + 3y = 34$

c)$2x + 3y = 16$ **d)** $2x - 3y = 34$

18) രണ്ടാമത്തെ വാചകത്തിൽനിന്ന്കിട്ടുന്ന സമവാക്യം

a)$4x - 5y = 16$ **b)**$5x + 4y = 16$

c)$5x - 4y = 16$ **d)** $5x - 4y = 34$

19) x ന്റെ വില എത്ര?

a)6 **b)** 4 **c)**8 **d)** 10

20) y യുടെ വില എത്ര?

a)6 **b)** 4 **c)**8 **d)** 10

Appendix –E2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (DRAFT)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Time: 45 minute — Marks: 20

Directions:

Given below are twenty questions from the chapter of Pairwise Equations. Four choices such as a, b, c, and d are given of which there is only one right answer. Circle the right choice for each question as shown (Eg: a, b, c, d). Make an attempt to answer all questions. You may use additional paper provided for performing more calculations.

---

1) If $2t + 4.5 = 16.5$, then $t =$ _____?

   a)14 b)11.5 c)6 d) 12

2) If $\frac{y+12}{2} = 15$, then $y =$ _____?

   a)42 b)5 c)25 d) 18

3) If $\frac{x}{5} = y$, then $x =$ _____?

   a)$y + 5$ b)$5y$ c)$y - 5$ d) $\frac{y}{5}$

4) If $\frac{k}{4} + 4 = 6$, then $k - 1 =$ _____?

   a)8 b)14 c)7 d) $\frac{2}{4}$

5) If $4(y + 1) = 20$ then $y + 1 =$ _____?

   a)16 b)5 c)6 d) 80

6) Which of the choices given below are equal to$x^2 - y^2$?

   a)$(x + y)(x + y)$ b)$(x - y)^2$
   c)$(x - y)(x - y)$ d) $(x + y)(x - y)$

7) You get the same two-digit number when sum of the digits of this number is multiplied by 7 and add 3 to the product, and when the difference of the digits is multiplied by 20 and subtracted 8 from the product. Which is the two-digit number?

   a)52 b) 25 c)42 d) 24

8) Find two numbers of which their difference is 4 and the difference of their squares is64.

a)$10, 6$ b) $8, 4$ c)$12, 8$ d) $11, 7$

9) If $\frac{y+4}{3} = 2$, then$2y - 1 =$ ____?

a)6 b) 4 c)3 d) 19

10) What is the values of u in the equation $u + 2t = 24$ if the value of t is 6?

a)36 b) 9 c)18 d) 12

11) What value of x would make $y = 3$ when $7x + 3y = 23$?

a)3 b) 2 c)1 d) 5

12) The sum of digits in a two-digit number is 8. The digit with the place holder of one is 2 times the tenth placeholder plus2. Which is the number?

To solve this problem, Salim and Rafi consider x as the tenth placeholder and y as the placeholder of one. The equations made by Salim and Rafi are given below.

Equations written by Salim

$10x + y = 8 \quad --(1)$

$2x + 2 = y \quad --(2)$

Equations written by Rafi

$x + y = 8 \quad --(1)$

$2x + 2 = y \quad --(2)$

Considering the equations, which choice is accurate?

a) Both equations written by Salim is correct

b) Both equations written by Rafi is correct

c) First equation written by Salim is correct

d) Second equation written by Rafi is incorrect

Answer 13, and14 using the information given

If $x + y = 18$ and $x - y = 12$

13) Value of x? a)12 b) 14 c)15d) 16

14) Value of y? a)6 b) 4 c)3 d) 2

Answer 15 and 16 based on the information given below.

The price for two pens and a notebook is Rs. 20. Four pens and three notebooks cost Rs. 50. What equations can be made by considering x as the price for a pen and y as the price for a notebook?

15) The equation based on the first statement is

a)$2x + y = 20$ b)$x + 2y = 20$

c)$x + y = 20$ d) $2x + 2y = 20$

16) The equation based on the second statement

a)$3x + 4y = 50$ b)$4x + 2y = 50$

c)$4x + 3y = 50$ d) $x + 3y = 50$

Find the answers for 17 to 20 using the information given

The sum of a number multiplied by two and another number multiplied by three is 34. The second number multiplied by four is subtracted from thefirst number multiplied by five and the gives 16. Let x and y be the first and second numbers, respectively.

17) What equation can be constructed from the first statement?

a)$x^2 + y^3 = 34$ b) $2x + 3y = 34$

c)$2x + 3y = 16$ d) $2x - 3y = 34$

18) What equation can be constructed form the second statement?

a)$4x - 5y = 16$ b)$5x + 4y = 16$

c)$5x - 4y = 16$ d) $5x - 4y = 34$

19) What ids the value of x?

a)6 b) 4 c) 8 d) 10

20) What is the value of y?

a)6 b) 4 c) 8 d) 10

Appendix -E3

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Response Sheet for

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (DRAFT)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: ……………………………………………….....…………………………

Class …………………….. Roll Number:………………..…

Sl. No.	a	b	c	d
1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d
9	a	b	c	d
10	a	b	c	d
11	a	b	c	d
12	a	b	c	d
13	a	b	c	d
14	a	b	c	d
15	a	b	c	d
16	a	b	c	d
17	a	b	c	d
18	a	b	c	d
19	a	b	c	d
20	a	b	c	d

Appendix –E4

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Scoring Key for

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS
(DRAFT)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Question Number	Answer
1	c
2	d
3	b
4	c
5	b
6	d
7	a
8	a
9	c
10	d
11	b
12	b
13	c
14	c
15	a
16	c
17	b
18	c
19	c
20	a

Appendix –E5

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (FINAL)

Dr. Abdul Gafoor. K Professor

Abidha Kurukkan Research Scholar

Time: 35 minute Marks: 17

നിർദ്ദേശങ്ങൾ:

സമവാക്യജോടികൾ എന്ന അദ്ധ്യായത്തിൽ നിന്നുള്ള 17 ചോദ്യങ്ങളാണ് ഇവിടെ തന്നിട്ടുള്ളത്. ഓരോ ചോദ്യത്തിനും a, b, c, d എന്നിങ്ങനെ നാല് ഉത്ത രങ്ങൾ തന്നിട്ടുണ്ട്, ഒന്ന് മാത്രമെ ശരിയായത് ഉള്ളു; ഉത്തരങ്ങൾ തന്നിട്ടുള്ള ഉത്തരക്കടലാസിൽ അനുയോജ്യമായ കോളത്തിൽ രേഖപ്പെടുത്തുക (ഉത്തരത്തെ സൂചിപ്പിക്കുന്ന അക്ഷര ത്തിനു ചുററും വട്ടം വരക്കുക. ഉദാ: a, b, c, d). എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതാൻ ശ്രമിക്കുക. എന്തെങ്കിലും ക്രിയചെയ്തു നോക്കണമെങ്കിൽ കൂടുതലായി തന്നിട്ടുള്ള പേപ്പർ ഉപയോഗിക്കാം.

1) $2t + 4.5 = 16.5$, എങ്കിൽ $t =$ _____?

a)14 b)11.5 c)6 d) 12

2) $\frac{x}{5} = y$, എങ്കിൽ $x =$ _____?

a)$y + 5$ b)$5y$ c)$y - 5$ d) $\frac{y}{5}$

3) $\frac{k}{4} + 4 = 6$, എങ്കിൽ $k - 1 =$ _____?

a)8 b)14 c)7 d) $\frac{2}{4}$

4) തന്നിട്ടുള്ളവയിൽ $x^2 - y^2$നു തുല്യമായത് ഏത്?

a)$(x + y)(x + y)$ b)$(x - y)^2$
c)$(x - y)(x - y)$ d) $(x + y)(x - y)$

5) ഒരു രണ്ടക്ക സംഖ്യയുടെ അക്കങ്ങളുടെ തുകയെ 7 കൊണ്ട് ഗുണിച്ച് 3 കൂട്ടിയാലും, അക്കങ്ങളുടെ വ്യത്യാസത്തെ 20 കൊണ്ട്ഗുണിച്ച് 8 കുറച്ചാലും ആ സംഖ്യതന്നെകിട്ടും, സംഖ്യ ഏത്?

a)52 b) 25 c)42 d) 24

6) അക്കങ്ങൽ തമ്മിലുള്ള വ്യത്യാസം 4ഉം അവയുടെ വർഗ്ഗങ്ങൾ തമ്മിലുള്ള വ്യത്യാസം 64ഉം ആകുന്നതരത്തിൽ രണ്ട് സംഖ്യകൾ കണ്ടെത്തുക.

a)10, 6 b) 8, 4 c)12, 8 d) 11, 7

7) $\frac{y+4}{3} = 2$, എങ്കിൽ $2\,y - 1 =$ _____?

a)6 b) 4 c)3 d) 19

8) $u + 2t = 24$ എന്ന സമവാക്യത്തിൽ t യുടെ വില 6 ആണെങ്കിൽ uഎത്ര?

a)36 b) 9 c)18 d) 12

9) $7x + 3y = 23$ആണ്, x ന്റെ വില എത്രയായാലാണ് y യുടെ വില 3 ആവുക?

a)3 b) 2 c)1 d) 5

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് 10, 11എന്നീ ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

$x + y = 18$ഉം$x - y = 12$ ഉംആണെങ്കിൽ

10) x ന്റെ വില എത്ര? a)12 b) 14 c)15 d) 16

11) y യുടെ വില എത്ര? a)6 b) 4 c)3 d) 2

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് 12, 13 എന്നീ ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

രണ്ട് പേനക്കും ഒരു നോട്ട്ബുക്കിനും കൂടി 20 രൂപ, 4പേനക്കും 3 നോട്ട്ബുക്കിനും കൂടി 50 രൂപ; പേനയുടെ വില xആയും നോട്ട്ബുക്കിന്റെ വില y ആയും എടുത്ത് ബീജഗണിത സമവാക്യങ്ങളാക്കിയാൽ കിട്ടുന്നസമവാക്യങ്ങൾ ഏതെല്ലാം?

12) ഒന്നാം വാചകത്തിൽനിന്ന് കിട്ടുന്ന സമവാക്യം

a)$2x + y = 20$ b)$x + 2y = 20$

c)$x + y = 20$ d) $2x + 2y = 20$

13) രണ്ടാം വാചകത്തിൽ നിന്ന് കിട്ടുന്ന സമവാക്യം

a)$3x + 4y = 50$ b) $4x + 2y = 50$

c)$4x + 3y = 50$ d) $x + 3y = 50$

തന്നിട്ടുള്ള വിവരങ്ങൾ ഉപയോഗിച്ച് 14 മുതൽ 17വരെയുള്ള ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തുക

ഒരു സംഖ്യയുടെ രണ്ട് മടങ്ങും മറ്റൊരു സംഖ്യയുടെ മൂന്ന് മടങ്ങും കൂട്ടിയപ്പോൾ 34 കിട്ടി. ആദ്യ സംഖ്യയുടെ അഞ്ച് മടങ്ങിൽനിന്ന് രണ്ടാമത്തെ സംഖ്യയുടെ നാല് മടങ്ങ് കുറച്ചപ്പോൾ 16 കിട്ടി.

ആദ്യസംഖ്യ x എന്നും രണ്ടാമത്തെ സംഖ്യ y എന്നും എടുത്തു എന്ന് കരുതിയാൽ;

14) ഒന്നാമത്തെ വാചകത്തിൽനിന്ന് കിട്ടുന്ന സമവാക്യം?

a)$x^2 + y^3 = 34$b)$2x + 3y = 34$

c)$2x + 3y = 16$d) $2x - 3y = 34$

15) രണ്ടാമത്തെ വാചകത്തിൽനിന്ന് കിട്ടുന്ന സമവാക്യം

a)$4x - 5y = 16$ b)$5x + 4y = 16$

c)$5x - 4y = 16$ d) $5x - 4y = 34$

16) x ന്റെ വില എത്ര?

a)6 b) 4 c)8 d) 10

17) y യുടെ വില എത്ര?

a)6 b) 4 c)8 d) 10

Appendix –E6

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (FINAL)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

Time: 35 minute — Marks: 17

Directions:

Given below are twenty questions from the chapter of Pairwise Equations. Four choices such as a, b, c, and d are given of which there is only one right answer. Circle the right choice for each question as shown (Eg: a, b, c, d). Make an attempt to answer all questions. You may use additional paper provided for performing more calculations.

1) If $2t + 4.5 = 16.5$,then$t =$ _____?
   a)14 b)11.5 c)6 d) 12
2) If $\frac{x}{5} = y$, then $x =$ _____?
   a)$y + 5$ b)$5y$ c)$y - 5$ d) $\frac{y}{5}$
3) If $\frac{k}{4} + 4 = 6$, then$k - 1 =$ _____?
   a)8 b)14 c)7 d) $\frac{2}{4}$
4) Which of the choices given below are equal to$x^2 - y^2$?
   a)$(x + y)(x + y)$ b)$(x - y)^2$
   c)$(x - y)(x - y)$ d) $(x + y)(x - y)$
5) You get the same two-digit number when sum of the digits of this number is multiplied by 7 and add 3 to the product, and when the difference of the digits is multiplied by 20 and subtracted 8 from the product. Which is the two-digit number?
   a)52 b) 25 c)42 d) 24
6) Find two numbers of which their difference is 4 and the difference of their squares is64.
   a)$10,\ 6$ b) $8,\ 4$ c)$12,\ 8$ d) $11,\ 7$
7) If $\frac{y+4}{3} = 2$, then$2y - 1 =$ _____?
   a)6 b) 4 c) 3 d) 19

8) What is the values of u in the equation $u + 2t = 24$ if the value of t is 6?
a)36 b) 9 c)18 d) 12

9) What value of x would make $y = 3$ when $7x + 3y = 23$?
a)3 b) 2 c)1 d) 5

Answer 10, and 11 using the information given

If $x + y = 18$ and $x - y = 12$

10) Value of x? a)12 b) 14 c)15 d) 16

11) Value of y? a)6 b) 4 c)3 d) 2

Answer 12and 13 based on the information given below.

The price for two pens and a notebook is Rs. 20. Four pens and threenotebooks cost Rs. 50. What equations can be made by considering x as the price for a pen and y as the price for a notebook?

12) The equation based on the first statement is
a)$2x + y = 20$ b)$x + 2y = 20$
c)$x + y = 20$ d) $2x + 2y = 20$

13) The equation based on the second statement
a)$3x + 4y = 50$ b)$4x + 2y = 50$
c)$4x + 3y = 50$ d) $x + 3y = 50$

Find the answers for 14to17 using the information given

The sum of a number multiplied by two and another number multiplied by three is 34. The second number multiplied by four is subtracted from thefirst number multiplied by five and the gives 16.
Let x and y be the first and second numbers, respectively.

14) What equation can be constructed from the first statement?
a)$x^2 + y^3 = 34$ b)$2x + 3y = 34$
c)$2x + 3y = 16$ d) $2x - 3y = 34$

15) What equation can be constructed form the second statement?
a)$4x - 5y = 16$ b)$5x + 4y = 16$
c)$5x - 4y = 16$ d) $5x - 4y = 34$

16) What ids the value of x?
a)6 b) 4 c)8 d) 10

17) What is the value of y?
a)6 b) 4 c)8 d) 10

Appendix -E7

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Response sheet for

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS (FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: ……………………………………………...…………………………

Class …………………….. Roll Number:………………..…

Sl. No.	a	b	c	d
1	a	b	c	d
2	a	b	c	d
3	a	b	c	d
4	a	b	c	d
5	a	b	c	d
6	a	b	c	d
7	a	b	c	d
8	a	b	c	d
9	a	b	c	d
10	a	b	c	d
11	a	b	c	d
12	a	b	c	d
13	a	b	c	d
14	a	b	c	d
15	a	b	c	d
16	a	b	c	d
17	a	b	c	d

Appendix –E8

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

Scoring Key for

TEST OF ACHIEVEMENT IN PAIRS OF EQUATIONS
(FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Question Number	Answer
1	c
2	b
3	c
4	d
5	a
6	a
7	c
8	d
9	b
10	c
11	c
12	a
13	c
14	b
15	c
16	c
17	a

Appendix –F1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF SELF-EFFICACY FOR LEARNING MATHEMATICS

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....…ക്ലാസ്സ്..

നിർദ്ദേശങ്ങൾ:

തന്നിട്ടുള്ള ഗണിത സംബന്ധിയായ പ്രവർത്തികൾ ചെയ്യാൻ കഴിയുമെന്ന് നിങ്ങൾക്ക് എത്രത്തോളം ആത്മവിശ്വാസമുണ്ട്; പൂജ്യം മുതൽ നൂറ് വരെയുള്ള ശതമാനമായി വലതുവശത്ത് രേഖപ്പെടുത്തുക. (യോജിക്കുന്നതിന് വട്ടംവരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക.

