CERTAIN PSYCHOLOGICAL VARIABLES PREDICTING MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS

Thesis

Submitted for the Degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

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CERTIFICATE

This is to certify that the thesis entitled "**CERTAIN PSYCHOLOGICAL VARIABLES PREDICTING MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS**" is an authentic record of research work carried out by MIDHUNDAS A.M., for the degree of Doctor of Philosophy in Education, University of Calicut, under my supervision and guidance and that no part there of has been presented before for any other Degree, Diploma, or Associate ship in any other University.

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DECLARATION

I, Midhundas A. M., do hereby declare that this thesis entitled as **"CERTAIN PSYCHOLOGICAL VARIABLES PREDICTING MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS"** is a genuine record of the research work done by me under the supervision of Dr. K. Vijayakumari, Associate Professor, Farook Training College; and that no part of the thesis has been presented earlier for the award of any Degree, Diploma or Associateship in any other University.

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Education is a tool for preparing the younger generation who are the pillars of the future of the country and the world itself. The sustainable development of a country in every aspect- social, economic, technological, depends upon the quality of education it imparts from elementary to higher education. Quality education ensures making the individuals more creative and productive. Through the enactment of Right to Education Act (RTE, 2009), India has made a giant leap towards quality education. RTE assures every child the fundamental right to quality education. It helps them to acquire basic literacy and numeracy, enjoy learning without fear and feel valued and included, irrespective of where they come from (UNICEF, 2000). Kothari Commission (1964) and National Education Policy (2020) also stressed the importance of Access to quality education for every child. For ensuring quality education, teachers have to play a significant role in the process of learning. They are expected to be dedicated and committed to develop motivation, skill, values, and lateral thinking among students and optimum utilization of resources (Nagoba & Mantri, 2015). They have to ensure overall performance of a child to make him/her self sufficient and feel as a responsible member of the society.

Mathematics is the numerical and calculation part of man's life and knowledge. It plays a predominant role in the everyday life of an individual and has become an indispensable factor for the progress of the present day world.

Mathematics reveals hidden patterns that help one to understand the world around and is a strategic key in the development of the whole mankind. The knowledge of mathematics helps a person at his workplace, enhances his mental abilities and provides a better understanding of how the world around him functions.

Identifying the significance of Mathematics in the life of an individual, and in the development of the country, various commissions and committees have reiterated the need of special attention in Mathematics education at school level (Zakir Hussain committee, 1937; The Secondary Education Commission, 1952; National Curriculum Framework, 2005). National Education Policy, 2020 has highlighted the need of ensuring essential knowledge and skill in mathematics at school level citing the status of fundamental literacy and numeracy among elementary school students of India. Ramanujam (2012) analyzed the status of Mathematics education in India and commented that the country has to traverse in some way to face the challenge of providing quality mathematics education for all at school level.

Mathematics as a subject of study, is considered as a key to success in school education. At the same time, the majority feel it as one amongst the most difficult subjects for learning (Ramanujam, 2012). Mathematics is treated by many as an inflexible subject that contains many equations and meaningless manipulations of numbers and symbols. A major reason for mathematics to be a herculean task for students can be linked to teaching of mathematics. It includes lack of application, innovation and technology, an obsession of giving over emphasis to the right answer among teachers than the process of reaching at the right answer, and rote learning.

More stereotyped and mechanical approach to teaching mathematics keeps the subject away from the majority of students. Mathematics learning should be joyful, meaningful and more process oriented so that learners will be engaged in the learning process. Innovative ideas in teaching and learning make the learning process more enjoyable and meaningful through active participation of the child in learning of mathematics.

The aim of teaching Mathematics at school level can be listed as practical, disciplinary, cultural, aesthetic and social. With respect to the disciplinary aims of teaching mathematics, one can observe that, learning of Mathematics disciplines the mind and develops reasoning power among children. A mathematics student will be capable of using his power of reasoning in an independent way. The disciplinary aims of mathematics learning also include development of constructive imagination and inventive faculties among learners, and helping the learner to be original and creative in thinking. Instead of following rote learning in mathematics a creative learning approach in which students are encouraged to use their creative and critical thinking to make new, meaningful ideas, to take risks, act independently with flexibility are to be adopted which will make them successful problem solvers. Mathematics, through the meothod of problem solving works as a platform for developing creativity. The nature of problems, the ways of solving them and even posing problems open doors to creativity.

The former Indian president and one of the great scientists of India Dr. APJ Abdul Kalam in an interview with India Knowledge @Wharton during Wharton-India Economic Forum in Philadelphia expressed the lines of a poem written by him

as “Learning gives creativity, Creativity leads to thinking, Thinking provides knowledge, Knowledge makes you great”. The importance of creative thinking is evident in these lines. The association of components of knowledge can generate enriched citizens. Essence of mathematics provides a suitable platform for developing creativity. Creative thinking in mathematics can bring changes in the general view of mathematics. Exercising mathematics helps an individual to develop the ability to manipulate ideas mentally in various situations, to develop divergent thinking and problem solving ability, leading to creativity.

Development of Mathematical Creativity is an important aspect of mathematics education. Creative thinking involves imagination, basic use of the scientific method, problem posing, problem solving, making interpretations and using symbols. As Cropley (1992) points out, there is considerable confusion about the nature of creativity and there are at least two major ways in which the term is used. On the one hand, it refers to a special kind of thinking or mental functioning, often called divergent thinking. On the other hand, creativity refers to the generation of products that are perceived to be creative such as work of arts, music etc.

Need and Significance of the Study

Poincare (1948) believed that discovery in mathematics is a combination of ideas and stated that “there are a lot of these combinations but a few of them are useful. In the process of finding these useful combinations, a great number of combinations are constructed and then meaningful combinations are distinguished from meaningless ones”. Thus creating useful mathematical concepts through combining previously known concepts or discovering unknown relations between

mathematical facts can be considered as a creative act of doing mathematics (Ervynck, 1991). Arriving at a rare solution through unfamiliar method to problem than using a standard method can be taken as an evidence of Mathematical Creativity. Chamberlin and Moon (2005) considered “divergent thinking as one of prevalent descriptors of Mathematical Creativity”. Laycock (1970) described “Mathematical Creativity as an ability to analyze a given problem from different perspectives, see patterns, differences and similarities, generate multiple ideas and choose a proper method to deal with unfamiliar mathematical situations”.

Fisher (2004) has suggested a revisit to mathematics education so that it becomes new stairs to engage students with challenging problems and experiences leading to creative problem solving. In order to make the learners prepared for a future work force and cope up with a complex world with emerging trends, creative thinking is essential. American Council of Teachers of Mathematics (2000) emphasized the need of challenging problems that stimulate students to develop diverse and sound ways of mathematical thinking and think creatively. Many studies have reported that the educational practices following in many countries are not appropriate for developing creative mathematical thinking (Chan, 2007; Mann, 2005). National Curriculum Framework of India (2005) suggested that creativity in arts, literature and other domains of knowledge are closely linked together. Education must provide means and opportunities to enhance a child's creative expression. A major goal of an educational system is fostering creativity, a dynamic property of the human mind among students.

The cognitive process dimensions suggested by Revised Bloom's taxonomy (Anderson & Krathwohl, 2001) include 'creating' as the highest level of cognitive process. They defined 'creating' as compile information together in a different way by combining elements in a new pattern or proposing alternative solutions. In order to reach this ultimate level of thinking, mathematics is to be learnt in a way that has meaning and relevance, rather than memorizing formulae, theorems and shortcuts. A classroom that encourages students to think freely, without the insistences that are expected in a normal mathematics class room is reported to be contributing to the development of creative thinking in Mathematics (Byron, Khazanchi & Nazarian, 2010; Perez-Tyteca, Castro, Segovia, Castro, Fernandez & Cano, 2009; Trujillo & Hadfield, 1999; Ervynck, 1991). Creative thinking promotes student engagement and makes learning more interesting and meaningful.

Mathematical Creativity is defined by many in different ways and there is no uniqueness in the approach of researchers towards Mathematical Creativity. Chamberlin and Moon (2005) define creativity in mathematics as "an unusual ability to generate novel and useful solutions to simulated or real applied problems using mathematical modelling". According to the International Commission on Mathematical Instruction (2004) Mathematical Creativity is "the capacity of a person to produce logical and imaginative numerical which are essentially novel and previously unknown to the producer". Meissner (2000) has highlighted the need of thorough knowledge in mathematics for the development of Mathematical Creativity, as excellent knowledge in the content helps individuals to make connections between different concepts and types of information. Ervynck (1991)

identified the role of creativity in mathematics in advanced mathematical thinking as helping to form reasonable inferences so that mathematical theories are formed and new knowledge is generated. Rather similar to this, Sriraman (2004) cheractirised professional mathematicians as having an exclusive domain of Mathematical Creativity. By practicing mathematical accuracy and fluency, students are expected to be more capable of expressing their creative thinking. According to Pehkonen (1997) mathematics creative thinking is a combination of logical and divergent thinking based on intuition with a conscious aim. Many researchers have supported flexibility, fluency and novelty as the components of divergent thinking in mathematical problem solving and problem posing (Siswono, 2004; Haylock, 1997; Silver, 1997; Krutetskii, 1976). These components respectively assess different parts and are independent of each other. If creative thinking is original and reflective, that may produce a complex product. The levels of creative thinking are not easily identified in the learning process of normal class rooms.

Research in the area of mathematics education is always a key concern for those who are engaged in the process of improving the status of mathematics education in the country. Banergy (2012) has made a review on the researches in mathematics education and found that the majority of studies are conducted at elementary level, especially on intervention strategies. At secondary level of education, the need for studies on cognitive and affective gains of students is highlighted in the report so that the curriculum can be structured more effectively. Mathematical Creativity is a complex concept and is a blooming area of research in India. Review of the studies in the area of Mathematical Creativity revealed that some studies focused on the relationship of academic achievement and

Mathematical Creativity (Bahar & Maker, 2011; Hungi & Changeiywo, 2009; Karimi, 2000) where as researches by Tyagi (2015), Kavitha (2009) and Sriraman (2005) focused on problem solving and Mathematical Creativity. Many studies are found to be reported on the relationship of Mathematical Creativity with variables like mathematics anxiety, intelligence, numerical aptitude, mathematical ability, educational administration, intellectual involvement, social involvement, self concept, optimism, and so on. (Jinu & Vijayakumari, 2018; Midhundas & Vijayajumari, 2017; Kanhai & Singh, 2016; Midhundas & Vijayajumari, 2016; Kattou, Kontoyianni, Pantazi, & Christou, 2013; Sreerekha, 2001; Tuli, 1980 & Jensen, 1973). Efficiency of certain approaches, methods, techniques and materials in facilitating divergent thinking and Mathematical creativity was the focus for many studies which is found to be a trend among studies in 21st century (Jinu, 2018; Vijayakumari & Kavithamol, 2014; Sharma, 2013; Idris & Mohd-Nor, 2010 & Kwon, Park & Park, 2006).

Studies in the area of Mathematical Creativity are mainly focusing on correlates and methods to foster Mathematical Creativity. Studies focusing on prediction of Mathematical Creativity are rare and most of the studies in this regard focus on environmental variables and achievement. Efficiency of psychological variables to predict Mathematical Creativity is not well explored. It will be beneficial for mathematics teachers, curriculum planners, school administrators and parents if the variables contributing to Mathematical Creativity of secondary school students are identified and their relative efficiency in predicting Mathematical Creativity are calculated.

Statement of the Problem

Mathematical creativity is an ability which is not uniquely defined and is very difficult to be identified by an average classroom teacher. It is usually ignored by the formal classroom practices but at the same time is an important aspect of mathematics education. Personal, social and environmental factors may affect Mathematical creativity. If the variables contributing to Mathematical Creativity and their relative efficiency to predict the variable are identified, it will be easier to focus on the creative ability of the child in mathematics. The present study attempts to find out the efficiency of some select psychological variables to predict Mathematical Creativity of secondary school students of Kerala. Thus the present study is entitled as "CERTAIN PSYCHOLOGICAL VARIABLES PREDICTING MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS".

Operational Definition of Key Terms

In order to get a clear picture on the statement of the problem, the key terms involved are defined operationally and are given below.

Psychological variables

The variables that are related to cognitive and emotional aspects of an individual are known as psychological variables. In the present study psychological variables stands for a set of variables both cognitive and affective viz.,

Problem Solving Ability in Mathematics

Mathematics Anxiety

Academic Stress

Locus of Control and

Optimism

Predicting

The SAGE dictionary of Social Science Research Methods (2006) explains predicting as "stating about what will be observed before the actual event, a foretelling of some future happening". The Oxford English dictionary (2006) defines predicting as "making a statement about the future".

In the present study predicting means the ability of the select psychological variables to predict variation in Mathematical Creativity among secondary school students calculated using multiple regression analysis.

Mathematical Creativity

The ability to think divergently and to transfer information is essential to creativity and creative ideas must be fluent, flexible, capable of elaborating and redefining problems (Guilford, 1967). Romey (1970) defined Mathematical Creativity as an ability to combine mathematical ideas, things, techniques and approaches in a new way and analyze a given problem from various dimensions. Mathematical Creativity means making new mathematical combinations from existing mathematical concepts, objects and elements. In the present study Mathematical Creativity is the total score obtained by an individual in a Mathematical Creativity Test developed by Midhundas and Vijayakumari (2017), the components considered being fluency, flexibility and originality.

Secondary School Students

In the present study secondary school students are students studying in VIII, IX and X classes following Kerala state syllabus.

Research Questions

The questions answered through this study are the following.

1. To what extent do the secondary school students of Kerala are Mathematically Creative?
2. Whether the select psychological variables are correlated to Mathematical Creativity?
3. To what extent the select psychological variables predict Mathematical Creativity?
4. What is the contribution of each of the select psychological variables in predicting Mathematical Creativity?

Objectives of the Study

The objectives of the study are the following.

1. To find out the extent of Mathematical Creativity among secondary school students of Kerala.
2. To find out whether the select psychological variables are significantly related to Mathematical Creativity of secondary school students.

i). To find out whether Problem Solving Ability in Mathematics is significantly related to Mathematical Creativity of secondary school students.

ii). To find out whether Mathematics Anxiety is significantly related to Mathematical Creativity of secondary school students.

iii). To find out whether Academic Stress is significantly related to Mathematical Creativity of secondary school students.

iv). To find out whether Locus of Control is significantly related to Mathematical Creativity of secondary school students.

v). To find out whether Optimism is significantly related to Mathematical Creativity of secondary school students.

3. To develop a regression equation for predicting Mathematical Creativity among secondary school students with the select psychological variables.

4. To find out the relative efficiency of the select psychological variables in predicting Mathematical Creativity of secondary school students.

Hypotheses of the Study

The hypotheses of the study are the following.

1. There exists significant relationship between Problem Solving Ability in Mathematics and Mathematical Creativity of secondary school students.

2. There exists significant relationship between Mathematics Anxiety and Mathematical Creativity of secondary school students.

3. There exists significant relationship between Academic Stress and Mathematical Creativity of secondary school students.

4. There exists significant relationship between Locus of Control and Mathematical Creativity of secondary school students.

5. There exists significant relationship between Optimism and Mathematical Creativity of secondary school students.

6. The select psychological variables significantly predict Mathematical Creativity among secondary school students.

Methodology of the Study

Design

The study is a correlation research with predictive design and focuses on prediction of the criterion variable with the select psychological variables.

Variables

The criterion variable of the study is Mathematical Creativity and the predictive variables are

Problem Solving Ability in Mathematics

Mathematics Anxiety

Academic Stress

Locus of Control

Optimism

Participants

Population of the study is secondary school students of Kerala and the participants of the study are 700 ninth standard students taken from various schools of Kozhikode, Wayanad, Kasargod, Palakkad, and Kollam districts selected using stratified sampling technique.

Instruments

The data was collected using the following instruments.

Mathematical Creativity Test (Vijayakumari & Midhundas, 2017)

Optimism Inventory (Vijayakumari & Midhundas, 2016)

Scale on Academic Stress (Vijayakumari, Sajmadas & Midhundas, 2015)

Test of Problem Solving Ability in Mathematics (Sumangala & Rinsa, 2008)

Mathematics Anxiety Scale (Sumangala & Malini, 1993)

Locus of Control Scale (Kunhikrishnan & Mathew, 1987)

Statistical Techniques used

The collected data was organized and analysed as per the research questions and objectives of the study. The hypotheses were tested using statistical techniques. The statistical techniques used for analyzing the data are given below.

- Descriptive statistics was used for knowing the extent of Mathematical Creativity among secondary school students.

- Pearson's Product Moment Coefficient of Correlation 'r' was used to estimate the extent and nature of relation between Mathematical Creativity and the select Psychological variables.
- Multiple Regression Analysis was used to develop an equation to predict Mathematical Creativity using the select Psychological variables.

Scope and Limitations of the Study

The present study attempted to find out the psychological variables that predict Mathematical Creativity of secondary school students of Kerala. Standardized tools were used with satisfactory validity and reliability to measure each variable. Study was conducted on a sample of 700 secondary school students from Kasargode, Wayanad, Kozhikode, Palakkad and Kollam districts of Kerala. The sample was selected using stratified sampling technique. Adequate representation of strata like gender, locality and type of management, was provided to enable generalization of results to the entire population. The present study is expected to be a support to understand the prevailing level of Mathematical Creativity among secondary school students of Kerala. The study helps to find out the most important variables among the select ones in predicting Mathematical Creativity among secondary school students of Kerala. The findings of the study will be useful for policy makers in planning programmes for developing Mathematical Creativity. The results of the study are expected to be generalizable to students of other states also.

In order to make the study feasible, the sampling frame was confined to secondary school students of 19 schools from five districts of Kerala. The basal sample was 800 ninth standard students from the 19 randomly selected schools. Due representation was given to various strata while selecting the sample to ensure the sample as the best representative one. The study was limited to government and aided school students and the unaided section was ignored. There are many variables for predicting mathematical creativity; investigator selected only five psychological variables for the study.

Despite the sincere efforts of the investigator to make the study as objective as possible some limitations have been inherited in the study. As some of the instruments are self reporting ones, the investigator recognizes the accuracy of responses in these instruments need not be perfect but it is not under control of the investigator. Though the basal sample size was 800, the final sample is 700 due to lack of cooperation of participants.

Organization of the Report

The report is presented in five chapters.

Chapter 1:

This chapter contains a brief introduction to the problem, need and significance of the study, statement of the problem, definition of key terms, research questions, objectives and hypotheses, methodology, scope and limitations of the study.

Chapter 2:

This chapter presents the conceptual overview of the concerned variables and review of the related studies.

Chapter 3:

This chapter describes the methodology of the study which consisted Method, Design, Variables, Participants, Instruments, Data collection procedure and Statistical techniques used for the study.

Chapter 4:

This chapter describes statistical analysis and interpretation, discussion of results and tenability of hypotheses.

Chapter 5:

This chapter deals with the summary of the study, major findings and implications of the study and suggestions for further research.

Chapter II

REVIEW OF RELATED LITERATURE

- Theoretical Overview
- Review of Related Studies

Review of related literature is an important characteristic of any investigation and it plays a vital role in any field of investigation. Literature review covers reviews of earlier research studies conducted in the field of current research area. It helps the investigator to get greater awareness of studies undertaken in the field of study and familiarizes him with the updates in the field or area in which he is trying to conduct the research. Through review of literature, he attains an insight about methodology used, tools developed etc., and which will guide to an improvement in research design. Review helps an investigator to identify and to avoid duplication of research in his field. Thus in depth analysis of the associated literature will help a researcher to experience the significance of present study and to develop a novel insight to the same.

The present study tries to find out the efficiency of certain psychological variables in predicting Mathematical Creativity among secondary school students. To have better awareness of the nature of study in this area, the researcher has gone through the relevant related literature. This chapter describes the background studies of the variables under study and tries to provide a better awareness of the concept of creativity.

These are presented under two sections viz.,

- Theoretical overview of Creativity and Mathematical creativity
- Review of related studies on Mathematical Creativity and the select Psychological Variables.

Theoretical Overview of Creativity and Mathematical Creativity

Creativity is a universal and cognitive function to think divergently and create something new. According to Levin (1978) creativity is a special form of thinking. It is the ability to discover new solutions to the existing problems; otherwise it can be producing new ideas, inventions or works of art. It helps individuals to solve complicated problems in their day to day life. There are many definitions for creativity with regard to process and product but there is no globally accepted one.

The word ‘creativity’ originated from an Indo-European word ‘kere’ which means ‘to create something’. Thus the epistemological meaning of the word ‘creativity’ is ‘to develop something new’. Thinkers develop varying viewpoints about creativity and hence some of the definitions are listed below.

Galton (1870) defines creativity as a cognitive ability of human beings to think divergently and produce a number of original and flexible responses to a set of specified stimuli.

According to Thurstone (1952) the novel ideas of an individual leads to solutions. If he reaches to the solution in a sudden closure as an instinct, he is said to be creative.

Ausubel (1963) defines creativity as a generalized constellation of intellectual abilities, personality variables and problem solving traits.

Newell, Shaw and Simon (1962) define creativity as an unconventional thinking which was initially vague and undefined. It leads to the formulation of a clear solution which is highly motivated and persistent. This type of unconventional thinking is termed as creativity. By them, the thinker and his culture have great value. Since the task involved is of great intensity, the product has novelty.

Parnes (1992) defines creativity as the process of thinking and responding. It is connected with our previous experience. It involves responding to stimuli such as objects, symbols, ideas, people, situations, etc. In his opinion all the thinking process should be result-oriented and it must end up with generating at least one unique combination.

According to Sternberg (1988) creativity is a process which results into a novel work, it is accepted as a tenable and useful trait. According to him, the novel work is satisfying at some point of time to a group of people.

Theories on Creativity

The first scientific explanation of creativity was given by Guilford (1950). He explained the construct creativity in general, in relation to the model of structure of intellect (SOI model). Guilford explained the structure of intelligence by

proposing a three dimensional model by using the statistical technique of factor analysis. According to this model every intelligence activity can be described in terms of three different basic parameters such as Operation, Contents and Products. Guilford identified five operations, five content, and six products. The dimension of the act of thinking is divided into five kinds of operations viz., evaluation, convergent thinking, divergent thinking, memory and cognition.The contents refer to ways of thinking more effectively about different kinds of information, such as visual, auditory, symbolic, semantic and behavioral.The products refer to the kind of information we process from content types. It contains – units, classes, relationship, systems, transformation and implication.Thus the maximum number of factors in terms of different possible combinations of these dimensions will be 5×5×6=150. Each factor has a trigram symbol, one symbol each from operation, content and product. This model may be diagrammatically represented as figure 1.

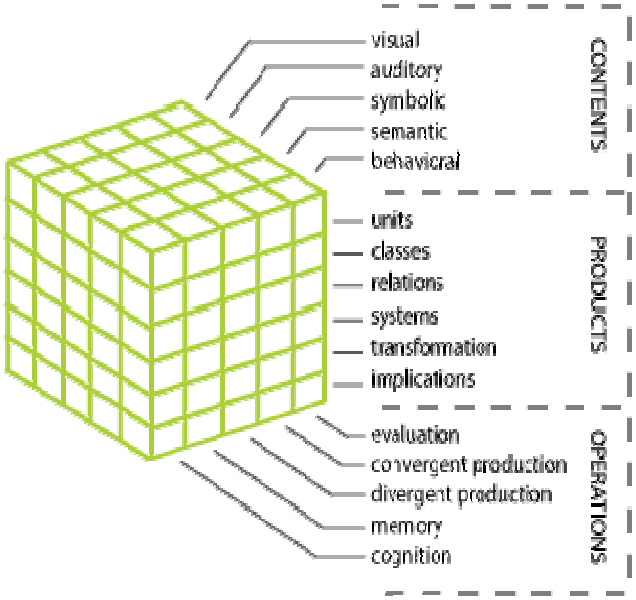


Figure 1. Guilford's Model of Structure of Intellect

(Source: https://madhavuniversity.edu.in/guilford-structure-of-intellect-theory.html)

Finke (1992) proposed the “Geneplore” theory, in which creativity takes place in two phases: a generative phase, where an individual constructs mental representations called pre-inventive structures and an exploratory phase, where those structures are used to come up with creative ideas. It is said that when people use their imagination to develop new ideas, these ideas are heavily structured in predictable ways by the properties of existing categories and concepts.

Honing Theory developed by Gabora in 1997 proposed that creativity arises due to the self organizing, self mending nature of a world view and that it is by way of the creative process the individual hones an integrated worldview. Honing theory places equal emphasis on the externally visible creative outcome and the internal cognitive restructuring brought about by the creative process. It focuses on not just restructuring as it pertains to the conception of the task, but to the world view as a whole. When faced with a creatively demanding task, there is an interaction between conception of the task and the world view. The conception of the task changes through interaction with the world view, and the world view changes through interaction with the task.This interaction is retreated until the task is complete, at which point not only is the task conceived differently, but the world view also is subtly or drastically transformed. Another distinguishing feature of honing theory is that the creative process reflects the natural tendency of a world view to attempt to resolve dissonance and seek internal consistency amongst its components, whether they be ideas, attitudes, or bits of knowledge.

Ward (2003) proposed Incubation theory in which the term incubation is a temporary break from creative problem solving that can result in insight. There has

been some empirical 'research' looking at whether, as the concept of 'incubation' implies a period of interruption or rest from a problem may aid creative problem solving. Ward lists various hypothesis that have been advanced to explain why incubation may aid creative problem solving and notes how some empirical evidence is consistent with the hypothesis that incubation aids creative problem solving in that it enables 'forgetting' of misleading clues. Absence of incubation may lead the problem solver to become fixed on inappropriate strategies of solving the problem. This work disputes the earlier hypothesis that creative solutions to problems arise mysteriously from the unconscious mind while the conscious mind is occupied on other tasks.

Helie and Sun in 2010 proposed a unified framework for understanding creativity in problem solving, namely the Explicit-Implicit Interaction (EII) theory of creativity. This new theory constitutes an attempt at providing a more unified explanation of relevant phenomena. The EII Theory relies mainly on five basic principles namely,

i) The co-existence of and the difference between explicit and implicit knowledge.

ii) The simultaneous involvements of implicit and explicit process in most tasks.

iii) The redundant representation of explicit and implicit knowledge.

iv) The integration of the results of explicit and implicit processing

v) The iterative and possibly bidirectional processing.

A computational implementation of the theory was developed and used to simulate relevant human data. This work represents an initial step in the development of process based theories of creativity encompassing incubation, insight and various other related phenomena.

According to Hemisphere theory of Creativity, creative acts are said to be the result of interaction between the two hemispheres of the individual's brain. This theory gives quite a predominant biological base to the upusage and functioning of creativity. The researches into hemisphere functioning of Clark (1983) and Kitano and Kirby (1986) have demonstrated that creative individuals are usually right hemisphere dominant while logical, rational thinkers are left hemisphere dominant.

According to the level theory proposed by Taylor (1975), creativity may be described as existing at five levels viz., Expressive, Productive, Inventive, Innovative and Emergenative in an ascending hierarchy. A person is said to be creative to the extent that he is able to reach these levels. Expressive Creativity stands for spontaneous expression without reference to originality and quality of the products. At Productive Creativity level, a person is able to produce something innovative. Inventive Creativity level is marked by the presence of ingenuity with a clear emphasis on novel use of old things. In the Innovative Creativity level, one is able to develop new ideas or principles with the help of highly developed abstract conceptualizing skills. Emergenative Creativity is the level of creation where most abstract ideational principles or assumptions underlying a body of art or science are used.

Psychoanalytic theory of creativity by Frued (1958), says that sublimation of repressed unconscious wishes, pregenital and libidinal urges determine creativity. They totally do not accept it to be an unconscious function since unconscious function is a stereotype. Hadamard (1945) gave importance to the unconscious. He says when somebody speaks, the thoughts are conscious but language is unconscious. Freud (1976) proposed that the basic idea of psycho dynamic approach was that creativity arises from the tension between conscious reality and unconscious drives. In order to express an individual's unconscious wishes concerning power, richness, fame, honor, or love, there exists a tension between conscious reality and unconscious drives.

The theory by Arieti (1974) represents the contemporary views about the nature and meaning of the terms creativity, the creative process and creative output. The author compares creative people and psychotic as creatives aim to change reality for broader and more useful social purpose and self actualization whereas psychotics transform reality within the framework of his private world regardless of any purpose. A creative person enjoys good mental health that energizes his cognitive abilities to create something new. The theory considers the creative process as a 'magic synthesis' of the two modalities, the primary process and the secondary process which can be termed as the 'tertiary process'.

The primary process originates in the primitive parts of the mind called the 'id' and the 'ego'. The secondary process is the outcome of the developed mind and involves logical and systematic thinking at the conscious level. In the words of Arieti (1976), "In the creative process, both these primary and secondary processes

work in quite strange and intricate combinations, synthesizing the rational with the irrational and thus instead of rejecting the primitive, the creative mind integrates it with the normal psychological process. It is from this magic synthesis that something new, novel, the unexpected and the desirable emerges".

Psychic creation model proposed by Barron (1965) stresses sub consciousness and the model supports the popular views of creativity as a mysterious process involving subconscious thoughts beyond the control of the creator. In contrast to the prominent role that some models give to subconscious processes, Perkin (1981) argues that subconscious mental processes are behind all thinking and therefore, play no extraordinary role in creative thinking. Inability to describe the thought processes does not mean inability to control them. Phases described by this model are,

Conception	-	In a prepared mind
Gestation	-	Time, intricately co-ordinated
Parturition	-	Suffering to be born
Bringing up the baby	-	Further period of development

Seven-Step Model for Creative Thinking by Osborn (1953), proposed orientation, preparation, analysis, ideation, incubation, synthesis and evaluation as the steps of developing creativity. The Seven-steps can be described as

- Orientation - Pointing up the problem
- Preparation - Gathering pertinent data
- Analysis - Breaking down the irrelevant material

- Isolation - Piling up alternatives by way of ideas
- Incubation - Letting up, to invite illumination
- Synthesis - Putting the pieces together
- Evaluation - Judging the resulting ideas

One of the earliest models of the creative process is attributed to Wallas (1926). According to him, the process of creativity is a combination of ideas that are not generally associated together. He proposed that creative thinking proceeds through the following four phases.

- Preparation - Gathering Information
- Incubation - Setting problem aside
- Illumination - Seeing the solution
- Verification - Refining the idea

Preparation: The problem is analyzed and the plan of action is formulated for its solution. Relevant facts and materials are collected for reaching the solution. A continuous effort is made to tackle the problem

Incubation: The solution does not come immediately. The problem is put aside for the time and the mind is directed to some other channel. This stage of inaction is called incubation. But the data collected are isolated below the conscious level of the mind. The unconscious mind continues to search and a clue is provided for the solution of the problem.

Illumination: The clue leads to the third stage, namely the stage of illumination. At this stage, the searcher experiences a sudden appearance of the solution to the problem.

Verification: In this stage the new theme is checked out to determine whether the solution emerging from the insight is the correct one. The individual rethinks, revises and refines the solution.

Guilford in 1967 proposed a distinction between convergent and divergent production and it is commonly renamed as convergent and divergent thinking. Convergent thinking involves a single correct solution to a problem, whereas divergent thinking involves creative generation of multiple answers to set problems. Divergent thinking is sometimes used as a synonym for creativity in psychology and literature. He noticed that creative people tend to exhibit this type of thinking more than others. He thus associated divergent thinking with creativity appointing it several characteristics as

I. Fluency - The ability to produce a number of ideas or problem solutions in a limited period. The fluency factors are,

   i. Word fluency: This refers to the ability to generate words having a specific letter or combination of letters.

   ii. Ideational fluency: This refers to the ability to construct ideas to meet certain requirements. It makes something to write about.

   iii. Expressional fluency: This means the ability to put ideas into words.

iv. Associational fluency: It focuses on the completion of relationships in distinction from ideational fluency.

II. Flexibility - The ability to simultaneously propose a variety of solutions to a specific problem. The flexibility factors are,

i. Spontaneous flexibility: It is defined as the ability to produce a great variety of ideas with freedom. What is measured is the variation is the kind of responses.

ii. Adaptive flexibility: This means a change in the interpretation of the task, approach or strategy to a solution. This shows best in the type of problem that requires the most unusual type of solution.

III. Originality – Originality means the ability to produce unfamiliar or uncommon responses, remote combinations or connections or clever responses.

IV. Elaboration – Systematic organization of details of an idea in hand and carry it out.

V. Redefinition - It means defining or perceiving in a way different from the usual established or intended way, use and so on. Redefinition can be figural, symbolic or semantic.

VI. Sensitivity to problems - It involves seeing defects, needs, deficiencies, seeing the odd, the unusual and seeing what must be done.

Torrance (1960) defined creativity as "a process of sensing problems, deficiencies, gaps in knowledge, missing elements, disagreement and so on, identifying the problems; seeking for solutions, making guesses or making hypotheses and possibly modifying and retesting them; and finally communicating the results". He identified four components through which individual creativity can be evaluated. They are Fluency, Flexibility, Originality and Elaboration.

Fluency means the ability to come up with many diverse ideas quickly. It is the number of relevant and acceptable responses. Flexibility is the number of different categories or variety of responses. It indicates how many ways an individual responds to a particular stimulus. It is an indicative of the individual's ability to respond to a similar situation, to think in a different mode and trying the unknown. Originality is the ability to produce unusual or uncommon responses, remote combinations or connections among the participants of the study. It is measured as their infrequency of occurrence or novelty of ideas generated among the participants under study whereas Elaboration means the amount of detail associated with an idea. It makes the production of detailed steps, with a variety of implications and consequences. It is the ability to elaborate upon ideas and fill them out with details.

Theories on Mathematical Creativity

Majority of existing definitions of Mathematical Creativity cited in literature are vague and there is no globally accepted definition of Mathematical Creativity. However definitions of some mathematicians like Poincare, Laycock, Ervynck and Sriraman are worth noting and are noted below.

French mathematician Poincare (1956) described the elemental aspect of Mathematical Creativity as the ability to choose from the large number of possible combinations of mathematical propositions, a minimal collection that leads to the proof. According to him, creating something in mathematics is the association of a lot of ideas, but a few of them are useful. Number of combinations are constructed for finding these useful combinations, useless ones are neglected. In other words, creating is the combination of forming, recognizing and choosing important from them.

Laycock (1970) defined Mathematical Creativity as the ability to analyze a given problem in various angles, viewing patterns, observing similarities and generating a suitable method for dealing with unfamiliar mathematical problems.

According to Ervynck (1991) Mathematical Creativity is the ability to generate mathematical objects. It involves the creation of a concept for managing mathematical problems within a mathematical situation. He says that mathematical creativity possesses certain characteristics such as relational, selective and briefly presentable. In his opinion, if an individual creates a useful mathematical concept by associating known concepts or discovering unknown relations between mathematical concepts. This act of finding new mathematical ideas or combinations is considered as an act of doing creative Mathematics.

According to Sriraman (2004), Mathematical Creativity is the process of reaching in unusual and insightful solutions to a given problem, without considering the level of complexity and the publication of original results in a prominent mathematical research journal. He explained Mathematical Creativity in terms of

originality and usefulness. He distinguished Mathematical Creativity between school level and professional level which provides unusual and new insights in mathematical situations and idea of new association at school level. According to his view; it is not practical for the identification and development of Mathematical Creativity in school students. However in the higher levels,

Mathematical Creativity can be defined as

1. The ability to produce original work that significantly extends the body of knowledge.
2. The ability to open up venues of new questions for other mathematicians.
3. The process that results in novel unusual, insightful solutions to a given problem or analogous problems.
4. The termination of new questions or possibilities that allow an old problem to be regarded from a new angle.

According to Investment theory proposed by Stenberg and Lubart (1995) creative individuals are like good investors. The creative people are those who invest a good time for understanding others to the intrinsic worth of their creative ideas. The high sales value of creativity means they let others pursue their idea. In short, creative people are the trend setters in the society. Six distinct but interrelated elements constituting creativity are intelligence, knowledge, thinking styles, personality, motivation and environment. By theory, the personality traits supported to nourish creativity are willingness to take sensible risks, overcome barriers,

tolerate ambiguity, motivation, self efficiency, supporting environment and reward (Sternberg, 1988). According to the investment theory of Mathematical Creativity, Mathematical Creativity is not just a simple total of six elements but it requires a certain threshold of knowledge. Creative endeavors can be encouraged with a high level of motivation, if an individual is in a non supportive environment.

System theory of Mathematical Creativity by Csikszentmihalyi (2000), views Mathematical Creativity as a process that involves the interaction between a person, task and environment. Novelty or originality of creativity differs person to person, task to task and environment to environment. This theory considers cultural and social aspects of Mathematical Creativity rather than individualistic processes. The field consists of individuals having any type of interaction or influence on the domain. An observable interaction between the three components of a system viz., individual, domain and field are necessary components of system theory of Mathematical creativity.

Review of Related Studies

In the field of research, the researcher has to acquire up-to-date information about what has been thought and done in the particular area from which the present problem has been taken up. Hence a thorough survey of related studies was conducted.

The survey of related studies implies locating, studying, and evaluating reports of relevant researches of published articles, going through related portions of Encyclopedias, and research abstracts, study of pertinent pages out of comprehensive books on the subject and going through related manuscripts, if any. The researcher has to build upon the accumulated and recorded knowledge of the past. Survey of related studies provides the investigator with new ideas, theories, explanations, hypotheses or methods of research valuable in formulating and studying the problem. It enables him to know the means of getting to the frontier in the field of his research. It helps to formulate hypotheses, which is the basis for the entire research plan.

The present study has Mathematical Creativity as the criterion variable and Problem Solving Ability in Mathematics, Mathematics Anxiety, Academic Stress, Locus of Control and Optimism as the predictor variables. Studies related to these variables are given under separate headings viz.,

- Studies on Creativity
- Studies on Mathematical Creativity
- Studies on Problem Solving Ability in Mathematics

- Studies on Mathematics Anxiety
- Studies on Academic Stress
- Studies on Locus of Control
- Studies on Optimism

Studies on Creativity

The researcher had reviewed studies on Creativity which is a much explored one compared to Mathematical Creativity and it helped to find the details of studies on creativity in other dimensions.

Shrividhya (2014) conducted a study on scientific creativity among secondary school students. The study was conducted on a sample of 500 secondary school students from Kannur District. Scientific creativity was measured using the scientific creativity test by Pekmez, Aktamis and Taskin (2009). The study revealed that the scientific creativity is found to be not satisfactory among secondary school students.

Singh (2013) studied the intermediate influence of achievement motivation, emotional intelligence and creativity on academic achievement on a sample of 745 student-teachers. The study found that achievement motivation and creativity have no direct influence on academic achievement, but emotional intelligence has significant influence on the variable academic achievement.

Rani and Dalal (2013) investigated the relationship between creativity and achievement motivation of senior secondary students. The data was collected from a sample of 640 students selected randomly from the various schools of Haryana

State. The findings of the study revealed that the variables creativity and achievement motivation has no significant relationship.

In a study "Comparison of Creative thinking abilities of high and low achievers secondary school students" Anwar, Shamim-ur-Rasool and Haq (2012) attempted to examine the creative thinking abilities of high and low achievers at secondary school level. The result of the study showed that there was no difference between high achievers and low achievers in terms of creative thinking abilities. However, girls and the students belonging to urban areas found better in their creative thinking.

Yadav and Wadhwa (2011) investigated the impact of creativity on academic achievement. The participants were adolescents studying in English medium and Hindi medium schools. The result shows that there is no impact of creativity on academic achievement. The girls and boys of English medium school possess more creativity and they are good achievers than the girls and boys of Hindi medium schools.

Baran, Erdogan and Cakmak (2011) conducted a study on the relationship between Creativity and Mathematical Ability of six year old students. In this study, data for creative ability were collected using Torrance Tests of Creative Thinking. Data for Mathematical Ability were gathered using a mathematical test, measuring aspects of informal and formal Mathematics. It was found that there is no significant relationship between Mathematical Ability and Creativity. Also there was no significant relationship between Mathematical Ability and Creativity components such as fluency, originality and elaboration.

Alam (2009) examined the relationship between academic achievement with creativity as well as achievement motivation. The analyses lead to the conclusion that both creativity and achievement motivation have a significant role on the academic achievement of students.

Reddy (2008) conducted a study on the influence of gender on creativity of student teachers. The result of the study found that male and female student teachers do not differ significantly with respect to their creativity.

Kim (2008) in an analysis of the available literature on creativity reported that the underachievement of gifted students may be tied to the interest and unrecognized creativity. He is of the opinion that many gifted students were underachievers and up to 30 percent of high school dropouts would be highly gifted.

Jacob (2007) investigated the relationship between creativity and self concept. The study revealed that there is a positive correlation between creativity and self-concept. The researcher highlighted the significance of creativity and the need for developing better and positive self-concept for developing creativity.

Sreekanth (2004) in an analytical study about the role of society in development of creativity among children found that the influence of society in the form of parents, teachers and school administrators should consider the learner-centric, learner-friendly views while developing curriculum.

Slavica (2004) conducted the relation between creativity, academic performance and academic preferences. The study find out a low positive correlation between creativity and achievement in the sub sample of girls. Also it was found that

initial step in the acquisition of knowledge will contribute to creative thinking of students.

Mahapatra (2000) conducted a study on the effectiveness of enrichment programmes in developing creative expressions at elementary stages. The result of the study indicated that girls were found to be better in developing composition writing when compared to boys. It also showed that the experimental treatment using enrichment programs had a positive impact on the overall performance of the children.

Kumari (2000) conducted a correlational study for finding the correlates of Creativity and nurturing the creative potential. The sample of the study was collected from pre-school children. The study revealed that intellectual characteristics, language characteristics, social characteristics and home environment have a significant effect on creativity and it's fostering.

Adey (1999) examined the influence of Cognitive Acceleration through Science Education (CASE) program on Scientific Creativity. The participants were secondary school students and Scientific Creativity was measured by Scientific Creativity Test. The study showed that the program promoted the overall development of Scientific Creativity. However the effects on different aspects of Scientific Creativity varied significantly.

Sunitha (1997) investigated creativity in relation to Achievement in Malayalam. A sample of 500 secondary school pupils was selected for the study. The data was collected using Generalized Achievement Test in Malayalam for

secondary classes and a comprehensive Test of Creativity. The result of the study indicated that creativity and its subcomponents have significant relation with Malayalam Achievement.

Dahiya (1995) examined the effect of mastery learning strategy on the creative abilities and achievement in Mathematics. The data was collected and analyzed from the sample of seventy students of secondary schools from Delhi. The conclusion of the study showed that the group of pupils taught mathematics through mastery learning strategy has shown significantly higher gain in verbal creativity and non verbal creativity than the group of pupils taught mathematics through conventional methods.

Remadevy (1993) examined the relationship between attitude towards science and creativity in the science of secondary school pupils. The data was collected from a sample of 704 secondary school pupils from different schools selected by stratified random sampling from three districts of Kerala. The findings of the study revealed that there exists a positive significant relationship between attitude towards science and creativity in science.

Prasad (1993) investigated the influence of gender difference on creativity. The data collected from 40 boys and 40 girls of sixth standard students in two Navodaya Vidyalaya of Orissa. To collect the data Torrance Test of Creative Thinking was used. The finding of the study revealed that the girls differ significantly in the measures of originality from the boys. In all the other creativity components gender difference is not present.

Jain (1992) conducted a correlational study on creativity in relation to teaching aptitude, skills and personality variables of teachers. The findings of the study indicate that there is a positive and highly significant correlation between creativity and classroom creativity, teaching aptitude and teaching skills.

Sreekala (1991) investigated the effect of certain attitude variables and intelligence on the creativity of secondary school pupils of Kerala. The study was conducted on a sample of 750 secondary school pupils. The major findings of the study are that the main effects of attitude towards mathematics, towards problem solving, towards education and intelligence on creativity are significant.

Naja (1989) conducted a study on the relationship between the factors of creativity and achievement in Mathematics. The participants of the study were nine hundred and sixty ninth standard students selected using the stratified random sampling technique. The results of the study showed that an increase in creative thinking was attended by a corresponding increase in the achievement in Mathematics and creativity has a determining influence on achievement in Mathematics.

Chandini (1989) examined the efficiency of some social familial variables in predicting creativity. The sample of the study was 780 secondary school pupils from Ernamkulam and Thrissur districts of Kerala. The study found that the social familial variables, home learning facility, family acceptance of education, family cultural level and family environment selected for the study were low inefficient to predict creativity and its components like verbal creativity, figural creativity and symbolic creativity of secondary school pupils.

Sukla and Sharma (1987) conducted a study to find out the level of creativity components in middle school children. The Sample of the study consisted of 230 urban, rural and refuge children. The scientific creativity test was administered to track the level of various creativity components such as fluency, flexibility and originality. It was found that the rural pupil scored higher in fluency than the refuge pupil. It was also revealed that the tribal pupil shows low score in creativity components.

Joshi (1981) studied the creativity and personality traits of intellectually gifted children. It was concluded that for urban population high achievers are highly creative and no correlation was found between achievement and creativity in rural population.

Badrinath and Sathyanarayana (1979) conducted a correlational study among high school students to find the correlates of creativity. It was found that students of first, second, third and fourth birth order do not differ significantly with respect to their creative scores.

Srivastava (1977) conducted a study to find out the relationship between creativity with birth order and the number of siblings. The data was collected from a sample of 543 urban and 354 rural students of the standard ten. The study found that birth order of the subjects has no impact on their creativity scores. However, the number of siblings in the family was reported to be positively and significantly correlated with creativity scores.

Studies on Mathematical Creativity

In his study Analysis of Mathematical Creativity in mathematics learning is open ended by Isnani, Waluya, Rochmad, Wardono (2020) analyzed the location, causes, and types of student errors in doing Open-Ended Real Analysis test questions through the use of the Newman Error Analysis (NEA) medium. The sample of the study taken from students of Real Analysis courses in the Mathematics Education Study Program at Pancasakti University, Tegal, Indonesia. The result of the study showed that injecting the creative character of students from the beginning of entering college, students are allowed to practice both formally and informally to work on high-level questions for about five semesters, thereby creative ability in mathematics are formed.

Lim, Ismail, Yudariah and Yusof (2019) in their exploratory research on fostering Mathematical Creativity among engineering undergraduates, tried to find out influence of creative problem solving towards Mathematical Creativity among the engineering undergraduates. Case study method was used for a deep explanation of three final year electrical engineering students. The research findings revealed that engineering undergraduates were able to generate different creative methods with the help of the SCAMPER- Substitute, Combine, Modify, Adapt, Put to other uses, Eliminate and Rearrange.

Jinu and Vijayakumari (2018) conducted a correlational study on influence of gender and intelligence on Mathematical Creativity. The study was conducted on 250 upper primary school students from Government schools of Kerala state among which 142 were male and 108 were female students. The data was analyzed using

Pearson's correlation coefficient, two way ANOVA and t-test. The findings were that there is a positive moderate relationship between Mathematical Creativity and Intelligence and, no gender difference exists in the relationship between the two variables.

With a sample of 24 eighth grade pupils from several schools, Jarmas and Raedi (2017) studied Mathematical Creativity among excellent eighth grade pupils. The findings showed that there are differences between the pupils regarding flexibility, originality and fluency and all students possess high level achievement.

Walia and Walia (2017) developed a Mathematical Creativity test. The sample of the study was 288 eighth grade students of Kurukshetra district of Haryana. Split- half reliability was found to be .89 which is significant. Content validity of the test was determined by the teachers from different schools and concurrent validity Product moment correlation was used to determine Concurrent validity. It was found 0.50 which is significant.

Tyagi (2017) conducted a study on Mathematical Creativity, Mathematical Intelligence and the causal relationship between them. A sample of four hundred and thirty nine students of age group eleven to fourteen were selected as participants of the study using the technique of random clustering. Mathematical Creativity among the students was measured using the test of Mathematical Creativity developed by Singh (1985). There are five types of activities present in the test are patterns, new relationship, nine-dot areas, subject and similarities. The results of the study revealed that there is no significant unidirectional causal relationship between Mathematical Creativity and mathematical intelligence, but there exists a symmetric

relation between the two variables. It was also revealed that mathematical intelligence is a cause of Mathematical Creativity and vice versa.

A correlational study by Akgul and Kahveci (2017) analysed student's mathematics self-efficacy, their metacognitive skills in mathematics and their mathematics achievement in relation to their Mathematical Creativity. 445 gifted and talented middle school students from 13 Science and Art Centers were selected for the study. The study found that Mathematical Creativity is significantly related with mathematical achievement, mathematical metacognition skills and self-efficacy in mathematics.

Vijitha (2016) conducted a correlational study on the spatial ability and Mathematical Creativity among higher secondary school students. The sample of the study was 281 male and 338 female higher secondary school students. The findings of the study revealed that there is significant positive correlation between spatial ability and Mathematical Creativity of higher secondary school students.

Singer and Voica (2015) examined the Mathematical Creativity of fourth to sixth grades high achievers in mathematics in relation to their problem posing abilities in geometry. The study found that the students showed a kind of cognitive flexibility which is mathematically specialized. Mathematical Creativity of the students is presented itself during problem posing contexts through a process of abstraction- generalization based on small, incremental changes of parameters so that synthesis and simplification are achieved.

Jaleel and Titus (2015) conducted a study to find relationship between Mathematical Creativity and Achievement of students at secondary level. The data was taken from 240 secondary school students of different schools from Ernakulam and Thrissur districts of Kerala State. Pearson's Product Moment Coefficient of Correlation was used to explore the correlation. The result of the study showed that there exists significant positive relationship between Mathematical Creativity and Achievement of students at secondary level.

In a study on an Educational program of Mathematical Creativity, Petrovici and Havarneanu (2015) attempted to find out the effectiveness of educational programs on Mathematical Creativity. Participants for the study were non-voluntary students of classes IV, V and VI of an urban school in Iasi, Romania. The findings of the study indicated that the educational innovation programs help students to develop extrinsic motivation in Mathematical Creativity activities.

Ibrahim and Irawan (2015) conducted a study on effectiveness of peer tutoring to increase Mathematical Creative thinking ability of class ninth students. The study found that the group of students who used peer tutoring approach improved the creative thinking in mathematics.

Vijayakumari and Kavithamole (2014) examined effectiveness of Mind Mapping technique in developing Mathematical Creativity. The study was conducted on a sample of 100 students (with 50 students each in the experimental and control groups) of higher secondary school students of Kerala. Mathematical Creativity was measured using the test of Mathematical Creativity by Sumangala

(1998). The result of the study showed that Mind Mapping is an important tool for developing Mathematical Creativity.

Kattou, Kontoyianni, Pitta-Pantazi, Christou and Cleanthous (2014) in their study on predicting mathematical creativity examined a number of cognitive factors such as mathematical ability, Intelligence, working memory, speed and control of processing that may predict creative ability in mathematics. The participants of the study were 359 fourth, fifth and sixth grade elementary school students in Cyprus. The findings of the study were that mathematical ability can predict Mathematical Creativity and other factors were not found to predict mathematical creativity.

Aizikovitsh-Udi (2014) attempted to find out the extent of Mathematical Creativity and aesthetics in Solving Problems among students attending the mathematically talented youth program. The study was on 57 eighth grade students attending the Mathematically Talented Youth Program. The findings showed that whether these students are solving the problems with clarity but they failed to develop high level of Mathematical Creativity and aesthetics in their solutions.

Sharma (2013) examined the effect of divergent mathematical exercises, creativity and their interaction on Mathematical Creativity of the students. The study was experimental in nature with pre-test post-test control group design. The sample consists of 127 class IX students of age ranging from 14 to 17 belonging to six different schools of Jalandhar district. Moghe test of creative thinking in Mathematics was used for calculating Mathematical Creativity and Passi tests of creativity for creativity. Data were collected and analyzed with the help of 2x2 Analysis of Covariance. The result of the study indicated that divergent

mathematical exercises were effective in fostering Mathematical Creativity when groups were matched on pre-test of Mathematical Creativity. Creativity was found to be a significant correlate of Mathematical Creativity. It was also revealed that when groups were matched with respect to the pre-test Mathematical Creativity was independent of interaction between treatment and creativity.

Sebastian (2013) conducted a correlational study among 992 secondary school students about the relationship between Mathematical Creativity and achievement in Mathematics. Mathematical Creativity test and Achievement test in Mathematics were the tools for data collection. The findings of the study revealed that a significant positive relationship exist between the two variables Mathematical Creativity and achievement in Mathematics.

Lew and Cho (2013) investigated the relationship between creativity, motivation and creative home environment. The sample of the study consisted of 150 students taken from five kindergartens and were statistically analyzed. The study revealed that there is significant positive relationship between the intrinsic motivation and the creative personality. Also it was found that there is no significant relationship between the intrinsic or extrinsic motivation and the creative thinking ability, significant relationship was observed for creative thinking ability and creative personality with the creative home environment.

Leikin and Lev (2013) studied the relationship between mathematical ability and mathematical creativity in secondary school children. They also examined relationships between mathematical creativity, general giftedness and excellence, explored creativity of adolescents with superior mathematical abilities, and the

power of different types of Multiple Solution Tasks (MSTs) for the identification of between-group differences related to mathematical creativity. The sample consisted of 184 students (16-18 years old) divided into four major experimental groups according to varying combinations of the levels of excellence in school mathematics (EM factor) and of general giftedness (G factor). Additionally 7 students (16-18 years old) with superior mathematical abilities (S-MG) took part in the study. The data was collected by means of written tests and individual interviews. The result indicated The G and EM factors are interrelated but different personality traits. The G and EM factors have different main effects on performance on different mathematical tasks. The G and EM factors interact on the flexibility criterion and identical tasks reveal different effects of the G and EM factors.

Kattou, Kontoyianni, Pantazi, & Christou (2013) conducted a study on connecting Mathematical Creativity to mathematical ability. Sample of 359 elementary school students from Cyprus were selected for the study. This requirement was due to the fact that the instruments were presented and solved in electronic form. The study showed that Mathematical Creativity and mathematical ability is positively related.

Betty (2013) investigated Mathematical Creativity and Ability for fundamental mathematical operations of primary school students with dyscalculia. The Sample selected for the study was 2024 primary school students from 50 schools of Ernakulum District. The study found that dyscalculic and normal students differ significantly with respect to Mathematical Creativity and ability for fundamental operations.

Githua and Njubi (2013) studied the effects of practicing Mathematical Creativity enhancing learning/teaching strategy during instruction on secondary school students' mathematics achievement by gender in Kenya's Nakuru municipality. The population consisted 2 students aged 16 years in sampled secondary schools of Nakuru Municipality. The Mathematics achievement Test was used to test mathematics achievement. The result of the study showed that the students who learned through mathematical creativity enhancing learning/teaching strategy attain high scores in maths than those who learned by traditional method and there is no gender difference in score of mathematics attained through Mathematical Creativity enhancing learning/teaching strategy.

Sambo and Ibrahim (2012) investigated Mathematical Creativity to find whether every child is born mathematically creative or not. The study revealed training in creativity has been found to improve student's creativity.

Bahar and Maker (2011) examined the relationship between Mathematical Creativity and Mathematical achievement. In the study students' score in Mathematics was correlated with 'Iowa Test of Basic Skills' (ITBS) and the 'Comprehensive Tests of Basic Skills' (CTBS). ITBS included measures of problem solving, data interpretation, Mathematics concepts, estimation and computation. The CTBS was used as a measure of Mathematical achievement in Mathematical concepts, estimation and computation. It was found that there exists a positive and significant correlation between Mathematical Creativity and its components-originality, fluency, flexibility, elaboration-with Mathematical achievement in both ITBS and CTBS tests.

Fetterly (2010) conducted an exploratory study of the use of a problem-posing approach to pre-service elementary education teacher's Mathematical Creativity, beliefs, and Anxiety. The participants of the study were juniors entering into the elementary education program at a research institution in the south-east region of the United States and were assessed using the Creative Ability in Mathematics, Mathematics Belief Questionnaire, the General Assessment Criteria, and the Abbreviated Math Anxiety Scale. The findings of the study revealed that intentional experience to Mathematical Creativity develops elementary pre-service teacher's Mathematical Creativity and also intentional experience to Mathematical Creativity decreases elementary pre-service teacher's Mathematics Anxiety. Also mathematical beliefs are not a predictor of elementary pre-service teacher's Mathematical Creativity.

Yaftian, Nadjafikhah, Bakhshalizadeh (2010) conducted a study about Mathematical Creativity and mathematics education which shows effective characteristics of mathematical creativity and describes how creativity in mathematical developments could be occurred. The study showed that the learners do not think of mathematics as a neat, clear, and explicit subject at the beginning and they may dare risk, mistake and make effort to be a creative person in mathematics and, they are able to play their role in generating new mathematics and taking part in active mathematics learning.

The relationship between Mathematical Creativity and Achievement in Mathematics was examined by Talawar and Madhusudhanan (2010). The participants were six hundred students from different English medium schools in

Bangalore. The results indicated that there is a significant positive relationship between Mathematical Creativity and achievement in Mathematics.

Nisha (2010) explored the influence of commercialized learning materials for the development of creativity in Mathematics in secondary school students. The sample of 607 secondary school students and 31 Mathematics teachers from 7 districts in Kerala state were selected for the study. The conclusion of the study revealed that opportunities and platform for the development of Mathematical Creativity was provided, the utilization of commercialized learning materials acted as a barrier for the development of creativity in Mathematics in secondary school students.

Leikin and Lev (2007) conducted a study in school children and introduced multiple solution tasks as a tool for measuring Mathematical Creativity. Students are of three different ability groups such as Gifted, Proficient (non-gifted), and regular were instructed to solve problems in different ways. Non-gifted proficient students show difference in the nonconventional task compared to their gifted peers but presents similar results in doing the conventional task. Gifted and non-gifted students differed meaningfully in all parameters from regular students.