0%	25%	50%	75%	100%
ചെയ്യാൻ പററുമെന്ന് കരുതുന്നില്ല	ചിലപ്പോഴൊക്കെ ചെയ്യാൻ പററും	ഏറെക്കുറെ ചെയ്യാൻ പററും	നന്നായി ചെയ്യാൻ പററും	വളരെ നന്നായി ചെയ്യാൻ പററും

1	പഠിച്ചകാര്യങ്ങൾ ഓർമിച്ച് വെക്കാൻഎനിക്ക് കഴിയും	0%	25%	50%	75%	100%
2	ഗണിതത്തിൽ ഞാൻ പഠിച്ചകാര്യങ്ങൾ ആവശ്യം വരുമ്പോൾ ഉപയോഗപ്പെടുത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
3	പഠിച്ച തത്വങ്ങൾ എങ്ങിനെ രൂപപ്പെട്ടുവെന്ന് വിവരിക്കാൻ എനിക്കാവും	0%	25%	50%	75%	100%
4	ഒരു ചോദ്യം കിട്ടിയാൽ അതിൽ തന്നിട്ടുള്ള വിവരങ്ങൾ മനസ്സിലാക്കിയെടുക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
5	ഒരു ചോദ്യം കണ്ടാൽ അതിന്റെ ഉത്തരം എങ്ങിനെ കണ്ടെത്താമെന്ന് മനസ്സിലാക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
6	ഒരു പ്രശ്നത്തിന്റെ ഉത്തരം തെററിപ്പോയാൽ ആ തെററ് എങ്ങിനെ സംഭവിച്ചുവെന്ന് കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
7	ഞാൻ ശരിയായി ചെയ്ത ഒരു ഗണിത പ്രശ്നത്തിന്റെ ഉത്തരം അതാണെന്ന് ഉറപ്പിച്ച് പറയാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%

8	ഗണിതത്തിൽ എനിക്ക് വിജയിക്കാൻ കഴിയും	0%	25%	50%	75%	100%
9	അധ്യാപകർ ക്ലാസ്സിൽ പറയുന്ന കാര്യങ്ങൾ മനസ്സിലാക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
10	അധ്യാപകർ ക്ലാസ്സിൽ തരുന്ന ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്തോൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
11	ഗണിതപ്പരീക്ഷകളിൽ മെച്ചപ്പെട്ട പ്രകടനം കാഴ്ചവെക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
12	മത്സരപ്പരീക്ഷകളിലും മററും വരുന്ന ഗണിതചോദ്യ ങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
13	ക്ലാസ്സ്റൂമിന് പുറത്ത് ഗണിത തത്വങ്ങൾ ഉപയോഗ പ്പെടുത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
14	ബീജഗണിതത്തിൽ (Algebra) മെച്ചപ്പെട്ട പ്രകടനം കാഴ്ച വെക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
15	ജ്യാമിതിയിൽ (Geometry) മെച്ചപ്പെട്ട പ്രകടനം കാഴ്ച വെക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
16	എളുപ്പമുള്ള ചോദ്യമാണെങ്കിൽ ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
17	അധികം ബുദ്ധിമുട്ടില്ലാത്ത ചോദ്യങ്ങൾക്ക് ഉത്തരം ക ണ്ടത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
18	ബുദ്ധിമുട്ടുള്ള ചോദ്യങ്ങൾക്കും ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
19	ആവശ്യമായ വിവരങ്ങളെല്ലാം വ്യക്തമായി തന്ന ചോദ്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
20	ആവശ്യമായ വിവരങ്ങൾ വ്യക്തമായി തന്നിട്ടില്ലെ ങ്കിലും ഒരു ചോദ്യത്തിന് ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%

Appendix –G1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF SELF-EFFICACY FOR LEARNING FRACTIONS

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

പേര്:... ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്..

നിർദ്ദേശങ്ങൾ:

തന്നിട്ടുള്ള ഗണിതസംബന്ധിയായ പ്രവർത്തികൾ ചെയ്യാൻ കഴിയുമെന്ന് നിങ്ങൾക്ക് എത്രത്തോളം ആത്മവിശ്വാസമുണ്ട്; പൂജ്യം മുതൽ നൂറ് വരെയുള്ള ശതമാനമായി വലതുവശത്ത് രേഖപ്പെടുത്തുക. (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക.

0%	25%	50%	75%	100%
ചെയ്യാൻ പററുമെന്ന് കരുതുന്നില്ല	ചിലപ്പോഴൊക്കെ ചെയ്യാൻ പററും	ഏറെക്കുറെ ചെയ്യാൻ പററും	നന്നായി ചെയ്യാൻ പററും	വളരെ നന്നായി ചെയ്യാൻ പററും

1	ഒരു ഭിന്നസംഖ്യക്ക് തുല്യമായ മറെറാരു ഭിന്നം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
2	ഒരു ഭിന്നസംഖ്യ കിട്ടിയാൽ അതിന് തുല്യവും അംശവും ഛേദവും ഏററവും ചെറുതുമായ ഒരു ഭിന്നസംഖ്യ കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
3	ഒരു ഭിന്നസംഖ്യാ പ്രശ്നത്തെ ബീജഗണിത രൂപത്തിലേക്ക് മാററാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
4	രണ്ട് ഭിന്നസംഖ്യകൾ കിട്ടിയാൽ അവ തുല്യമാണോ എന്ന് പറയാൻ എനിക്ക് സാധിക്കും	0%	25%	50%	75%	100%
5	രണ്ട് തുല്യ ഭിന്നങ്ങൾ കിട്ടിയാൽ അവ ഉപയോഗിച്ച് അവക്ക് തുല്യമായ പുതിയൊരു ഭിന്നം ഉണ്ടാകാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
6	രണ്ട് ഭിന്ന സംഖ്യകൾ തന്നാൽ അവയിൽ വലുത്/ ചെറുത് ഏതാണെന്ന് പറയാൻ എനിക്ക് സാധിക്കും	0%	25%	50%	75%	100%
7	രണ്ട് ഭിന്നസംഖ്യക്ക് ഇടയിലായിവരുന്ന മറെറാരു ഭിന്നസംഖ്യ കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%

8	ഏത് രണ്ട് ഭിന്നസംഖ്യകളുടേയും തുക കാണാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
9	ഏത് രണ്ട് ഭിന്നസംഖ്യകളുടേയും വ്യത്യാസം കാണാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
10	ഏത് രണ്ട് ഭിന്നസംഖ്യകളേയും തമ്മിൽ ഗുണിക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
11	ഏത് രണ്ട് ഭിന്നസംഖ്യകളേയും തമ്മിൽ ഹരിക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
12	ബീജഗണിത രീതിയിൽ തന്നിട്ടുള്ള ഭിന്നസംഖ്യകൾ ഉൾപ്പെട്ട പ്രശ്നങ്ങൾ ക്രിയചെയ്യാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
13	ഭിന്നസംഖ്യാരൂപത്തിൽ എഴുതിയ ബീജഗണിത വാചകങ്ങളെ ലഘൂകരിക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
14	ഭിന്നസംഖ്യാ ക്രമങ്ങൾ ബീജഗണിതം ഉപയോഗിച്ച് തെളിയിക്കാൻ എനിക്ക്കഴിയും	0%	25%	50%	75%	100%
15	ഏതൊരു ഭിന്നസംഖ്യയേയും ദശാംശരൂപത്തിൽ എഴുതാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
16	ഭിന്നസംഖ്യകളുമായി ബന്ധപ്പെട്ട് ക്ലാസ്സ്റൂമിന് പുറത്ത് വരുന്ന പ്രശ്നങ്ങൾ പരിഹരിക്കാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%

Appendix –G2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF SELF-EFFICACY FOR LEARNING FRACTIONS

Dr. Abdul Gafoor. K — Professor
Abidha Kurukkan — Research Scholar

Name: ………………………………………………… ………………; Male/Female

Age: ………………….. Class ……………………………………………………

Directions:

Provide your confidence level in percentage between zero and 100 in solving the given mathematical activities (Circle the right indicator). Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

0%	25%	50%	75%	100%
I do not think I can solve them	I can solve them sometimes	I can solve them to an extent	I can solve them well	I can solve them really well

1	I can find a fraction that is equivalent to another fraction.	0%	25%	50%	75%	100%
2	I can find an equivalent fraction of a given fraction in its simplest form.	0%	25%	50%	75%	100%
3	I can covert a fraction to its algebraic form.	0%	25%	50%	75%	100%
4	I can tell if two given fractions are equivalent.	0%	25%	50%	75%	100%
5	I can generate a new equivalent fraction if I am given two equal fractions.	0%	25%	50%	75%	100%
6	I can figure out smaller and bigger fractions from two given fractions.	0%	25%	50%	75%	100%
7	I can find the fraction that comes in between two other fractions.	0%	25%	50%	75%	100%
8	I can find the sum of any two fractions.	0%	25%	50%	75%	100%
9	I can find the difference between any two fractions.	0%	25%	50%	75%	100%
10	I can multiply any two fractions.	0%	25%	50%	75%	100%
11	I can divide any two fractions.	0%	25%	50%	75%	100%
12	I can solve algebraic problems involving fractions.	0%	25%	50%	75%	100%
13	I can simplify algebraic expressions in fractional forms.	0%	25%	50%	75%	100%
14	I can prove fractional sequences using algebra.	0%	25%	50%	75%	100%
15	I can express any fraction in decimal form.	0%	25%	50%	75%	100%
16	I can solve problems related to fractions outside my classroom.	0%	25%	50%	75%	100%

Appendix –H1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF SELF-EFFICACY FOR LEARNING SYSTEMS OF LINEAR EQUATIONS

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്...

നിർദ്ദേശങ്ങൾ:

തന്നിട്ടുള്ള ഗണിത സംബന്ധിയായ പ്രവർത്തികൾ ചെയ്യാൻ കഴിയുമെന്ന് നിങ്ങൾക്ക് എത്രത്തോളം ആത്മവിശ്വാസമുണ്ട്; പൂജ്യം മുതൽ നൂറ് വരെയുള്ള ശതമാനമായി വലതുവശത്ത് രേഖപ്പെടുത്തുക. (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക.

0%	25%	50%	75%	100%
ചെയ്യാൻ പററുമെന്ന് കരുതുന്നില്ല	ചിലപ്പോഴൊക്കെ ചെയ്യാൻ പററും	ഏറെക്കുറെ ചെയ്യാൻ പററും	നന്നായി ചെയ്യാൻ പററും	വളരെ നന്നായി ചെയ്യാൻ പററും

1	ഏതൊരു ഗണിതപ്രശ്നത്തേയും ബീജഗണിത രൂപത്തിലേക്ക് മാററാൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
2	ഒരു ചരം മാത്രം ഉപയോഗിച്ചുള്ള, ഒന്നാം കൃതിയിലുള്ള ബീജഗണിത സമവാക്യത്തിൽ നിന്ന് ചരത്തിന്റെ വില കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
3	രണ്ട് ചരങ്ങൾ ഉപയോഗിച്ചുള്ള, ഒന്നാം കൃതിയിലുള്ള ബീജഗണിത സമവാക്യത്തിൽ നിന്ന് ചരങ്ങളുടെ വില കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%
4	$x+y = 12$ & $xy = 11$ എന്ന രീതിയിലുള്ള സമവാക്യങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ എനിക്ക്കഴിയും	0%	25%	50%	75%	100%
5	ബീജഗണിത സമവാക്യങ്ങൾ ഉപയോഗിച്ച് ഗണിതക്ലാസ്സിന് പുറത്തുള്ള പ്രശ്നങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ എനിക്ക് കഴിയും	0%	25%	50%	75%	100%

Appendix -H2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF SELF-EFFICACY FOR LEARNING SYSTEMS OF LINEAR EQUATIONS

Dr. Abdul Gafoor. K **Abidha Kurukkan**
Professor **Research Scholar**

Name: ……………………………………………… ……………; Male/Female

Age: …………………….. Class ……………………………………………

Directions:

Provide your confidence level in percentage between zero and 100 in solving the given mathematical activities (Circle the right indicator). Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

0%	25%	50%	75%	100%
I do not think I can solve them	I can solve them sometimes	I can solve them to an extent	I can solve them well	I can solve them really well

1	I can convert any mathematics problem into an algebraic expression.	0%	25%	50%	75%	100%
2	I can find the value of the variable in a first order algebraic equation with one variable.	0%	25%	50%	75%	100%
3	I can figure out the values of the variables if given a first order algebraic equation with two variables.	0%	25%	50%	75%	100%
4	I can solve equations like x+y=12 &xy=11.	0%	25%	50%	75%	100%
5	I can solve problems outside my mathematics classroom using algebraic equations.	0%	25%	50%	75%	100%

Appendix –I1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF TASK VALUE OF LEARNING MATHEMATICS

Dr. Abdul Gafoor. K **AbidhaKurukkan**
Professor Research Scholar

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്...

നിർദ്ദേശങ്ങൾ:

താഴെപറയുന്ന കാര്യങ്ങളോരോന്നും ഈ ക്ലാസ്സിലെ ഗണിതവിദ്യാർത്ഥി എന്ന രീതിയിൽ നിങ്ങളെ സംബന്ധിച്ച് എത്രത്തോളം ശരിയാണെന്ന്, തന്നിട്ടുള്ള സ്കെയിൽ പ്രകാരം അടയാളപ്പെടുത്തുക (യോജിക്കുന്നതിന് വട്ടംവരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയുംവിധം കൃത്യമായ ഉത്തരം നൽകുക, നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക

1	2	3	4	5
തീർത്തും തെററാണ്	ഏറെക്കുറെ തെററാണ്	ശരിയോ തെറേറാ എന്ന് പറയാൻ കഴിയില്ല	ഏറെക്കുറെ ശരിയാണ്	വളരെ ശരിയാണ്

1	ഗണിതക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന കാര്യങ്ങൾ പ്രധാനമാണെന്ന് ഞാൻ കരുതുന്നു	1 2 3 4 5
2	ഗണിതം പഠിക്കുന്നത് എന്നെ സംബന്ധിച്ച് സുപ്രധാനമാണ്	1 2 3 4 5
3	കണക്ക് നന്നായി മനസ്സിലാക്കുക എന്നത് എനിക്ക് പ്രധാനമാണ്	1 2 3 4 5
4	മററു വിഷയങ്ങളുമായി താരതമ്യപ്പെടുത്തുമ്പോൾ ഗണിതം ഉപകാരപ്രദമാണ്	1 2 3 4 5
5	ഗണിതക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന പല കാര്യങ്ങളും ഉപയോഗമുള്ളതാണെന്ന് ഞാൻ കരുതുന്നില്ല	1 2 3 4 5
6	ഗണിതത്തിൽ പഠിക്കുന്ന കാര്യങ്ങൾ എവിടെയെങ്കിലും ഉപകാരപ്പെടുത്താൻ കഴിയുമെന്ന് ഞാൻ കരുതുന്നില്ല	1 2 3 4 5
7	എന്റെ ലക്ഷ്യങ്ങൾ നേടാൻ ഗണിതപഠനം ആവശ്യമാണ്	1 2 3 4 5
8	ഗണിതം രസകരമാണ്	1 2 3 4 5
9	ഗണിതം എനിക്ക് ഇഷ്ടമാണ്	1 2 3 4 5
10	ഗണിതം പഠിക്കാൻ ഞാൻ താത്പര്യപ്പെടുന്നു	1 2 3 4 5
11	ഗണിതം പഠിക്കുന്നതിനേക്കാൾ നല്ലത് വേറെ വിഷയങ്ങൾ പഠിക്കുന്നതാണ്	1 2 3 4 5
12	ഗണിതം പഠിക്കുന്നത് നഷ്ടമാകില്ല	1 2 3 4 5

Appendix –I2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SCALE OF TASK VALUE OF LEARNING MATHEMATICS

Dr. Abdul Gafoor. K
Professor

AbidhaKurukkan
Research Scholar

Name: ……………………………………………… ………………; Male/Female

Age: …………………….. Class ……………………………………………………

Directions:

As a student of mathematics in this class, rate the given statements that how well they are true about you according to the given scale (Circle the right indicator). Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

1	2	3	4	5
Utterly False	Almost False	Neither True Nor False	Almost True	Utterly True

1	I think the topics covered in mathematics classes are important.	1	2	3	4	5
2	It is very important for me to learn mathematics.	1	2	3	4	5
3	It is important for me to understand mathematics really well.	1	2	3	4	5
4	Mathematics is useful compared to other subjects.	1	2	3	4	5
5	I do not think many topics covered in mathematics are useful.	1	2	3	4	5
6	I do not think that learning mathematics can be useful in any way	1	2	3	4	5
7	Learning mathematics is required to meet my goals.	1	2	3	4	5
8	Mathematics is interesting.	1	2	3	4	5
9	I like mathematics.	1	2	3	4	5
10	I like to learn mathematics.	1	2	3	4	5
11	Learning other subjects is better than learning mathematics.	1	2	3	4	5
12	Learning math would not be a waste of time.	1	2	3	4	5

Appendix –J1

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SELF-REGULATED LEARNING STRATEGY QUESTIONNAIRE (DRAFT)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

പേര്:..; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്..