Sak and Maker (2006) investigated the developmental variations in children's creative Mathematical thinking as a function of schooling, age and knowledge. A mathematical test was administered to measure mathematical knowledge and divergent production abilities such as originality, flexibility, elaboration and fluency. It was found that knowledge has a significant contribution

in describing variance in divergent production abilities such as originality, flexibility and elaboration in fourth and fifth graders.

Purpose of cultivating divergent thinking in mathematics through an open-ended approach by Kwon, Park and Park (2006) was to develop a program to help cultivate divergent thinking in mathematics based on open-ended problems and to analyze its effect by using a method of pre- and post-testing. The result of the study indicated that the treatment group students performed better than the comparison students overall on each component of divergent thinking skills, with the components fluency, flexibility, and originality. The developed program can be a useful resource for teachers to use in developing their students' creative skills.

Hong and Aqui (2004) have suggested that content knowledge is a crucial factor for Mathematical Creativity. He also opined that creative students in mathematics are more cognitively resourceful than their peers who achieved high grade in school mathematics.

Banerjee (2003) conducted a comparative study on self concept and cognitive style of creative and non-creative students. The sample of the study consists of 560 school students from seventh and eighth standard. Grade-wise comparison showed that students of seventh standard are relatively higher than eighth standard in cognitive style and self concept. Hence it revealed that cognitive style and self-control are independent of grade. It was also revealed that there exists a significant positive correlation in cognitive style and self concept with creativity. Major findings were that the factors discriminating between high, moderate and low

creative are fluency, both verbal and non-verbal elaboration and originality. Cognitive style did not significantly discriminate between creativity groups.

Sreerekha (2001) examined the relationship between self concept, intelligence, Mathematics Creativity and achievement in mathematics of secondary school pupils by using the test on Mathematical Creativity, scale on self-concept and Intelligence test using Raven's colored progressive matrices. The findings of the study pointed out that intelligence and Mathematical Creativity related positively and significantly with mathematics achievement.

Resmi (1997) examined the interaction effect of Mathematics study Approach and Mathematical Creativity on Achievement in Mathematics of secondary school pupils in Kerala. The study consists of 600 ninth standard students from three districts. Test of Mathematical Creativity, Mathematics study approach and achievement test in Mathematics were used for collection of data. The study revealed that there is no positive correlation between mathematics study approaches with Achievement in Mathematics. However there exists a significant positive correlation between Mathematical Creativity and Achievement in Mathematics.

Haylock (1997) conducted a study among secondary school students for recognizing Mathematical Creativity. The study showed that students with same degree of mathematical achievement have significant difference in Mathematical Creativity and mathematical ability. The general conclusion of the study enlighted that several factors differentiate Mathematical Creativity from mathematical ability.

George (1994) investigated the Mathematical Creativity of secondary school students in relation to their intelligence and mathematical achievement. A sample of 8000 secondary school students was selected for the study. The finding of the study revealed that there exists a significant and positive correlation between Mathematics creativity and Mathematics achievement.

Haylock (1987) studied the aspects of Mathematical Creativity among children of age of eleven to twelve. It was reported that children may show a fixation in Mathematics and the fixation may provide some self restriction that may cause them to fail to solve problems. He suggested that mathematical attainment limits the pupil's creativity but does not determine it. Low attaining pupils who do not have sufficient mathematical knowledge and skills demonstrate creative thinking. In highest attaining group there is a significant number of pupils who show very low level of these kinds of creative thinking in Mathematics.

Singh (1985) assessed Mathematical Creativity among the students by using the test of Mathematical Creativity. There are five kinds of activity in the test such as patterns, new relationship, nine-dot areas, subject and similarities. The results of the study revealed that there is no significant unidirectional causal relationship between Mathematical Creativity and mathematical intelligence. However there exists an equilibrium relationship between the two variables. It was also revealed that mathematical intelligence is a cause of Mathematical Creativity and vice versa.

Tuli (1980) conducted a correlational study among school students for studying Mathematical Creativity in relation to aptitude and achievement in

mathematics. It was found that Mathematical Creativity is significantly correlated to aptitude and achievement in Mathematics.

Jensen (1973) investigated the relationships among Mathematical Creativity, numerical aptitude and mathematical achievement. It was suggested that the possibility of Mathematical Creativity as an additional evidence for student's Mathematics performance. The study found that moderately high correlation exist among the constructs Mathematical Creativity, numerical aptitude and mathematical achievement.

Studies on Problem Solving Ability in Mathematics

Sonia and Bindu (2017) conducted a correlational study on relationship between problem solving ability in mathematics and numerical ability of secondary level students. The result of the study revealed that there is a positive significant relationship between problem solving ability in mathematics and numerical ability of secondary school students.

Lizzie (2017) investigated the problem solving ability in mathematics in relation to their academic achievement among higher secondary school students. The study revealed that there exists a positive relationship between problem solving ability in mathematics and achievement.

Jyothi and Renuka (2017) investigated problem solving ability in mathematics of secondary students. The study aimed to find influence of the mother occupation and age on the problem solving ability of students. Data was collected from 300, ninth class students in Chittoor District using stratified random sampling

technique. The study showed that mother occupation and age have a significant influence on the problem solving ability in mathematics of IX class students.

Vidya and Malini (2016) checked the relationship between critical thinking skills and problem solving ability among adolescents. The study revealed that there exists a significant relationship between critical thinking skills and problem solving skills.

Suresh (2016) conducted a study on Creativity and Problem Solving Ability among Higher Secondary School Students. The sample of the study consists of 160 higher secondary school students studying in the government and private school students of attur taluk in the academic year 2014-2015 using simple random sampling technique. The findings of the study showed that there is no significant relationship between creativity and problem solving ability among higher secondary school students. And there is no significant difference found in the level of creativity and problem solving ability between male and female higher secondary school students.

Kanhai and Singh (2016) conducted an experimental study to find whether there exists any causal relation between Mathematical Creativity and mathematical problem solving performance. Sample of the study was 770 seventh grade students. The study found that there exists a significant positive correlation between Mathematical Creativity and attitudinal and environmental characteristics. The study predicts the influence of attitudinal characteristic-self-concept in determining Mathematical Creativity. Also the environmental factors-resource adequacy, creative stimulation by teachers, etc. were found to be predictors of Mathematical Creativity

in the study. Social and intellectual involvement among students and educational administration of schools were found suppressive factors.

Dhadhich (2016) conducted a study on problem solving ability of 9th standard students. The result revealed that there is significant difference between problem solving ability of boys and girls of 9th standard students.

Ayllon, Gomez and Claver (2016) investigated Mathematical thinking and creativity through mathematical problem posing and solving. Both concepts are complex processes that shares elements, such as fluency, flexibility, novelty and elaboration. The result of the study based on certain studies showed that problem posing and solving related to the development of mathematical knowledge and creativity.

A study on Problem solving ability in Mathematics of ninth standard students in Dindigul district by Kannan, Sivapragasam and Senthilkumar (2016) on 80 ninth standard students's revealed that level of Problem solving ability in Mathematics of ninth standard students is average.

Tyagi (2015) checked the relationship between Mathematical creativity and Mathematical problem solving ability Performance. Sample comprises 480 eighth grade students. The result of the study showed that there exists a positive significant relationship between Mathematical Problem Solving Performance and Mathematical Creativity.

Asharani and Francis (2015) investigated the effect of Vedic mathematics on speed and accuracy in problem solving ability in mathematics among secondary

school students. The study revealed that Vedic mathematics method is comparatively more effective than the activity oriented method in developing speed and accuracy of problem solving ability in mathematics.

Gnanadevan and Selvaraj (2013) conducted a study to find out the science attitude and problem solving ability of higher secondary school students in relation to their achievement in science with respect to gender, type of school, residential area and medium of school. The study revealed that the male and female students do not differ significantly in their science attitude, but differ significantly in their problem solving ability. The students studying in government school and private school differ significantly in their science attitude, problem solving ability and achievement in science. The study also found that the students residing at urban and rural area differ significantly in their science attitude and achievement in science, but do not differ significantly in their problem solving ability. Also the students studying in Tamil medium and English medium differ significantly in their science attitude and problem solving ability and do not differ significantly in their achievement in science.

Anjali (2013) studied role of play schools with regard to the behavioral profile, creativity, problem solving ability and social cognition of preschoolers. The sample of 300 preschoolers (150 had attended play school and 150 had not attended play school) participated in the study. The study revealed a positive indication of the influence of play school on the behavioral profile, creativity, problem solving ability and social cognition of preschoolers.

Jose and Thomas (2011) studied the relationship between problem solving ability and scholastic achievement of secondary school students. The sample comprised of 320 secondary school students of Kottayam District. The study revealed that there is no significant difference in the relationship between problem solving ability and scholastic achievement of secondary school students with respect to gender but there is a significant difference between these variables with respect to locale and type of school.

Siswono (2010) conducted a study on leveling student's creative thinking in solving and posing mathematical problem. The data from thirteen eighth grades of Junior Secondary School students collected by using task based interview method and yielded the following results as five levels of creative thinking, namely level 0 to level 4 with different characteristics in each level and difference in each level based on fluency, flexibility, and novelty in mathematical problem solving and problem posing.

Karasel, Ayda and Tezer (2010) studied the relationship between mathematics anxiety and mathematics problem solving skills among primary school students and found out a low level of relationship between mathematics anxiety and mathematics problem solving ability.

Fadlelmula (2010) made an attempt to demonstrate how mathematical problem solving and self- regulated learning are two important and interrelated concepts in mathematics education, and how they contribute to effective mathematics learning. The study revealed that the use of self-regulatory strategies is a crucial characteristic of, and an important predictor of effective problem solving

experiences. Especially, the use of metacognitive self-regulatory strategies significantly contributes to success in students' problem solving processes. Therefore, it is evident that self-regulated learning contributes to more effective problem solving in mathematics learning. In addition, it is clear that an integral part of developing students' problem solving experiences gets through enhancing their self-regulatory skills. For this reason, mathematics instruction should foster utilizing self-regulatory strategies, and self-regulated learning should be an integral part of all mathematics learning.

Kavitha (2009) examined the interaction effect of Mathematical Creativity, Intelligence and Problem Solving Ability on achievement in mathematics of ninth standard students of Bangalore District. The sample consists of 600 students of ninth standard students studying in different types of English medium schools in Bangalore. It was found that there is a significant positive relationship between Mathematical Creativity and Problem Solving Ability.

Akinsola (2008) investigated the relationship of some psychological variables in predicting problem solving ability of in-service mathematics teachers. The sample consists of 92 females and 30 male out of 122 in-service mathematics teachers enrolled in the B.Ed primary education programme in the Department of Primary Education, University of Botswana. The findings of the study revealed that mathematics anxiety, mathematics teaching efficacy belief, locus of control and study habits all have significant relationship with problem solving ability but more the mathematics anxiety of in-service teachers the weaker their problem solving ability.

Preethy (2008) conducted a study on relative efficiency of problem solving ability, mathematical interest and awareness in the utility of mathematics in predicting achievement in mathematics of secondary school pupils of Kerala. A sample of 500 students of ninth standard drawn from 10 schools of Kozhikode and Malappuram districts of Kerala participated in the study. The study revealed that problem solving ability, mathematics interest and awareness in the utility of mathematics have significant positive correlation with achievement in mathematics.

Soumya (2007) investigated the relationship between creative thinking and problem solving ability of ninth standard students of Ernakulum district. Total of 300 students of ninth standard in Ernakulum district was administered for the study. The study found that there exists a significant positive relationship between creative thinking and problem solving ability.

Nifsa (2007) examined the interaction effect of creativity and formal reasoning on problem solving ability in physics of secondary school students. The sample consists of 550 secondary school students from ninth standard. The study found that there is a direct relationship between creativity and problem solving ability in physics.

Ashalatha (1990) investigated the relationship between problem solving ability and creativity. By using specific creativity test, students were grouped into high, average and low scores according to their level of creativity. The findings of the study showed that high, average and low groups of creative pupils differ in their problem solving ability.

Jayasree (1988) examined the effect of select attitude variables on creativity of secondary school students. The results of the study indicated that the effect of attitude towards problem solving, attitude towards mathematics and attitude towards education on creativity are significant.

Studies on Academic Stress

Manikandan and Neethu (2018) investigated student engagement in relation to academic stress and self-efficacy under the participants as 280 adolescents students from higher secondary schools situated at Calicut district of Kerala. The result of the study revealed that student engagement is significantly associates to academic stress and self-efficacy. Thus self efficacy increases, the student engagement increases and decreases academic stress and also when academic stress increases, decreases student engagement and self-efficacy.

In their study, a study of academic stress among higher secondary school students Sagar and Singh (2017) examined the level of academic stress among higher secondary school students. 180 students were selected for the sample obtained from 10 higher secondary schools at Bareilly district by using academic stress scale. The findings for the study suggested that male students have more academic stress than female students, but there is no significant difference was found among academic stress of arts, science and commerce stream students, academic stress of government aided and self finance school students and rural & urban area school students.

Kumari, Ram and Barwal (2016) conducted a study of the relationship between stress and mathematics achievement of high school students. The data for the study consists of 200 students of 10th standard studying in rural and urban government high schools belonging to the Mandi district of Himachal Pradesh. The finding of the study revealed that boy students shows more amount of stress than girls, girls had higher mathematics achievement than the boys, There exists no significant relationship between stress and mathematics achievement of rural and urban high school students and there exists a significant relationship between stress and mathematics achievement of high school girls.

Nikitha, Jose and Valsaraj (2014) studied the correlation between academic stress and self-esteem among higher secondary students in selected schools of Udupi District. The data was collected and analyzed from 96 first year students of science batch in private school. The study found that there exists a significant but low negative correlation between academic stress and self- esteem among the students.

Menaga and Chandrasekaran (2014) investigated whether there exists any significant difference in the academic stress among higher secondary school students with respect gender, stream of study, type of school management, type of family and family income. The study was conducted on 250 higher secondary school students in Thiruvannamalai District. The study found that there is a significant difference in the academic stress in relation to their gender, type of family and type of school management, but there is no significant difference in the variable academic stress in connection to family income and stream of study.

Owolabi (2013) conducted an experimental study to investigate the impact of emotional intelligence training on academic stress and self- efficacy among senior secondary school students. The study was conducted on 140 participants and found that emotional intelligence training had a positive impact on academic stress. The study also identified that the efficacy of the programme had a greater impact on female participants than the male participants.

Lal (2013) studied the relationship between academic stress and intelligence among adolescents. The data was collected from 200 high school students. The tool used for the study was the Students Academic stress scale by Dr. Abha Rani Bist and Intelligence Test by Dr. R.K. Ojha. The study revealed that the intelligence quality had slightly influenced on academic stress of senior secondary school students.

Bartwal and Raj (2013) examined the relationship between academic stress and emotional intelligence of school going adolescents. The study was conducted on 200 senior school students of Bathinda District and identified that there exists a significant relationship between academic stress and emotional intelligence among the school going adolescents.

Byron, Khazanchi and Nazarian (2010) conducted a study onthe relationship between stressors and creativity: A meta-analysis examining competing theoretical models. The findings of the experimental study revealed that the effect of stressors on creative performance depends on how stress induced and the extent to which an evaluative context is made salient can serve to either increase or decrease creative

performance; in contrast contexts characterized by uncontrollability serve to only decrease creative performance.

Hussain, Kumar and Hussain (2008) examined the level of academic stress and overall adjustment among public and government high school students and also find the relationship between these two variables. The data was collected from 100 students of class ninth from two different schools. The study revealed that the magnitude of academic stress was significantly higher among the public school students whereas government school students were significantly better in the level of adjustment. The study also identified a negative correlation between academic stress and level of adjustment among high school students.

Studies on Mathematics Anxiety

Hill, Mammarella, Devine, Caviola, Passolunghi and Szucs (2016) investigated maths anxiety in primary and secondary school students: gender differences, developmental changes and anxiety specificity. A sample of 1014 children both boys and girls attending both primary and secondary schools in Italy were selected for the study. The study revealed that girls show higher maths anxiety than boys at both educational levels. While there was a reliable negative correlation between maths anxiety and secondary student's arithmetic performance, no such relationship was revealed in primary students.

Tok, Bahtiyar and Karalok (2015) studied the effects of teaching Mathematics Creatively on academic achievement, attitudes towards mathematics, and mathematics anxiety. The sample of the study consists of 42 sixth graders

attending a state elementary school in Denizli city's central county, Turkey. The study revealed that teaching mathematics with creativity increases attitude towards maths and achievement and decreases the anxiety towards mathematics.

Mutawah (2015) studied the influence of mathematics anxiety in middle and high school student's math achievement on 1352 students of Grade 8, 9 and 10 in 14 middle and high schools across Bahrain. The study revealed that anxiety increases as the student's progress through the grade levels and there is a gender differences in mathematics anxiety among students. It also found that the level of the anxiety is highest among those who perceived themselves as low achievers.

Srivastava, Imam and Sing (2015) investigated mathematics anxiety among secondary school students in relation to gender and parental education. The data was collected from 1000 secondary school students from Lucknow using the tool of mathematical anxiety scale and personal background assessment questionnaire. The study showed that female have more anxiety level than males in mathematics. The children whose parents are not educated or less educated are more anxious than those who have both or one parent having higher level of education.

Sharma (2014) investigated the effects of strategy and Mathematics Anxiety on Mathematical Creativity of school students. The subjects of the study consists of 111 grade ninth students ranging from 14 – 17 years belonging to three different schools using cluster random sampling technique. The study showed that the students with low mathematical anxiety was found to be best for developing mathematical creativity.

Morsaniya, Busdraghi and Primi (2014) investigated the link between mathematical anxiety and performance on the cognitive reflected test (CRT) the experiment was conducted on the university students and secondary school students. The study revealed that mathematics anxiety is a significant predictor of cognitive reflection, even after controlling for the effects of general mathematical knowledge, school mathematical achievement and test anxiety.

Barwal and Sharma (2013) examined academic achievement of high school students in relation to their mathematics anxiety. The sample comprises of 200 high school students belonging to Mandhi districts of Himachal Pradesh. The study showed that there exists highly significant relationship between academic achievement and mathematics anxiety of high school students.

Abbasi, Samadzadeh and Shahbazzadegan (2013) investigated mathematics anxiety in high school students and its relationship with self-esteem and teacher's personality characteristics. The sample of the study consists of 480 school students and 60 mathematics teachers were chosen in accordance with their characteristics. The result revealed that there exists a negative significant relationship between the student's, mathematical anxiety and their self-esteem and also exist a significant relationship between the students, mathematical anxiety and their teacher's personality characteristics.

Zakaria, Zain, Ahmad and Erlina (2012) conducted a study on Mathematics anxiety and achievement among secondary school students. The study involved 195 secondary school students from Selangor, Malaysia. The research examined the differences in mathematics anxiety according to gender as well as the differences in

mathematics achievement of students based on the level of mathematics anxiety. The study concluded that there were significant differences in achievement based on the level of mathematics anxiety. Thus, math anxiety is one factor that affects student achievement.

Keow (2012) studied mathematics anxiety in secondary school students on 294 students in Singapore through interviews and surveys. Results revealed an average anxiety level of 44% and a negative correlation with achievement.

Gangadharrao and Marathwada (2012) studied the scientific creativity of students in secondary school level and compared the level of scientific creativity between the students of private school and Navodhaya school. The study was conducted on 207 students of ninth standard. The study showed that the scientific creativity level of Navodhaya school students is better than private school students due to students from these schools are chosen on merit basis.

Vitasari, Herawan, Wahab, Othman and Sinnadurai (2010) investigated about the exploring mathematics anxiety among engineering students. The study examined whether mathematics anxiety is one of the study anxiety sources among UMP'S Engineering students. The result showed that there is difference in mathematics anxiety among engineering students on the dimensions gender, expectation and differences based on faculties.

Rana and Mahmood (2010) studied the relationship between test anxiety and academic achievement. 414 science students from university in Lahore were randomly selected for sample. The study showed that when test anxiety score

decreases, student's achievement score increases and the students with higher test anxiety must be identified and treated in order to increase their academic achievement.

Mohammed and Tarmizi (2010) made an attempt to compare mathematical anxiety levels and its impacts on performance between Malaysia and Tanzania secondary school mathematics learners. The study was performed using correlation survey and analyzed data using t-test. The result revealed that there were higher mean scores in test related anxiety in Malaysian students than Tanzanian students.

Kargar, Tarmizi and Bayat (2010) conducted a study on the relationship between mathematical thinking, mathematics anxiety and mathematics attitudes among university students. The sample of the study consists of 203 university students from the faculty of science, engineering, food science, and human ecology in one of the public university in Malaysia. The correlation analysis was used to find out the relationship between mathematical thinking, mathematics attitude, and mathematics anxiety and independent t-test was used to examine differences between the two gender groups and two race groups on their mathematics anxiety, attitudes toward mathematics and mathematical thinking. The study revealed that significant high positive correlation exists between mathematical thinking and mathematics attitude and there was negative moderate relationship between mathematical thinking and mathematics anxiety.

Naderi, Abdulla, Aizan, Sharir and Kumar (2009) conducted a study to examine whether creativity, age and gender are predictors of academic achievement among undergraduate student. The data was collected from 153 undergraduate

students in Malaysian Universities. Multiple regression analysis showed that the interaction effect between creativity, age and gender as low predictors of academic achievement.

Karimi and Venkatesan (2009) studied mathematics anxiety, mathematics performance and academic hardiness in high school students on 284 tenth grade high school students from Karnataka state. It was found that mathematics anxiety has significant negative correlation with mathematics performance but no significant correlation is found with academic hardiness. Significant gender difference in mathematics anxiety was reported but no significant gender difference was found in mathematics performance and academic hardiness.

Zakaria and Nordin (2008) investigated the effects of mathematics anxiety on matriculation students on motivation and achievement by selecting a sample of 88 students who were at the end of their second semester of study using three instruments namely mathematics anxiety scale, effectance motivation scale and the mathematics achievement test. The result of the study revealed that a significant low positive correlation between motivation and achievement and also a student with high anxiety tends to be less motivated to work with mathematics.

Philip (2008) studied the relationship between intelligence, scientific creativity, achievement motivation, home environment and achievement in science. The data was collected and analysed from 1120 students of standard XII from four Districts of Kerala. The study revealed that there is a significant relationship between each of the independent variables and achievement in science for the total sample and sub samples based on gender, place of residence and nature of the

institution. The study also identified that achievement motivation has a negligible relationship with scientific creativity and home environment and all other independent variables have a significant positive relationship with each other.

Archana (2006) studied the interaction effect of academic anxiety, achievement motivation and sex on performance in Biology. The study was conducted on a sample of 500 students of standard ninth and the data were collected using scale of academic anxiety and scale of achievement motivation. The result of study revealed that academic anxiety is a debilitating factor of performance in Biology (increasing level of academic anxiety causes decreasing performance in biology) and achievement motivation is a facilitating factor of performance in biology.

Mathematics anxiety and mathematics achievement was studied by Brian, Sherman and David (2003). It was found that lack of mathematics achievement causes mathematics anxiety. Changes in mathematics achievement causes related variation in anxiety. Investigator also found that there is a negative correlation between mathematics anxiety and mathematics achievement.

Cates and Rhymer (2003) investigated the relationship between mathematics anxiety and mathematics performance in an instructional hierarchy perspective. The sample selected from college students were assigned to one of two groups as high anxiety or low anxiety based on the score on mathematics anxiety. The study revealed that the higher mathematics anxiety group had significantly lower fluency level across all mathematical operations tests.

Studies on Locus of Control

Ciftci (2019) studied the effect of mathematics teacher candidates' locus of control on math anxiety using structural equation modeling. The subjects were 402 students from three different state universities in Turkey selected using a combination of convenience and purposive sampling. The result of the study showed that locus of control positively affected math anxiety and a significant positive relationship was found between the external locus of control and the total and sub-scale scores of math anxiety.

Kalamu, Hulukati, Badu and Panai (2018) investigated the effect of locus control on mathematical problem solving ability of gorontalo city state middle school students. The data for the study collected from Gorontalo City Middle School students totaling 1729 people with multistage random sampling with 95 people. The study revealed that there is a positive direct effect of locus of control on mathematical problem solving abilities of students.

Hans, Deshpande, Pillai, Fernandes, Arora, Kariya and Uppoor (2017) investigated the self-efficacy, locus of control and commitment in select private management colleges in Oman. A sample of 50 teachers participated in the study. The result of the study showed that locus of control and self-efficacy negatively related with the commitment level of the faculty members working in these private management colleges.

Bharathi (2017) checked the influence of self-concept, locus of control and maths anxiety on the computation ability of mathematics students at secondary level.

A sample of 15 secondary school students were selected for collecting the data regarding the study. The study showed that most of the students who are studying at secondary levels are found to be moderate level in self-concept, locus of control and maths anxiety while dealing their academic streams and particularly in mathematics students require more concentration for dealing with mathematical problems.

Angelova (2016) investigated the locus of control and its relationship with some social-demographic factors. Sample of the study consists of 608 persons ranged between 15 and 65 years old. The findings of the study revealed that out of three social-demographic factors -education, family status, professional activity and place of residence, three of them are shows a significant relationship with locus of control and other without a significant relationship with locus of control.

Naik (2015) conducted a study on the locus of control among college students of Gulbarga. The study was conducted on samples of B.A and B.Sc. with the age range of 16 – 25 years, studying in Gulbarga city degree colleges by using random sampling method. The findings of the study not showed any difference in the locus of control among male and female college students, science and arts college students, and urban and rural college students.

Lather, Jain and Shukla (2014) examined the student's creativity in relation to locus of control. The data was selected from a sample of 450 students of Mysore University out of which 40 belonged to Electronics and communication, 44 were from Civil Engineering, 40 from Environmental Sciences, 37 from Biotechnology, 40 from Geography, 16 from mathematics, 20 from Food and Nutrition and 7 from Centre for Women Studies. The study revealed that students with high creativity are

significantly high in Internal Locus of Control and the students who were low on creativity are significantly higher on External Locus of Control. The study also found that students at post graduate level show high external locus of control than graduate level. Finally, understanding at the locus of control of various academic disciplines, the decreasing order of External Locus of Control of various academic disciplines is falling as Geography being on top followed by sciences and engineering, mathematics, food and nutrition and Centre for Women studies has lowest External Locus of Control.

Griffin (2014) conducted a study titled as Locus of Control and psychological well-being: separating the measurement of internal and external constructs. A sample of 577 students took part in a survey through an online data-collection system. The study showed that external LOC predicted unique variance in self-esteem, depression, and stress and Internal LOC was found to have no unique association with psychological well-being.

Ghanbari, Talb, Karimzade and Saeed (2014) studied the effect of teaching problem solving skills and locus of control on the academic achievement of mathematics students. The sample of the study consists of 30 students from Lordegan selected via multi stage cluster sampling. The result of the study revealed that the teaching of problem solving skills and locus of control had significantly related to the academic performance of the mathematics students- training of problem solving skills can improve the academic achievement of mathematics students and a higher internal locus of control provides higher level of self confidence.

Keshavarz and Baharudin (2013) studied the moderating role of father's education on the association between perceived paternal parenting styles and locus of control among Malaysian adolescents. The findings of the study are 1) there were significant negative relationships between fathers' authoritative parenting style and authoritarian parenting style with adolescents' internal locus of control and 2) father's high level of education moderated the relationship between perceived paternal authoritarian parenting and locus of control.

Joo, Lim and Kim (2013) examined locus of control, self efficacy and task value as the predictors of learner satisfaction, achievement and persistence in an online university located in South Korea. The study found that locus of control, self-efficacy and task value were significant predictors of learner satisfaction, while self-efficacy and task value predicted achievement.

Mihaela, Magdalena and Loredana (2012) conducted a study on relation between locus of control and creative attitudes in the structure of didactic competence. The samples included 96 students and teachers having didactic experience between 5 and 35years with 63 women and 33 men and were selected using the locus of control scale questionnaire method. The study found that teacher’s personality structure, locus of control and creative attitudes are considered as predictors of didactic competence. Persons with an internal locus of control have high values of creative attitudes, which mean the superiority of the belief in the internal control as compared to the external one in the structure of didactic competence.

Zaidi and Mohsin (2011) examined a study on Locus of Control in Graduation Students. The sample of the study consists of 200 individuals both men and women equally between the ages of 18 to 25 years old. The result of the study revealed that there is a significant difference in locus of control among men and women. The study reported that men scored high on internal locus of control as compared to women.

Kutanis, Mesci and Ovdur (2011) investigated the effects of locus of control on learning performance. The sample consists of 450 tourism and hotel management studied in the academic year of 2009-2010. The result of the study revealed that the learning performances of the students with internal locus of control are high, and they are more proactive and effective during the learning process. On the other hand, the ones with external locus of control are more passive and reactive during this period.

Bhogayata (1998) conducted a study on the relationship among creativity, self-concept and locus of control. The study revealed that the students with higher self-concept are more fluent, original and creative than the students with a lower concept.

Enger, Howerton and Cobbs (1994) investigated internal or external locus of control, self-esteem, and parental verbal interaction of at-risk black male adolescents. A sample of 42 male students in Grades 6, 7, and 8 from the United States was administered for the study. A moderate positive relationship found between self-esteem and parental verbal interaction was consistent with a previous finding of no significant relationship for Black elementary children. A weak, yet

significant, negative relationship was found between locus of control and parental verbal interaction.

Studies on Optimism

Mathur and Sharma (2015) studied Academic Stress in relation with Optimism and resilience on the sample of 300 senior school students drawn from public, private and missionary schools. The findings of the study revealed that Academic stress correlated negatively with optimism and resilience and both the variables significantly predicted academic stress.

Mathai (2015) conducted a study on the mediating effect of coping styles on the optimism athletic performance relationship among track and field athletes. 148 athletes randomly chosen from different schools and colleges in Kerala participating in district, state and national levels under the age range of 16- 19 were the sample administered for the study. The study showed that individuals are optimistic on the use of positive copying strategies that give better performance.

Rezaei, Mousavi, Safari, Bahrami, Menshadi (2015) conducted a study of the relationship between optimism, pessimism and coping strategies with mental health among university students of Lorestan. The sample of the study was 367 students from Lorestan University in the academic year 2014 by using stratified random sampling technique. The result of the study showed that there is a significant relationship between optimism and pessimism with mental health. People who viewed as more optimistic about events were positively correlated with mental health.

The Relationship between Optimism-Pessimism and Personality Traits among Students in the Hashemite University by Mahasneh, Al-Zoubi and Batayeneh (2013) examined the relationship between optimism and personality characteristics. The sample of the study was 534 students among undergraduate students enrolled in the Hashemite University. The study showed that a positive significant relationship exists between optimism and introversion and pessimism emotional equilibrium.

Moran, Bankole, Roxanne, Mitchel and Moore (2012) checked student academic optimism: a confirmatory factor analysis. A sample consists of 35 elementary schools, nine middle schools, and five high schools with a total population of over 34000 students in urban districts in the mid-Atlantic region The findings of the study revealed that student academic optimism was unrelated to socio economic status(SES) and that student academic optimism has a significant effect on achievement over and above the effects of SES and student demographic characteristics leads the authors to consider the possibility that SES may not be as influential as once thought when other conditions of the school environment are taken into consideration.

Sanchez, Brufau, Mendez, Corbalan and Liminana (2010) studied the relationship between optimism, creativity and psychopathological symptoms in University students. The study was conducted on 113 University students from different degree programs. The study found that a strong negative correlation between optimism and psychopathological symptoms exist, there is no significant correlation between creativity and psychopathological symptoms.

Gordon (2008) conducted a study on attributional style and athletic performance. A sample of 18 female basketball players (ages: 18–24 years) from a division II collegiate team completed the attributional style questionnaire and the life orientation test measures during the third week of the season. Team performance can be predicted based on the assessment of the attributional style optimism of team members and coaches. The key to performance was perseverance in the face of failure, a product of attributing bad events to one-off, non-pervasive external causes as optimists do.

Schumacher (2006) conducted a study on assessing the relationship between optimism and academic success. The sample of the study included 48 students from a senior secondary high school, population 1384, in central British Columbia by using a questionnaire. The findings of the study revealed that there is no significant relation between grade and optimism scores and also suggested that further study is needed to delineate all of the factors affecting the association between optimism and academic achievement.

Rudski (2004) studied the illusion of control, superstitious belief, and optimism among 275 participants. The study showed that no relationship between optimism or pessimism and the illusion of control were observed.

Aspinwall and Taylor (1992) conducted a longitudinal study on impact of individual differences and coping on college adjustment and performance. The study revealed that optimism at the beginning of college predicted a smoother, psychologically healthier transition to college life, as well as larger groups of new friends.

Conclusion

The researcher made an earnest effort to include almost all relevant studies in the review. The investigator has made an attempt to review studies in the area of Creativity, Mathematical Creativity especially the relationship of Mathematical Creativity with other variables in India and abroad in an exhaustive way. The review helped the researcher to arrive at a conclusion that many studies in Creativity and Mathematical Creativity are done in India as well as outside India. But Indian studies mainly focus on the relationship of Creativity with other variables like academic achievement, intelligence, mathematical ability, self concept, achievement motivation etc. (Topno, 2014; Sing, 2013; Rani & Dalal 2013; Jayaram, 2013; Baran, Erdogan & Cakmak 2011; Yadhav & Wadhva, 2011; Alam, 2009; Reddy, 2009; & Jacob, 2007).

Many studies are found to be reported on the relationship of Mathematical Creativity with other variables like intelligence, spatial ability, problem posing ability, self concept, mathematical ability, numerical aptitude, educational administration, intellectual involvement, social involvement, etc. (Isnani, Waluya, Rochmad, Wardono, 2020; Lim, Ismail, Yudariah & Yusof, 2019; Jinu & Vijayakumari, 2018; Tyagi, 2017; Kanhai, 2016; Vijitha, 2016; Singer & Voica, 2015; Leikin & Lev, 2013; Kattou, Kontoyianni, Pantazi, & Christou, 2013). A number of studies in the area of Mathematical Creativity are on its relationship with achievement in mathematics (Jaleel & Titus, 2015; Nicemol, 2013; Sebastian, 2013; Bahar & Maker, 2011; Talawar & Madhusudhan, 2010; Sreerekha, 2001; Haylock, 1997; Resmi, 1997; Gorge, 1994; Tuli, 1980; Jensen, 1973).

Some studies focused on certain strategies like concept mapping, educational courseware, and commercialized learning materials and approaches, methods, techniques and materials in facilitating divergent thinking and Mathematical Creativity (Jinu, 2018; Daunis & Scullin, 2017; Varghese, 2016; Yeh & Lin, 2015; Vijayakumari & Kavithamol, 2014; Smogorzewske, 2014; Sharma, 2013; Kuveri, 2013; Sharma, 2013; Albert & Kormos, 2011; Idris & Mohd-Nor, 2010; Kwon, Leikin & Lev, 2007; Park & Park, 2006 & Haylock, 1997).

Some studies are found to be reported on the relationship of Mathematical Creativity with Problem Solving Ability (Moore-Russo and Demler, 2018; Kanhai & Sing, 2016; Suresh, 2016; Tyagi, 2015; Ayllon, Gomez & Claver, 2015; Kavitha, 2009; Nifsa, 2007; Ashalatha, 1990; Jayasree, 1988; Torrance, 1987). The review of related literature indicates that a few studies are reported on the relationship between Mathematical Creativity and the variables like Academic stress, Mathematical anxiety, Locus of control and Optimism (Bharathi, 2017; Sharma, 2014; Lather, Jain and Shukla, 2014; Byron, Khazanechi & Nazarian, 2010; Fetterly, 2010; Sanchez, Brufau, Mendez, Corbalan & Liminana, 2010; Johny, 2008; Akinsola, 2008; Bhogayata, 1998; Shaham, Singer & Scharffer, 1992; Spielberger & Rickman, 1990; Haylock, 1987; Teichner, Arees & Reilly, 1963).

As a result of the investigative review, very few studies in Kerala are found to be reported on Mathematical Creativity. The studies on Mathematical Creativity do not give a consistent result on relationship with many psychological variables. Main focus of these researches was to find the relationship between Mathematical Creativity and mathematical achievement. If the combination of more than one

psychological variables that affect Mathematical Creativity is established, it will be useful for teachers, parents, school authorities and curriculum developers to nurture Mathematical Creativity in students. So the researcher decided to conduct a study to find out how the five psychological variables problem solving ability in mathematics, academic stress, mathematics anxiety, locus of control and optimism affect Mathematical Creativity and their relative efficiency to predict mathematical creativity among secondary school students of Kerala.

Chapter 3

METHODOLOGY

- Design of the Study
- Variables of the Study
- Participants of the Study
- Instruments Used
- Data Collection Procedure, Scoring and Consolidation of Data
- Statistical Techniques Used for Analysis of Data

This chapter describes the method followed in the study. The present study focuses on the ability of the select psychological variables to predict Mathematical Creativity among secondary school students. The method adopted, variables under study, participants, instruments, data collection procedure and the statistical techniques used are described in detail under the following headings

Design of the Study

Variables of the Study

Participants of the Study

Instruments used

Data collection procedure, Scoring and Consolidation of data

Statistical Techniques used for analysis of data

Design of the Study

Research design is a wide master plan of the research to ensure collection of requisite data with the problem at hand in order to answer the research questions as clearly as possible.

The investigator adopted survey method to understand the extent of Mathematical Creativity among secondary school students and to find out whether the select variables are significant predictors of Mathematical Creativity. For this,

correlational research with prediction design was used. In a correlational research, the investigator describes the degree of association between the related variables. In a prediction design outcome variable is anticipated by using certain variables as predictors. Using the prediction design the investigator studied the relationship of the select psychological variables with Mathematical Creativity and the efficiency of these variables in predicting Mathematical Creativity.

Variables of the Study

The two types of variables in a prediction design are the outcome (criterion) variable and the predictor variables. The present study attempts to predict Mathematical Creativity using the select psychological variables. Hence Mathematical Creativity is the outcome (criterion) variable and the predictor variables are the select psychological variables viz., Problem Solving Ability in Mathematics, Mathematics Anxiety, Academic Stress, Locus of Control and Optimism.

Problem Solving Ability in Mathematics

A problem is a perplexing situation, the solution to which is not immediate. Problem solving means the process of discovering the correct sequence of alternatives leading to an ideal solution to a problem. Problem solving requires higher order mental abilities like reasoning and creative thinking. It is a vertical thinking, a sequential logic based process to arrive at the best solution for a problem where as lateral thinking results in breakthroughs and innovations (Walsh, 2015). These two types of thinking are related to each other. Problem solving needs

creative thinking and creativity is fostered through solving novel problems that are challenging to the learner. Researchers like Cropley (2005), Saragih and Habeahan (2014) and Suresh (2016) have reported positive relationship between problem solving ability and creativity. Hence in the present study, Problem solving ability in mathematics was selected as a predictor variable for Mathematical Creativity.

Mathematics Anxiety

Mathematics Anxiety is a feeling of tension, apprehension, or fear that interferes with math performance (Ashcraft & Kirk, 2001). It is a fear of mathematics that can interrupt mathematical problem solving and mathematics related activities in everyday life. Anxiety is generally considered as a negative variable that hinder the free thinking and information processing. Loudon and Deininger (2016) studied the physiological response to creative tasks and found that divergent thinking and psycho physiological state are correlated and an initial relaxed state is not a predictor of creativity. Daker, Cortes, Lyons and Green (2019) reported a new type of anxiety, ‘creative anxiety’ that can predict creativity in areas like art, science and mathematics. It will be remarkable if the role of mathematics anxiety in predicting mathematical creativity is explored.

Academic Stress

Academic Stress is mental distress with respect to some anticipated frustration associated with academic failure, anticipation of such failure, or even an awareness of the possibility of such failure (Gupta & Khan, 1987). It is the concern and stress that comes from schooling and education as physical, mental or emotional

reaction in the academic life. A meta analysis of studies on relationship of stress and creativity conducted by Byron, Nazarian and Khazanchi (2010) revealed that the results are inconsistent and more studies are needed to explore the relationship. They made a conclusion that an environment in which the individual has more control increases the creative performance. Academic stress among students may affect their creativity and hence it was included as a predictor variable.

Locus of Control

According to Rotter (1960), behavior of an individual is affected by how he expects its consequences or results. If the consequence is positive, the behavior is encouraged, otherwise discouraged. If a person believes that he can control what happens to him, he is referred to as having an internal locus of control. A belief that one is controlled by luck, fate or powerful others, is referred to as having external locus of control. Lather, Jain and Shukla (2014) have reported that students having internal locus of control have higher creativity and those with external locus of control have low level of creativity. Locus of control is a variable which need more exploration in the context of creative thinking and was included as a predictor variable of Mathematical Creativity.

Optimism

Seligman (1990) defined optimists as those who tend to believe that defeat is just a temporary setback, when confronted with hard knocks of the world and they believe that the causes for the present failure is confined to this particular case. They perceive the setback or the bad situation as a challenge and work hard to confront

the same. Optimism moderates many psychological and physiological states like positive emotions, mental and physical health. Cropley (2015) has reported a positive correlation between optimism and creativity. The relationship need not be direct, but may have a mediating role on creativity. So optimism was also included in the select psychological variables as an affective variable.

Diagrammatic representation of the variables involved in the study is given as figure 2.

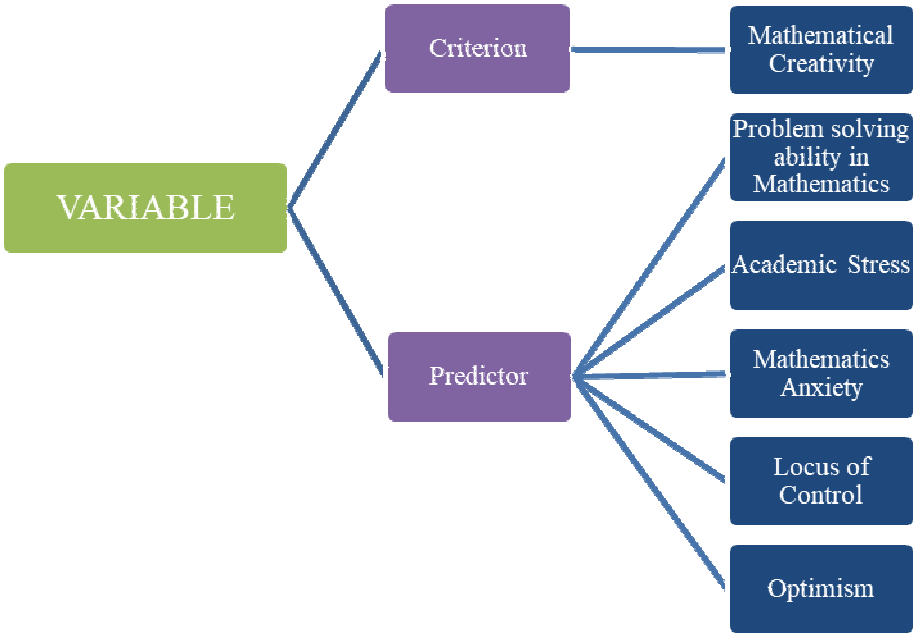


Figure 2. Diagrammatic representation of the variables involved in the study

Participants of the Study

The population of the study is secondary school students of Kerala. The study was delimited to ninth standard students studying in Government and Aided schools of Kerala with the assumption that ninth standard students will be a more representative group of secondary school students. Schools from Northern, Central

and Southern part of the Kerala state were included in order to get a cross section of the Kerala state. Stratified sampling technique was used to select the participants of the study. The participants were selected from 19 schools of five districts of Kerala state. Four schools from Kasaragod, three schools from Wayanad, five from Kozhikode, three from Palakkad and four schools from Kollam were selected randomly. Care was taken to include schools from urban and rural areas as well as government and aided schools. The sampling frame of the study is given as table 1.

Table 1

Sampling Frame of the Study

District	No. of Schools	No. of Schools from Rural	No. of Schools from Urban	No. of Govt: Schools	No. of Aided Schools
Kasaragod	4	3	1	2	2
Wayanad	3	2	1	2	1
Kozhikode	5	2	3	3	2
Palakkad	3	2	1	2	1
Kollam	4	2	2	2	2

The basal sample included 800 ninth standard students from 19 schools of five districts of Kerala state. From each school a randomly assigned ninth class was taken and the entire students of that class were included in the sample. Equal representation of male and female students was given in the basal sample. The distribution of the basal sample is given as table 2.

Table 2

Basal Sample Selected for the Study

Gender		Type of Management		Locale	
Male	Female	Government	Aided	Rural	Urban
400	400	450	350	450	350

The list of schools selected is given as Appendix 1.

Instruments Used

Collection of relevant data is an important aspect of any research work. Various techniques and instruments are to be used to collect feasible data. Selection of suitable instrument for collecting data is of vital importance for a successful research. A researcher is expected to select an appropriate one among the available instruments. If no such instrument with quality is available he/she is expected to construct a new one.

In the present study, the researcher has to measure the dependent variable Mathematical Creativity and the independent variables Problem Solving Ability in Mathematics, Mathematics Anxiety, Academic Stress, Locus of Control and Optimism. Standardized tools were available to measure Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control. Instruments to measure Mathematical Creativity, Academic stress and Optimism were developed by the researcher with his supervising teacher. The list of instruments used in the study is given below,

Mathematical Creativity Test (Vijayakumari & Midhundas, 2017)

Optimism Inventory (Vijayakumari & Midhundas, 2016)

Scale on Academic Stress (Vijayakumari, Sajmadas & Midhundas, 2015)

Test of Problem Solving Ability in Mathematics (Sumangala & Rinsa, 2008)

Mathematics Anxiety Scale (Sumangala & Malini, 1993)

Locus of Control Scale (Kunhikrishnan & Mathew, 1987)

Each instrument is discussed below in detail.

Mathematical Creativity Test (Vijayakumari & Midhundas, 2017)

A Mathematical Creativity Test was constructed and standardized by the investigator with the help of supervising teacher to measure Mathematical Creativity of secondary school students. The procedure of development of the test is explained under the titles planning of the test, item writing, pilot testing, item analysis, scoring procedure, reliability and validity.

Planning of the Test

As the first step, the investigator reviewed the literature available in the area of Mathematical Creativity and identified appropriate definition and components of the variable. Laycock (1970) described mathematical creativity as “an ability to analyze a given problem from different perspective, see patterns, differences and similarities, generate multiple ideas and choose a proper method to deal with unfamiliar mathematical situations”. The investigator decided to select the components of creativity as Fluency, Flexibility and Originality as per the theories on Creativity by Guilford (1967) and Torrence (1969).

Creativity is originality in thinking which needs a clear notion of the subject matter. Hence the selection of content for the test needs much attention so that students are very familiar with the concept. Hence basic branches of mathematics are to be included in the test. Basic branches of Mathematics are arithmetic, algebra, geometry and trigonometry. Among these, arithmetic and geometry are the major areas dealt in primary and upper primary levels. Secondary school students are expected to be more confident in basic arithmetic and geometry. Hence it was decided to restrict the content of the test to arithmetic and geometry. Items to measure Mathematical Creativity were so framed that responses can be scored for three components fluency, flexibility and originality. Fluency means the number of original ideas produced by an individual corresponding to a stimulus. Flexibility is the ability to change the approach. Flexibility is taken as the different approaches taken by the individual in response to the same stimulus. Originality means an answer is rare, that is occurring occasionally in a given population.

Altogether 16 items with 8 items from arithmetic and 8 from geometry were prepared by the investigator. The items were undergone scrutiny by experts and as per their suggestions 6 items were removed, one from arithmetic and five from geometry. Thus the draft test consists of ten items 7 from arithmetic and 3 from geometry.

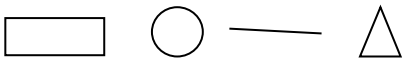
To test the feasibility of the test, and get an idea about the time needed to respond to the item, the test was administered on a sample of 30 secondary school students. Students were encouraged to ask doubts or clarification on the items and a close observation was made on the style of responding. Modifications in the

wording were made for those items for which students asked for clarification. The total time limit for the test was fixed as 30 minutes and specific time limit for each item was also given.

Example: Arithmetic: Write down maximum numbers using five ones.

(1 1 1 1 1)

Geometry: Using the following images make different meaningful figures.



Pilot testing

The draft test was administrated on a sample of 370 secondary school students of ninth standard selected through stratified sampling technique, giving equal weightage to gender of students, locality and type of management of the school. The purpose of pilot testing is to collect data for item analysis. The investigator approached the headmasters of the randomly selected schools and sought permission for administering the tool in the class. The draft test was administered to the allotted class and proper instruction was given before responding. Sample item were worked out in the class to make them familiar with the procedure. Time limit was strictly followed in all groups.

Item analysis

The response sheets were scored as per the scoring procedure of each component. The fluency score was taken as the number of relevant responses for each item. Flexibility score was the number of categories of responses for each item

and originality score was taken based on the frequency of occurrence of that response among the group. The total score on fluency, flexibility and originality for each item was taken as the Mathematical Creativity score on the item for that respondent. Based on the total Mathematical Creativity score, the entire sheets were arranged in ascending order and the highest 27 percent (100) and the lowest 27 percent (100) were separated. The group with higher score was treated as upper group and with lower score was taken as the lower group. Mean and standard deviation of each item were calculated for both upper and lower groups. Then t-value for each item was calculated using the formula

$$t = \frac{M_1 - M_2}{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

where M_1 is the mean score on Mathematical Creativity obtained for an item for the upper group, M_2 is the mean score on Mathematical Creativity obtained for that item for lower group. Here σ_1 is the standard deviation of the distribution of Mathematical Creativity scores for the item for upper group and σ_2 is the standard deviation of the distribution of Mathematical Creativity scores for the item for lower group.

Test of significance of difference between means for two large independent groups was used to calculate the discriminating power of the item. Items having critical ratio greater than or equal to 2.58 (The tabled value for significance at .01

level) were included in the final test. The details of item analysis of Mathematical Creativity Test are given in table 3.

Table 3

Details of item analysis of Mathematical Creativity Test

Item No.	M_1	M_2	σ_1	σ_2	t – Value	Remarks
1	10.39	3.83	4.29	2.01	13.82	Accepted
2	2.09	0.25	4.61	0.78	3.93	Accepted
3	5.84	1.97	2.99	2.03	10.67	Accepted
4	8.95	3.39	4.95	2.71	9.85	Accepted
5	10.88	3.47	4.88	3.18	12.69	Accepted
6	13.15	6.58	3.85	2.98	13.47	Accepted
7	11.72	3.70	6.78	2.68	10.98	Accepted
8	33.89	6.52	14.19	3.92	18.58	Accepted
9	14.55	5.72	4.49	3.70	15.15	Accepted
10	17.72	4.54	9.68	2.60	13.14	Accepted

All the items in the test have critical ratio greater than 2.58 and hence all the ten items of the draft test can be selected for the final test.

The item total correlation was calculated by correlating the score on each item of the Mathematical Creativity Test with the total score obtained for the test. This was done to verify whether the score of each item significantly contribute to the Mathematical Creativity Score. The correlation coefficients are presented in table 4.

Table 4

Item - total correlation of Mathematical Creativity Test

Item No.	1	2	3	4	5	6	7	8	9	10
Correlation	0.63	0.33	0.56	0.60	0.60	0.66	0.69	0.83	0.68	0.61

The correlation coefficients indicate that significant correlation exist between the scores of all the items and the total Mathematical Creativity Score at .01 level.

The correlation coefficient for the scores on the three dimensions and the total Mathematical Creativity Score were also calculated. The details are given as table 5.

Table 5

Correlation coefficient for scores on dimensions with Mathematical Creativity Score

Dimension	Correlation coefficient with Mathematical Creativity Score
Fluency	0.96
Flexibility	0.84
Originality	0.72

The correlation coefficients obtained show that the dimensions are highly correlated with total score of Mathematical Creativity. Considering all the three criteria for selection of items in the test, all the ten items in the draft test were selected for the final test.

Scoring procedure

The Mathematical Creativity Test has been scored for three factors of creativity, viz., fluency, flexibility and originality. The responses to each item of the test receives three types of scores and the sum of all the three scores for all the items

of the test is considered as the total score of Mathematical Creativity. The scoring pattern of Fluency, Flexibility and Originality are explained below.

Fluency

For each item the relevant responses are counted and each response is assigned a score of one. The total score obtained for all the items in the test is the total score of the individual on Fluency.

Flexibility

The responses are classified into categories and a score of one is assigned for each category. No additional score is assigned for more than one response in a category. The sum of the scores obtained for the items is taken as the Flexibility score.

Originality

The score is given based on different degrees of uncommonness of the response as shown in table 6.

Table 6

Scoring procedure for Originality

Sl. No.	Groups according to uniqueness of response	Score
1	Less than 5%	5
2	5% to 10%	4
3	10 to 15%	3
4	15 to 20%	2
5	20 to 25%	1
6	More than 25%	0

The responses to each item is to be analyzed in the whole sample and based on the uniqueness of each response, score is to be assigned. Total of these scores is the originality score obtained for that item. Sum of the originality score of all the items is the score on Originality. The total of the scores on Fluency, Flexibility and Originality obtained by a respondent is his/her Mathematical Creativity score. As per the nature of the test, the minimum score is zero and there is no maximum score. The higher the score, the higher will be Mathematical Creativity.

Reliability

The reliability of the test was measured using Cronbach Alpha Coefficient which is an index of internal consistency of the test. The value obtained is .782 indicating that the test is reliable (N= 370).

Cronbach Alpha coefficient was calculated for each component viz., Fluency, Flexibility and Originality. The details are given as table 7.

Table 7

Cronbach Alpha coefficients for Fluency, Flexibility and Originality

Components	Item 1	Item 2	Item 3	Item 4	Item 5	Item 6	Item 7	Item 8	Item 9	Item 10
Fluency α = .778	.764	.762	.772	.776	.762	.766	.776	.765	.755	.775
Flexibility α = .692	.597	.661	.595	.617	.629	.627	.596	.669	.620	.667
Originality α = .743	.589	.637	.594	.606	.578	.604	.646	.730	.589	.622

The reliability coefficients (Cronbach α) obtained for the components Fluency, Flexibility and Originality are .778, .692 and .743 respectively. The values of α when each item is dropped from the set of 10 items is less than the total value obtained in the case of Fluency, Flexibility and Originality and hence all the ten items sufficiently explain the components.

Validity

Content validity of the test was ensured by taking much care in framing items for the test. Suggestion from experts in the field was incorporated while preparing the test. Concurrent validity of Mathematical Creativity Test was estimated by correlating the score of the test with marks obtained by 35 students in the Test of Mathematical Creativity developed by Sumangala (1998). The correlation coefficient obtained is .764 indicating that the test is valid to measure Mathematical Creativity among secondary school students.

A copy of the final form of the Mathematical Creativity Test (Malayalam and English version) is appended as Appendix 2.

Optimism Inventory (Vijayakumari & Midhundas, 2016)

The concept of Learned Optimism was introduced by Seligman (1992) and according to him optimists as those who tend to believe that defeat is just a temporary setback when confronted with hard knocks of the world and they believe that the causes for the present failure is confined to this particular case. The inventory prepared by Seligman (1992) contains 41 items and is based on western culture.

Construction of the Tool

The first step in the construction and standardization of any tool is planning of the tool. For the present study, the investigator prepared Optimism Inventory to study the Optimism in secondary school students of Kerala based on the inventory by Seligman. The items are given as a statement to which there are two options, namely optimistic and not optimistic. The inventory (draft form) contains 41 items related to the life situations of students.

Example: A friend surprised you with a gift.

a) The friend got a high mark in the exam

b) The previous day, I also gave a gift.

Item analysis

The inventory was administered on a sample of 370 secondary school students selected by stratified random sampling technique giving due representation to gender of the students. The 370 response sheets obtained were scored and the total score for each sheet was calculated. Then these were arranged in descending order of the total score and the lowest and highest 27 percentage of the 370 sheets (100 sheets each) were separated. As the responses to the item are dichotomous, discriminating power of the items were calculated using the formula

$$D_p = \frac{U-L}{N}$$

Where

U = Total mark scored by the upper group on an item.

L = Total mark scored by the lower group on the item.

N = Size of the groups.

The discriminating power of each item was calculated and presented as table 8.

Table 8

Discriminating Power of Items of Optimism Inventory

Item No.	Upper	Lower	D_p	Remarks
1	49	21	0.28	Accepted
2	59	26	0.33	Accepted
3	81	64	0.17	Rejected
4	71	33	0.38	Accepted
5	64	30	0.34	Accepted
6	41	27	0.14	Rejected
7	68	46	0.22	Rejected
8	58	30	0.28	Accepted
9	62	31	0.31	Accepted
10	38	19	0.19	Rejected
11	40	19	0.21	Rejected
12	81	48	0.33	Accepted
13	65	28	0.37	Accepted
14	84	41	0.43	Accepted
15	84	47	0.37	Accepted
16	46	30	0.16	Rejected
17	67	36	0.31	Accepted
18	63	46	0.17	Rejected
19	27	29	-0.02	Rejected
20	62	33	0.29	Accepted
21	80	44	0.36	Accepted

Item No.	Upper	Lower	D_p	Remarks
22	42	33	0.09	Rejected
23	63	39	0.24	Rejected
24	41	28	0.13	Rejected
25	30	17	0.13	Rejected
26	75	46	0.29	Accepted
27	68	44	0.24	Rejected
28	58	34	0.24	Rejected
29	66	32	0.34	Accepted
30	62	27	0.35	Accepted
31	43	23	0.2	Rejected
32	60	26	0.34	Accepted
33	69	37	0.32	Accepted
34	76	45	0.31	Accepted
35	71	40	0.31	Accepted
36	52	22	0.3	Accepted
37	62	30	0.32	Accepted
38	26	15	0.11	Rejected
39	73	32	0.41	Accepted
40	64	30	0.34	Accepted
41	57	30	0.27	Accepted

Items with discrimination power greater than or equal to .25 were selected for the final tool. Based on this, 25 items were retained and 16 statements were rejected.