നിർദ്ദേശങ്ങൾ:

ഗണിതപഠനത്തിനായി നിങ്ങൾ ഉപയോഗിക്കുന്ന രീതികളെക്കുറിച്ചുള്ള ചോദ്യങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. ഇവ നിങ്ങളെ സംബന്ധിച്ച് എത്രത്തോളം ശരിയാണെന്ന്, തന്നിട്ടുള്ള സ്കെയിൽ പ്രകാരം രേഖപ്പെടുത്തുക (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയും വിധം കൃത്യമായ ഉത്തരം നൽകുക. നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക

1	2	3	4	5
തീർത്തും തെററാണ്	ഏറെക്കുറെ തെററാണ്	ശരിയോ തെററോ എന്ന് പറയാൻ കഴിയില്ല	ഏറെക്കുറെ ശരിയാണ്	വളരെ ശരിയാണ്

1	കണക്ക് പഠിക്കുമ്പോൾ ഞാൻ സമവാക്യങ്ങൾ വീണ്ടും വീണ്ടും പറഞ്ഞ് പഠിക്കാറുണ്ട്	1	2	3	4	5
2	ക്ലാസ്സിൽ അധ്യാപകൻ/അധ്യാപിക ചെയ്യിപ്പിച്ച കണക്കുകൾ ഞാൻ വീണ്ടും വീണ്ടും ചെയ്ത് നോക്കാറുണ്ട്	1	2	3	4	5
3	കണക്കിലെ ഒരു പാഠം പഠിക്കുമ്പോൾ അതിലെ സമവാക്യങ്ങൾ എഴുതി മനഃപാഠമാക്കുകയാണ് ചെയ്യുന്നത്	1	2	3	4	5
4	കണക്കിലെ ഓരോ സമവാക്യങ്ങൾ/ ആശയങ്ങൾ പഠിക്കുമ്പോഴും അവ എങ്ങിനെ രൂപപ്പെട്ടു എന്നും കൂടി പഠിക്കാറുണ്ട്	1	2	3	4	5
5	ഒരു പാഠം പഠിക്കുമ്പോൾ ടീച്ചർ ക്ലാസ്സിൽ ചെയ്യിക്കാത്ത പുതിയ ചോദ്യങ്ങൾ കണ്ടെത്തി അതിനുത്തരം കണ്ടെത്താൻ ശ്രമിക്കാറുണ്ട്	1	2	3	4	5
6	കണക്കിലെ പാഠഭാഗങ്ങൾ പഠിക്കുമ്പോൾ അത് എവിടെയെല്ലാം ഉപയോഗപ്പെടുത്താം എന്ന് ഞാൻ ചിന്തിക്കാറുണ്ട്	1	2	3	4	5
7	ഒരു പാഠം പഠിക്കാൻ തുടങ്ങുമ്പോൾ അതിൽ എന്തെല്ലാമാണ് പഠിക്കാനുള്ളതെന്ന് ഒന്ന് ഓടിച്ചു നോക്കാറുണ്ട്	1	2	3	4	5
8	കണക്കിലെ പാഠഭാഗങ്ങൾ പഠിക്കുമ്പോൾ അവ, മുൻപ് പഠിച്ച കാര്യങ്ങളുമായി ബന്ധപ്പെടുത്താൻ ശ്രമിക്കാറുണ്ട്	1	2	3	4	5
9	ഒരു പാഠം കഴിഞ്ഞാൽ അതിൽ പഠിച്ച പ്രധാന ആശയങ്ങൾ പ്രത്യേകം എഴുതി വെക്കാറുണ്ട്	1	2	3	4	5
10	ഗണിതപാഠങ്ങൾ പഠിക്കുമ്പോൾ അവ ചിട്ടപ്പെടുത്താനായി രേഖാചിത്രങ്ങളൊ കുറിപ്പുകളൊ (ഷോർട്ട് നോട്ട്സ്) ഒക്കെ ഉണ്ടാക്കാറുണ്ട്	1	2	3	4	5
11	ഗണിത പഠനവുമായി ബന്ധപ്പെട്ട് എനിക്ക് ലക്ഷ്യമുണ്ട്	1	2	3	4	5
12	ലക്ഷ്യം വെച്ചു കൊണ്ടാണ് ഞാൻ എപ്പോഴും പഠനം തുടങ്ങുന്നത്	1	2	3	4	5

13	പഠനത്തിന് ഞാൻ വ്യക്തമായ പ്ലാൻ ഉണ്ടാക്കാറുണ്ട്	1	2	3	4	5
14	പഠനം തുടങ്ങും മുൻപ് എന്തൊക്കെയാണ് പഠിക്കാനുള്ളതെന്ന് ഓടിച്ച് നോക്കി മനസ്സിലാക്കാറുണ്ട്	1	2	3	4	5
15	പുതിയ പാഠം തുടങ്ങുമ്പോൾ അതിനാവശ്യമായ മുന്നറിവുകൾ എനിക്കുണ്ടെന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1	2	3	4	5
16	പുതിയ പാഠത്തിലേക്ക് ആവശ്യമായ മുന്നറിവുകൾ എനിക്കില്ലെന്ന് തോന്നിയാൽ അത് ഞാൻ പഠിച്ചെടുക്കാറുണ്ട്	1	2	3	4	5
17	ടീച്ചർ ക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന കാര്യം നന്നായി മനസ്സിലായിഎന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1	2	3	4	5
18	ക്ലാസ്സ് സമയത്ത് മററു കാര്യങ്ങൾ ചിന്തിച്ചിരിക്കുന്നതിനാൽ ക്ലാസ്സിലെ പ്രധാനഭാഗങ്ങൾ എനിക്ക് നഷ്ടപ്പെടാറുണ്ട്	1	2	3	4	5
19	പാഠം പഠിക്കുമ്പോൾ എന്തെങ്കിലും ബുദ്ധിമുട്ട് അനുഭവപ്പെട്ടാൽ അതിന്റെ കാരണം എന്തായിരിക്കുമെന്ന് ഞാൻ അന്വേഷിക്കാറുണ്ട്	1	2	3	4	5
20	പഠിക്കുന്നതിനിടയിൽ, കാര്യങ്ങൾ എനിക്ക് മനസ്സിലാവുന്നുണ്ടെന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1	2	3	4	5
21	കണക്ക് പഠിക്കുമ്പോൾ അതെനിക്ക് മനസ്സിലായി എന്നുറപ്പിക്കാ നായി ചോദ്യങ്ങൾ കണ്ടെത്തി അവക്കുത്തരം കണ്ടെത്താൻ ശ്രമിക്കാറുണ്ട്	1	2	3	4	5
22	പഠിച്ചുകൊണ്ടിരിക്കെ, ഒരു ഭാഗം മനസ്സിലായില്ലെന്ന് തോന്നിയാൽ ആ ഭാഗത്തേക്ക് തിരിച്ച്പോയി വീണ്ടും പഠിക്കാറുണ്ട്	1	2	3	4	5
23	എന്റെ ലക്ഷ്യത്തിലേക്ക് എത്താൻ വേണ്ട കാര്യങ്ങൾ ചെയ്യുന്നു ണ്ടെന്ന് ഞാൻ ഇടക്കിടെ ഉറപ്പിക്കാറുണ്ട്	1	2	3	4	5
24	എനിക്ക് ശരിയായി മനസ്സിലാകുന്നില്ലെങ്കിലും ഒരു പ്രത്യേക രീതിയിൽ തന്നെ ഞാൻ പഠിച്ചു കൊണ്ടേയിരിക്കും	1	2	3	4	5
25	ക്ലാസ്സിൽ നിന്ന്എന്റെ ശ്രദ്ധപോകുമ്പോഴെല്ലാം ബോധപൂർവ്വം തിരിച്ച് കൊണ്ടുവരാറുണ്ട്	1	2	3	4	5
26	പഠിക്കുമ്പോൾ ബുദ്ധിമുട്ടാണെന്ന് തോന്നുന്ന ഭാഗങ്ങൾ വിട്ട്കളയാ റുണ്ട്	1	2	3	4	5
27	കുറച്ച് ബുദ്ധിമുട്ടാണെന്ന് തോന്നുന്ന ഭാഗത്ത് കൂടുതൽ ശ്രദ്ധ ചെലുത്താ റുണ്ട്	1	2	3	4	5
28	പഠനത്തിൽ എനിക്ക് ശ്രദ്ധയൂന്നാൻ കഴിയാറില്ല	1	2	3	4	5
29	പഠനത്തിനായിഉണ്ടാക്കുന്ന പ്ലാൻ അനുസരിച്ച് പോകാൻ എനിക്ക് കഴി യാറില്ല	1	2	3	4	5
30	എനിക്ക് പഠനം പെട്ടെന്ന് മടുക്കാറുണ്ട്	1	2	3	4	5
31	പഠനത്തിനായി എനിക്കൊരു സമയക്രമം ഉണ്ട്	1	2	3	4	5
32	പഠനത്തിന നീക്കിവെച്ച സമയത്തിൽ നിബന്ധനയോടെ പഠിക്കാൻ എനിക്ക് ബുദ്ധിമുട്ടാണ്	1	2	3	4	5
33	ബുദ്ധിമുട്ടുള്ള ഭാഗങ്ങൽ പഠിക്കാനായി ഞാൻ കൂടുതൽ സമയം മാററി വെക്കാറുണ്ട്	1	2	3	4	5
34	എന്റെ പഠനസമയം ഞാൻ പരമാവധി ഉപയോഗപ്പെടുത്താറുണ്ട്	1	2	3	4	5
35	മററു പ്രവർത്തികളാൽ പഠനത്തിൽ കൂടുതൽ സമയം ചിലവഴിക്കു ന്നില്ല	1	2	3	4	5
36	പരീക്ഷ സമയങ്ങളിൽ മാത്രമെ ഞാൻ പഠിക്കാറൊള്ളു	1	2	3	4	5
37	ഗണിതം പഠിച്ചിട്ട് മനസ്സിലാകാത്തപ്പോൾ ഞാൻ അധ്യാപകരുടേയോ സുഹൃത്തുക്കളുടേയോ സഹായം തേടാറുണ്ട്	1	2	3	4	5
38	മനസ്സിലാകാത്ത ഭാഗങ്ങൾ ടീച്ചറോട് ഒന്ന്കൂടി ചോദിച്ച് മനസ്സിലാക്കാറില്ല	1	2	3	4	5
39	ഒരു കണക്ക് എനിക്ക് സ്വന്തമായി ചെയ്യാൻ കഴിഞ്ഞില്ലെങ്കിൽ ആരുടെയെങ്കിലും സഹായം തേടും	1	2	3	4	5

Appendix –J2

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SELF-REGULATED LEARNING STRATEGY QUESTIONNAIRE (DRAFT)

Dr. Abdul Gafoor. K **Abidha Kurukkan**
Professor Research Scholar

Name: ……………………………………………… …........………; Male/Female

Age: ………………….. Class ……………………………………………......………

Directions:

The following questions ask about your learning strategies for learning mathematics. Rate the given statements that how well they are true about you according to the given scale (Circle the right indicator). Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

1	**2**	**3**	**4**	**5**
Very False	Almost False	Neither True Nor False	Almost True	Very True

1	I practice reciting equations while learning mathematics.	1	2	3	4	5
2	I repeatedly review the problems that my teacher lets me do in class regularly.	1	2	3	4	5
3	Whenever I learn a lesson in mathematics, I memorize the equations in it.	1	2	3	4	5
4	Whenever I learn concepts or equations in mathematics, I learn how they are derived.	1	2	3	4	5
5	While learning mathematics, I come up with equations and their answers that are not normally covered in class by the teacher.	1	2	3	4	5
6	Whenever I learn mathematics topics, I think about their applicability.	1	2	3	4	5
7	I usually scroll through the materials when I begin to study a lesson.	1	2	3	4	5
8	Whenever I learn math topics, I try to connect them with topics studied previously.	1	2	3	4	5

9	I make notes on major concepts in a lesson when it is covered.	1	2	3	4	5
10	While learning mathematics, I make use of diagrams or short notes to arrange the math topics in order.	1	2	3	4	5
11	I have a goal for learning mathematics.	1	2	3	4	5
12	I usually begin my learning with a goal.	1	2	3	4	5
13	I make clear plans for learning.	1	2	3	4	5
14	Prior to learning, I scroll through the material to get an overall idea of the material.	1	2	3	4	5
15	I used to make sure that I have the required prior knowledge before learning a new lesson.	1	2	3	4	5
16	I make efforts to acquire the required prior knowledge if I realize that I do not have it sufficiently.	1	2	3	4	5
17	I make sure that I understand the material that the teacher covers in class.	1	2	3	4	5
18	I miss important topics during class due to thinking about other things.	1	2	3	4	5
19	If I come across difficulty in learning a lesson, I used to analyze possible reasons for such a difficulty.	1	2	3	4	5
20	I do make myself sure that I understand the material while learning.	1	2	3	4	5
21	While learning mathematics, I make questions myself and solve them to confirm my understanding.	1	2	3	4	5
22	When I feel that a particular topic is not clearly understood, I go back and learn the material again.	1	2	3	4	5
23	I make sure very often that I do the needful to reach my goals.	1	2	3	4	5
24	I always follow a specific way of learning even if I do not understand the material.	1	2	3	4	5
25	Whenever I lose attention in class, I try to bring it back.	1	2	3	4	5
26	I leave all those topics that I perceive are difficult.	1	2	3	4	5
27	I pay more attention to the topics that are difficult.	1	2	3	4	5
28	I am not able to pay attention to my studies.	1	2	3	4	5

29	I am not able to follow the plan that I make for studies.	1	2	3	4	5
30	I get fed up with my studies easily.	1	2	3	4	5
31	I have a timetable for my studies.	1	2	3	4	5
32	It is difficult for me to stick to certain rules or a time table that has been allotted for studies.	1	2	3	4	5
33	I reserve more time to study difficult topics.	1	2	3	4	5
34	I make very good use of my study time.	1	2	3	4	5
35	I do not spend more time for studies due to other activities.	1	2	3	4	5
36	I used to study only during the exam seasons.	1	2	3	4	5
37	I seek help from teachers and friends when I do not understand mathematics topics.	1	2	3	4	5
38	I never ask teacher to explain when topics are not clear.	1	2	3	4	5
39	I seek help from others when I am not able to solve a problem by myself.	1	2	3	4	5

Appendix - J3

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SELF-REGULATED LEARNING STRATEGY QUESTIONNAIRE (FINAL)

Dr. Abdul Gafoor. K — Professor

Abidha Kurukkan — Research Scholar

പേര്:...; ആൺ/പെൺ

വയസ്സ്: ....ക്ലാസ്സ്...

നിർദ്ദേശങ്ങൾ:

ഗണിതപഠനത്തിനായി നിങ്ങൾ ഉപയോഗിക്കുന്ന രീതികളെക്കുറിച്ചുള്ള ചോദ്യങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. ഇവ നിങ്ങളെ സംബന്ധിച്ച് എത്രത്തോളം ശരിയാണെന്ന്, തന്നിട്ടുള്ള സ്കെയിൽ പ്രകാരം രേഖപ്പെടുത്തുക (യോജിക്കുന്നതിന് വട്ടം വരക്കുക). ഉത്തരങ്ങളിൽ ശരിയും തെററും ഇല്ല എന്ന് പ്രത്യേകം ഓർക്കുക, കഴിയുംവിധം കൃത്യമായ ഉത്തരം നൽകുക.നിങ്ങൾ ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയൊള്ളൂ. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക

1	2	3	4	5
തീർത്തും തെററാണ്	ഏറെക്കുറെ തെററാണ്	ശരിയോ തെറേറാ എന്ന് പറയാൻ കഴിയില്ല	ഏറെക്കുറെ ശരിയാണ്	വളരെ ശരിയാണ്

1	കണക്ക് പഠിക്കുമ്പോൾ ഞാൻ സമവാക്യങ്ങൾ വീണ്ടുംവീണ്ടും പറഞ്ഞ് പഠിക്കാറുണ്ട്	1 2 3 4 5
2	ക്ലാസ്സിൽ അധ്യാപകൻ/അധ്യാപിക ചെയ്യിപ്പിച്ച കണക്കുകൾ ഞാൻ വീണ്ടുംവീണ്ടും ചെയ്ത് നോക്കാറുണ്ട്	1 2 3 4 5
3	കണക്കിലെ ഒരു പാഠം പഠിക്കുമ്പോൾ അതിലെ സമവാക്യങ്ങൾ എഴുതി മനഃപാഠമാക്കുകയാണ് ചെയ്യുന്നത്	1 2 3 4 5
4	കണക്കിലെ ഓരോ സമവാക്യങ്ങൾ/ ആശയങ്ങൾ പഠിക്കുമ്പോഴും അവ എങ്ങിനെ രൂപപ്പെട്ടു എന്നും കൂടി പഠിക്കാറുണ്ട്	1 2 3 4 5
5	ഒരു പാഠം പഠിക്കുമ്പോൾ ടീച്ചർ ക്ലാസ്സിൽ ചെയ്യിക്കാത്ത പുതിയ ചോദ്യങ്ങൾ കണ്ടെത്തി അതിനുത്തരം കണ്ടെത്താൻ ശ്രമിക്കാറുണ്ട്	1 2 3 4 5
6	കണക്കിലെ പാഠഭാഗങ്ങൾ പഠിക്കുമ്പോൾ അത് എവിടെയെല്ലാം ഉപയോഗപ്പെടുത്താം എന്ന് ഞാൻ ചിന്തിക്കാറുണ്ട്	1 2 3 4 5
7	ഒരു പാഠം പഠിക്കാൻ തുടങ്ങുമ്പോൾ അതിൽ എന്തെല്ലാമാണ് പഠിക്കാനുള്ളതെന്ന് ഒന്ന് ഓടിച്ചു നോക്കാറുണ്ട്	1 2 3 4 5
8	കണക്കിലെ പാഠഭാഗങ്ങൾ പഠിക്കുമ്പോൾ അവ, മുൻപ് പഠിച്ച കാര്യങ്ങളുമായി ബന്ധപ്പെടുത്താൻ ശ്രമിക്കാറുണ്ട്	1 2 3 4 5
9	ഒരു പാഠംകഴിഞ്ഞാൽ അതിൽ പഠിച്ച പ്രധാന ആശയങ്ങൾ പ്രത്യേകം എഴുതി വെക്കാറുണ്ട്	1 2 3 4 5
10	ഗണിതപാഠങ്ങൾ പഠിക്കുമ്പോൾ അവ ചിട്ടപ്പെടുത്താനായി രേഖാചിത്ര ങ്ങളോ കുറിപ്പുകളോ (ഷോർട്ട് നോട്ട്സ്) ഒക്കെ ഉണ്ടാക്കാറുണ്ട്	1 2 3 4 5