Scoring procedure

There are two options namely A, B for every item and one option shows optimistic and other shows not optimistic respectively. In this, one mark is given for choosing optimism and zero for the other. The total mark obtained by a student is

the optimism score.Option A in items 1, 8, 9, 13, 14, 17, 26, 29, 35, 37, 39 and option B in items 2, 4, 5, 12, 15, 20, 21, 30, 32, 33, 34, 36, 40, 41 denote optimism.

Reliability

Internal consistency of the tool was calculated by using KR-20 formula. The reliability coefficient obtained is .82, the value shows that the tool is highly reliable.

Validity

The Optimism Inventory has construct validity as the items were prepared on the basis of concept of Learned Optimism by Seligman (1992).

A copy of the draft and final form of the Optimism Inventory (Malayalam and English version) are appended as Appendix 3.

Scale on Academic Stress (Vijayakumari, Sajmadas & Midhundas, 2015)

The Scale on Academic stress was developed and standardized by the investigator, Sajmadas and supervising teacher, to measure the stress experienced by students during their academic period. Detailed description of the construction of the tool is given below.

Planning

The first step in the construction and standardization of any tool is planning. It was planned to prepare a scale to measure academic stress among secondary school students. After reviewing literature, the factors suggested by Lin and Chen

(2009) for academic stress were selected for the scale. The seven factors based on which the scale was prepared are given in table 9.

Table 9

Factors Affecting Academic Stress of Students

Stress from teachers	Teaching materials, teaching and exercise items.
Stress from results	Stress from Parents, including conflicts between expectations and opinions and drops in grades.
Stress from tests	Worry about how to prepare for a test and redo the compulsory courses.
Studying in group stress	Exercise reports, grouping, etc.
Peer stress	Academic competition, peer interferences, etc.
Time management stress	Social activities and student association, time management and choices, etc.
Self-inflicted stress	Self-expectation, interests of course selection, etc.

The detailed descriptions of the factors are as follows

Stress from Teachers

The cause for stress can be teacher related and such stress is rooted with teachers, their method of teaching, the teaching materials, and the exercise items assigned for students. Students become less interested and motivated to learn when their teachers do not have enough energy and passion for inspirational teaching (Klusmann, Kunter, Trautwein, Lüdtke, & Baumert, 2008; Skaalvik & Skaalvik, 2007). Way of teaching of particular teachers cannot be digested by certain pupils. Some lessons are too difficult and strict teachers lead them to reduce interest in associate subjects. This creates severe stress in pupils. Some teachers provide too

much data which causes difficulty to assimilate knowledge in a proper way. Lack of support from teachers is another cause of stress to students.

Stress from results

The stress from results is the feeling of anxiety when waiting for an exam result such as fear of failure, and stress from parents, including conflicts between expectations and opinions and drops in grades. A feel of failure in test papers is an important reason for test stress in the pupils.

Stress from tests

Perceived stress has been shown to increase during exam periods (Zunhammer, Eberle, Eichhammer & Busch, 2013). Test stress means getting a little nervous in a test situation. A student with test anxiety has debilitating feelings of worry and fear which impacts a negative performance. When the exam is getting nearer, the pressure of teachers and guardians upon the students become very high and hence they come under high stress. Lack of preparation, redoing of exams, illness, lack of memory, not getting enough sleep, test preparation etc also cause stress in pupils.

Studying in group stress

Learning in groups plays an important role in enhancing learning. Anxious thoughts in some students influence learning and often face problems when working with groups. Certain worries made obstacles to perform well and in completing academic works.

Peer stress

Peer pressure is the direct influence on students by their peers, or an individual who gets encouraged to follow their peers. They may change their attitudes, values, or behaviors and some behave strangely from their comfort zone. Peer stress is very strong during adolescence, is the period of stress and strain, so acceptance and sense of feelings are developed during this period. Generally academic competitions and useless interference among the peers contribute to peer stress.

Time management stress

An individual fails to cope up with balancing his commitments, such as academic work and volunteering sports, hobbies, and social activities, can sometimes make frustration. Time management is one of the most valuable skills one learns in schools, and is an important component for being successful.

For making a successful life, time scheduling is one of the valuable skills. Time management is an ability of decision making and helps each one how to allocate time to reaching their goals. Some students show maladjustment with scheduling the time between academic and social activities, with student association etc., that causes stress in them.

Self-inflicted stress

Self – inflicted stress is the stress due to inability to set a mind on how to manage the expectations, time, relationships, and interest. Stress is induced in the mind of the pupil due to various reasons like lack of timely preparation, emotional problems and some barriers. Family, illness, physical and mental disturbances etc also make stress in students.

Preparation of the Tool

While writing items for the scale based on the above dimensions, great care was taken to make it clear and simple. Based on the seven dimensions 35 statements were written and have undergone discussion with experts. According to the suggestions from experts some items were discarded and some were modified. Thus 32 items were selected for the draft scale. These 32 statements are so framed that the possible responses for each statement is Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) or Strongly Disagree (SD). The dimension, number of items in each dimension and sample items are given as table 10.

Table 10

Seven Dimensions and Number of Items under each Dimension

Sl. No.	Dimension	No. of items	Sample items
1	Stress from Teachers	6	I feel that the exercises and reports of some teachers are too difficult.
2	Stress from Results	7	I feel that there is vast difference between my current results and upper primary school results.
3	Stress from tests	5	I do not get good enough sleep at night because I worry about school tests.
4	Group stress	3	I feel nervous when I conducting a speech or give a presentation.
5	Peer stress	2	I feel anxiety that my exam results are not as good as those of my classmates are.
6	Time management stress	3	I feel that it is very difficult for me to adjust between my academic and social activities.
7	Self-inflicted stress	6	I have no interest in some subjects.

Try out

The draft scale was administered on a sample of 370 secondary school students of ninth standard selected through stratified sampling technique.

The strata considered are gender of students, locality and type of management of the school. For the try out, the investigator sought permission from the concerned authorities and administered the scale in the assigned class. Proper instructions were given regarding the procedure, especially the method of responding. Doubts were clarified during the administration of the scale. When the students completed their responses, the sheets were collected back and scored as per the scoring procedure.

The 370 response sheets obtained were scored and the total score for each sheet was calculated. Then these sheets were arranged in descending order of the total score and the lowest and highest 27 percent of the 370 sheets (100 sheets each) were separated. The mean and standard deviation obtained for each item for the lower and upper groups were calculated separately. The critical ratio for testing significance of difference between two means for large independent groups was calculated for each item using the formula

$$t = \frac{M_1 - M_2}{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

where M_1 is the mean score on an item in the Scale on Academic Stress for the upper group, M_2 is the mean score on the item for lower group, σ_1 is the standard

deviation of the scores for that item for upper group and σ_2 is the standard deviation of the scores on the item for the lower group.

After calculating critical ratio, items having critical ratio greater than or equal to 2.58 were included in the final scale. The details of items analysis of Scale on Academic Stress is given in table 11.

Table 11

Data and Results of Item Analysis of Scale on Academic Stress

Item No.	M_1	σ_1	M_2	σ_2	t-value	Remarks
1	4.26	1.03	2.39	1.24	11.56	Accepted
2	3.90	1.00	2.59	1.27	8.09	Accepted
3	3.73	1.91	2.79	1.23	6.11	Accepted
4	3.78	.83	2.73	1.44	6.27	Accepted
5	4.01	.88	2.76	1.33	7.81	Accepted
6	4.06	1.88	3.26	1.26	5.04	Accepted
7	4.29	.71	2.47	1.50	10.95	Accepted
8	3.86	1.02	2.04	1.29	11.02	Accepted
9	4.37	1.96	3.868	1.28	4.29	Accepted
10	3.90	1.10	2.50	1.32	8.12	Accepted
11	3.51	1.16	2.17	1.24	7.84	Accepted
12	3.85	1.06	3.10	1.28	4.49	Accepted
13	4.03	.99	2.32	1.14	11.25	Accepted
14	3.86	1.01	2.14	1.26	10.61	Accepted
15	3.62	1.16	2.19	1.13	8.80	Accepted
16	3.60	1.13	1.98	1.12	10.11	Accepted
17	4.21	.93	2.49	1.47	9.85	Accepted
18	4.29	.80	2.96	1.54	7.61	Accepted
19	3.36	1.03	2.05	1.13	8.56	Accepted

Item No.	M_1	σ_1	M_2	σ_2	t-value	Remarks
20	3.80	1.94	2.57	1.29	7.67	Accepted
21	3.92	.99	2.28	1.03	11.43	Accepted
22	3.85	.74	2.55	1.20	9.15	Accepted
23	3.35	1.15	1.85	.94	10.02	Accepted
24	3.97	.78	2.34	1.27	10.90	Accepted
25	4.00	1.96	2.16	1.18	12.03	Accepted
26	4.03	1.95	2.54	1.32	9.09	Accepted
27	4.07	.90	2.39	1.21	11.11	Accepted
28	3.14	1.27	1.75	1.03	8.46	Accepted
29	4.14	1.03	2.93	1.40	6.92	Accepted
30	3.32	1.29	1.82	1.11	8.78	Accepted
31	3.26	1.26	1.81	1.20	8.32	Accepted
32	4.10	.89	2.54	1.35	9.59	Accepted

The items with critical ratio, ‘t’ greater than 2.58, the tabled value of ‘ t’ required for significance at .01 level were selected for the final scale. Thus all the 32 items in the draft scale were selected for the final scale. A student needs approximately 20 minutes to respond to these 32 items.

Scoring Procedure

The Scale on Academic Stress is a five point Likert type Scale with responses- Strongly agrees (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). A score of 5 was given for a response Strongly Agree, 4 for Agree, 3 for Undecided, 2 for Disagree and 1 for Strongly Disagree. The minimum score obtainable in the scale is 32 and maximum is 160.

Reliability

The internal consistency of the scale was established by calculating Cronbach alpha coefficient. The value obtained is .87 (N=370) and hence the scale can be considered as a reliable one.

Validity

The validity of the present scale was ensured through face validity, content validity and concurrent validity. Content validity of the scale was ensured by taking much care in framing items for the scale. Suggestion from experts in the field was incorporated while preparing the scale. The items in the present scale were phrased in the least ambiguous way and the meaning of all the terms were clearly defined, so that the subjects responded to the items without difficulty and misunderstanding. Hence the scale possesses face validity. Concurrent validity of Scale on Academic stress was estimated by correlating with the score obtained by 30 students in the Academic stress Inventory developed by Department of Psychology, University of Calicut. The correlation coefficient obtained is .789 indicating that the scale is valid to measure Academic stress among secondary school students.

A copy of the final form of the Scale on Academic Stress (Malayalam and English version) is appended as Appendix 4.

Test of Problem Solving Ability in Mathematics (Sumangala & Rinsa, 2008)

Test of Problem Solving Ability in Mathematics developed by Sumangala and Rinsa (2008) was adopted for measuring Problem Solving Ability of students in Mathematics. Six types of problems viz., Logical problems, Algorithmic Problems,

Story Problems, Rule using Problems, Troubleshooting Problems, Situated case Problems are included in the test and there are 25 multiple choice items in the test. The total time limit for the test was fixed as 35 minutes. The number of items under each type of problem is given as table 12.

Table 12

Number of Items based on Types of Problems

Sl. No.	Types of problems	No. of Items
1	Logical problems	9
2	Algorithmic problems	4
3	Story problems	2
4	Rule using problems	7
5	Troubleshooting problems	2
6	Situated case problems	1
	Total	25

The types of problems included in the test are explained with sample item from each.

Logical problems

Logical problems are problems that need mental acuity, clarity and logical reasoning to reach at the solution.

Example: Raman walks in front of Krishnan, Rajan walks in front of Rama, Sethu walks in front of Rajan and Sita walks in front of Rama. Who is at the last?

Sita

Krishnan

Sethu

Rajan

Algorithmic Problems

For solving such problems, learners need to select and present the proper sequence of operations.

Example: If $1^3=1^2$, $1^3 + 2^3 =3^2$ $1^3+2^3+3^3+4^3=10^2$ then $1^3+2^3+3^3+4^3+5^3+6^3$ =?

21^2

15^2

6^2

21

Story Problems

Story problem is a mathematical exercise where significant background information needed to solve an algorithm is presented as a text. Using this, learners find out a mathematical equation for solving the problem; extract the values for the narrative and solve for the unknown quantity.

Example: Bimal went for a walk after sunrise in the early morning. After a while he met Stephen who was coming from the opposite direction. While talking to Stephen, Stephen's shadow appeared on Bimal's right side. So which direction was Bimal facing?

East

West

South

North

Rule using Problems

Many problems have correct solutions with multiple solution paths or multiple rules governing the process. They tend to have a clear purpose or goal that is constrained but not restricted to a specific procedure or method. The purpose of rule using problems is to find the most relevant information in the least amount of time.

Example: If the difference between 6 times and 8 times of a number is 40 then the number is?

240

320

40

20

Troubleshooting Problems

Troubleshooting Problem is one of the most common forms of everyday problem solving. The primary purpose of troubleshooting is fault state diagnosis. That is, some part of a system is not functioning properly, resulting in a set of symptoms, which have to be diagnosed and match with the user's knowledge of various fault states. Troubleshooting skills requires a combination of domain and

system knowledge, troubleshooting strategies such as search and replace, serial elimination, and space splitting and experience. These skills are integrated and organized by the trouble shooter's experience.

Examples: Find three different numbers in which the sum of reciprocals of these numbers is a natural number?

1,2,3

2,5,6

1,3,6

None of these.

Situated case Problems

Case problems are situations. Case problem requires the solver to articulate the nature of the problem and the different perspectives that impact the problem before suggesting solutions. They are contextual and justifying the decision is the most important process in solving the problem.

Example: A soap measures 5cm × 4cm × 1.5cm. How will you find how many soaps a card board box can contain, which measures 55cm × 48cm × 15cm.

$$\frac{5 \times 4 \times 1.5}{55 \times 48 \times 15}$$

$$\frac{5 \times 4 \times 1.5}{55 + 48 + 15}$$

$$\frac{55 \times 48 \times 15}{5 \times 4 \times 1.5}$$

$$\frac{55 + 48 + 15}{5 \times 4 \times 1.5}$$

Scoring procedure

The test contains 25 multiple choice items and the responses are given as a, b, c and d among which one is the correct answer and the other three are distractors. A separate answer sheet is provided along with the test which contains the four options for each item. A respondent has to mark his/her response by putting a (✓) mark against a letter denoting the answer that he/she thinks as the correct one. For each correct response a score of 1 is assigned whereas a zero score is given for an incorrect response. The maximum score obtainable in the test is 25 and the minimum is zero.

Reliability

The test developers have reported the reliability coefficient as .75 calculated by test- retest method (N=40). Hence the scores of the test can be considered as reliable.

Validity

Concurrent validity of Test of Problem Solving Ability in Mathematics was established by correlating the score of the test with the marks obtained by the students in another test of Problem Solving Ability in Mathematics developed by Sumangala and Vijayakumari (2000) using Pearson's Product Moment Coefficient of Correlation. The correlation coefficient obtained is 0.59. A significant positive correlation between the scores of the two tests indicates that the test is valid to measure Problem Solving Ability in Mathematics.

A copy of the Test of Problem solving ability in Mathematics is appended as Appendix 5.

Mathematics Anxiety Scale (Sumangala & Malini, 1993)

The variable Mathematics Anxiety was measured using the Scale of Mathematics Anxiety developed by Sumangala and Malini (1993) after re-standardization with the consent of the original developers. This scale is in the form of a five point Likert type Attitude scale and is intended to measure the extent of fear or the feeling of apprehension in working with Mathematics on the assumption that a feeling of apprehension would possibly spur a student into working hard and hence improve his/her performance. If the apprehension is so intense that the normal reasoning process is inhibited, then it is fear and hence debilitating anxiety. The original scale consists of 29 statements in which 23 are for measuring debilitating anxiety and 6 are for measuring facilitating anxiety. To each statement, students are to respond in any of the five ways, viz., Strongly agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD).

Example:

Debilitating anxiety: In the classroom, I face difficulties while doing calculations which I use daily.

Facilitating anxiety: Even if my answer is wrong, I will do calculations on the board if I get a chance.

As the scale was prepared more than 20 years back, it was re-standardized by the investigator. The Mathematics Anxiety Scale was administered on a sample of

370 secondary school students selected by stratified random sampling technique giving due representation to gender of the students, locale of the schools and type of management of schools. The 370 response sheets obtained were scored and the total score for each sheet was calculated. Then these sheets were arranged in descending order of the total score and the lowest and highest 27 percentage of the 370 sheets (100 sheets each) were separated. The mean and standard deviation obtained for each item for the lower group and upper group were calculated separately.

Then t-value for each item was calculated using the formula

$$t = \frac{M_1 - M_2}{\frac{\sigma_1^2}{N_1} + \frac{\sigma_2^2}{N_2}}$$

where M_1 is the mean score on Mathematics Anxiety obtained for an item for the upper group, M_2 is the mean score on Mathematics Anxiety obtained for that item for lower group, σ_1 is the standard deviation of the Mathematics Anxiety scores for that item for upper group and σ_2 is the standard deviation of the Mathematics Anxiety scores for that item for lower group. N_1 and N_2 stand for the size of upper and lower group respectively. After calculating critical ratio, items having critical ratio greater than or equal to 1.96 were selected for the final scale. The details of item analysis of Mathematics Anxiety scale are given in table 13.

Table 13

Data and Results of Item Analysis of Mathematics Anxiety Scale ($N_1=N_2=100$)

Item No	M_1	σ_1	M_2	σ_2	t-value	Remarks
1	2.20	1.35	4.30	1.13	11.88	Accepted
2	2.60	1.33	4.38	0.70	11.79	Accepted
3	2.67	1.31	4.01	1.07	7.89	Accepted
4	2.83	1.36	3.97	0.90	6.96	Accepted
5	3.07	1.40	3.96	1.01	5.11	Accepted
6	2.35	1.22	3.91	0.98	9.91	Accepted
7	2.58	1.34	2.88	1.35	1.57	Rejected
8	1.75	1.14	3.08	1.45	7.17	Accepted
9	2.84	1.38	3.94	1.02	6.44	Accepted
10	2.48	1.12	2.87	1.21	2.35	Accepted
11	3.07	1.38	4.18	0.94	6.60	Accepted
12	2.07	1.13	3.79	1.10	10.84	Accepted
13	2.14	1.24	3.90	1.05	10.75	Accepted
14	2.92	1.24	3.61	1.17	4.03	Accepted
15	1.88	1.05	3.67	1.23	11.03	Accepted
16	2.12	1.28	4.29	1.14	12.56	Accepted
17	2.32	1.20	3.92	1.04	10.04	Accepted
18	1.83	0.94	3.53	1.30	10.55	Accepted
19	1.28	0.60	3.32	1.37	13.56	Accepted
20	1.87	1.16	3.47	1.34	8.98	Accepted
21	2.00	0.99	3.92	1.05	13.26	Accepted
22	2.20	1.19	2.45	1.29	1.42	Rejected
23	2.38	1.10	3.93	1.06	10.08	Accepted
24	2.64	1.32	2.84	1.23	1.10	Rejected
25	2.62	1.24	4.13	0.97	9.56	Accepted
26	2.43	1.09	4.06	0.91	11.40	Accepted
27	2.27	1.21	2.53	1.29	1.46	Rejected
28	2.63	1.31	2.81	1.32	0.96	Rejected
29	2.58	1.27	4.05	1.18	8.45	Accepted

Items with critical ratio greater than 1.96, the value required for significance at .05 level were selected for the final scale. Thus 24 items were selected for the final scale and five items were rejected. Among 24 items, one item is for facilitating anxiety and the 23 items are for debilitating anxiety. A student needs approximately15 minutes to complete responses of the 24 items.

Scoring Procedure

The Mathematics Anxiety Scale is a five point Likert Scale with responses- Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D) and Strongly Disagree (SD). For a debilitating Anxiety item, the scores assigned are 5, 4, 3, 2 and 1 and for facilitating Anxiety item, the scores assigned are 1, 2, 3, 4 and 5 for the responses SA, A, U, D and SD respectively. The sum of scores for all the items is the score on the Mathematics Anxiety Scale.

The revised version of Mathematics Anxiety scale contains 24 items and the minimum score obtainable is 24 and the maximum score is 120.

Reliability

The test developers have claimed that the test- retest reliability coefficient as .86 (N = 35) and the Cronbach's Alpha coefficient as .80 (N = 100). Cronbach Alpha coefficient was calculated for the revised version of Mathematics Anxiety scale to test the internal consistency of the scale. The value obtained is .85 indicating that the scale is a reliable one. The alpha coefficient when each item is dropped is given as table 14.

Table 14

Item – Excluded Alpha Coefficient for the Mathematics Anxiety Scale

Item No.	Cronbach's α	Item No.	Cronbach's α
1	0.830	13	0.842
2	0.825	14	0.832
3	0.833	15	0.828
4	0.831	16	0.831
5	0.836	17	0.830
6	0.828	18	0.829
7	0.838	19	0.831
8	0.835	20	0.822
9	0.842	21	0.827
10	0.836	22	0.831
11	0.828	23	0.827
12	0.829	24	0.830

The values of Alpha coefficient when each item is dropped from the set of 24 items are less than the value obtained from the entire set of the 24 items and hence the 24 items in the scale sufficiently explains the construct, Mathematics Anxiety.

Thus the items of the revised version of Mathematics Anxiety Scale are internally consistent and hence the scale is reliable.

Validity

The statements of the original scale were phrased in the least ambiguous way and hence wording of the statement will suggest that the scale is a good measure of Mathematics Anxiety. So it can be said that the scale has face validity.

Construct validity of the scale was examined by the developers through testing the following hypotheses.

i. The measure of the scale will discriminate significantly between high and low achievers in Mathematics.

ii. The measures of the scale will be negatively related to measures of the scale of Self Concept in Mathematics by testing, using a sample of 30 students the above two hypotheses were found confirmed. (t-value 38.207 and r = -.632). Validity of the scale was estimated empirically by comparing the scores on the scale with the scores of Kerala Examination Anxiety scale (Nair,1976) and by correlating with Achievement scores in Mathematics. The correlation coefficients obtained are .57 and -.64 (N = 40) respectively.

As no change in the structure of the scale was made, the revised version of the scale is also valid to measure Mathematics Anxiety of secondary school students.

A copy of the final Mathematics Anxiety Scale is appended as Appendix 6.

Locus of Control Scale (Kunhikrishnan & Mathew, 1987, Re-standardized by Manikandan & Sujisha, 2017)

The scale was developed by Kunhikrishnan and Mathew (1987) on the basis of Rotter I-E Scale and Reid-Ware Three Factor Scale. The original scale contained 70 items with possible responses as right or wrong. The items are to be scored in favour of external locus of control.

The original scale was re-standardized by Manikandan and Sujisha (2017). The modified scale contains 46 items, the pattern of responding and scoring being the same as the original version.

Example: If you start a day well, all the other activities of the day will be good.

Scoring procedure

For an item indicating external Locus of Control, a score of '1' is to be given for the response 'Right' and for the response 'Wrong' zero. For the reverse items, the scoring is in the reverse order. The total score obtainable in the scale is 46 and minimum zero.

Reliability

Reliability of the original scale was estimated by split- half method (N=200) and the reliability coefficient reported is .825.

Reliability of the modified form was estimated by Manikandan and Sujisha (2017) using test- retest method and reliability coefficient obtained is .78. The values show that the scale is a reliable one.

Validity

Criterion related validity was established by taking the external criterion as the scores on Locus of Control Questionnaire (Kunhikrishnan, Chandran & Kuruvilla, 1979). The correlation coefficient obtained is .72 which indicates that the scale is valid to measure Locus of Control.

A copy of the Locus of Control Scale is appended as Appendix 7.

Data Collection Procedure

After making a clear idea about the sample, the investigator prepared a detailed plan of procedure for data collection. The investigator visited the schools selected for data collection and sought permission from the heads of the institution officially. After getting permission, the investigator contacted the teachers in charge of the assigned classes and informed them about the nature of data collection. Six instruments were to be administered among students in order to collect necessary data and it took approximately 3 hours to complete the administration of the instruments. The investigator informed the purpose and nature of data collection procedure to students and ensured the confidentiality of data. After seeking their co-operation the investigator administered the instruments one by one by giving proper instruction and working out examples (especially for Mathematical Creativity Test). While administering the Mathematical Creativity Test and Test of Problem Solving ability in Mathematics, the time schedule was strictly followed. For other instruments, when students completed their responses for one instrument, the sheets were collected back and the next instrument was distributed. At most care was taken to make the data collection procedure uniform to all the groups.

Scoring and Consolidation of Data

The response sheets were sorted and arranged the set for each participant. The incomplete response sheets were discarded, and if one response sheet of a participant is found to be incomplete, the entire set of response sheets of that participant was rejected. This reduced the final sample size to 700, though data was collected from 800 students.

The breakup of the final sample was presented in figure 3.

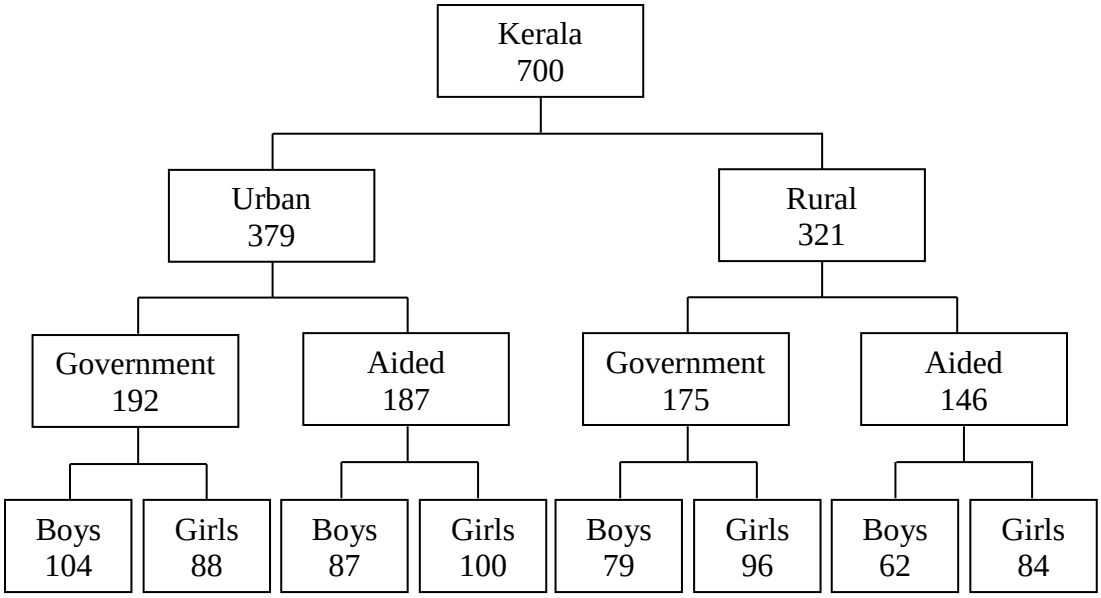


Figure 3. Breakup of the final sample

Each response sheet was scored based on the scoring procedure and tabulated in the Excel worksheet. The statistical analysis was carried out using statistical package for social sciences (SPSS) and JAMOVI.

Statistical Techniques

The data collected was systematically tabulated, consolidated and subjected to suitable statistical analysis. This part deals with a detailed description of statistical techniques employed to test the tenability of the hypotheses formulated for the present study. Statistical techniques used for the present study are explained below.

Preliminary Analysis

Descriptive statistical measures such as mean, standard deviation and deciles of the scores on dependent variable were calculated for the total sample and subsamples based on gender of the students, locality and type of management of school. 99 percent Confidence Interval for Mean of Mathematical Creativity was calculated to estimate the population mean. Skewness and Kurtosis of the distribution for the total sample were also calculated.

Pearson's Product Moment Coefficient of Correlation

Pearson's correlation coefficient is the test statistics that measures the statistical relationship between two continuous variables. It gives information about the magnitude of the correlation, as well as the direction of the relationship.

Pearson's Product Moment Coefficient of Correlation 'r' was used to estimate the extent of relation between Mathematical Creativity and the select Psychological variables. Shared variance ($r^2 \times 100$) was calculated to know the variance accounted for by one variable on other.

Multiple Regression Analysis

Multiple regression equation for Mathematical Creativity with problem solving ability in mathematics, academic stress, mathematics anxiety, locus of control and optimism was developed. The method of multiple regression analysis deals with estimating a dependent variable from some combination of a number of independent variables.