11	ഗണിത പഠനവുമായി ബന്ധപ്പെട്ട് എനിക്ക് ലക്ഷ്യമുണ്ട്	1 2 3 4 5
12	ലക്ഷ്യം വെച്ചു കൊണ്ടാണ് ഞാൻ എപ്പോഴും പഠനം തുടങ്ങുന്നത്	1 2 3 4 5
13	പഠനത്തിന് ഞാൻ വ്യക്തമായ പ്ലാൻ ഉണ്ടാക്കാറുണ്ട്	1 2 3 4 5
14	പഠനം തുടങ്ങും മുൻപ് എന്തൊക്കെയാണ് പഠിക്കാനുള്ളതെന്ന് ഓടിച്ച് നോക്കി മനസ്സിലാക്കാറുണ്ട്	1 2 3 4 5
15	പുതിയ പാഠം തുടങ്ങുമ്പോൾ അതിനാവശ്യമായ മുന്നറിവുകൾ എനിക്കുണ്ടെന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1 2 3 4 5
16	പുതിയ പാഠത്തിലേക്ക് ആവശ്യമായ മുന്നറിവുകൾ എനിക്കില്ലെന്ന് തോന്നിയാൽ അത് ഞാൻ പഠിച്ചെടുക്കാറുണ്ട്	1 2 3 4 5
17	ടീച്ചർ ക്ലാസ്സിൽ പഠിപ്പിക്കുന്ന കാര്യം നന്നായി മനസ്സിലായി എന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1 2 3 4 5
18	പാഠം പഠിക്കുമ്പോൾ എന്തെങ്കിലും ബുദ്ധിമുട്ട് അനുഭവപ്പെട്ടാൽ അതിന്റെ കാരണംഎന്തായിരിക്കുമെന്ന് ഞാൻ അന്വേഷിക്കാറുണ്ട്	1 2 3 4 5
19	പഠിക്കുന്നതിനിടയിൽ, കാര്യങ്ങൾ എനിക്ക് മനസ്സിലാവുന്നുണ്ടെന്ന് ഞാൻ ഉറപ്പിക്കാറുണ്ട്	1 2 3 4 5
20	കണക്ക് പഠിക്കുമ്പോൾ അതെനിക്ക് മനസ്സിലായിഎന്നുറപ്പിക്കാനായി ചോദ്യങ്ങൾ കണ്ടെത്തി അവക്കുത്തരം കണ്ടെത്താൻ ശ്രമിക്കാറുണ്ട്	1 2 3 4 5
21	പഠിച്ചുകൊണ്ടിരിക്കെ, ഒരു ഭാഗം മനസ്സിലായില്ലെന്ന് തോന്നിയാൽ ആ ഭാഗത്തേക്ക് തിരിച്ച്പോയി വീണ്ടും പഠിക്കാറുണ്ട്	1 2 3 4 5
22	എന്റെ ലക്ഷ്യത്തിലേക്ക് എത്താൻ വേണ്ട കാര്യങ്ങൾ ചെയ്യുന്നുണ്ടെന്ന് ഞാൻ ഇടക്കിടെ ഉറപ്പിക്കാറുണ്ട്	1 2 3 4 5
23	ക്ലാസ്സിൽ നിന്ന് എന്റെ ശ്രദ്ധപോകുമ്പോഴെല്ലാം ബോധപൂർവ്വം തിരിച്ച് കൊണ്ടുവരാറുണ്ട്	1 2 3 4 5
24	പഠിക്കുമ്പോൾ ബുദ്ധിമുട്ടാണെന്ന് തോന്നുന്ന ഭാഗങ്ങൾ വിട്ട്കളയാറുണ്ട്	1 2 3 4 5
25	കുറച്ച് ബുദ്ധിമുട്ടാണെന്ന് തോന്നുന്ന ഭാഗത്ത് കൂടുതൽ ശ്രദ്ധചെലുത്താറുണ്ട്	1 2 3 4 5
26	പഠനത്തിൽ എനിക്ക് ശ്രദ്ധയൂന്നാൻ കഴിയാറില്ല	1 2 3 4 5
27	പഠനത്തിനായി ഉണ്ടാക്കുന്ന പ്ലാൻ അനുസരിച്ച് പോകാൻ എനിക്ക് കഴിയാറില്ല	1 2 3 4 5
28	എനിക്ക് പഠനം പെട്ടെന്ന് മടുക്കാറുണ്ട്	1 2 3 4 5
29	പഠനത്തിനായി എനിക്കൊരു സമയക്രമം ഉണ്ട്	1 2 3 4 5
30	പഠനത്തിന നീക്കി വെച്ച സമയത്തിൽ നിബന്ധനയോടെ പഠിക്കാൻ എനിക്ക് ബുദ്ധിമുട്ടാണ്	1 2 3 4 5
31	ബുദ്ധിമുട്ടുള്ള ഭാഗങ്ങൽ പഠിക്കാനായി ഞാൻ കൂടുതൽ സമയം മാററി വെക്കാറുണ്ട്	1 2 3 4 5
32	എന്റെ പഠനസമയം ഞാൻ പരമാവധി ഉപയോഗപ്പെടുത്താറുണ്ട്	1 2 3 4 5
33	മററു പ്രവർത്തികളാൽ പഠനത്തിൽ കൂടുതൽ സമയം ചിലവഴിക്കുന്നില്ല	1 2 3 4 5
34	പരീക്ഷ സമയങ്ങളിൽ മാത്രമെ ഞാൻ പഠിക്കാറൊള്ളു	1 2 3 4 5
35	ഗണിതം പഠിച്ചിട്ട് മനസ്സിലാകാത്തപ്പോൾ ഞാൻ അധ്യാപകരുടേയോ സുഹൃത്തുക്കളുടേയോ സഹായം തേടാറുണ്ട്	1 2 3 4 5
36	മനസ്സിലാകാത്ത ഭാഗങ്ങൾ ടീച്ചറോട് ഒന്ന്കൂടി ചോദിച്ച് മനസ്സിലാക്കാറില്ല	1 2 3 4 5
37	ഒരു കണക്ക് എനിക്ക് സ്വന്തമായി ചെയ്യാൻ കഴിഞ്ഞില്ലെങ്കിൽ ആരുടെയെങ്കിലും സഹായം തേടും	1 2 3 4 5

Appendix –J4

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

SELF-REGULATED LEARNING STRATEGY QUESTIONNAIRE (FINAL)

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: ………………………… …………….. ……….......………; Male/Female

Age: ………………….. Class …………………………………………......………

Directions:

The following questions ask about your learning strategies for learning mathematics. Rate the given statements that how well they are true about you according to the given scale (Circle the right indicator). Remember that there is no right or wrong answer. Try to provide accurate response as much as possible. Your responses will only be used for research purposes. Pay attention in providing your responses for each statement.

1	2	3	4	5
Very False	Almost False	Neither True Nor False	Almost True	Very True

1	I practice reciting equations while learning mathematics.	1 2 3 4 5
2	I repeatedly review the problems that my teacher lets me do in class regularly.	1 2 3 4 5
3	Whenever I learn a lesson in mathematics, I memorize the equations in it.	1 2 3 4 5
4	Whenever I learn concepts or equations in mathematics, I learn how they are derived.	1 2 3 4 5
5	While learning mathematics, I come up with equations and their answers that are not normally covered in class by the teacher.	1 2 3 4 5
6	Whenever I learn mathematics topics, I think about their applicability.	1 2 3 4 5
7	I usually scroll through the materials when I begin to study a lesson.	1 2 3 4 5
8	Whenever I learn math topics, I try to connect them with topics studied previously.	1 2 3 4 5
9	I make notes on major concepts in a lesson when it is covered.	1 2 3 4 5
10	While learning mathematics, I make use of diagrams or short notes to arrange the math topics in order.	1 2 3 4 5

11	I have a goal for learning mathematics.	1 2 3 4 5
12	I usually begin my learning with a goal.	1 2 3 4 5
13	I make clear plans for learning.	1 2 3 4 5
14	Prior to learning, I scroll through the material to get an overall idea of the material.	1 2 3 4 5
15	I used to make sure that I have the required prior knowledge before learning a new lesson.	1 2 3 4 5
16	I make efforts to acquire the required prior knowledge if I realize that I do not have it sufficiently.	1 2 3 4 5
17	I make sure that I understand the material that the teacher covers in class.	1 2 3 4 5
18	If I come across difficulty in learning a lesson, I used to analyze possible reasons for such a difficulty.	1 2 3 4 5
19	I do make myself sure that I understand the material while learning.	1 2 3 4 5
20	While learning mathematics, I make questions myself and solve them to confirm my understanding.	1 2 3 4 5
21	When I feel that a particular topic is not clearly understood, I go back and learn the material again.	1 2 3 4 5
22	I make sure very often that I do the needful to reach my goals.	1 2 3 4 5
23	Whenever I lose attention in class, I try to bring it back.	1 2 3 4 5
24	I leave all those topics that I perceive are difficult.	1 2 3 4 5
25	I pay more attention to the topics that are difficult.	1 2 3 4 5
26	I am not able to pay attention to my studies.	1 2 3 4 5
27	I am not able to follow the plan that I make for studies.	1 2 3 4 5
28	I get fed up with my studies easily.	1 2 3 4 5
29	I have a timetable for my studies.	1 2 3 4 5
30	It is difficult for me to stick to certain rules or a time table that has been allotted for studies.	1 2 3 4 5
31	I reserve more time to study difficult topics.	1 2 3 4 5
32	I make very good use of my study time.	1 2 3 4 5
33	I do not spend more time for studies due to other activities.	1 2 3 4 5
34	I used to study only during the exam seasons.	1 2 3 4 5
35	I seek help from teachers and friends when I do not understand mathematics topics.	1 2 3 4 5
36	I never ask teacher to explain when topics are not clear.	1 2 3 4 5
37	I seek help from others when I am not able to solve a problem by myself.	1 2 3 4 5

Appendix -K

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

GOAL PLANNER

Dr. Abdul Gafoor. K
Professor

AbidhaKurukkan
Research Scholar

Name: ………………………………………………………….; Male/Female

Class ……………………………

Directions:

The questions shown here are about your goals set toward learning mathematics. Write down one goal and the associated matters carefully about the lesson of fractions that you are about learn.

Your goal of learning mathematics
Your goal while learning the lesson Fractions:
Why do you set such a goal?
Are you sure that you would meet that goal?
Within what time do you plan to meet this goal?
What score, out of 25, can you achieve on a test based on fractions? out of 25__________

Appendix - L

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

LEARNING DIARY

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

Name: …………………………………………………................…… Class ………

Directions:

The questions given below deal with your own assessment on your weekly learning and attempts to reach your weekly goals. You are required to provide such an assessment report to your teacher every week.

Learning Assessment					**Week 1**
What have you learned this week?					
How do you evaluate your learning this week? (Choose from below)					
Learned very well		Learned moderately		Not learned enough	
Which part of the lesson that you understood really well?					
Which part of the lesson that you still did not understand?					
Have you made attempts to understand the material mentioned above?					
What can you do additionally to better understand that part of the lesson?					

What difficulties did you have upon learning?
What did you do to overcome your learning difficulties?
Have you learned enough to reach your goals?
Prepare short notes on that you have learned this week
Teacher’s remark:

Appendix -M

UNIVERSITY OF CALICUT
DEPARTMENT OF EDUCATION

A MODEL CONCEPT CHART ON UNIT FRACTIONS

Dr. Abdul Gafoor. K
Professor

Abidha Kurukkan
Research Scholar

ഭിന്നസംഖ്യകൾ

ഭിന്നസംഖ്യകൾ → തുല്യഭിന്നങ്ങൾ → എതിർഗുണനം → വലുതുംചെറുതും → ഭിന്നക്രിയകൾ → ദശാംശരൂപം

തുല്യഭിന്നങ്ങൾ

$\frac{a}{b} = \frac{an}{bn}$ ഈ ആശയം ഉപയോഗിച്ച് സംഖ്യാക്രമങ്ങൾ ശരിയാണൊ എന്ന് പരിശോധിക്കുന്നു

എതിർഗുണനം

(ഭിന്നസംഖ്യകളുടെ തുല്യതാ പരിശോധന)

- പൊതുഘടകങ്ങൾ മാററിനോക്കി
- $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ $aq = pb$ ആയിരിക്കും, (തിരിച്ചും)
- ഒരു ജോടി തുല്യ ഭിന്നങ്ങളിൽനിന്ന് മൂന്ന്ജോടി തുല്യഭിന്നങ്ങൾ
  $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ $\frac{b}{a} = \frac{q}{p}, \frac{a}{p} = \frac{b}{q}$, $\frac{p}{a} = \frac{q}{b}$
- തുല്യഭിന്നങ്ങൾക്ക് തുല്യമായ ഭിന്നം
  $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ $\frac{a}{b} = \frac{p}{q} = \frac{a+p}{b+q}$
- തുല്യഭിന്നങ്ങളിൽ നിന്ന് പുതിയ തുല്യഭിന്നം
  $\frac{a}{b} = \frac{p}{q}$ എങ്കിൽ $\frac{a+b}{a-b} = \frac{p+q}{p-q}$

വലുതുംചെറുതും

- ഛേദം തുല്യമായ രണ്ടു ഭിന്നസംഖ്യകളിൽ അംശം വലുതായ ഭിന്നസംഖ്യയായിരിക്കും വലുത്
- അംശം തുല്യമായ ഭിന്നസംഖ്യകളിൽ ഛേദം ചെറുതായ ഭിന്നസംഖ്യയായിരിക്കും വലുത്
- അംശം വലുതാവുകയും ഛേദം ചെറുതാവുകയും ചെയ്താൽ ഭിന്നസംഖ്യ വലുതാവും
- $\frac{a}{b} < \frac{p}{q}$ എങ്കിൽ $aq < pb$ ആയിരിക്കും, (തിരിച്ചും)
- $a < b$ എങ്കിൽ $\frac{a}{b} < \frac{a+1}{b+1}$
- $b < a$ എങ്കിൽ $\frac{a+1}{b+1} < \frac{a}{b}$
- $\frac{a}{b} < \frac{p}{q}$ എങ്കിൽ $\frac{a}{b} < \frac{a+p}{b+q} < \frac{p}{q}$
- $\frac{a}{b} > \frac{p}{q}$ എങ്കിൽ $\frac{a}{b} > \frac{a+p}{b+q} > \frac{p}{q}$

ഭിന്നക്രിയകൾ

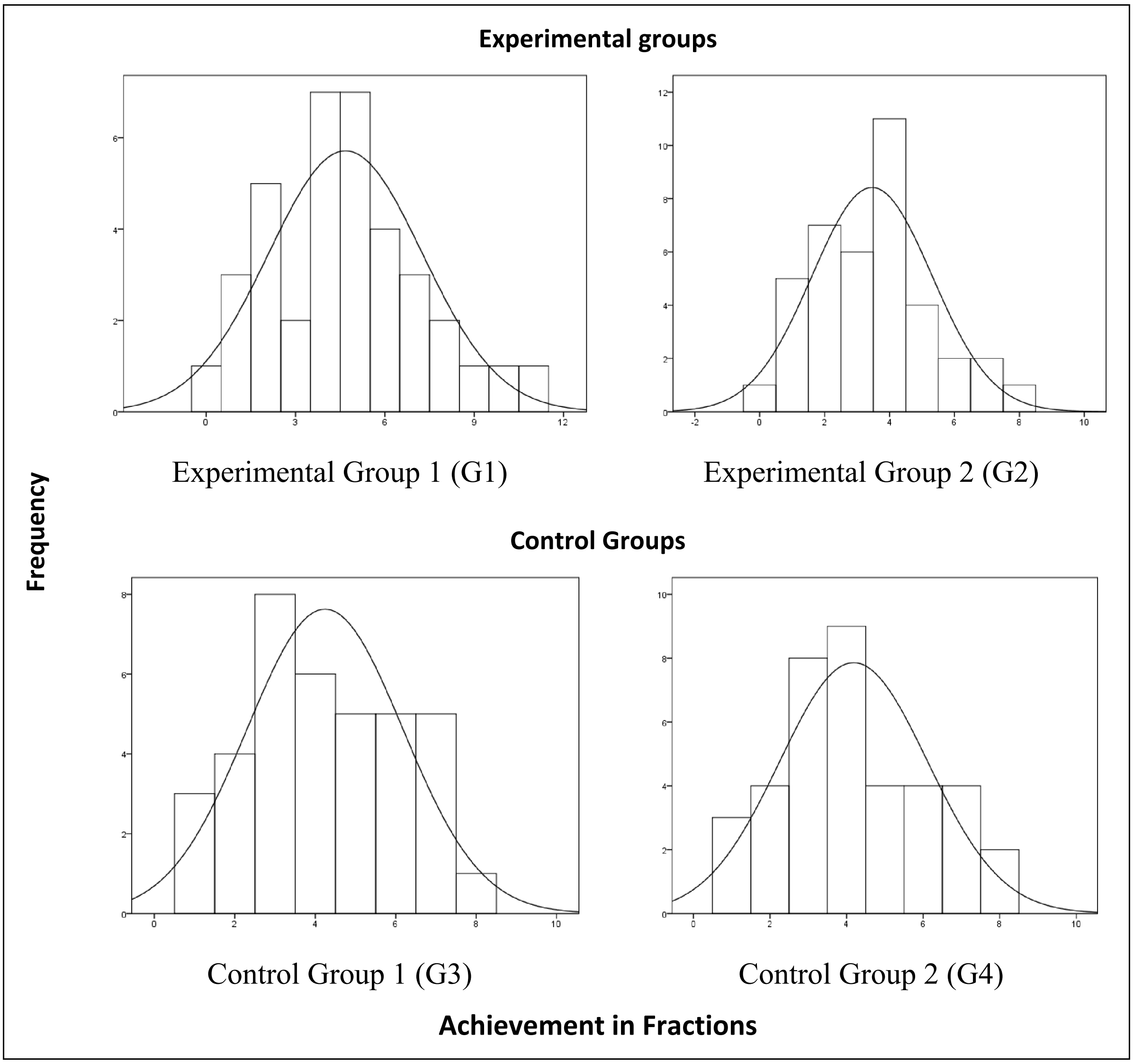
- $\frac{a}{b} + \frac{p}{q} = \frac{aq+bp}{bq}$
- $\frac{a}{b} - \frac{p}{q} = \frac{aq-bp}{bq}$
- ഏത് ഏകാംശഭിന്നങ്ങളേയും വത്യസ്തമായ രണ്ട് ഏകാംശ ഭിന്നങ്ങളുടെതുകയായി എഴുതാം
- $\frac{a}{b} \times \frac{p}{q} = \frac{ap}{bq}$
- $\frac{a}{b} \div \frac{p}{q} = \frac{aq}{bp}$

ദശാംശ രൂപം

- ഛേദം പത്തോ പത്തിന്റെ കൃതികളോ ആയ ഭിന്നസംഖ്യകളുടെ ദശാംശരൂപം
- ഛേദം പത്തോ പത്തിന്റെ ഘടകങ്ങളോ ആയ ഭിന്നസംഖ്യകളുടെ ദശാംശരൂപം
- ഛേദം പത്തിന്റെ കൃതികളായി മാററാൻ കഴിയാത്ത ഭിന്നസംഖ്യകളെ ഛേദം പത്തിന്റെ കൃതികളായി വരുന്ന ഭിന്നസംഖ്യകളുടെ അവസാനിക്കാത്ത ഒരു നിരയുടെ തുകയായി എഴുതാം
- ഛേദം പത്തിന്റെ കൃതികളായി മാററാൻ കഴിയാത്ത ഭിന്നസംഖ്യകളുടെ ദശാംശരൂപം

Appendix -N1

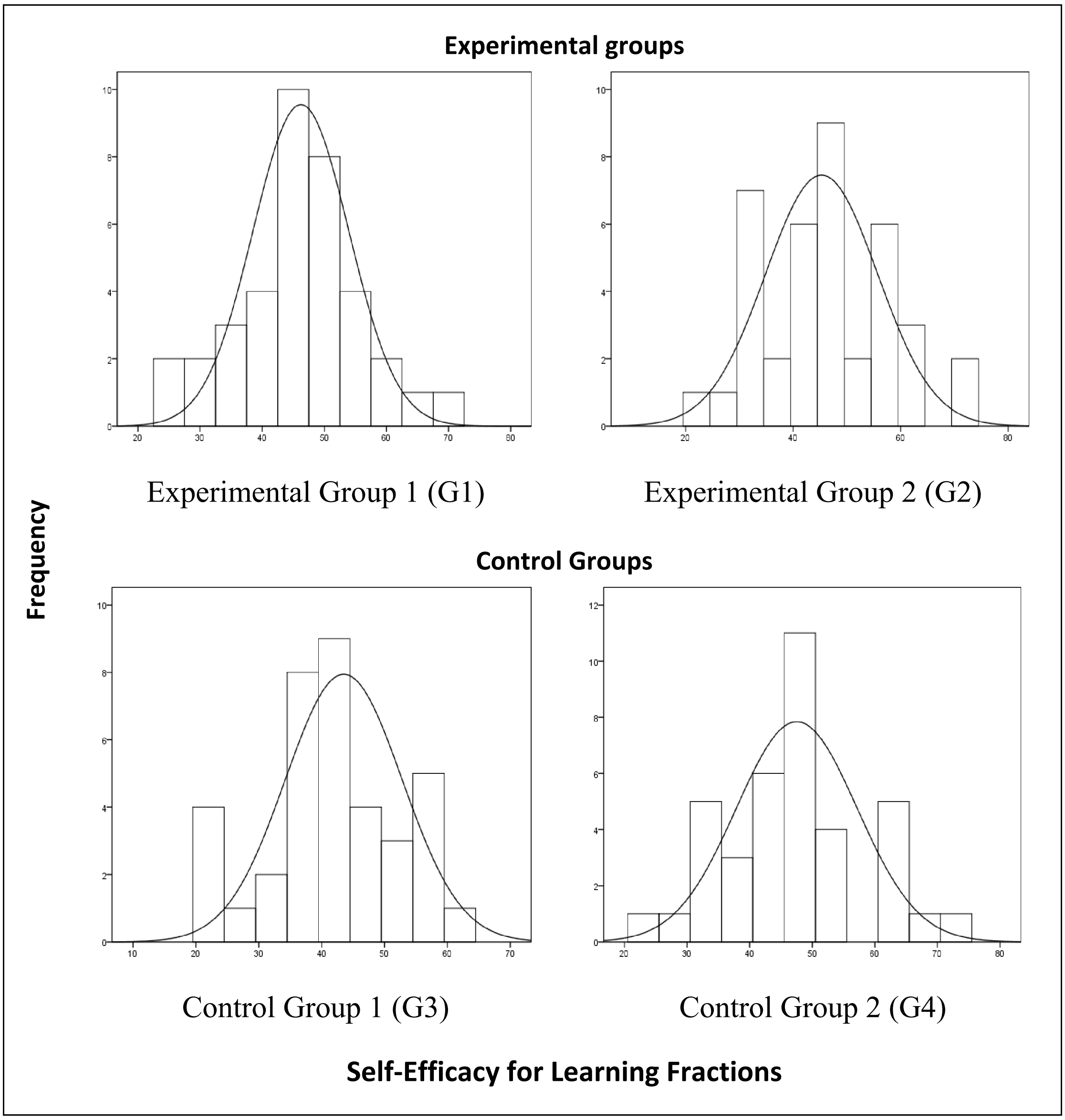
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF ACHIEVEMENT IN FRACTIONS



Histograms with the normal curves which best fit on them of pretest scores of achievement in fractions for the experimental and control groups

Appendix -N2

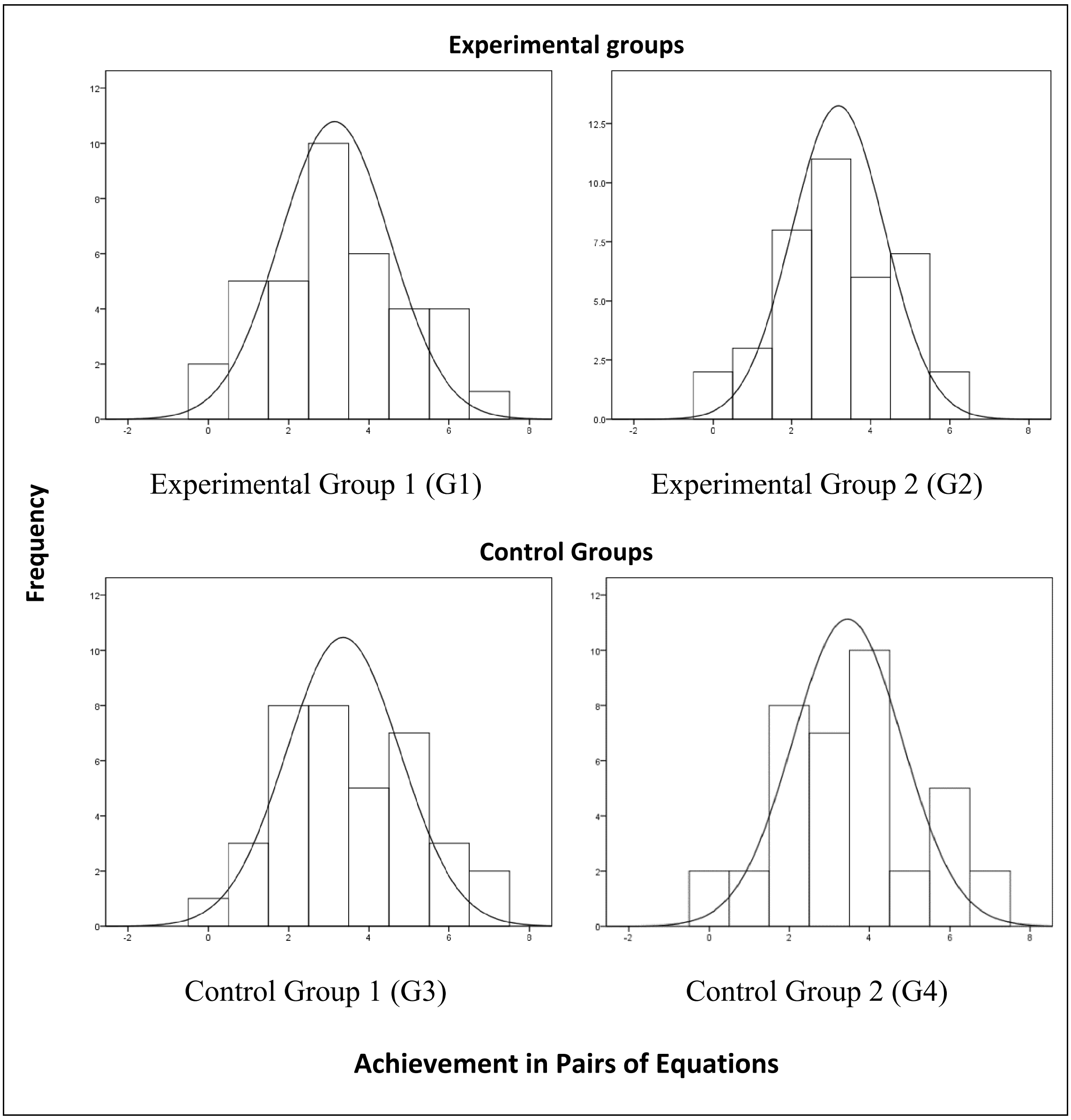
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF SELF-EFFICACY FOR LEARNING FRACTIONS



Histograms with the normal curves which best fit on them of pretest scores of self-efficacy for learning fractions for the experimental and control groups

Appendix -N3

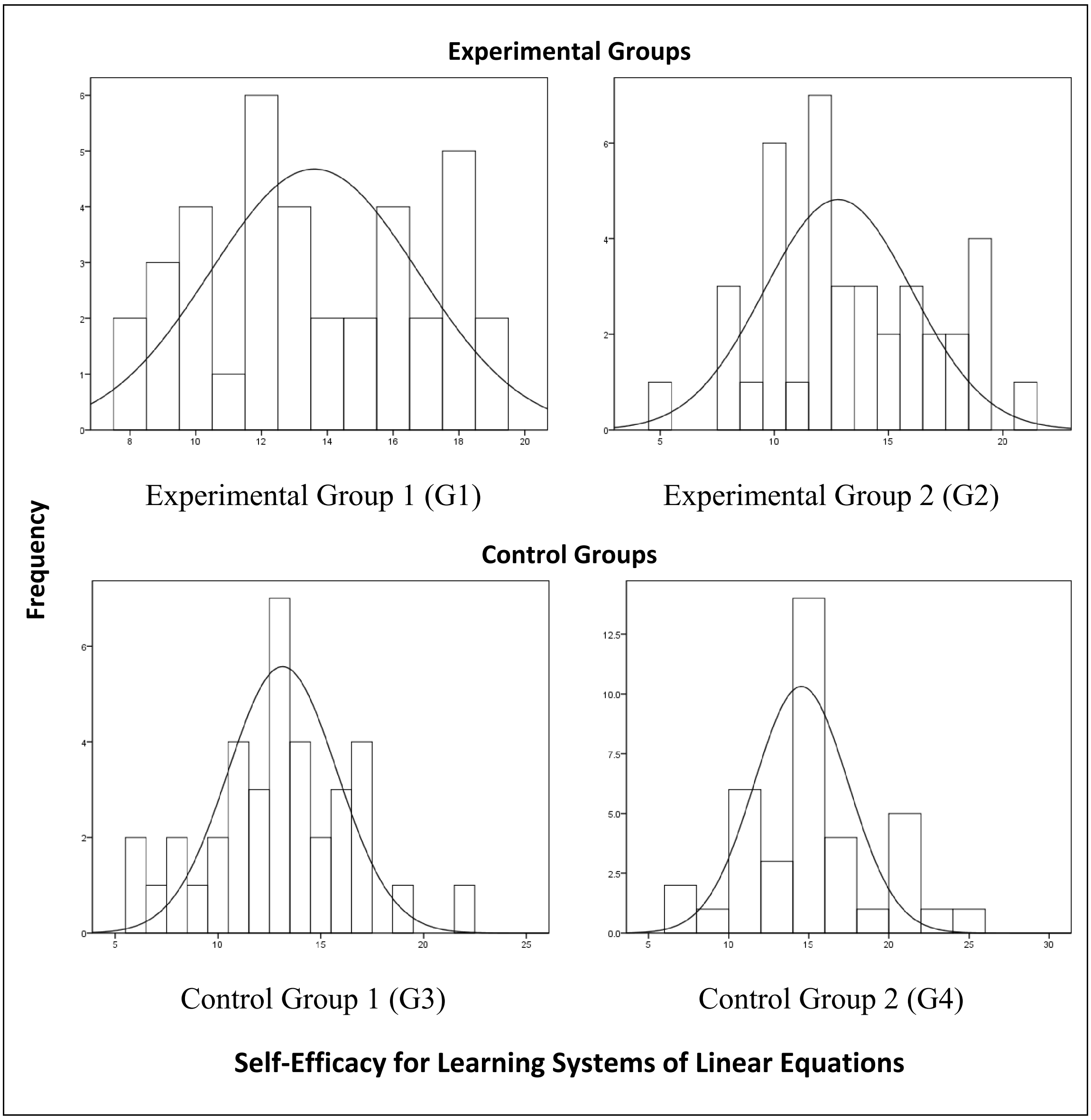
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF ACHIEVEMENT IN PAIRS OF EQUATIONS



Histograms with the normal curves which best fit on them of pretest scores of achievement in pairs of equations for the experimental and control groups

Appendix -N4

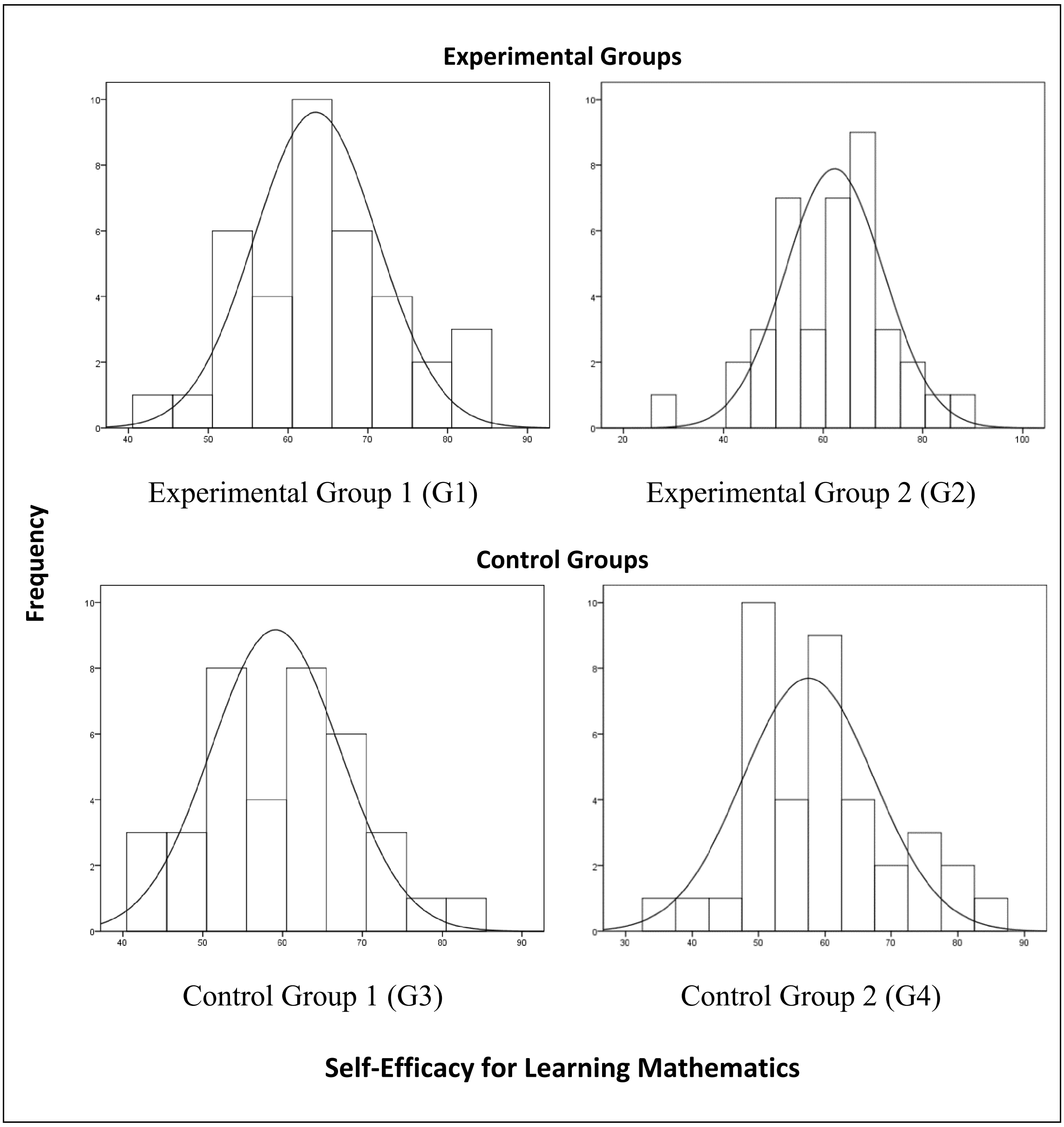
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF SELF-EFFICACY FOR LEARNING SYSTEMS OF LINEAR EQUATIONS