Multiple regression analysis is used to explain the relationship between two or more independent variables and one dependent variable. A dependent variable is formed as a function of several independent variables with corresponding coefficients, along with the constant term. A regression equation is developed to predict the dependent variable from the select independent variables.

The multiple regression equation can be explained as

$$y = b_1x_1 + b_2x_2 + \ldots + b_nx_n + c.$$

Here, b_1,b_2…..b_n are the regression coefficients, which represent the value at which the criterion variable changes when the predictor variable changes. The b values explain the degree at which each predictor variable affects the criterion variable when the effects of all other predictor variables are kept constant.

Multiple regression analysis was used for the present study to predict individual and joint effect of the select psychological variables on Mathematical Creativity. Forced entry method was used for this using JAMOVI

Regression analysis being a parametric test has to satisfy some assumptions, major ones being the assumptions on Homoscedasticity, Autocorrelation, Multicollinearity and Normality of the residuals.

While using multiple regression, first of all the predictor variables must be measured in an interval or ratio scale (or dichotomous) and the criterion variable must be quantitative/ in interval or ratio scale, continuous and unbounded. Also the predictor variables are expected to have non zero variance.

Homoscedasticity means equality of the variance of the residuals at each level of the independent variables. The assumption of homoscedasticity can be tested through Levene's test or can be interpreted from the data through scatter plot of standardized residuals against standardized predicted values.

Autocorrelation means when regression analysis is performed on data taken over successive time intervals the residuals are often correlated. Assumption of independent error or absence of autocorrelation can be tested by calculating Durbin-Watson statistics. The value varies from zero to four, as a rule of thumb, it is accepted that a value less than one or greater than three indicates presence of autocorrelation. A value greater than one, near to two indicates lack of autocorrelation.

Multicollinearity is the existence of linear relationships between two or more independent variables. The presence of multicollinearity between variables causes some difficulties with the regression analysis. So it should therefore be ensured that the data do not show Multicollinearity. The assumption of multicollinearity can be tested using Variance Inflation Factors (VIF). VIF's less than 10 and tolerance statistics greater than .2 indicate absence of linear relation between the predictor variables.

The assumption of normality determined by underline residuals are normally distributed and is tested by using Shapiro – Wilk test. It is assumed that the residuals are random variables that are normally distributed with mean zero.

The results of multiple regression analysis are interpreted through the following values.

Regression Coefficients: The coefficients of the predictor variables in the regression equation formed are known as regression coefficients or b-values. A positive b-value indicates a positive relation between that predictor variable and the criterion variable, whereas a negative b-value indicates a negative relationship between the variables. It indicates the degree of the effect of the predictor variable on the criterion variable, the effects of other variables being considered as constant. t-values calculated for each b-values gives idea about whether the b-value is significantly different from zero. Variables with a non-zero b-values are taken as significant predictors of the criterion variable.

Standardized Regression Coefficients: The β values are the standardised b- values which are independent of the units of measurement. The beta value explains the number of standard deviations that the criterion variable will change as the result of change in the predictor variable by one standard deviation.

Structure Coefficient: It is the coefficient obtained by dividing the bivariate correlation coefficient between the predictor variable and the criterion variable by the multiple correlation. A squared value of structural coefficient gives information on how much variance of R^2 effect, the predictor can explain or the explained variance accounted for by the predictor variable (Ziglari, 2017).

R and R^2: R is the correlation between the observed and the predicted values of the dependent variable. R^2 indicates how close the observed data are to the fitted

regression line. It is the percentage of variation or the amount of variance in the data explained by the model. F-value is calculated to know the significance of R^2.

Adjusted R^2 denotes the amount of variance in Y accounted for by the model if it is derived from the population than the sample values. A negligible difference between R^2 and adjusted R^2 shows the model is valid to predict the criterion variable. That is adjusted R^2 is calculated to cross- validate the regression model.

Proportional reduction in error (PRE): PRE is an index for the extent that knowing a variable helps to predict the criterion variable. A value of zero indicates no reduction in error where as a value of 1 indicates complete prediction. Usually a value greater than .4 is taken for representing a strong reduction in error. It is calculated by finding the difference between the residuals of the models with and without the variable and dividing it with the residual in the model without that predictor variable.

Conclusion

This chapter focuses on the method, participants, instruments used, data collection procedure and the statistical techniques used for analyzing the data. A detailed description of the instruments developed by the investigator is also attempted in this chapter.

Chapter 4

ANALYSIS AND INTERPRETATION

- Extent of Mathematical Creativity among Secondary School Students
- Relationship between Mathematical Creativity and the Select Psychological Variables
- Efficiency of the Select Psychological Variables in Predicting Mathematical Creativity

Analysis of data is a vital step in research as it helps the researcher to address research questions or testing the hypotheses. As Marshall and Rossman (1990) describe, analysis of data helps to arrange the collected data in order, makes it structured and gives meaning by describing the nature of the data and coming up with findings and their conclusion.

This chapter includes analysis of the data collected, followed by discussion of the results. Analysis of the collected data was done according to the objectives and hypotheses of the study and the details are given under the major headings viz.,

- Extent of Mathematical Creativity among secondary school students.
- Relationship between Mathematical Creativity and the select Psychological Variables.
- Efficiency of the select Psychological Variables in Predicting Mathematical Creativity.

The major objectives based on which analysis was done are the following.

- To find out the extent of Mathematical Creativity among secondary school students of Kerala.

- To find out whether the select psychological variables are significantly related to Mathematical Creativity of secondary school students.
- To develop a regression equation for predicting Mathematical Creativity with the select psychological variables.
- To find out the relative efficiency of the select psychological variables in predicting Mathematical Creativity.

Extent of Mathematical Creativity among Secondary School Students

The Mathematical Creativity Test used in the study for measuring Mathematical Creativity among secondary school students of Kerala contains 10 items and the scoring pattern of the test suggests that the minimum score on the test is zero, but there is no maximum score. In the data collected from 700 secondary school students, the least value obtained is two and the maximum value is 201.

To know the extent of Mathematical Creativity among secondary school students, the mean, standard deviation and 99 percent confidence interval for mean were calculated for the total sample and the subsamples based on gender of the students, type of management and locale of the school. The values are given in table 15.

Table 15

Extent of Mathematical Creativity among Secondary School Students

Group	N	Mean	SD	99 Percent Confidence Interval	
				Lower Limit	Upper Limit
Total	700	79.1	35.5	75.63	82.56
Boys	332	80.9	35.3	75.91	85.89
Girls	368	77.5	35.6	72.72	82.28
Government	367	73.9	33.2	69.48	78.31
Aided	333	84.9	37.1	79.65	90.14
Urban	379	81.1	30.7	77.03	85.16
Rural	321	76.8	40.4	70.98	82.61

Result and Discussion

Table 15 shows that the mean score of Mathematical Creativity obtained for the total sample (N=700) is 79.1 with standard deviation 35.5. The 99 percent confidence interval for mean is (75.63, 82.56). This indicates that the probability that the mean score of Mathematical Creativity of secondary school students of Kerala will be in between 75.63 and 82.56 is .99, the probability that the value may be outside this interval is being less than or equal to .01.

The mean score of Mathematical Creativity obtained for boys (N=332) is 80.9 with standard deviation 35.3. The 99 percent confidence interval for mean is (75.91, 85.89). This indicates that the mean score of Mathematical Creativity of secondary school boy students will be in between 75.91 and 85.89 with a confidence

of 99 percent and the maximum number of cases that may lie outside this interval is only 1 out of 100.

From table 15 it is found that the mean score of Mathematical Creativity obtained for girls (N=368) is 77.5 with standard deviation 35.6. The 99 percent confidence interval for mean is (72.72, 82.28). This indicates that the probability that the mean score of Mathematical Creativity of secondary school girl students will be in between 72.72 and 82.28 is .99. The probability that the value may lie outside this interval is less than or equal to .01.

Table 15 shows that the mean score of Mathematical Creativity obtained for the government secondary school students (N=376) is 73.9 with a standard deviation 33.2. The 99 percent confidence interval for mean is (69.48, 78.31). This indicates that the mean score of Mathematical Creativity of government secondary school students of Kerala will be in between 69.48 and 78.31, with a probability of .99, the probability that the value may be outside this interval be less than or equal to .01.

The mean score of Mathematical Creativity obtained for the aided secondary school students (N=333) is 84.9 with standard deviation 37.1(Table 15). The 99 percent confidence interval for mean is (79.65, 90.14). This indicates that the probability of the mean score of Mathematical Creativity of aided secondary school students of Kerala to be in between 79.65 and 90.14 is .99, the probability that the value may lie outside this interval is being less than or equal to .01.

Table 15 shows that the mean score of Mathematical Creativity obtained for the urban secondary school students (N=379) is 81.1 with standard deviation 30.7.

The 99 percent confidence interval for mean is (77.03, 85.16). This indicates that it is 99 percent confident that the mean Mathematical Creativity score of urban secondary school students of Kerala will be in between 77.03 and 85.16.The probability that the value may be outside this interval is less than or equal to.01.

From table 15 it can be seen that the mean score of Mathematical Creativity obtained for the rural secondary school students (N=321) is 76.8 with a standard deviation 40.4. The 99 percent confidence interval for mean is (70.98, 82.61). This indicates that the probability that the mean score of Mathematical Creativity of rural secondary school students of Kerala will be in between 70.98 and 82.61 is .99. The probability that the value may lie outside this interval is less than or equal to .01.

To get a clear picture of the distribution of data, deciles were calculated for the total group and subgroups based on Gender, Locale and Type of Management. Details are given in table 16.

Table 16

Deciles for the Total group and Sub groups based on Gender, Locale, and Type of Management

	Deciles								
Group	P_{10}	P_{20}	P_{30}	P_{40}	P_{50}	P_{60}	P_{70}	P_{80}	P_{90}
Total	38	48	57.7	66.6	76	84	94.3	107	126
Boys	38.1	47.2	58	69	80	88.6	100	109	131
Girls	38	48	57	65	75	82	91	103	124
Government	35	43	52	61	73	80.6	90	102	119
Aided	42.2	55	63	72.8	82	89	100	115	132
Urban	44	55	62	72	79	86	94	103	119
Rural	30	41	50	61	74	82	95	112	132

Results and Discussion

Table 16 gives the values of the deciles calculated for the variable Mathematical Creativity for the total group as P_{10} (D_1) 38, P_{20} (D_2) 48, P_{30} (D_3) 57.7, P_{40} (D_4) 66.6, P_{50} (D_5) 76, P_{60} (D_6) 84, P_{70} (D_7) 94.3, P_{80} (D_8) 107 and P_{90} (D_9) 126. The tenth percentile score of Mathematical Creativity for secondary school students of Kerala is 38 which means that ten percent of secondary school students in Kerala are having Mathematical Creativity scores measured through the Mathematical Creativity Test is less than 38. The score of 48 as P_{20} means that 20 percent of secondary school students of Kerala have score on Mathematical Creativity less than 48. The score of 57.7 as P_{30} indicates that 30 percent of secondary school students in Kerala have a score on Mathematical Creativity less than 57.7. The score of 66.6 as P_{40} means that 40 percent of secondary school students of Kerala have score on Mathematical Creativity less than 66.6. The score of 76 as P_{50} indicates that 50 percent of secondary school students of Kerala have score on Mathematical Creativity less than 76. The score of 84 as P_{60} means that 60 percent of secondary school students of Kerala have score on Mathematical Creativity less than 84. The score of 94.3 as P_{70} indicates that 70 percent of secondary school students of Kerala have score on Mathematical Creativity less than 94.3. P_{80} is 107 indicating that 80 percent of the entire group of secondary school students of Kerala have score on Mathematical Creativity less than 107. P_{90} as 126 indicates that ten percent of the population have score on Mathematical Creativity greater than 126.

In the case of boys, the tenth percentile score of Mathematical Creativity is 38.1, whereas it is 38 for the total group. But P_{20} for boys is slightly less than that of the total group and all other calculated percentiles are greater than that of the total group. Ten percent of the secondary school boy students have score greater than 131, whereas it is 126 in the case of the total group.

Table 16 gives the values of the deciles calculated for the variable Mathematical Creativity for the secondary school girl students. All the deciles for girls are less than that of the total group, except the first and second deciles (P_{10} and P_{20}) which are equal to that of the total group.

The nine deciles calculated for the variable Mathematical Creativity for the government secondary school students as given in table 16 are 35, 43, 52, 61, 73, 80.6, 90, 102 and 119 which are less than that of the total group. But in the case of aided school students, the values of the deciles calculated are 42.2, 55, 63, 72.8, 82, 89, 100, 115 and 132 respectively which are greater than the deciles for the total group.

The values of the deciles calculated for the variable Mathematical Creativity for the urban secondary school students as given in Table 16. All the deciles for urban school students are greater than that of the total group, except the decile values D_7, D_8 and D_9 which are less than that of the total group. But in the case of rural school students, all the decile values are less than that of the total group, except D_7, D_8 and D_9 which are greater than that of the total group.

The histogram and the frequency curve of the data on Mathematical Creativity of secondary school students were drawn and presented as figure 4.

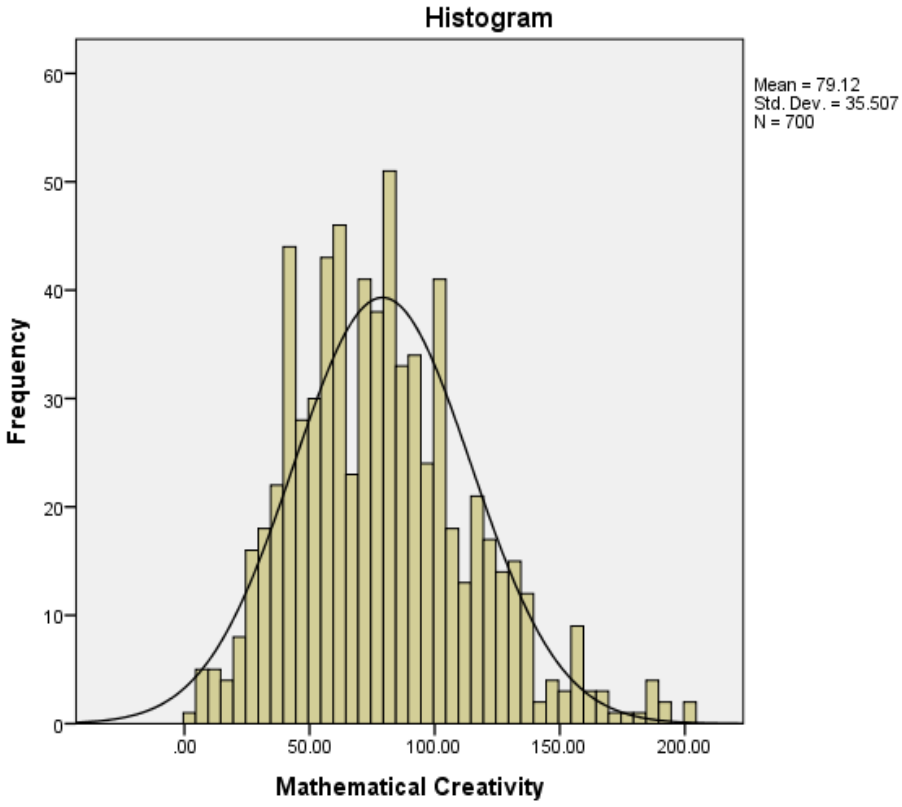


Figure 4. Histogram and frequency curve of the distribution of Mathematical Creativity scores of secondary school students measured through Mathematical Creativity Test. (N=700)

The histogram shows that the students with high score in Mathematical Creativity are comparatively less than that with low score.

The values of skewness and kurtosis for Mathematical Creativity were calculated. The details are given as table 17.

Table 17

Skewness and Kurtosis of the distribution of Mathematical Creativity

Statistic	Values	SE
Skewness	0.604	0.092
Kurtosis	0.406	0.185

The skewness of the distribution was found to be 0.604. The value shows that the distribution is slightly positively skewed. That is the number of students who got higher score is comparatively less than the students who got lower scores in Mathematical Creativity. The kurtosis value was found to be 0.406. The value suggests a slightly leptokurtic curve. But both the values are less than 1.5 indicating that the distribution is not remarkably deviating from symmetry and the distribution is mesokurtic. Hence the distribution of scores for Mathematical Creativity is not deviating from normality.

The highest score obtained for Mathematical Creativity in the sample is 201 but the mean score is 79.1 which is far below the highest score obtained. On the basis of the mean score of Mathematical Creativity obtained for the total sample with standard deviation, the deciles for the total group, the confidence interval and histogram representation, it was found that Mathematical Creativity is not at a satisfactory level among secondary school students of Kerala. Below average level of Mathematical Creativity among secondary school students of Israel and Indonesia was reported in the studies of Aizikovitsh-Udi (2014) and Isnani, Waluya, Rochmad and Wardono (2020) respectively.

Relationship between Mathematical Creativity and the select Psychological Variables

For the purpose of analyzing the relationship between the variable Mathematical Creativity and the select psychological variables of secondary school students, Pearson's Product Moment Coefficient of Correlation was used. The coefficient of correlation was calculated for each predictor variable with Mathematical Creativity and its components viz., Fluency, Flexibility and Originality. Shared variance was also calculated in each case and the details are presented in table 18.

Table 18

Pearson's Product Moment Coefficient of Correlation and Shared Variance (r^2 ×100) for Mathematical Creativity and the Select Psychological Variables

Variable	Problem solving ability in Mathematics	Academic Stress	Mathematics Anxiety	Locus of Control	Optimism
Mathematical Creativity	.502** (25.2)	-.173** (2.99)	-.261** (6.81)	-.281** (7.89)	.047
Fluency	.489** (23.91)	-.165** (2.72)	-.258** (6.65)	-.284** (8.06)	.025
Flexibility	.398** (15.84)	-.151** (2.28)	-.185** (3.42)	-.209** (4.36)	.068
Originality	.367** (13.46)	-.125** (1.56)	-.200** (4)	-.190** (3.61)	.063

Result and Discussion

From table 18 it can be seen that Pearson's coefficient of correlation for Mathematical Creativity and Problem Solving Ability in Mathematics is .502. As this value is greater than tabled value .101 for significance at .01 level (N = 700), the relationship between the two variables are significant. The positive sign indicates a positive relationship between the variables. The magnitude of 'r' shows that there exists a substantial relationship between Problem Solving Ability in Mathematics and Mathematical Creativity. The shared variance obtained is 25.2 and it shows that Problem Solving Ability in Mathematics accounts for 25.2 percent of the variance in Mathematical Creativity.

The analysis of correlation coefficient obtained for Problem Solving Ability in Mathematics and Mathematical Creativity showed that the two variables are substantially, positively related and the relationship is significant. The same result was reported by Tyagi (2015) and Kavitha (2009) among secondary school students of India, Moore-Russo and Demler (2018) among instructors and staff associated with a gifted mathematics program in the United States, Torrance (1987) and Ayllon, Gomez and Ballesta-Claver (2016).

When Mathematical Creativity and Academic Stress are considered, the 'r' value obtained is -.173, which is greater than tabled value .101 (N= 700), for significance at .01 level. Hence Mathematical Creativity and Academic Stress are significantly related, but the relationship is negative and very low. That is, Mathematical Creativity decreases at a low rate when the Academic Stress increases.

Academic Stress is accounted for 2.99 percent of the variance in Mathematical Creativity.

That is Academic Stress and Mathematical Creativity are significantly related, the relationship is low and negative. The meta-analysis of 76 experimental studies conducted by Byron, Khazanchi and Nazarian (2010) supports the finding of a negative relationship between Creativity and Stress.

From table 18, the coefficient of correlation for the variables Mathematical Creativity and Mathematics Anxiety (N=700) is -.261. This value is greater than the tabled value of 'r' (N = 700, α = .01) showing that the relationship between the two variables is significant at .01 level. The negative sign indicates a negative relationship, explained as for an increase in one variable there is a corresponding decrease in the other variable. The magnitude of 'r' shows that the relationship is low. That is, Mathematical Creativity and Mathematics Anxiety are significantly negatively related but the extent of relationship is low. When shared variance is considered (6.812), it can be inferred that the percentage of variance in Mathematical Creativity explained by variance in Mathematics Anxiety is about 6.8 percent.

The study revealed that Mathematics Anxiety and Mathematical Creativity are significantly related, the relationship is low and negative. This finding of the study is in line with the findings of studies by Sharma (2014), Midhundas and Vijayakumari (2016) and Johny (2008) among secondary school students of India. Haylock (1987) in a study on three middle school students aged between 11 - 22 years of Norwich, also reported the same result. Fetterly (2010) also found a

significant relationship between Mathematical Creativity and Mathematics Anxiety and reported that an interposed, intentional experience to Mathematical Creativity, at least in some cases lowers Mathematics Anxiety among pre service elementary education teachers.

The coefficient of correlation obtained for Mathematical Creativity and Locus of Control is -.281. As this value is greater than tabled value .101 for the significance at .01 level (N=700), the two variables are negatively related. The 'r' value has a magnitude that indicates a slight low relationship between the variables. Locus of Control accounts for 7.89 percent of the variance in Mathematical Creativity.

Analysis of correlation coefficient obtained for Locus of Control (External) and Mathematical Creativity showed that the relationship between the two variables is significant and the relationship is negative and low. This finding is agreeable with the finding of the study by Lather, Jain and Shukla (2014) among students of University of Mysore.

Pearson's coefficient of correlation 'r' for Mathematical Creativity and Optimism is .047. This value is less than the table value .078 (N= 700) which shows that the relationship between Mathematical Creativity and Optimism is not significant at .05 level.

That is, Optimism and Mathematical Creativity are not significantly related. This finding is concomitant with the finding of Sanchez, Brufau, Mendez, Corbalan and Liminana (2010) in the study among Murcia university students from Spain.

Midhundas and Vijayakumari (2015) found a significant positive and low relationship between Optimism and Mathematical Creativity among secondary school students.

From table 18 it can be seen that Pearson's coefficient of correlation for Fluency and Problem Solving Ability in Mathematics is .489. As this value is greater than tabled value .101 for significance at .01 level (N = 700), the two variables are significantly related. The positive sign indicates a positive relationship between the variables. The magnitude of 'r' shows that there exists a substantial relationship between Problem Solving Ability in Mathematics and Fluency. When shared variance is considered (23.91), it can be inferred that the percentage of variance in Fluency explained by variance in Problem Solving Ability in Mathematics is about 24 percent.

When Fluency and Academic Stress are considered, the 'r' value obtained is -.165, which is greater than tabled value .101 (N= 700), for significance at .01 level. That is, Fluency and Academic Stress are significantly related, but the relationship is negative and very low. That is, Fluency decreases when the Academic Stress increases but the rate of change is very low. When shared variance is considered (2.722), it can be inferred that the percentage of variance in Fluency explained by variance in Academic Stress is about 2.7 percent.

From table 18, the coefficient of correlation for the variables Fluency and Mathematics Anxiety for the total sample (N=700) is -.258. This value is greater than the tabled value of 'r' (N = 700, α = .01) showing that the relationship between the two variables is significant at .01 level. The negative sign indicates a negative

relationship, explained as for an increase in one variable there is a corresponding decrease in the other variable. The magnitude of 'r' shows that the relationship is low. That is, Fluency and Mathematics Anxiety are significantly negatively related but the extent of relationship is low.

The coefficient of correlation obtained for Fluency and Locus of Control is -.284. As this value is greater than tabled value .101 for the significance at .01 level (N=700), the two variables are negatively related. The 'r' value has a magnitude that indicates a slight low relationship between the variables. Locus of Control is accounted for 8 percent of the variance in Fluency.

Pearson's coefficient of correlation 'r' for Fluency and Optimism is .025. This value is less than the table value .078, (N= 700) which shows that there is no significant relationship between Optimism and Fluency at .05 level.

From table 18 it can be seen that Pearson's coefficient of correlation for Flexibility and Problem Solving Ability in Mathematics is .398. As this value is greater than tabled value .101 for significance at .01 level (N = 700), the two variables are significantly related. The positive sign indicates a positive relationship between the variables. The magnitude of 'r' shows that there exists a low relationship between Flexibility and Problem Solving Ability in Mathematics. When shared variance is considered (15.84), it can be inferred that the percentage of variance in Flexibility explained by variance in Problem Solving Ability in Mathematics is about 15.8 percent.

When Flexibility and Academic Stress are considered, the 'r' value obtained is -.151, which is greater than tabled value .101 (N= 700), for significance at .01 level. That is, Flexibility and Academic Stress are significantly related, but the relationship is negative and very low. That is, Flexibility decreases by a small amount when the Academic Stress increases. Academic Stress accounts for 2 percent of the variance in Flexibility.

The coefficient of correlation for the variables Flexibility and Mathematics Anxiety for the total sample (N=700) is -.185. This value is greater than the tabled value of 'r' (N = 700, α = .01) showing that the relationship between the two variables is significant at .01 level. The negative sign indicates a negative relationship, explained as for an increase in one variable there is a corresponding decrease in the other variable. The magnitude of 'r' shows that the relationship is very low. That is, Flexibility and Mathematics Anxiety are significantly negatively related but the extent of relationship is low.

The coefficient of correlation obtained for Flexibility and Locus of Control is -.209. As this value is greater than tabled value .101 for the significance at .01 level (N=700), the two variables are negatively related. The 'r' value has a magnitude that indicates a low relationship between the variables. The obtained shared variance is 4.368, that is 4 percent variance in Flexibility is explained by variance in Locus of Control.

Pearson's coefficient of correlation 'r' for Flexibility and Optimism is .068. This value is less than the table value .078, (N= 700) which shows that there is no significant relationship between Optimism and Flexibility at .05 level.

From table 18 it can be seen that Pearson's coefficient of correlation for Originality and Problem Solving Ability in Mathematics is .367. As this value is greater than tabled value .101 for significance at .01 level (N = 700), the two variables are significantly related. The positive sign indicates a positive relationship between the variables. The magnitude of 'r' shows that there exists a low relationship between Originality and Problem Solving Ability in Mathematics. Problem Solving Ability in Mathematics accounts for 13 percent of the variance in Originality.

When Originality and Academic Stress are considered, the 'r' value obtained is -.125, which is greater than tabled value .101 (N= 700), for significance at .01 level. That is, Originality and Academic Stress are significantly related, but the relationship is negative and very low. That is, Originality decreases at a low rate when the Academic Stress increases. When shared variance is considered (1.562), it can be inferred that the percentage of variance in Originality explained by variance in Academic Stress is only 1.5 percent.

From table 18, the coefficient of correlation for the variables Originality and Mathematics Anxiety for the total sample (N=700) is -.200. This value is greater than the tabled value of 'r' (N = 700, α = .01) showing that the relationship between the two variables is significant at .01 level. The negative sign indicates a negative relationship, explained as for an increase in one variable there is a corresponding decrease in the other variable. The magnitude of 'r' shows that the relationship is low. That is, Originality and Mathematics Anxiety are significantly negatively related but the extent of relationship is low.

The coefficient of correlation obtained for Originality and Locus of Control is -.190. As this value is greater than tabled value .101 for the significance at .01 level (N=700), the two variables are negatively related. The 'r' value has a magnitude that indicates a very low relationship between the variables. The obtained shared variance is 3.61, that is 3.6 percent variance in Originality is explained by variance in Locus of Control.

Pearson's coefficient of correlation 'r' for Originality and Optimism is .063. This value is less than the table value .078, (N= 700) which shows that there is no significant relationship between Originality and Optimism at .05 level.

Efficiency of the select Psychological Variables in Predicting Mathematical Creativity

Multiple regression analysis was done to develop a model to predict values of Mathematical Creativity from the select psychological variables. Basic input of regression analysis is the correlation matrix. The correlation coefficients for the select variables except Optimism with Mathematical Creativity were calculated and the matrix is presented as table 15. The variable Optimism was excluded from the set of predictor variables as the variable was found to have no significant correlation with Mathematical Creativity even at .05 level.

Table 19

Correlation Matrix of the Select Variables with Mathematical Creativity (N=700)

Sl. No	Variables	Mathe-matical Creativity	Problem Solving Ability in Mathematics	Academic Stress	Mathematics Anxiety	Locus of Control
1	Mathematical Creativity	-				
2	Problem Solving Ability in Mathematics	.502	-			
3	Academic Stress	-.173	-.183	-		
4	Mathematics Anxiety	-.261	-.195	.630	-	
5	Locus of Control	-.281	-.293	.255	.178	-

Result and Discussion

Regression analysis being a parametric test has to satisfy some basic assumptions like homoscedasticity and absence of autocorrelation for the predictor variables, no multi-collinearity among predictor variables and normality of the residuals. The assumption of homoscedasticity was satisfied by the data as the scatter plot of standardized residuals against standardized predicted values (Figure 5) shows that the data are randomly and evenly dispersed throughout the plot.