Histograms with the normal curves which best fit on them of pretest scores of self-efficacy for learning systems of linear equations for the experimental and control groups

Appendix -N5

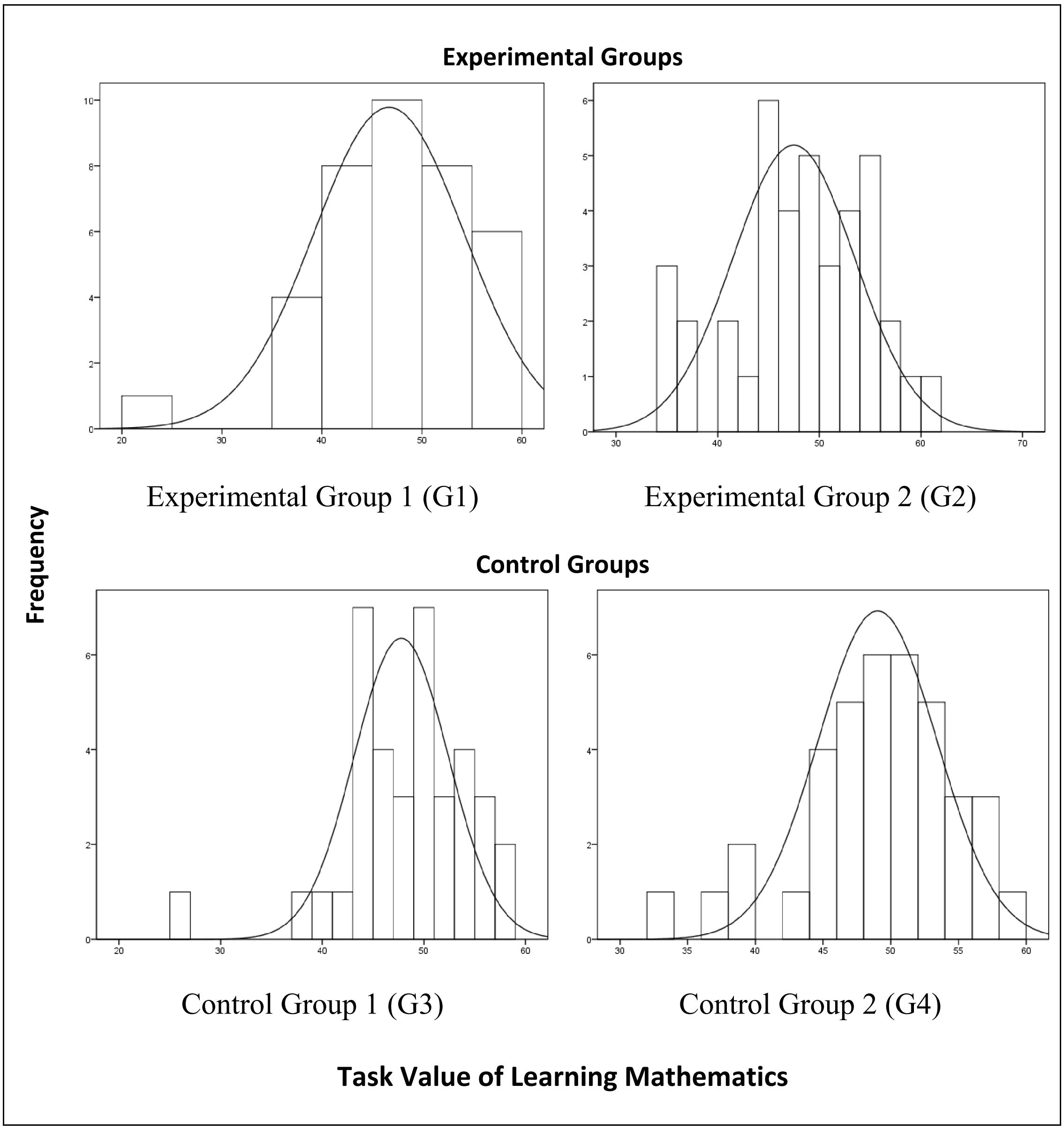
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF SELF-EFFICACY FOR LEARNING MATHEMATICS



Histograms with the normal curves which best fit on them of pretest scores of self-efficacy for learning mathematics for the experimental and control groups

Appendix -N6

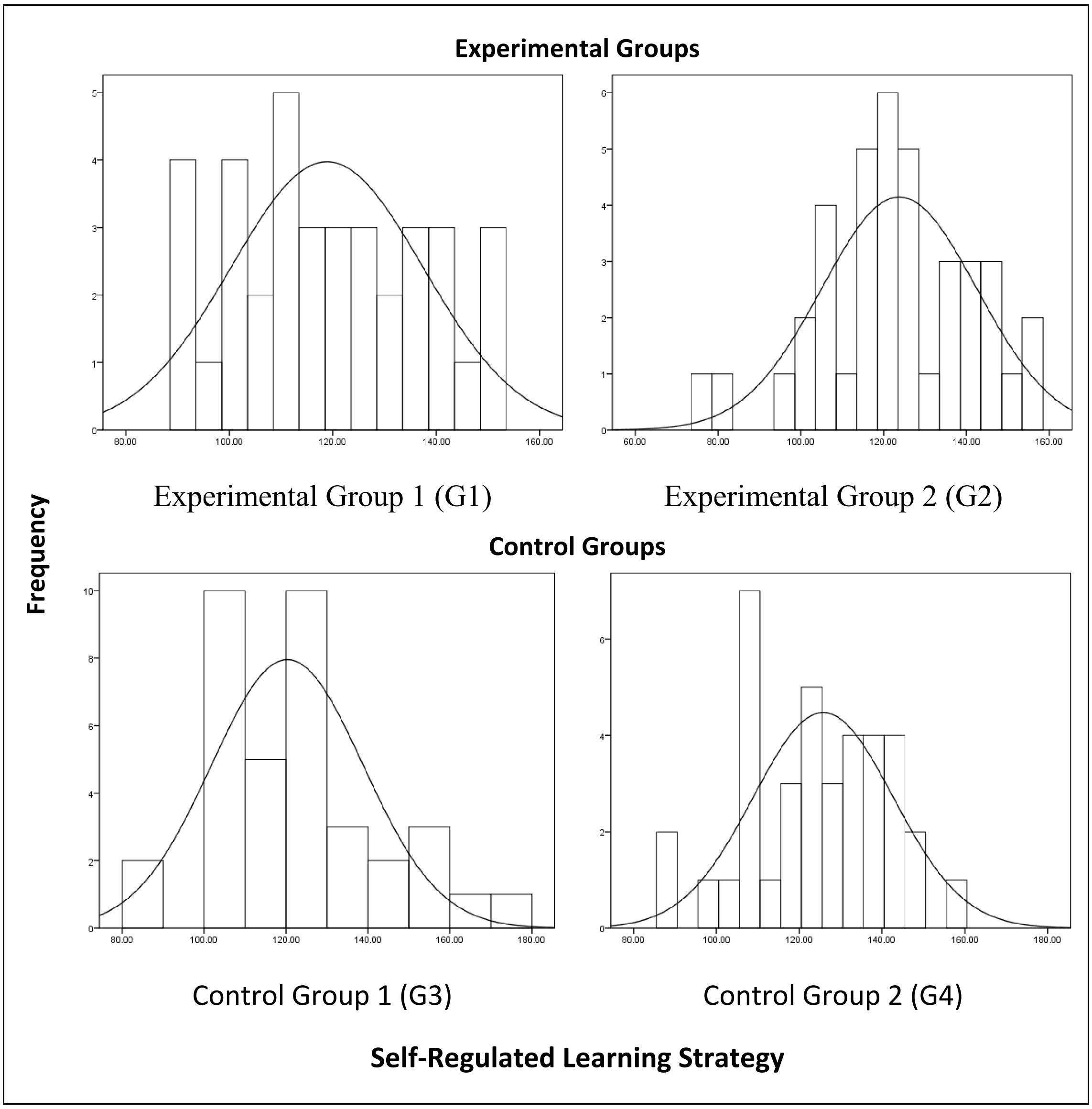
HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF TASK VALUE OF LEARNING MATHEMATICS



Histograms with the normal curves which best fit on them of pretest scores of task value of learning mathematics for the experimental and control groups

Appendix -N7

HISTOGRAMS WITH THE NORMAL CURVES OF PRETEST SCORES OF SELF-REGULATED LEARNING IN MATHEMATICS



Histograms with the normal curves which best fit on them of pretest scores of self-regulated learning in mathematics for the experimental and control groups

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NEED FOR MANAGING MATHEMATICS TEACHING LEARNING PROCESS FROM AN AFFECTIVE OUTCOME PERSPECTIVE

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Abstract

Mathematics education usually concentrates on achievement in cognitive domain. However, affect of a person also is important in cognitive tasks as it influences task choice, effort and perseverance. Affect would reflect in the end product also. This study analyzes students' likes and dislikes, motivational beliefs, learning strategies and their perceptions regarding the difficulties in learning mathematics. The data were collected from 178 standard nine students (90 boys and 88 girls) from Malappuram and Kozhikode districts of Kerala using difficulties in learning mathematics questionnaire. Percentage analysis and chi square test were used to analyze data. Despite recognizing importance of mathematics, most of the students perceive the subject as difficult and boring, and possess a belief that mathematics is not in their reach, and only people with high intelligence can learn mathematics. Most of the students follow surface learning strategies. Based on the students' perception, the study counsels educators for managing the affective factors in mathematics teaching- learning process, with focus on motivational beliefs, interest and anxiety. Suggestions are made on the basis of the observed interrelations among the affective beliefs of students.

Keywords: *Mathematics teaching, learning, affective beliefs, difficulties in learning mathematics.*

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Introduction

Mathematical literacy is vital to all individual for a better living, so mathematics plays an important role in the school curriculum. For reasons including knowledge of mathematics being important for the learning of all other subjects like sciences, and its practical value, we all give importance for achievement in mathematics especially in cognitive domain. Many students feel learning of mathematics as difficult. Mathematics learning is known for demanding relatively more cognitive abilities and associated instructional and learning efforts. Usually schools, teachers and parents pay attention to cognitive aspect of learning mathematics. However, management of instruction and learning in mathematics is not usually discussed from an affective perspective. Learning outcomes whether cognitive or affective, including of maths, results from the experiences.

Hence all learning experiences, within and without classrooms and in and out of schools, needs to be cared for when seeking answers to problems which persists even after concerted efforts, as the case is with maths learning in schools. Learning experiences, intellectual and emotional, should be managed in ways that improve learning and its horizontal and vertical transfer. This paper reports findings from an exploration of children's affective responses towards mathematics and the implications thereof to management of children’s in and out of classroom affective experiences related to maths.

Significance of exploring affective Beliefs in Managing Maths Learning

“Children’s feeling about mathematics, aspects of the classroom such as teacher-student relationships, or their perception of themselves as learners of mathematics” (Reyes, 1984) constitutes affective factors in maths learning. To be good in learning mathematics, effort is needed from the part of students to master the contents in each standard. Effort of students is determined by their affect. Only when they have sufficient interest and motivation students will take effort. Children’s feelings about mathematics include their attitudes, subjective beliefs like expectancy value, task value, self-efficacy, epistemological beliefs and goal orientations. Development of positive attitude towards maths study is valuable as it further the future effort, learning and development in that area. Attitude towards mathematics is a complex of negative or positive emotions that associate with mathematics, individual beliefs towards mathematics and their behaviour associate with mathematics (Hart, 1989). Individual beliefs are subjective conceptions of students, may be implicit or explicit, and thought to be true, that influence their learning (Op’tEynde, De Corte &Verschaffel, 2002). Expectancy value, task value, self efficacy, epistemological beliefs and goal orientations are identified as affective beliefs that having influence on mathematics outcomes.

Self-efficacy is a person's perception about his ability to reach the goal (Bandura, 1977). Self-efficacy does not represent one's ability, but his beliefs; it affects achievement through the selection of task and effort. Expectancies for success are defined as one's beliefs about the success of his or her performance on an upcoming task (Eccles et al, 1983). When a number of electives are available, one will choose a task with more success expectation and value.Task value beliefs are "beliefs about the importance of, interest in, and value of the task" (Pintrich, 1999). Epistemological beliefs are beliefs held by students about the nature of knowledge and its acquisition. Epistemic beliefs of students are known to influence the nature of achievement goals, learning strategies and student achievement (Muis, 2008; Muis& Franco, 2009; Trautwein & Ludtke, 2007).It is the teachers' duty to manage the classroom in such a way asto develop positive beliefs in students. This study is an exploration of select affective beliefs, emotions and learning strategies held by high school students in learning mathematics to know, how well the expected quality of mathematics education is met in affective perspective.

Objective

This study aims to identify the difficulties felt by students in learning mathematics, students' affective reasons for disliking mathematics and to know how the teacher and teaching style and students' motivational beliefs are related to students' liking of subject and expectancy about its difficulty. Based on data, need for, nature and areas of affective management of mathematics teaching learning process are discussed.

Methodology

1.1. Participants

Participants were 178 standard nine students (90 boys and 88 girls) from Malappuram and Kozhikode districts of Kerala. Students' willingness to be a part in the study is obtained before starting the survey.

1.2. Instrument

Difficulties in learning mathematics questionnaire is administered to obtain data on students' likes and dislikes, motivational beliefs, learning strategies and their perceptions regarding difficulties in learning mathematics. This questionnaire includes open ended as well as scaled items.

1.3. Procedure

After creating rapport with students, and giving reassurance on anonymity and ensuring their willingness to provide the data, approximately fifty minutes were allowed for completing the questionnaire with factual clarification from the administrator wherever required.

1.4. Data Analysis

Categorization of student perceptions, Percentage analysis and χ^2test of independence and mapping of the student perception of mathematics and their interrelationships were used to draw findings.

Results

1. ***Vast majority of students value maths learning, but a considerable proportion is yet to realise it***

Almost 97%of students agree that they need to learn math for different reasons like, to use in daily life, for higher education, to use in next standards, and to get their favourite jobs. They are agreeing that, everywhere in daily life, we need math. But 11%of students do not have any personal values attached with math learning due to disliking and inability in learning and understanding it. Almost all students (98%) agree that the materials learned in mathematics will be useful in more or less; but only 15% are well aware of the use of the content that they learn in math. A higher portion of students (66%) are valuing learning subject other than math.

2. ***Students have clear perception of maths than other subjects , whether positive or negative***

Mathematics is the most liked (24%) and the most disliked subject (20.78%) for good share of grade 9 students. More students have clear perception of maths, whether positive or negative, than about other school subjects. Maths is clearly preferred as well as abhorred by most number of students. The second place goes for Malayalam in case of preferred subject and for English and Physics in case of disliked subject. Students' reasons for liking mathematics are *it is an easy subject, easily and well understanding, easy to learn, interesting, no need of writing notes, we use it everywhere in daily life*. Students' reasons to dislike mathematics were *difficulty in understanding math, difficult to learn, and material once learned by them are forgotten easily, bad teacher and teaching style*.

3. ***Mathematics is difficult but interesting for students if teaching and teacher's style is liked by them***

Some students reported that though Mathematics is difficult to understand, it is interesting. And it is found that rating of their teacher and teaching style (good or bad) influences very much in their selection of liked or disliked subject. As they cannot follow the teacher, they dislike the subject. While 63 % students like mathematics, 37 % dislike Mathematics. Students who like their mathematics teachers tend to like mathematics [$\chi^2(1, N=178) =14.71, p<0.01$]. At the same time, 57% of students perceive themselves as not good in math. Their reasons for bad performance are difficulty in learning math, difficulty in understanding math, forgetting and bad teaching. Some are performing well in class but they can'tdo the same in exams. These students are using blind strategies likebye-hearting equations or learning only the class notes.

4. ***Students perceive difficulty in learning maths as mostly related to cognitive factors, but their affect also significantly influence it***

The most frequent factors, identified by students, that make difficulty in learning math are lack of previous knowledge (69%), rapid forgetting (59%), difficulty in understanding math (37%), lack of family members to help in learning process (34%), do not know how to learn math (30%), inability in learning math (28%), difficulty of mathematics as a subject (26%), lack of hard work (24%), and can't understand the class (13%).Those who lack previous knowledge tends to have feeling of mathematics as a difficult subject [$\chi^2(3, N=178) = 10.69, p<0.05$]. Moreover, the most frequent factors that make math learning easy are very good teaching (75%), liking math (38%), tuition (27%), simplicity of math (20%), and ease to understand (16%). Eight percent of the students responded that mathematics is not at all easy by any reason. Significantly more number of students who feel mathematics as difficult tends to dislike mathematics (81%) than those who feel mathematics as easy (11%) [$\chi^2(1, N=178) = 82.35, p<0.01$].

Among the students, 36%perceive math as a very difficult subject, 40% as comparatively difficult and 24% as an easy subject. Most of the students (84%) find Algebra as difficult area rather than Geometry (10%). One in four (28%) of students believe that they cannot learn math. Many students (64%) are taking effort to solve a problem only if they feel it as easy. When confronting with a difficult problem, 40% of students leave the problem with more or less effort, only 55% seeking help from others. In case of retrieving or using previous knowledge, 74% are unable or rarely able to retrieve and use previous knowledge. 54% of students are unable to solve problems in textbooks themselves.

5. ***Student disinterest and dislike towards maths is mostly related to their blind beliefs, especially math-fear and low self-efficacy***

A good portion of students (68%) are in agreement with learning of math is interesting, but 27% of students find mathematics as a boring subject. One in five (22%) students believes that they can't succeed in math. Some blind beliefs held by students include the following. Only people with high intelligence can learn math (15%), math learning is influenced more or less by inborn ability (54%), a person's chance for failing or succeeding in math is fixed (17%), and math should be learnt by heart (46%). 17% of students have intense fear and 61% has an average level of fear regarding math, 85% of students reported that they are forgetting equations due to fear.And the students are trying to escape from math related situations.

Liking math affects students' expectancy related behaviours, feeling of interest or boredom, self-efficacy, task value, epistemological beliefs, and fear. Most of the students who like mathematics found interest in learning maths (85%) than those who dislike maths (27%) [$\chi^2(1, N=178) = 82.15, p<0.01$]. However, significant more number of students who dislike maths has a feeling of boredom (56%) than the students who like maths (21%) [$\chi^2(1, N=178) = 46.49, p<0.01$]. Students' likes toward mathematics is significantly affected by their self-efficacy for learning maths [$\chi^2(1, N=178) = 17.21, p<0.01$].That is, students who like mathematics has self-efficacy (72%) and those who dislike tends to do not have self-efficacy (46%). And, it is found that task value is significantly associated to liking of the subject [$\chi^2(1, N=178) = 8.5, p<.05$] in a way that as they like math they are valuing the task. Significant more number of students who do not like math tends to hold negative epistemological beliefs; like, every one can't learn math (70%) [$\chi^2(1, N=178) = 9.6, p<0.01$], hard work will not improve learning of math[$\chi^2(2, N=178) = 20.91, p<0.01$], only people with high intelligence can learn math [$\chi^2(2, N=178) = 9.31, p<0.01$].

6. ***Feeling difficult affects students' liking of math which in turn impact their strategies, effort and perseverance***

Feeling mathematics as a difficult subject affects not only their liking of math but also their expectancy behaviour, perseverance, interest and boredom, self-efficacy beliefs, epistemological beliefs and fear. Itis also found that lack of previous knowledge is significantly related to feeling of difficulty. Significant more number of students who feel mathematics as difficult are not trying to solve a problem if they are not expecting a success (56%) [$\chi^2(1, N=178) = 5.05, p<0.05$]. Significant more number of students who feel mathematics not difficult shows perseverance and help seeking (82%) than who feel mathematics as difficult (29%) [$\chi^2(3, N=178) = 21.49, p<0.01$]. Students who feel mathematics as difficult tends to have low interest in learning math (68%) significantly more than those who feel maths as easy (10%) [$\chi^2(1, N=178) = 62.54, p<0.01$], and students who feel mathematics as difficult tends to feel boredom in mathematics (51%) significantly more than those who feel it as not difficult (12%) [$\chi^2(1, N=178) = 30.51, p<0.01$]. Students' self-efficacy beliefs is significantly dependent on their feeling of difficulty in mathematics [$\chi^2(1, N=178) = 15.17, p<0.01$]. Despite these, significant more number of students who feel mathematics as difficult hold beliefs like no effect for hard work [$\chi^2(2, N=178) = 16.83, p<0.01$], "I never understand maths" [$\chi^2(2, N=178) = 22.92, p<0.01$], fixed faith [$\chi^2(1, N=178) = 6.32, p<0.05$] and only people with high intelligence can learn mathematics [$\chi^2(2, N=178) = 20.61, p<0.01$]. Regardless of these, when the students have a feeling of difficulty there are feeling of fear also [$\chi^2(2, N=178) = 34.4, p<0.01$].And students who reported themselves as backward in maths tend to follow blind strategies like learning equations or class notes only [$\chi^2(2, N=178) = 12.58, p<0.01$].

Discussion

Almost all students accept the utility value of mathematics, but a significant number of students grant less personal value for it because of difficulty in learning or understanding it. That is, they comprehend the utility of mathematics butdon't know where and how to use the particular concept. Cost value belief has shown the same trend. Students believe that learning of other subjects will be profitable than learning of mathematics. If the difficulty beliefs of students regarding mathematics were high, they try to stave off mathematics in spite of its practical value owing to low personal value along with high cost value.

It is interesting that, mathematics is on the top of most liked and most disliked subjects for secondary school students. This is among all nine school subjects, including languages, sciences, social sciences and information technology. From the school perspective, students' likes or dislikes towards a subject is mostly determined by their likes or dislikes towards the teacher. Most of the students' most liked subject is, the subject that taught by their best teacher. That is attitude towards teacher (liking or disliking) is directly linked to liking of the subject. And when they like math teacher, they have interest in math and are not feeling boredom in learning it.Andas to the reason for mathematics learning being easy, the most students report good teaching. These imply the influential role of teacher. It is clear from the result that the role of teacher can't be replaced by any other means. Teacher effectiveness is a contributing variable to students like or dislike towards the subject. Students perceive good teaching as the factor that makes mathematics learning easy. And, instead of their roles, students find teachers' role as more important in their learning. There are previous researches that demonstrated teachers' interest in the subject and interpersonal behavior are contributing to students' learning motivation (Lapointe, Legault & Batiste, 2005; Skinner & Belmont, 1993).

Students mostly pointed forgetting as the reason for disliking and feeling of difficulty in mathematics. Forgetting may occur for different reasons like ineffective coding, decay, interference, retrieval failure. Most of these problems can be overcome by proper coding or by improving the encoding process. Students' use of learning strategies has a crucial role in this. Student motivation also has a positive correlation in the retrieval of the learned material.

Students mostly cite lack of previous knowledge, rapid forgetting and difficulty in understanding mathematics as the reasons for difficulty in learning mathematics. These reasons are closest one another. Lacking previous knowledge means they have forgotten the content. And, it also means learning of subsequent content will suffer due to lack of basics. This is also pointing to the inefficiency of students' learning strategy as we have discussed in the preceding section and their inability to see the interconnections between topics.

The most evident reason for feeling difficulty in math learning is the lack of previous knowledge and quick forgetting of learned material. These implies that students follow blind strategies for learning, and they are not taking the learning seriously. They learn it for a short time goal, only to pass exams. Students should be given a clear picture about the inter connection between current topic with those they had learn and with those they have to learn. This will improve the understanding about the topic and of course task value beliefs.

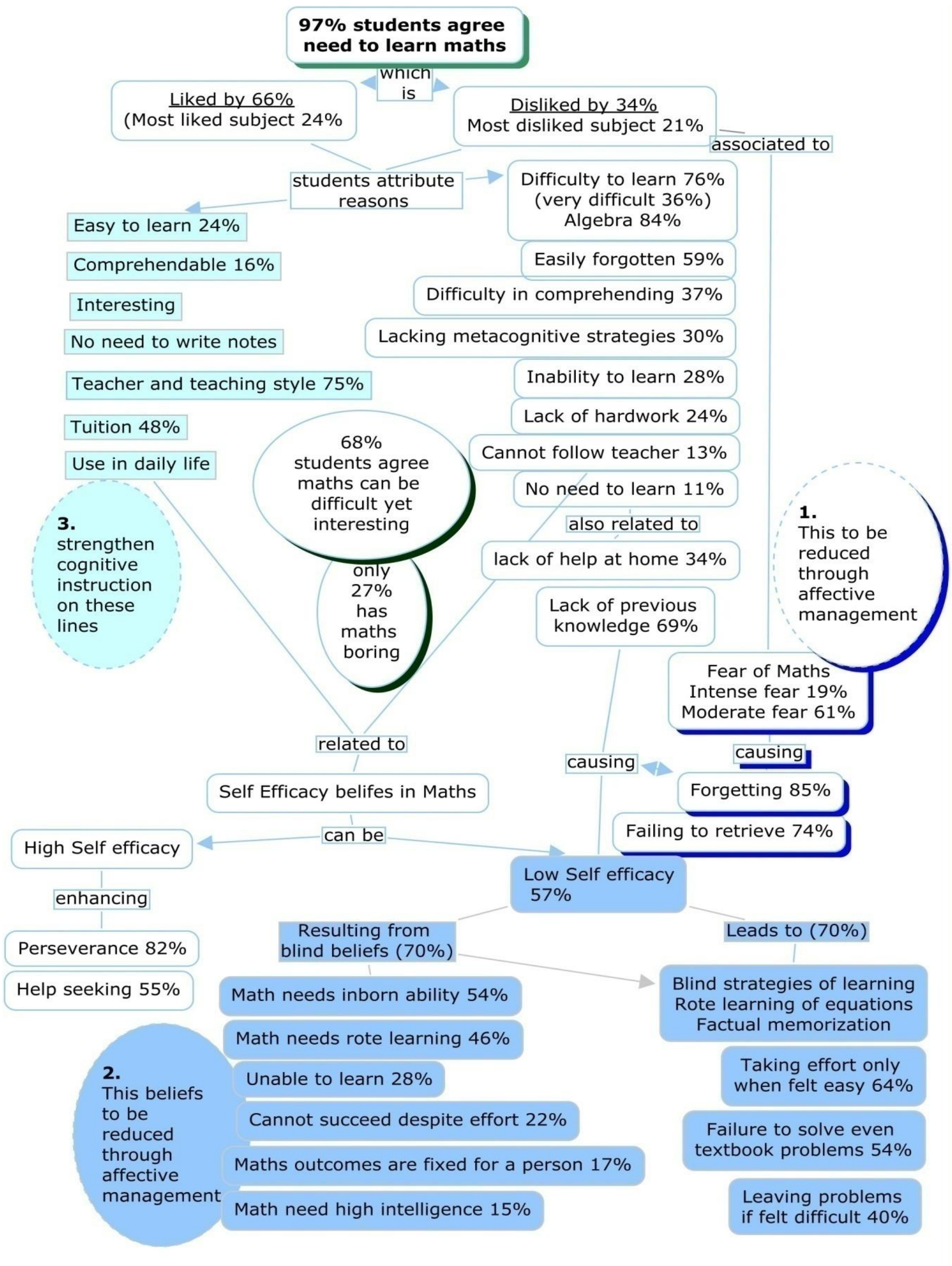
Most of the students' disadvantageous beliefs found related to their dislike and feeling of difficulty in mathematics; and their favorable beliefs found related to likes and feeling that mathematics is not a difficult subject. Though we can't say definitely which one is determining the other, of course beliefs will have more deep roots. As the students attested that teacher is is important in creating likes and feeling of ease about mathematics, teacher can improve students' learning by guiding their beliefs through proper interpersonal relationship and by using teaching learning strategies that take care of affective factors as well as cognitive factors.

There is strong association between students' belief regarding the difficulty of math and dislike towards math, and these two are associated to lower interest, higher boredom and low perseverance. That is, dislike and feeling of difficulty causes for negative reactions from students. Whereas liking of subject and absence of the feeling of difficulty are affected by higher self-efficacy, good task value, and positive epistemological beliefs. The same is found by Zan and Martino (2008) that if the students can do math they like it, otherwise they dislike it.

In the light of these findings we call for teachers' attention on students' feelings and beliefs in mathematics learning. The identified difficulties are lack of previous knowledge, difficulty in understanding math, students' perception about teacher and teaching style; do not know how to learn math, blind beliefs and fear. These are mostly need to be managed by teachers; it includes cognitive and affective management. Students need cognitive as well as affective instruction as shown in Figure 1.

The diagram gives a pictorial representation of interconnection between beliefs, likes and dislikes, and reasons for these. It highlights the factors to be improved from the cognitive and affective aspects in learners.

Management in the cognitive part includes making basics in students; make the teaching in the understanding level of students. Also learning groups can be set in the classroom. Prior to starting a unit; activities in the area of previous knowledge can be given to learning groups. Management of affect includes making liking towards math, positive beliefs; reduce negative beliefs and fear, of students regarding mathematics.



Need and importnce of affective management in maths instruction

Figure 1: Need and importance of affective management in mathematics instruction

Conclusion

Affective instruction refers to teaching learning process that relates to students' interest, attitudes and motivation. Affective teaching will improve expression of their thoughts, ideas, feelings and self-awareness, and students' personal and emotional involvement will improve their task behavior (Shechtman&Leichtentritt, 2004). To make liking towards mathematics in students, teachers need to eliminate the factors that create dislike. Hence, to consider change in beliefs like low self-efficacy, blind beliefs regrding effort and ability.

Teachers should be aware of their students' beliefs regarding mathematics and its nature. In society, many declare that he or she is not good in mathematics, which makes a meaning, that mathematics is a difficult subject and majority cannot learn that. The teachers should move this belief. At least in school context, mathematics and related experience should be managed such that students never come to hear that mathematics is a difficult subject. When introducing a new topic, instead of explicitly saying that the topic is difficult, teachers can instruct students to take more effort and its relevance in practical field may be explained. Teachers need to provide experiences to make believe students that they *can do* and to value of effort. To change students' belief they should be given short courses on learning of mathematics, and how to learn math. In the classroom, teachers can make small groups and can give simple activities to help the students to make belief that they *can do* by giving problems in their level; as a result, they will improve their effort.

To manage students' learning, it should be taught to students how to learn mathematics. Adoption of self-regulated learning strategy will help students to know themselves well as learners. Self-regulated learning strategy is defined as being met cognitively, motivationally and behaviorally active in one's own learning process and in achieving one's own goals (Eccles&Wigfield, 2002). Teachers can help the students to set their own goals, to follow deep learning strategy, teach every topic with at least one practical use and over all provide a stage for affectionate and interesting learning.

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Self-Regulated Learning: A Motivational Approach for Learning Mathematics

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Self-Regulated Learning: A Motivational Approach for Learning Mathematics

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Abstract:
Self-regulated learning is identified as a fruitful learning strategy as evidenced from the increase in the number of researches in academic self-regulation since year 2000. Knowing to manage one's own learning is helpful in attaining the goals. This analysis of literature on self-regulated learning focuses on the factors that affect self-regulated learning and the students' learning outcomes from application of self-regulated learning. This paper identifies major categories of variables studied in relation to self-regulated learning, and summarizes the findings there from. Factors like cognitive strategy use, meta-cognition, self-efficacy and other motivational beliefs and some individual differences were considered. An inter relationship between self-efficacy and self-regulated learning is manifest. Mastery goal orientation favours self-regulated learning. Areas of language and mathematics education manifests more studies on self-regulated learning than other curricular areas. Findings from both the areas confirm that self-regulated learning results in enhanced achievement and desirable affective outcomes. How the self-regulated learning is linked to mathematics learning outcomes is specifically elaborated for facilitating future research and classroom practices especially in mathematics education context around this motivational construct.

Keywords: *Self-regulated learning, Motivational beliefs, Mathematics learning*

I. INTRODUCTION

Earlier research on students' learning and its' outcomes has given emphases to cognitive strategies, metacognition, motivation, task selection and engagement, and social supports in classrooms. Self-regulated learning (SRL), a cognitive motivational approach to learning, covers various aspects of academic learning, and discusses more holistic view of student acquisition of the skills, knowledge, and motivation (Paris & Paris, 2001). Self-regulated learning is a part of social cognitive theories. A great deal of research has been conducted on the topic of self-regulated learning, because it is found very helpful in attaining goals and improving performance in varied human acts.

Self-regulation is the ability to manage one's own energy states, emotions, behaviours and attention, in ways that are socially acceptable and help achieve positive goals, such as maintaining good relationships, learning and maintaining wellbeing. Self-regulated learners are learners who manage their learning, engage in more metacognitive monitoring and control, and are more intrinsically motivated (Zimmerman, 1990). SRL is "an active, constructive process whereby learners set goals for their learning and then attempt to monitor, regulate, and control their cognition, motivation, and behaviour, guided and constrained by their goals and the contextual features in the environment" (Pintrich, 2000). Self-regulated learners are distinctive in being meta-cognitively, motivationally and behaviourally active in one's own learning process and in achieving one's own goals (Eccles&Wigfield, 2002). SRL has interconnections with many factors, like self-efficacy, goal orientation, task value, strategy use and metacognition (Pintrich, 1999). Research suggest that self-regulated learning and performance are related (Zimmerman,1998; Pintrich, 1999). Accordingly numerous studies have been conducted to examine these relations.