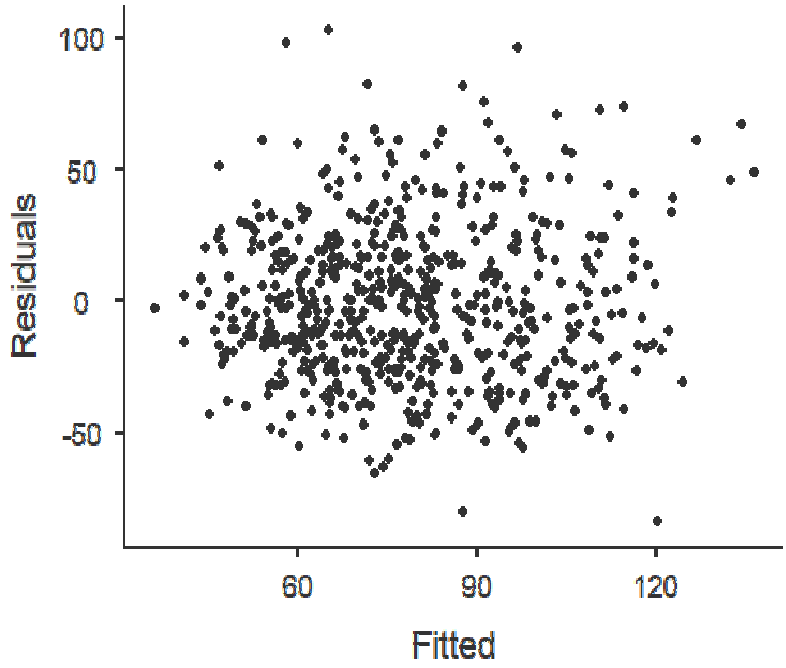


Figure 5. Scatter plot of $Z_{Residual}$ against $Z_{Predicted}$ (Mathematical Creativity).

Assumption of independence of data or absence of autocorrelation was tested by calculating Durbin Watson statistic and the value is given in table 20.

Table 20

Statistics for Ensuring Absence of Autocorrelation

Autocorrelation	DW Statistic	p
.381	1.24	<.01

Durbin Watson test statistic near to 2 indicates that the autocorrelation in the set of data can be neglected.

The assumption of multicollinearity was tested using Variance Inflation Factors (VIF) and the values are given as table 21.

Table 21

Variation Inflation factor of the predictor variables

	VIF	Tolerance
Problem solving ability	1.12	0.892
Mathematics Anxiety	1.68	0.596
Locus of control	1.15	0.872
Academic stress	1.72	0.581

The values of VIF for the variables are almost 1 and the tolerance values are greater than .4. Hence there is low level of multicollinearity between the independent variables or the correlation of each independent variable with other independent variables is negligible. That is, multicollinearity of the predictor variables is not remarkable and hence the assumption of multicollinearity is satisfied.

The normality of the residuals was tested using Shapiro – Wilk test, the value obtained is .991 ($p \leq .01$) which shows a deviation from normality. As the sample size is large, even a small variation from normality will be marked as significant by the test. A Q-Q plot was drawn to depict the distribution and is given as figure 6.

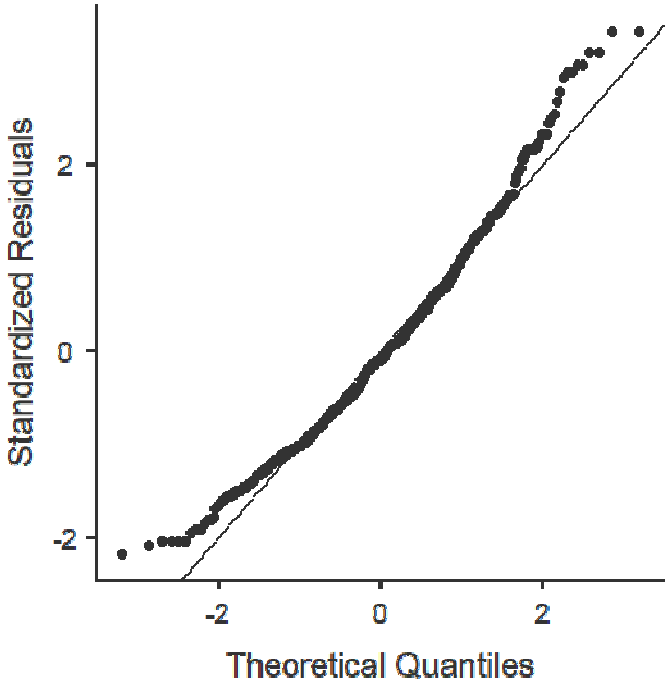


Figure 6. Normal Q-Q Plot on the scores of Mathematical Creativity

The points lie on the line indicating the normality of the data but at the ends of the line, points are deviating from the line which can be considered as outliers. Also the sample size is large enough to assume normality.

Multiple regression analysis was done for Mathematical Creativity with the predictors Problem Solving Ability in Mathematics, Academic Stress, Mathematics Anxiety and Locus of Control. Optimism was excluded from the list as it was found that Optimism is not significantly related to Mathematical Creativity.

The details of regression analysis are given as table 22 and 23.

Table 22

Value of R, R^2 and Adjusted R^2 for Model 1

R	R^2	Adjusted R^2
.544	.296	.292

Table 23

Details of Regression Coefficients

Predictor	Regression Coefficients	t	p
Intercept	81.081	8.67	< .01
Problem solving ability in Mathematics	3.822	12.95	< .01
Academic stress	0.122	1.48	0.139
Mathematics Anxiety	-0.458	-4.63	< .01
Locus of control	-1.036	-3.95	< .01

In this model with the predictors Problem Solving Ability in Mathematics, Academic Stress, Mathematics Anxiety and Locus of Control, the unstandardized regression coefficient for the variable Academic Stress is found to be not significantly different from zero as the t value obtained is less than 1.96. Hence another model 2 was tried excluding the variable Academic Stress, the details of the regression analysis with the predictors Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control is given as table 24 and 25.

Table 24

Values of R, R^2 and Adjusted R^2 of Model 2

Model	R	R^2	Adjusted R^2	Overall Model Test			
				F	df_1	df_2	p
2	0.542	0.294	0.291	96.5	3	696	< .01

Table 25

Details of Regression Coefficients b, Beta and Structure Coefficient for Model 2

Predictor	Regression Coefficients	t	p	Standardized Regression Coefficients	Structure Coefficient
Intercept	85.827	9.76	< .01		
Problem Solving ability in Mathematics	3.808	12.90	< .01	0.435	.926
Mathematics Anxiety	-0.369	-4.70	< .01	-0.154	-.482
Locus of Control	-0.969	-3.75	< .01	-0.126	-.518

Table 24 shows that the R^2 value obtained for the model with Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control as predictors is .294. It means that 29.4 percent of variance in Mathematical Creativity is explained by the regression model developed with variables Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control. The F-value obtained shows that this model is a good one ($F= 96.5$, $p<.01$) to predict Mathematical Creativity. The value of the adjusted R^2 is .291, the difference between R^2 and adjusted R^2 being .003. It means that instead of a sample, if the

model was derived from population, approximately 0.3% less variance will be in the outcome variable. As this difference is negligible, the regression model is cross-validated.

Table 25 gives t-values in each case which shows that the b-values obtained differ significantly from zero. Hence the variables Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control are significant predictors of Mathematical Creativity.

With the values of b, the regression model can be expressed as

$Y^1 = 85.827 + 3.808\ X_1 + -0.369X_2 + -0.969X_3$ where Y^1 is the predicted value of Mathematical Creativity, X_1 score on Problem Solving Ability in Mathematics, X_2 score on Mathematics Anxiety and X_3 score on Locus of Control.

The standardized Beta values for the predictors were used to derive the equation for predicting the standardized value of Mathematical Creativity.

The equation of the model is

$$Z^1 = .435\ Z_1 + -0.154Z_2 + -0.126Z_3$$

Where Z^1 is the predicted standard score of Mathematical Creativity, Z_1, Z_2 and Z_3 being the standard scores of Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control respectively.

The degree to which each predictor variable affects the outcome variable Mathematical Creativity provided the effects of all the other predictors are kept constant as well as the relative predictor contribution to the total variance explained

by the model by interpreting the regression coefficients and the structure coefficients is attempted. The individual contribution of the predictor variables by calculating proportional reduction in error (PRE) was also calculated and the results are explained below.

Problem Solving Ability in Mathematics

The b- value obtained for Problem Solving Ability in Mathematics is 3.808 (Table 25) which indicates that when Problem Solving Ability in Mathematics increases by one unit Mathematical Creativity increases by 3.808 units, when the effects of Mathematics Anxiety and Locus of Control are kept constant.

A β value of 0.435 indicates that as Problem Solving Ability in Mathematics increases by one standard deviation (4.05), Mathematical Creativity increases by 0.435 standard deviation, provided the effects of other two predictors are kept constant. Thus for an increase of 4.05 in Problem Solving Ability in Mathematics, an increase of 15.442 will be there in Mathematical Creativity score.

A structure coefficient (r_s) of .923 for the variable Problem Solving Ability in Mathematics gives a squared r_s as .857indicating that .252 out of .294 (.857X.294), the variance in Mathematical Creativity explained by the model, is accounted for by the variable Problem Solving Ability in Mathematics.

The residual sum of squares with Problem Solving Ability in Mathematics and without the variable was calculated and is given as table 26 and table 27.

Table 26

ANOVA details for the model with Problem solving ability in Mathematics

	Sum of Squares	df	Mean Square	F	p
Problem Solving Ability in Mathematics	148715	1	148715	166.3	< .01
Mathematics Anxiety	19749	1	19749	22.1	< .01
Locus of Control	12583	1	12583	14.1	< .01
Residuals	622461	696	894		

Table 27

ANOVA Details for the Model without Problem Solving Ability in Mathematics

	Sum of Squares	df	Mean Square	F	p
Mathematics Anxiety	40615	1	40615	36.7	< .01
Locus of Control	49994	1	49994	45.2	< .01
Residuals	771176	697	1106		

The proportional reduction in error (PRE) for the variable Problem Solving Ability in Mathematics is 19.28 which means that the effect size of the variable Problem Solving Ability in Mathematics in predicting Mathematical Creativity is 19.28 or 19.28 percent of variance in Mathematical Creativity is the unique contribution of Problem Solving Ability in Mathematics. The individual contribution of Problem Solving Ability in Mathematics to the model is 21.84 % (.435X.502).

Mathematics Anxiety

The b- value obtained for Mathematics Anxiety is -0.369 (Table 25) and it implies that for a unit increase in Mathematics anxiety, there will be a 0.369 unit decrease in Mathematical Creativity, provided the effects of Problem Solving Ability in Mathematics and Locus of Control are kept constant.

The β value is -0.154 which indicates that an increase of one standard deviation in Mathematics Anxiety score will bring a decrease of 0.154 standard deviation in Mathematical Creativity. That is for an increase of 14.8 in Mathematics anxiety, a decrease of 5.47 will be there in Mathematical Creativity provided the effects of Problem solving ability in Mathematics and Locus of Control are kept constant.

An r_s of -.482 gives a squared value .232 and .068 out of .294, the variance explained by the model is attributable to the variable Mathematics Anxiety.

The residual sum of squares when the model excludes Mathematics Anxiety is given as table 28.

Table 28

Details of ANOVA for the Model Excluding Mathematics Anxiety

	Sum of Squares	df	Mean Square	F	p
Problem Solving Ability in Mathematics	169581	1	169581	184	< .01
Locus of Control	17240	1	17240	18.7	< .01
Residuals	642210	697	921		

The PRE for the predictor variable Mathematics Anxiety is 3.07 which shows that the percent of variance in Mathematical Creativity uniquely explained by the predictor variable Mathematics Anxiety is 3.07. That is the effect size of Mathematics Anxiety in predicting Mathematical Creativity is 3.07. The individual contribution of Mathematics Anxiety to the model is only 4%.

Locus of Control

A value of -0.969 (Table 25) for b in the case of Locus of Control indicates that for a unit increase in Locus of Control, there will be a decrease of 0.969 units in Mathematical Creativity when the effects of other two predictors are kept constant.

The β value is -0.126 which means that for an increase of one standard deviation in Locus of Control, there will be a decrease of 0.126 standard deviation in Mathematical Creativity, the effects of other two predictors being kept constant. That is for an increase of 4.62 in Locus of Control, Mathematical Creativity decreases by 4.473.

The structure coefficient for the variable Locus of Control is -.518 and the squared value is .268 indicating that 26.8% of the explained variance in Mathematical Creativity by the model is accounted for by the variable Locus of Control.

The residual sum of squares when the model excludes Locus of Control is given as table 29.

Table 29

Details of ANOVA for the Model Excluding Locus of Control

	Sum of Squares	df	Mean Squares	F	P
Problem Solving Ability in Mathematics	186126	1	186126	204.3	<.01
Mathematics Anxiety	24406	1	24406	26.8	<.01
Residuals	635044	697	911		

The PRE for the variable Locus of Control is 1.98 indicating that 1.98 percent of variance in Mathematical Creativity is the unique contribution of the predictor variable Locus of Control. Also the effect size of Locus of Control as a predictor of Mathematical Creativity is 1.98. The individual contribution of the variable Locus of Control to the model is only 3.541%.

The beta weights, structure coefficient, individual contribution and PRE for the predictor variables are consolidated in table 30.

Table 30

Standardized Regression Coefficients, Structure Coefficients, Individual Contribution and Proportionate Reduction in Error of the predictor variables in predicting Mathematical Creativity

Variable	β	r_s	Contribution (%)	PRE
Problem Solving Ability in Mathematics	0.435	.926	21.84	19.28
Mathematics Anxiety	-0.154	-.482	4	3.07
Locus of Control	-0.126	-.518	3.541	1.98

Table 30 reveals that based on all the three estimates of multiple regression analysis, Problem Solving Ability in Mathematics is the powerful predictor of Mathematical Creativity in the model. Based on β, individual contribution and PRE, Mathematics Anxiety occupies the second position in the model for the efficiency of predicting Mathematical Creativity, but the structure coefficient shows that Locus of Control has a slight increase in contribution to the explained variance by the model in predicting Mathematical Creativity. A change in the relative position may be due to the relationship between the predictor variables, which are found to be not remarkable through the test of multicollinearity.

Thus the variables in the order of effect size to predict Mathematical Creativity in the model can be listed as Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control. Sing (2000) has reported that anxiety and test anxiety inhibit students' Mathematical Creativity, Thakur (2014) found anxiety as not contributing to creativity of girls but is a facilitator for boys.

Conclusion

The extent of Mathematical Creativity among secondary school students is not up to a satisfactory level, the mean score being 79.1 with standard deviation 35.5. The deciles also show that secondary school students are not having high level of Mathematical Creativity measured through the test on Mathematical Creativity.

The mean score of Mathematical Creativity obtained for boys and girls are 80.9 and 77.5 with standard deviation 35.3 and 35.6. Mean score for boys are slightly greater than the mean score of Mathematical Creativityfor the entire group.

The deciles also show that secondary school boys and girls are not having high level of Mathematical Creativity. The mean score of Mathematical Creativity obtained for the government and aided secondary school students are 73.9 and 84.9 with standard deviation 33.2 and 37.1.The mean score for aided school students is higher than that of government school students and the total group. The deciles show that government and aided secondary school students are not having high level of Mathematical Creativity. The mean score of Mathematical Creativity obtained for the urban and rural secondary school students are 81.1 and 76.8 with standard deviations 30.7 and 40.4. Urban secondary school students have higher mean score in Mathematical Creativity than rural students and the total sample.The deciles show that urban and rural secondary school students are not having high level of Mathematical Creativity.

Problem Solving Ability in Mathematics, Academic Stress, Mathematics Anxiety and Locus of Control (external) are found to be significantly related to Mathematical Creativity, among which the correlation between Problem Solving Ability in Mathematics and Mathematical Creativity is positive and moderate, but all other correlations are negative and low. Optimism is found to be not significantly related to Mathematical Creativity.

Among the components of Mathematical Creativity- Fluency, Flexibility and Originality are significantly related to Problem Solving Ability in Mathematics, Academic Stress, Mathematics Anxiety and Locus of Control (external). Optimism is found to be not significantly related to Fluency, Flexibility and Originality. The correlation between Fluency and Problem Solving Ability in Mathematics is positive

and substantial but the correlation with Academic Stress, Mathematics Anxiety and Locus of Control (external) are negative and low. Correlations of Flexibility and Originality with Problem Solving Ability in Mathematics are positive, but all other correlations are negative and low.

The model defined by the predictor variables Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control (External) is a significant one with R^2 .294 and Problem Solving Ability in Mathematics is the most powerful predictor of Mathematical Creativity among the variables in the model. Individual contribution of the predictor variables in predicting Mathematical Creativity are

Problem Solving Ability in Mathematics (21.84)

Mathematics Anxiety (4)

Locus of Control (3.54)

Chapter 5

SUMMARY, CONCLUSION AND SUGGESTIONS

- Study in Retrospect
- Major Findings of the Study
- Tenability of Hypotheses
- Conclusions
- Educational Implications
- Suggestions for Further Research

This chapter gives a bird's-eye view of the study under the headings Study in Retrospect, Major Findings of the Study, Tenability of Hypotheses, Conclusion, Educational Implications and Suggestions for Further Research in the area.

Study in Retrospect

The various aspects at different stages of the present investigation like the Title, Variables, Research questions, Objectives, Hypotheses, Methodology used are viewed retrospectively.

Restatement of the Problem

The study focused on finding the efficiency of some select psychological variables to predict Mathematical Creativity of secondary school students of Kerala. Thus the study was entitled as "CERTAIN PSYCHOLOGICAL VARIABLES PREDICTING MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS".

Variables Selected for the Study

As the study was to find out the efficiency of the select psychological variables to predict Mathematical Creativity among secondary school students, the outcome variable was Mathematical Creativity and the select psychological

variables viz., Problem Solving Ability in Mathematics, Mathematics Anxiety, Academic Stress, Locus of Control and Optimism were the predictor variables.

Objectives of the Study

The following are the objectives of the study. To find out the extent of Mathematical Creativity among secondary school students of Kerala.

i. To find out whether the select psychological variables are significantly related to Mathematical Creativity of secondary school students.

ii. To develop a regression equation for predicting Mathematical Creativity among secondary school students with the select psychological variables.

iii. To find out the relative efficiency of the select psychological variables in predicting Mathematical Creativity of secondary school students.

Hypotheses of the Study

The hypotheses of the study are the following.

i. There exists significant relationship between Problem Solving Ability in Mathematics and Mathematical Creativity of secondary school students.

ii. There exists significant relationship between Mathematics Anxiety and Mathematical Creativity of secondary school students.

iii. There exists significant relationship between Academic Stress and Mathematical Creativity of secondary school students.

iv. There exists significant relationship between Locus of Control and Mathematical Creativity of secondary school students.

v. There exists significant relationship between Optimism and Mathematical Creativity of secondary school students.

vi. The select psychological variables significantly predict Mathematical Creativity among secondary school students.

Methodology

Participants of the Study

The study was conducted on a sample of 700 Secondary School Students selected from Kozhikode, Wayanad, Kasargod, Palakkad, and Kollam Districts of Kerala. Due weightage was given to the relevant subgroups of the population such as Gender, Type of Management and Locale of the school. Stratified sampling technique was used for the selection of the sample.

Instruments Used for the Study

The instruments used for collecting data from the sample are

Mathematical Creativity Test (Vijayakumari & Midhundas, 2017)

Test of Problem Solving Ability in Mathematics (Sumangala & Rinsa, 2008)

Mathematics Anxiety Scale (Sumangala & Malini, 1993)

Scale on Academic Stress (Vijayakumari, Sajmadas & Midhundas, 2015)

Locus of Control Scale (Kunhikrishnan & Mathew, 1987)

Optimism Inventory (Vijayakumari & Midhundas, 2016)

Statistical Techniques Used

The Statistical techniques used are

Preliminary Analysis

Descriptive statistical measures such as mean, standard deviation, deciles, skewness and kurtosis of the scores on dependent variable were calculated for the total sample and subsamples based on the gender, locality of the school and type of management of school. 99 percent Confidence Interval for Mean of Mathematical Creativity was also calculated.

Pearson's Product Moment Coefficient of Correlation

Pearson's Product Moment Coefficient of Correlation 'r' was used to estimate the extent of relation between the select Psychological Variables and Mathematical Creativity. The correlation coefficient was also calculated for the three components of Mathematical Creativity viz., Fluency, Flexibility and Originality to find the relationship with the select psychological variables. Shared variance was also calculated for each predictor variable.

Multiple Regression Analysis

Multiple regression analysis was used for predicting individual and joint effect of the select psychological variables in predicting Mathematical Creativity.

Major Findings of the Study

- The extent of Mathematical Creativity among secondary school students is low [Table 15 & 16, Mean = 79.1, SD = 35.5 $CI_{.99}$ = (75.63, 82.56), P_{50} = 76]

- Mathematical Creativity among boys and girls are found to be not at satisfactory level. But boys are found to have a higher mean score in Mathematical Creativity than girls.

  [Table 15 & 16, Boys; Mean = 80.9, SD = 35.3, $CI_{.99}$ = (75.91, 85.89), P_{50} = 80; Girls; Mean = 77.5, SD = 35.6, $CI_{.99}$ = (72.72, 82.28), P_{50} = 75]

- Mathematical Creativity among Government and Aided secondary school students are found to be not satisfactory. Aided school students are found to have a higher mean score in Mathematical Creativity than Government school students.

  [Table 15 & 16, Government; Mean = 73.9, SD = 33.2, $CI_{.99}$ = (69.48, 78.31), P_{50} = 73; Aided; Mean = 84.9, SD = 37.1, $CI_{.99}$ = (79.65, 90.14), P_{50} = 82]

- Mathematical Creativity among Urban and Rural secondary school students are not at a satisfactory level. A higher mean score is found for Urban school students compared to that of Rural school students.

  [Table 15 & 16, Urban; Mean = 81.1, SD = 30.7, $CI_{.99}$ = (77.03, 85.16), P_{50} = 79; Rural; Mean = 76.8, SD = 40.4, $CI_{.99}$ = (70.98, 82.61), P_{50} = 74]

- There exists significant, positive and substantial relationship between Problem Solving Ability in Mathematics and Mathematical Creativity of secondary school students of Kerala (Table 18, r = .502, p≤.01).

- A significant, negative but very low relationship was found between Academic Stress and Mathematical Creativity of secondary school students of Kerala (Table 18, r = -.173, p≤.01).

- There exists significant, negative but low relationship between Mathematics Anxiety and Mathematical Creativity of secondary school students of Kerala (Table 18, r = -.261, p≤.01).

- There exists a significant, negative low relationship between Locus of Control and Mathematical Creativity of secondary school students of Kerala (Table 18, r = -.281, p≤.01).

- The relationship between Optimism and Mathematical Creativity is not significant at .05 level (Table 18, r = .047, p>.05).

- Problem Solving Ability in Mathematics is significantly related to Fluency and the relationship is positive and substantial (Table 18, r = .489, p≤.01).

- A significant negative and very low relationship is found between Academic Stress and Fluency of secondary school students of Kerala (Table 18, r = -.165, p≤.01).

- There exists significant, negative but low relationship between Mathematics Anxiety and Fluency of secondary school students of Kerala (Table 18, r = -.258, p≤.01).

- There exists a significant, negative and low relationship between Locus of Control and Fluency of secondary school students of Kerala (Table 18, r =-.284, p≤.01).

- The relationship between Optimism and Fluency is not significant at .05 level (Table 18, r = .025, p>.05).

- Problem Solving Ability in Mathematics is significantly related to Flexibility and the relationship is positive and low (Table 18, r = .398, p≤.01).

- A significant negative and very low relationship is found between Academic Stress and Flexibility of secondary school students of Kerala (Table 18, r = -.151, p≤.01).

- There exists significant, negative but very low relationship between Mathematics Anxiety and Flexibility of secondary school students of Kerala (Table 18, r = -.185, p≤.01)

- There exists a significant negative low relationship between Locus of Control and Flexibility of secondary school students of Kerala (Table 18, r = -.209, p≤.01)

- The relationship between Optimism and Flexibility is not significant at .05 level (Table 18, r = .068, p>.05).

- There exists a significant, positive and low relationship between Problem Solving Ability in Mathematics and Originality of secondary school students of Kerala (Table 18, r = .367, p≤.01).

- A significant, negative and very low relationship is seen between Academic Stress and Originality of secondary school students of Kerala (Table 18, r = -.125, p≤.01).

- There exists significant, negative but low relationship between Mathematics Anxiety and Originality of secondary school students of Kerala (Table 18, r = -.200,p≤.01)

- There exists a significant, negative, very low relationship between Locus of Control and Originality of secondary school students of Kerala (Table 18, r = -.190)

- The relationship between Optimism and Originality is not significant at .05 level (Table 18, r = .097, p>.05).

- The prediction equation for Mathematical Creativity is

  Y^1 = 85.827+ 3.808 X_1+ -0.369X_2+ -0.969X_3 (Unstandardized) or Z^1= .435 Z_1+ -0.154Z_2+ - 0. 126Z_3 (Standardized)

  The model is good at predicting Mathematical Creativity among secondary school students (Table 24, F =96.5, p≤.01).

- 29.4 percent of variation in Mathematical Creativity is predicted by the model with the predictor variables, Problem Solving Ability in Mathematics,

Mathematics Anxiety and Locus of Control (external) (Table 24, R=.542, R^2= .294).

- When Problem Solving Ability in Mathematics increases by one unit Mathematical Creativity increases by 3.808 units, when the effects of Mathematics Anxiety and Locus of Control are kept constant. (Table 25, b=3.808).

- When Mathematics Anxiety increases by one unit 0.369 unit decrease in Mathematical Creativity, provided the effects of Problem Solving Ability in Mathematics and Locus of Control are kept constant. (Table 25, b= -.369).

- For a unit increase in Locus of Control, there will be a decrease of 0.969 units in Mathematical Creativity, when the effects of other two predictors are kept constant. (Table 25, b= -.969).

- The effect size of the predictor variables, Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control(external) in predicting Mathematical Creativity are 19.28, 3.07 and 1.98 respectively (Table 30).

- Academic Stress is not a significant predictor of Mathematical Creativity among secondary school students (Table 23, b= 0.122, t= 1.48, p> .05).

- The Variables in the order of individual contribution in predicting Mathematical Creativity among secondary school students are Problem solving ability in Mathematics (21.84), Mathematics Anxiety (4) and Locus of Control External (3.541). (Table 30).

Tenability of Hypotheses

The tenability of hypotheses was examined on the basis of analysis and its findings.

1. The first hypothesis states that '**There exists significant relationship between Problem Solving Ability in Mathematics and Mathematical Creativity of secondary school students**'.

The study found that there exists a significant positive and substantial relationship between Problem Solving Ability in Mathematics and Mathematical Creativity of secondary school students. Hence the first hypothesis is substantiated.

2. The second hypothesis is '**There exists significant relationship between Academic Stress and Mathematical Creativity of secondary school students**'.

The study shows that a significant, negative but very low relationship exists between Academic Stress and Mathematical Creativity of secondary school students. Hence the second hypothesis is substantiated

3. The third hypothesis states that '**There exists significant relationship between Mathematics Anxiety and Mathematical Creativity of secondary school students**'.

It was found that there exists significant, negative but low relationship between Mathematics Anxiety and Mathematical Creativity of secondary school students. Hence the third hypothesis is substantiated

4. The fourth hypothesis is '**There exists significant relationship between Locus of Control and Mathematical Creativity of secondary school students**'.

The study found that there exists a significant negative very low relationship between Locus of Control and Mathematical Creativity of secondary school students. Hence the fourth hypothesis is substantiated

5. The fifth hypothesis states that '**There exists significant relationship between Optimism and Mathematical Creativity of secondary school students**'.

It was found that there is no significant relationship between Optimism and Mathematical Creativity. This finding does not substantiate the hypothesis and hence the fifth hypothesis is not substantiated.

6. The sixth hypothesis is '**The select psychological variables significantly predict Mathematical Creativity among secondary school students**'.

The study revealed that Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control are significant predictors of Mathematical Creativity among secondary school students.. But Academic Stress and Optimism are found to be not significantly contributing to predict Mathematical Creativity. Hence the sixth hypothesis is not completely substantiated.

Conclusion

The present study was to find out the efficiency of certain psychological variables in predicting Mathematical Creativity among secondary school students. Analysis of data revealed that the secondary school students of Kerala are not up to a satisfactory level in Mathematical Creativity. Problem solving ability in Mathematics is found to have a substantial positive relationship with Mathematical Creativity and its component, Fluency but the relationship is low with Flexibility and Originality.