II. NEED FOR THIS REVIEW

Self-regulation is viewed as the fourth 'R' of education as critical to student success as a firm foundation in reading, writing and arithmetic (The fourth R, 2014). This analysis of literature is important because no recent reviews of studies on self-regulated learning are available. This review reveals the growing importance of self-regulated learning researches and focuses on the factors that affect self-regulated learning and on the students' learning outcomes from application of self-regulated learning.

III. OBJECTIVES

This review is to study the researches on factors that have a bearing on self-regulatory skills in academic learning and to specifically explore the effect of such skills on mathematics related outcomes. Specifically this meta-analytic review is to answer the questions viz., what leaner and schools factors are associated with self-regulated learning, what factors will help enhance self-regulated learning and what impact self-regulated learning has specifically on mathematics related outcomes. In doing so, this study reveals the trends in researches on self-regulated learning during the last one and half decades.

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IV. SAMPLE

Thirty-five studies on self-regulated learning reported in journals spanning from1998 to 2016 obtained from Google search with key term self-regulated learning were reviewed in this study.

V. METHODS

Analysis of the sampled studies was done in terms of year of study, independent and dependent variables, level of education (primary, secondary, and tertiary or teacher education), design of study, sample size, tools/ techniques used in data collection and methods of analysis.

VI. RESULT AND DISCUSSION

The results had been grouped under two broad sections namely studies on self-regulated learning in general academics and interrelationship among self-regulated learning, self-efficacy and mathematics outcomes. Different headings were given on the basis of aim, variables considered and methodology followed in the study.

Studies on self-regulated learning in general academics

Studies on enhancing SRL and achievement

A number of experimental or case studies had been conducted in different levels of schooling with a view to improve SRL and thus to improve learning outcomes. In case of kindergarten students, creating classroom contexts that support young children's development of self-regulated learning helps the learners to develop self-regulated learning (Perry &VandeKamp, 2000). Use of metacognitive strategy among eleventh graders is affected by their goal orientation and the reward they got (McWhaw & Abrami, 2001). Use of metacognitive strategy is found affected also by students' achievement level (DiFrancesca, Nietfeld & Cao, 2016) and prior knowledge (Taub, Azevedo, Bouchet & Khosravifar, 2014).

It is possible to enhance students' self-regulatory judgments and math performance greatly through self-regulatory strategy training (Ramdass & Zimmerman, 2008).Also, significant effect was found for a learning mediation, text based learning associated with the elaboration of concept maps and training of self-regulated learning, in improving in-depth processing (Mih & Mih, 2011). Kostons, Gog and Paas (2012) have proved that training self-assessment and task-selection skills are effective cognitive approaches to improve self-regulated learning. They observed that observing a human model engaging in self-assessment, task selection, or both could be effective for secondary education students' acquisition of the same and the acquisition, either through examples or through practice, would enhance the effectiveness of self-regulated learning.

Personality and motivation factors influence SRL

Concept of self-regulation is emerged from the research in personality psychology. Self-regulation affects all types goal directed behaviours of a person; when it is regarding learning behaviours it is called as self-regulated learning. There had been a number of researches analyzing the relationship between personality and self-regulated learning. The study conducted by Bidjerano and Dai (2007), regarding the relationship between the big-five model of personality and self-regulated learning strategies, reported that self-regulated learning strategies co-vary with personality dimensions. Use of time management, effort regulation and higher order cognitive skills shows high positive correlation to consciousness and intellect. Furthermore, self-efficacy for self-regulated learning is above and beyond previous academic achievement, gender, SES, intelligence, personality traits, and self-esteem in predicting academic achievement (Zuffiano et al, 2013).

Self-regulated learning is a motivation based learning theory; motivation is an essential component of self-regulated learning. Consequently many studies analyzed the function of different motivational factors in SRL. It is reported that need for achievement is a significant predictor of mastery-approach goals, and it is a significant predictor of metacognitive strategies. Also fear of failure is negatively associated to metacognitive self-regulation (Bartels & Magun-Jackson, 2009). Whereas metacognitive regulation strategies are found the strongest predictor of academic adjustment; self-regulated learning strategies, academic self-efficacy and test anxiety are also found as predictive of academic adjustment (Cazan, 2012). Another adverse factor, academic procrastination, is found to have negative correlation with intrinsic goal orientation, extrinsic goal orientation, metacognitive self-regulation, time/study environmental management and effort regulation (Motie, Heidari & Sadeghi, 2012). Self-efficacy for self-regulated learning is a stronger predictor of self-regulated learning than intelligence, personality traits, and self-esteem (Zuffiano et al., 2013). And accuracy in self-efficacy and self-evaluation correlated positively with performance (Ramdass & Zimmerman, 2008). But Lee, Lee and Bong (2014) observed that self-efficacy predicts self-regulation and achievement only when grade goals mediated the relationship, but individual interest functioned as direct predictor of self-regulation. Savoji, Niusha and Boreiri (2013) advocated that academic achievement can be predicted by dimensions of epistemological beliefs and motivational strategies and there is a positive relation between self-regulated learning strategies (cognitive, meta-cognitive) and academic achievement.

Disciplinary, Gender and individual differences in SRL

SRL is domain specific (Greene, Bolick, Jackson, Caprino, Oswald & McVea, 2015). There are variations in SRL across disciplines and gender, as the role of individual factors is vital in this approach. Among the diverse disciplines, minor mean differences is emerging in all the sub dimensions of SRL, students in different discipline differing in their use of self-regulatory strategies, though no clear regularity on any discipline's favour was perceived (Virtanen & Nevgi, 2010). Moreover female students are higher than male students in help-seeking strategies, utility value and on performance anxiety. Girls are showing significantly lower academic self-efficacy, interest and self-regulation in mathematics, than boys did (Lee, Lee & Bong, 2014). Low achieving students reported low level study strategies and low self-efficacy (DiFrancesca, Nietfeld & Cao, 2016). Students at high, average, and low grade point averages differed in overall use of SRL strategies (Nandagopal & Ericsson, 2012).

Groups based on intelligence and achievements do not differ significantly in SRL on short run but they differ significantly in SRL in long term (Sontag& Stoeger, 2016).

Interrelationship among self-regulated learning, self-efficacy and mathematics outcomes

SRL strategies are significantly correlating to secondary school student's performance of problem solving (Puteh & Ibrahim, 2010), fifth grade students' math competence (Friedrich, Jonkmann, Nagengast, Schmitz & Trautwein, 2013), female prospective teachers' academic achievement in mathematics; but it is not true for male prospective teachers (Acara & Aktamis, 2010).

Contextual differences in terms of gender and subject of study found to have effect on students' motivation and SRL; females possess less adaptive self-efficacy beliefs than males for learning mathematics (Wolters & Pintrich, 1998).They observed greater cognitive strategy use in social studies and English than mathematics. Effect of task value beliefs on performance outcomes is not significant as self-efficacy, and this is true for all contexts. But in the study conducted among seventh graders by Cleary and Chen (2009), girls reported more frequent use of self-regulation strategies than boys. They observed variations in students' motivation and use of self-regulation strategies across grade level; it diminishes towards higher grades.

Among the motivational beliefs in relation to SRL, self-efficacy, goal orientation, task value and epistemological beliefs were studied frequently. Many studies found that self-efficacy as a strong predictor of mathematics achievement (Wolters & Pintrich, 1998; Mousoulides & Philippou, 2005; Jaafar & Ayu, 2010), problem solving (Puteh & Ibrahim, 2010), and mathematics metacognition (Jaafar & Ayu, 2010), and found having significant correlation with self-regulated learning (Jain &Dowson, 2009; Usher, 2009; Puteh &Ibrahim, 2010). Cleary and Chen (2009) (among middle school students) and Mousoulides and Philippou (2005) (among pre-service teachers) observed task value as the primary motivational predictor of students' use of regulatory strategies during math learning where as Wolters and Pintrich(1998) observed that effect of task value beliefs on performance outcomes is not as significant as self-efficacy among seventh and eighth graders.

In an experiment among seventh graders, on instructional practice based on SRL, Pape, Bell and Yetkin (2003) observed that students are more able than previously to communicate mathematical understanding and justify their mathematical reasoning. It is also known that an integral part of developing students' SRL was to provide a context to support their growing awareness of themselves as agents in the learning process by supporting their strategic behaviours and to attribute outcomes to these behaviours.

It is possible to improve mathematical problem solving and self-regulation competencies of eighth grade students with higher learning competencies through short trainings (Perels, Gurtler & Schmitz, 2005). The same is proved in regular mathematics classroom (Perels, Dignath & Schmitz, 2009). Also, it is possible to support self-regulation competencies and mathematical achievement by self-regulation intervention within regular mathematics lessons of 6th-grade students (Perels, Dignath & Schmitz, 2009). SRL can be used for improving problem solving skills and pedagogical knowledge of prospective teachers (Bracha & Revach, 2009). Possibilities of self-regulated learning through the assistance of computers also were experimented. It is found that mathematics literacy can be improved through online metacognitive instruction (Kramarski & Mizrachi, 2006). Computer supported collaborative learning strategies also help to acquire self-regulated problem-solving skills in mathematics (Lazakidou & Retalis, 2010). Direct and indirect influences on SRL and its effects on mathematics outcomes revealed in research during 2000 to 2016 are portrayed in the Figure.1.

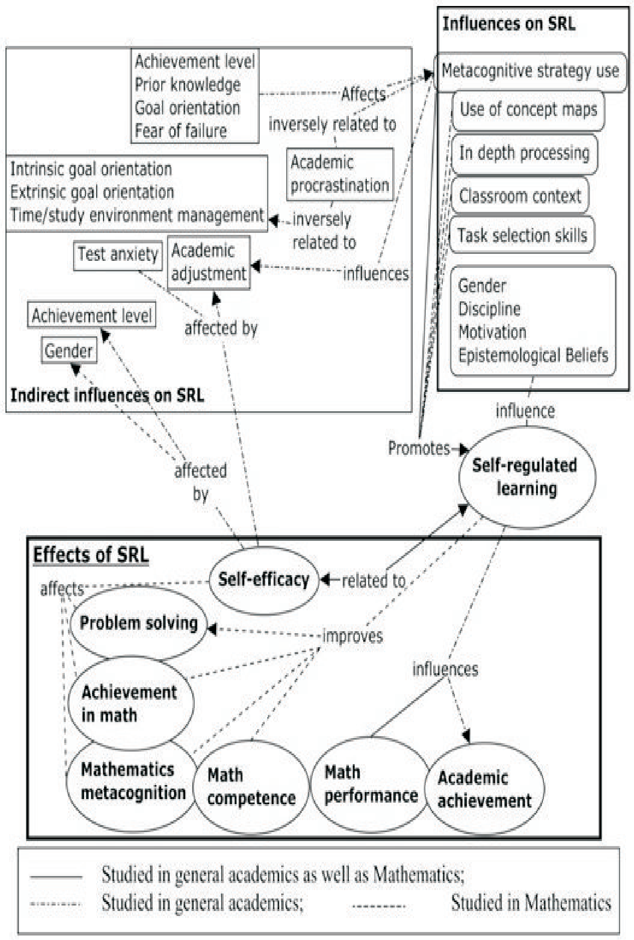

Figure 1. Direct and indirect influences on SRL and its effects on mathematics outcomes revealed in research during 2000 to 2016

VII. CONCLUSION

1. A host of cognitive and emotional factors within and outside the learner reciprocally impacts SRL in learners irrespective of level of education

The review demonstrated that self-regulated strategies, factors affecting self-regulatory behaviours and their relation to general academic outcomes are studied across all the three levels of education. There is moderate to strong effect of self-regulatory behaviours on academic outcomes including academic adjustment, especially at secondary and tertiary levels, and teacher performance if used in teacher training. SRL strategies accounted for up to 51% of the variance in academic performance. Studies suggest that the strongest predictors tend to be the metacognitive regulation strategies. Studies evidence that in adult learners self-regulated learning strategies co-vary with personality dimensions. High Consciousness and Intellect are related to higher tendencies for the use of time management and effort regulation and higher order cognitive skills. High-interest students selected more main ideas and used more metacognitive strategies than low-interest students. Individuals profiled as predominantly rational engage in more self-reported metacognitive self-regulation than individuals profiled as predominantly empirical. Need for achievement was significantly related to metacognitive self-regulation, and mastery-approach goals partially mediated this relationship. Achievement goals, mathematics self-efficacy, and cognitive engagement have a mediating role between dimensions of epistemological beliefs and math achievement. Fear of failure was negatively associated with metacognitive self-regulation. Mastery-approach goals significantly predicted metacognitive strategies. Among high school students, academic procrastination was negatively correlated with metacognitive self-regulation, time/ study environmental management and effort regulation.

2. Self-efficacy and problem solving are studied closely in connection with SRL and found to enhance in-depth processing

Self-efficacy is one variable that is explored by many a studies in relation to SRL. Among middle schoolers, Self-efficacy and self-evaluation which are components of SRL correlated positively with math performance. Self-efficacy (SE) predicted self-regulation. Reciprocal relation between students' SE and SRL is fairly established. Other studies confirm unique contribution of SESRL on academic achievement above and beyond previous academic achievement, gender, SES, intelligence, personality traits, and self-esteem. Self-regulated learning enhances in-depth processing and thus performance on inferential questions and not for factual questions among middle school graders.

3. How gender, cultural context and discipline impacts SRL and consequent academic outcomes is not settled

Gender variation is evidenced in metacognitive strategies. Studies suggest that effect of gender on self-regulated learning is mediated by culture, discipline of study and age. In Asian cultures the females tend to manifest less regulatory behaviours especially in mathematics, though the same is not manifested in studies that used European and American samples. In a Korean study for example, Girls showed significantly lower academic self-efficacy, interest and self-regulation in mathematics. Females do not have adaptive self-efficacy beliefs as males for learning mathematics. However, other studies show that Female students scored moderately higher than male students on help-seeking strategies, utility value and on performance anxiety. Especially in maths, girls reported more frequent use of self-regulation strategies. Female high school students demonstrated positive relation between self-regulated learning strategies (cognitive, meta cognitive) and academic achievement. Among the diverse disciplines, minor mean differences emerged on all the sub dimensions of SRL though no clear regularity on any discipline's favour was perceived.

4. SRL can be enhanced even through short term regular classroom interventions

Practice would enhance the effectiveness of self-regulated learning. Self-regulated strategies can be enhanced through targeted interventions from kindergarten onwards; and it works even in teacher preparation. In Kindergarten, supporting classroom environments helps the learners to develop self-regulated learning. Among fifth and sixth graders- strategy training greatly enhanced students' self-regulatory judgments and thus performance. In this respect, context to support their growing awareness of themselves as agents in the learning process is identified as important. Among Secondary school students observing a human model engaging in self-assessment, task selection, or both could be effective for acquisition of self-assessment and task-selection skills.

5. Moderate to strong effects of self-regulation on mathematics related outcomes is evidenced

Review of studies on SRL in mathematics learning reveals that the most frequently used measure is Motivated Strategies for Learning Questionnaire. Studies evidenced that teachers are capable of differentiating between students' use of self-regulated learning. Self-efficacy is the variable studied in close relation to SRL in maths, followed by problem solving and achievement in nearly half the studies reported. Task value beliefs and anxiety are also studied. Especially in SRL in relation to mathematics, there is recent shift to experimental studies beyond the exploratory surveys. Also, in the case of maths outcomes in comparison to academic achievement in general, there are more studies among grade 6-8 students, with a lesser but significant number of studies at secondary and tertiary level. Studies that focused on grades below five are only one, with recent studies shifting into non-conventional samples as primary students and tertiary students. Self-efficacy and test anxiety varies according to gender and subject. There was greater cognitive strategy use in social studies and English than mathematics. Irrespective of level of education; Moderate to strong effects of self-regulation on mathematics related outcomes is evidenced. As with general learning, task interest was shown to be the primary motivational predictor of students' use of regulatory strategies during math learning. Likewise, self-regulation strategies are negatively related to mathematics anxiety.

6. Strategy training through methods including Computer-based instruction, semi-structured guidance, and face-to-face discussion enhances SRL in maths

Opportunities for self-regulated learning had a positive effect on students' cognitive activation and on students' emotional experience. Though it is difficult to train self-regulation compared to problem-solving competencies, it is possible to improve mathematical problem solving and self-regulation competence even through short training. Significant increase in metacognition and problem-solving of primary class students after Computer-based instructional method within an authentic context consisting of three main phases: observation, collaboration and semi-structured guidance are observed. Among fifth and sixth graders strategy training greatly enhanced students' self-regulatory judgments and math performance. Thus in middle school level, it is possible to support self-regulation competencies and mathematical achievement by self-regulation intervention within regular mathematics lessons. Meta-cognitive guidance (online discussion without metacognitive guidance, face-to-face discussion) attained a higher level mathematical literacy. This is especially of significance as middle-school students exhibited a more maladaptive self-regulation and motivation profile than sixth graders, and achievement groups in seventh grade (high, moderate, low) were more clearly differentiated across both self-regulation and motivation than achievement groups in sixth grade. Also, by this level students perceive themselves as poorer self-regulators than younger students.

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