Academic Stress is found to have a negative very low relationship with Mathematical Creativity and its components fluency, flexibility and originality. In the case of Mathematics Anxiety, the relationship with Mathematical Creativity and its components fluency and originality are negative and low but the relationship is negative but very low with flexibility. The relationship of External Locus of Control with Mathematical Creativity and its components fluency and flexibility are negative and low but the relationship is negative and very low with originality. Optimism is found to have no significant relation with Mathematical Creativity or its components. The regression model with Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control (External) was found to be good for predicting Mathematical Creativity of secondary school students. Problem Solving Ability in Mathematics, Mathematics Anxiety and Locus of Control are found to be significant predictors of Mathematical Creativity. But only 29.4 percent of variance in Mathematical Creativity was accounted for with the model and 70.6 percent of the variance is explained by variables other than the select ones.

Educational Implications

Present study has implications in various dimensions for students, teachers, parents, educational administrators and curriculum developers. It is essential that students have a high level of mathematical creativity so that they can think like a mathematician and become experts in the field.

The study found that secondary school students of Kerala are not up to a satisfactory level of Mathematical Creativity. Mathematics teachers have to reflect on the classroom environment. The classroom environment must encourage divergent thinking among students. Problem Solving Ability in mathematics is moderately related to Mathematical Creativity and the relationship is positive. Hence problem based approach in which more life related, unstructured problems are used for teaching- learning process may be adopted in teaching Mathematics. This will increase the ability to solve problems among students and foster Fluency, Flexibility and Originality in dealing with mathematical concepts and principles. Teachers must be given enough freedom to adopt different methods and strategies and they are expected to be resourceful for being flexible in their approach. The practice of over emphasizing the textbook and the exercise problems should be discouraged. The assessment practices also have to be changed to make the learning more original, flexible and creative. Structuring questions and posing problems based on the content discussed in the class and experimenting with various methods to arrive at a solution can be recommended for assessment, instead of asking students to reproduce the answers taught in the class.

Though the extent of relationship is very low, Academic stress is found to be negatively related to mathematical creativity of secondary school students. The overcrowded curriculum for secondary education will make the learning monotonous and students may feel stress in completing academic activities. This will negatively affect the creative approach to teaching and learning mathematics and reduce the mathematical creativity of students. It is recommended to reduce the curriculum at secondary level and include more activities related to mathematics so that students will enjoy learning mathematics. The approaches of teaching and assessment followed in the education system create anxiety among students and anxiety in mathematics is found to be a negative contributor to mathematical creativity. Together with more transparent, sound assessment practices, regular, effective guidance and counseling must be a part of the education system. The phobia in learning mathematics should be minimized through arranging interesting, motivating classroom activity, proper counseling and sympathetic approach of teachers and parents.

An average or a below average teacher will completely demolish the spark of creative thinking among students. Only creative and talented teachers can kindle the minds of learners with originality in thinking. The youth who are creative and talented have to be attracted to the field of mathematics education.

Students have to adopt better learning styles which encourage the use of divergent thinking instead of cramming the formulae and method of arriving at solutions. Group discussions and activities are to be done in order to share novel ideas and methods to arrive at solutions.

External locus of control was found to be a factor that hinder mathematical creativity. That is, how the student perceives the causes of his academic success or failure has a role, though minor one, on mathematical creativity. Parents should know the belief of their wards on the factors that influence their success or failure, whether external factors that are beyond their control or their hard work and the efforts they invest in education. The habit of attributing success or failure to factors beyond their control must be discouraged by parents. Children must be encouraged to take up the responsibility for their success or failure. Cognitive Behavior Therapy can be used to change the external locus of control to internal locus of control. Parents and teachers must appreciate student abilities and support the learners in setting goals and their successful achievement.

Teachers, curriculum developers and parents must take initiatives to improve the level of mathematical creativity among students, an essential element for which is ensuring mastery of the essential knowledge in mathematics. Bridge courses at different levels of education will help in this regard and self learning must be promoted among learners.

Teachers can predict the mathematical creativity of students using the scores on problem solving ability, mathematics anxiety and external locus of control. Based on the level of creativity, teachers can individualize instruction.

Suggestions for Further Research

At each stage of the study, the researcher has admitted certain delimitations as well as limitations. It is difficult, if not impossible, to conduct such a study

perfectly. Experience of conducting this study made the investigator put forward some suggestions for further research.

- The study can be replicated on other groups of students of different levels like primary, upper primary, higher secondary and higher education including more variables like Self- confidence and Intelligence, related to Mathematical Creativity.
- Studies of similar nature can be conducted in other subjects like science.
- The study can be replicated by adopting problem based approach to Mathematical Creativity.
- Development and validation of instructional or learning packages for fostering Mathematical Creativity can be done.
- Study can be conducted on development of ICT integrated mathematical modules to foster Mathematical Creativity among secondary school students.
- Theoretical models for predicting Mathematical or Scientific Creativity can be developed by incorporating better predictors and moderator variables.

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APPENDICES

Appendix 1

Details of the participants for the study

Districts	Name of the Schools	Type of Managemnt	Locale
Kasaragod	GHSS Belluru	Govt	Rural
	MRHS Paravanadukkam	Govt	Urban
	Sree Anna Poorneswari HSS Agalpadi	Aided	Rural
	Navajeevana Ghss Badiadukka	Aided	Rural
Wayanad	GHS Valeri	Govt	Rural
	GSHSS Batheri	Govt	Urban
	MTDM Thondranadu	Aided	Rural
Kozhikode	GHSS Kokkallur	Govt	Rural
	GHSS Cheruvannur	Govt	Urban
	GHSS Madappalli	Govt	Urban
	NHSS Vattoli	Aided	Urban
	TIM HSS Nadhapuram	Aided	Rural
Palakkad	GVHSS Malapuzha	Govt	Urban
	GHS Agali	Govt	Rural
	ST. Peters HS	Aided	Rural
Kollam	GHSS Sooraanad	Govt	Rural
	GHSS Punalur	Govt	Urban
	KNNM VHSS Pavithreswaram	Aided	Rural
	ST GORETTI HSS, Punalur	Aided	Urban

Appendix 2A

MATHEMATICAL CREATIVITY TEST (Final, Malayalam)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College
Research Centre in Education
Calicut

Midhundas A.M
Research Scholar
Farook Training College
Research Centre in Education
Calicut

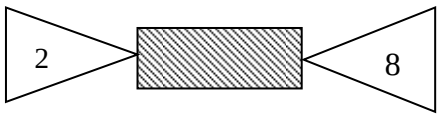
Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

നിർദ്ദേശങ്ങൾ:

നിങ്ങളുടെ ഗണിത ശാസ്ത്രസർഗ്ഗാത്മകത അളക്കാനുള്ള ഏതാനും ചോദ്യങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. ഓരോ ചോദ്യങ്ങളും ശ്രദ്ധയോടെ വായിച്ച് ഓരോ ചോദ്യത്തിനും അനുവദിച്ചിരിക്കുന്ന നിശ്ചിത സമയത്തിനുള്ളിൽ ഉത്തരം എഴുതുക.

1) താഴെ തന്നിരിക്കുന്ന സംഖ്യായന്ത്രത്തിൽ 2 നെ 8 ആക്കും ഏതെല്ലാം രീതിയിലായിരിക്കും രണ്ട് '8' ആകുന്നത്? **(3 മിനുട്ട്)**



Eg: 2+6=8

2) 4 ½ X 1.75 എന്നതിനെ വ്യത്യസ്ത രീതിയിൽ എഴുതുക.

Eg: $\frac{9}{2}\times 1.75$ **(4 മിനുട്ട്)**

3) ഒരു സംഖ്യ എഴുതി അതിന്റെ പ്രത്യേകതകൾ എഴുതുക.

Eg: സംഖ്യ -പൂജ്യം

പ്രത്യേകതകൾ: 1) ഏറ്റവും ചെറിയ അഖണ്ഡസംഖ്യ

2) പോസിറ്റീവ് സംഖ്യയേയും നെഗറ്റീവ് സംഖ്യയേയും വേർതിരിക്കുന്ന സംഖ്യ

3) ഏതു സംഖ്യയുടെ കൂടെ കൂട്ടിയാലും കുറച്ചാലും അതേ സംഖ്യതന്നെ കിട്ടും.

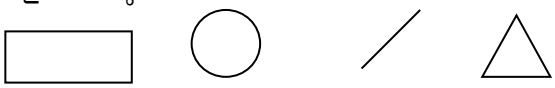
4) ഏതു സംഖ്യയുടെ കൂടെ ഗുണിച്ചാലും പൂജ്യം തന്നെ കിട്ടും.

(3 മിനുട്ട്)

4) 0, 1 എന്നീ സംഖ്യകളും (സംഖ്യകൾ ആവർത്തിച്ചുപയോഗിക്കാം) ഗണിത ചിഹ ങ്ങളും ഉപയോഗിച്ച് ഉത്തരം 'ഒന്ന്' കിട്ടത്തക്കവിധത്തിൽ പരമാവധി സമവാക്യ ങ്ങൾ ഉണ്ടാക്കുക.

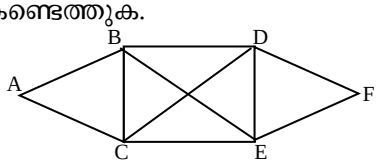
Eg: 0 X 0+1=1 **(3 മിനുട്ട്)**

5) താഴെ തന്നിരിക്കുന്ന ചിത്രങ്ങൾ ഉപയോഗിച്ച് വ്യത്യസ്ത അർത്ഥവത്തായ രൂപ ങ്ങൾ ഉണ്ടാക്കുക.



(3 മിനുട്ട്)

6) താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ 'A' യിൽ നിന്നും 'F' ൽ എത്തിച്ചേരാനുള്ള വ്യ ത്യസ്ത വഴികൾ കണ്ടെത്തുക. **(2 മിനുട്ട്)**



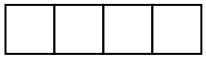
7) 1 ലിറ്റർ, 1/2ലിറ്റർ, 1/4ലിറ്റർ അളവുകളിലുള്ള പാത്രങ്ങൾ ഉപയോഗിച്ച് 3 ലിറ്റർ പാലിനെ നിറയ്ക്കാവുന്ന വ്യത്യസ്ത രീതികൾ എഴുതുക.

Eg: 3L = 1, ½, ¼, ¼, 1 **(3 മിനുട്ട്)**

8) സംഖ്യയിലെ അക്കങ്ങളുടെ തുക '9' വരുന്ന പരമാവധി സംഖ്യകൾ എഴുതുക.

Eg: 18, 1+8=9 **(3 മിനുട്ട്)**

9) നാല് സമചതുരങ്ങൾ ഉപയോഗിച്ച് പലതരത്തിലുള്ള രൂപങ്ങൾ തയ്യാറാക്കുക.

Eg  **(3 മിനുട്ട്)**

10) '5' ഒന്നുകൾ കൊണ്ട് നിർമ്മിക്കാൻ കഴിയുന്ന പരമാവധി സംഖ്യകൾ എഴുതുക.

Eg: 1 1 1 1 1 **(3 മിനുട്ട്)**

Appendix 2B

MATHEMATICAL CREATIVITY TEST (Final, English)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College
Research Centre in Education
Calicut

Midhundas A.M
Research Scholar
Farook Training College
Research Centre in Education
Calicut

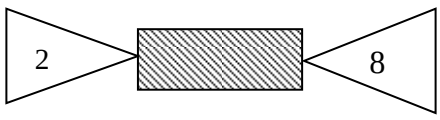
Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

Instructions:

Below are a few questions to measure your mathematical creativity. Read each question carefully and answer each question within the allotted time

1) Let 2 be 8 in the number machine given below. Write the ways that make 2 to 8. **(3 Minutes)**



Eg: 2+6=8

2) Write 4 ½ X 1.75 differently.

Eg: $\frac{9}{2} \times 1.75$ **(4 Minutes)**

3) Write a number and its characteristics.

Eg: Zero

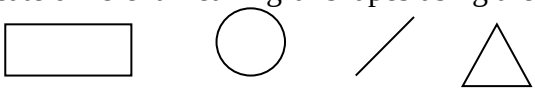
Characteristics:

1) The smallest whole number
2) The number that separates the positive number from the negative number
3) Adding or subtracting any number gives the same number
4) Multiply by any number and you get zero **(3 Minutes)**

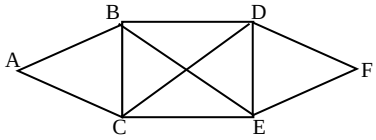
4) Create maximum equations with numbers 0 and 1 (Numbers can be used repeatedly) and mathematical symbols to get 1 as answer.

   Eg: 0 X 0+1=1 **(3 Minutes)**

5) Create different meaningful shapes using the pictures below. **(3 Minutes)**



6) Find different ways to reach from A to F in the figure. **(2 Minutes)**



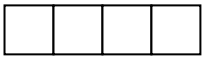
7) Write different methods of filling 3 liters of milk with 1 liter, .5 liter and .25 liter containers.

   Eg: 3L = 1, ½, ¼, ¼ , 1 **(3 Minutes)**

8) Write the numbers in which the sum of the digits is 9.

   Eg: 18, 1+8=9 **(3 Minutes)**

9) Make a variety of shapes using four squares.

   Eg:  **(3 Minutes)**

10) Write numbers that can be made with five ones.

    Eg: 1 1 1 1 1 **(3 Minutes)**

Appendix 3A

OPTIMISM INVENTORY (Draft, Malayalam)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College
Research Centre in Education
Calicut

Midhundas A.M
Research Scholar
Farook Training College
Research Centre in Education
Calicut

Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

Instructions:

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ നിങ്ങൾ ഉൾപ്പെട്ടതാണെന്ന് സങ്കല്പിക്കുക. ഓരോ സന്ദർഭത്തിനും രണ്ട് വിശദീകരണങ്ങൾ വീതം നൽകിയിരിക്കുന്നു. ചിലപ്പോൾ ഈ സന്ദർഭങ്ങൾ നിങ്ങൾ നേരിടാത്തതാകാം. അല്ലെങ്കിൽ തന്നിരിക്കുന്ന വിശദീകരണങ്ങൾ നിങ്ങളെ സംബന്ധിച്ചിടത്തോളം അനുയോജ്യമാണെന്ന് തോന്നുന്നില്ലായിരിക്കും. എങ്കിലും ഏകദേശം നിങ്ങളെ സംബന്ധിച്ച് ശരിയെന്ന് തോന്നുന്നതിന് നേരെ (✓) രേഖപ്പെടുത്തുക.

1. നിങ്ങൾ നേതൃത്വം കൊടുക്കുന്ന പ്രവർത്തനം വൻവിജയമാണ്.
   a) ഞാൻ എല്ലാവരുടെ പ്രവർത്തനത്തെയും കൃത്യമായി മേൽനോട്ടം നടത്തിയിരുന്നു.
   b) എല്ലാവരും ഒരുപാട് സമയവും ഊർജ്ജവും ഇതിനായി ചെലവഴിച്ചു.
2. സുഹൃത്തുമായി വഴക്കിട്ടാലും പെട്ടെന്ന് ഇണങ്ങും.
   a) ഞാൻ സുഹൃത്തിനോട് വേഗം ക്ഷമിക്കും.
   b) ഞാൻ പൊതുവെ മറ്റുള്ളവരോട് ക്ഷമിക്കുന്നവനാണ്
3. സുഹൃത്തിന്റെ വീട്ടിലേക്ക് പോകുമ്പോൾ നിങ്ങൾക്ക് വഴിതെറ്റി
   a) ഞാൻ ഒരു വളവ് ശ്രദ്ധിച്ചില്ല
   b) എന്റെ സുഹൃത്ത് പറഞ്ഞുതന്ന വഴി തെറ്റായിരുന്നു.

4. സുഹൃത്ത് ഒരു സമ്മാനംതന്ന് നിങ്ങളെ അത്ഭുതപ്പെടുത്തി.

   a) സുഹൃത്തിന് പരീക്ഷയിൽ ഉയർന്ന മാർക്ക് ലഭിച്ചു.

   b) കഴിഞ്ഞ ദിവസം ഞാനും ഒരു സമ്മാനം നൽകിയിരുന്നു.

5. സുഹൃത്തിന്റെ പിറന്നാൾ നിങ്ങൾ മറുന്നുപോയി.

   a) ഞാൻ ഇങ്ങനെ ദിനങ്ങൾ ഓർത്തുവെക്കുന്നതിൽ പിറകോട്ടാണ്.

   b) ഞാൻ പല കാര്യങ്ങളാൽ തിരക്കിലായിരുന്നു.

6. സ്കൂളിലെ ഒരു കുട്ടിയിൽ നിന്നും നിങ്ങൾക്ക് അനുമോദനം ലഭിച്ചു.

   a) എന്നെ അവർക്ക് വളരെ ഇഷ്ടമാണ്.

   b) ഞാൻ വളരെ പ്രശസ്തനായ ആളാണ്.

7. സ്കൂൾ ലീഡർ സ്ഥാനത്തേക്ക് പരിശ്രമിച്ചു നിങ്ങൾ അതിൽ വിജയിച്ചു.

   a) ഞാൻ ഒരുപാട് സമയവും ഊർജ്ജവും പ്രചരണത്തിനായി ചെലവഴിച്ചു.

   b) ചെയ്യുന്നതെന്തിനും ഞാൻ നന്നായി കഷ്ടപ്പെടും.

8. നിങ്ങൾ സ്കൂളിലെ പ്രധാനപ്പെട്ട ഒരു പരിപാടി മറന്നുപോയി.

   a) ചില സമയത്ത് എന്റെ ഓർമ്മ ശക്തി പിറകോട്ടാണ്.

   b) ഞാൻ എന്റെ സ്കൂൾ ഡയറി നോക്കാൻ മറന്നുപോയി.

9. സ്കൂൾ തിരഞ്ഞെടുപ്പിൽ നിങ്ങൾ പരാജയപ്പെട്ടു.

   a) ഞാൻ നന്നായി പ്രചരണം നടത്തിയില്ല.

   b) ഇതിൽ വിജയിച്ച കുട്ടിക്ക് ഒരുപാട് കുട്ടികളുമായി നല്ലബന്ധം ഉണ്ടായിരുന്നു.

10. വിജയകരമായി പ്രസംഗിക്കാൻ നിങ്ങൾക്ക് സാധിച്ചു.

    a) ഞാൻ അന്ന് വളരെ ഊർജ്ജിതനായിരുന്നു.

    b) ഞാൻ നല്ലൊരു അവതാരകനാണ്.

11. കൃത്യസമയത്ത് അധികാരികളെ അറിയിച്ചതിനാൽ ഒരു കുറ്റകൃത്യം തടയാൻ നിങ്ങൾക്ക് കഴിഞ്ഞു.

    a) അപരിചിതമായ എന്തോ ഒന്ന് എന്റെ ശ്രദ്ധയിൽപ്പെട്ടു.

    b) ഞാൻ അന്ന് വളരെ ശ്രദ്ധാകുലനായിരുന്നു.

12. നിങ്ങൾ എപ്പോഴും വളരെ ആരോഗ്യവാനാണ്.

    a) അസുഖമുള്ളവരുമായി ഞാൻ അധികം അടുത്ത് ഇടപെടാറില്ല.

    b) ഞാൻ കൃത്യസമയത്ത് ഭക്ഷണവും വിശ്രമവും ഉറപ്പുവരുത്താറുണ്ട്.

13. നിങ്ങൾ പറഞ്ഞ ദിവസം ലൈബ്രറി പുസ്തകം തിരിച്ചുനൽകാത്തതിന് പിഴ അടക്കേണ്ടി വന്നു.

    a) വായനയിൽ മുഴുകിയപ്പോൾ പുസ്തകം തിരിച്ചു നൽകേണ്ട ദിവസം മറന്നു പോയി.

    b) പരീക്ഷയുടെ തിരക്കിലായിരുന്നു.

14. ഗണിതശാസ്ത്രമേളയിൽ നിങ്ങൾക്ക ഒന്നാം സമ്മാനം ലഭിച്ചു.

    a) പുതിയ കാര്യങ്ങൾ കണ്ടുപിടിക്കാൻ ഞാൻ ആഗ്രഹിക്കുന്നു.

b) ഗണിത അധ്യാപകൻ വളരെ പ്രശസ്തനാണ്.

15. നിങ്ങൾ ഒരു അത്‌ലറ്റിക് മീറ്റിൽ വിജയിച്ചു.

a) തോറ്റുകൊടുക്കാൻ ഇഷ്ടപ്പെടാത്ത വ്യക്തിയാണ് ഞാൻ.

b) ഞാൻ ഒരുപാട് പരിശ്രമിച്ചു.

16. നിങ്ങൾ പ്രധാന പരീക്ഷയിൽ ഞാൻ തോറ്റുപോയി.

a) മറ്റു കുട്ടികൾ എന്നേക്കാൾ മികച്ചവരായിരുന്നു.

b) ഞാൻ നന്നായി തയ്യാറെടുത്തില്ല.

17. നിങ്ങൾ സുഹൃത്തിന് ഒരു ചിത്രം വരച്ച് കൊടുത്തപ്പോൾ സുഹൃത്ത് അത് വേണ്ട വിധത്തിൽ ഗൗനിച്ചില്ല.

a) ഞാൻ നല്ലൊരു ചിത്രകാരനല്ല.

b) ഞാൻ തിരക്കുപിടിച്ചാണ് ആ ചിത്രം വരച്ചത്.

18. പരീക്ഷ എഴുതിക്കൊണ്ടിരിക്കെ പേനയുടെ മഷി തീർന്നുപോയി.

a) പേനയിൽ മഷി ഉണ്ടോ എന്ന് ഞാൻ നോക്കിയിരുന്നില്ല.

b) ഇത്രയധികം എഴുതേണ്ടി വരുമെന്ന് എനിക്കറിയില്ലായിരുന്നു.

19. സുഹൃത്തിനോട് നിങ്ങൾ ദേഷ്യപ്പെട്ടു.

a) എന്നെ എപ്പോഴും കുറ്റപ്പെടുത്തിക്കൊണ്ടിരിക്കും.

b) ആ സമയത്തെ സുഹൃത്തിന്റെ പെരുമാറ്റം ശരിയായില്ല.

20. ഒരു ഗെയിം നടന്നുകൊണ്ടിരിക്കെ നിങ്ങളെ കളിയിലേക്ക് ക്ഷണിച്ചു.

a) ഞാൻ മുൻനിരയിൽ ഇരിക്കുന്നുണ്ടായിരുന്നു.

b) എന്നെയാണ് ഏറ്റവും ആവേശത്തോടെ കളികാണുന്ന ഒരാളായി അവർക്ക് തോന്നിയത്.

21. ഗാന്ധിജയന്തിയോടനുബന്ധിച്ചുള്ള സേവനവാരം പരിപാടിക്ക് നിങ്ങളോട് നേതൃത്വം നൽകാൻ ആവശ്യപ്പെട്ടു.

a) ഞാൻ ആ പരിപാടിയിൽ നിന്നും വിട്ടുനിൽക്കും.

b) ഞാൻ ആ പരിപാടി വളരെ കൃത്യമായി നിർവ്വഹിക്കും.

22. നിങ്ങൾ സുഹൃത്തിന് ഒരു സമ്മാനം വാങ്ങി പക്ഷേ സുഹൃത്തിന് അത് ഇഷ്ടമായില്ല.

a) അങ്ങനെയുള്ള കാര്യങ്ങളിൽ ഞാൻ അത്ര ശ്രദ്ധിക്കാറില്ല.

b) എന്റെ സുഹൃത്തിന്റെ ഇഷ്ടങ്ങൾ വളരെ വ്യത്യസ്തമാണ്.

23. നിങ്ങൾ ഒരു സെമിനാർ നന്നായി അവതരിപ്പിച്ചു.

a) ആ സമയത്ത് എനിക്ക് നല്ല ധൈര്യം കിട്ടിയിരുന്നു.

b) ഞാൻ നന്നായി പരിശ്രമിച്ചിരുന്നു.

24. നിങ്ങളുടെ തമാശ എല്ലാവരെയും ചിരിപ്പിച്ചു.

a) അത് വളരെ ഹാസ്യകരമായിരുന്നു.

b) എന്റെ സമയം വളരെ നന്നായിരുന്നു.

25. നിങ്ങളുടെ അധ്യാപകൻ ഒരു പ്രൊജക്ട് ചെയ്യാൻ വളരെ കുറച്ച് സമയമാണ് ത ന്നത്. പക്ഷേ നിങ്ങൾ അത് ചെയ്തു തീർത്തു.

    a) ഞാൻ എന്റെ ജോലി നന്നായി ചെയ്യാറുണ്ട്.

    b) ഞാൻ വളരെ കഴിവുള്ള വ്യക്തിയാണ്.

26. കുറച്ചു ദിവസമായി നിങ്ങൾ വളരെ ക്ഷീണിതനാണ്.

    a) വിശ്രമിക്കാൻ സമയം കിട്ടാറില്ല.

    b) ഈ ആഴ്ച ഞാൻ വളരെ തിരക്കിലായിരുന്നു.

27. വെള്ളത്തിൽ മുങ്ങിപ്പോയ നിങ്ങളുടെ സുഹൃത്തിനെ നിങ്ങൾക്ക് രക്ഷിക്കാൻ ക ഴിഞ്ഞു.

    a) ശ്വസന തടസ്സം മാറ്റാനുള്ള മാർഗ്ഗം എനിക്കറിയാം.

    b) അടിയന്തര സാഹചര്യങ്ങളിൽ ഇടപെടാൻ എനിക്കറിയം.

28. ഗണിത പരീക്ഷയ്ക്ക് മാർക്ക് കുറഞ്ഞുപോയപ്പോൾ സുഹൃത്ത് നിങ്ങളെ ആശ്വസി പ്പിച്ചു.

    a) മറ്റുള്ളവരുടെ വിഷമങ്ങളിൽ ഞാൻ പങ്കുചേരാറുണ്ട്.

    b) എന്റെ സുഹൃത്തുക്കൾ നല്ല മനസ്സുള്ളവരാണ്.

29. നിങ്ങളുടെ മനസ്സ് വിഷമിപ്പിക്കുന്ന ഒരു കാര്യം നിങ്ങളുടെ സുഹൃത്ത് പറഞ്ഞു.

    a) മറ്റുള്ളവർ എന്ത് ചിന്തിക്കും എന്നു നോക്കാതെയാണ് എന്റെ സുഹൃത്ത് ഒരോ കാര്യങ്ങൾ വിളിച്ചുപറയുന്നത്.

    b) എന്റെ സുഹൃത്തിന്റെ മാനസികാവസ്ഥ ആ സമയം ശരിയല്ലായിരുന്നു. ആ ദേഷ്യം എന്നോട് കാണിച്ചു.

30. നിങ്ങളുടെ സുഹൃത്ത് ഒരു ഉപദേശം ആവശ്യപ്പെട്ടു

    a) എന്നോട് ചോദിച്ച കാര്യത്തിൽ ഞാൻ വളരെ സമർത്ഥനായിരുന്നു.

    b) നല്ല ഉപദേശങ്ങൾ കൊടുക്കുന്നതിൽ ഞാൻ സമർത്ഥനാണ്.

31. നിങ്ങളുടെ സുഹൃത്ത് ഒരു പഠനപ്രവർത്തനത്തിൽ ബുദ്ധിമുട്ടിയപ്പോൾ നിങ്ങൾ സഹായിച്ചു. അതിന് സുഹൃത്ത് നന്ദി പറഞ്ഞു.

    a) അതുപോലുള്ള സാഹചര്യങ്ങളിൽ സഹായിക്കുന്നതിൽ ഞാൻ സന്തോഷി ക്കുന്നു.

    b) ഞാൻ മറ്റുള്ളവരുടെ കാര്യങ്ങൾ ശ്രദ്ധിക്കുന്നയാളാണ്.

32. ഈ സ്കൂളിൽ നിങ്ങൾ വളരെ സന്തോഷവാനാണ്.

    a) എല്ലാവരും വളരെ സൗഹാർദ്ദത്തിലാണ്.

    b) ഞാൻ മറ്റുള്ളവരുമായി വളരെ സൗഹാർദ്ദത്തിലാണ്.

33. നിങ്ങളുടെ കായികാധ്യാപകൻ നിങ്ങൾ നല്ല ആരോഗ്യമുള്ളയാളാണ് എന്ന് പ റഞ്ഞു.

    a) ഞാൻ ഇടയ്ക്കിടെ വ്യായാമം ചെയ്യാറുണ്ട്.

    b) ഞാൻ ആരോഗ്യകാര്യത്തിൽ വളരെ ശ്രദ്ധാലുവാണ്.

34. സ്കൂളിൽ നിന്നും ഒരാഴ്ച്ചത്തെ വിനോദയാത്രയ്ക്ക് ഞാനും പോകുന്നു.

    a) കുറച്ച് ദിവസം എങ്ങനെയെങ്കിലും ചിലവഴിക്കണം എന്നുണ്ടായിരുന്നു.

b) പുതിയ പുതിയ സ്ഥലങ്ങൾ കാണാൻ ഇഷ്ടമാണ്.

35. നിങ്ങളോട് അമിതമായി മധുരം കഴിക്കരുത് എന്ന് ഡോക്ടർ അഭിപ്രായപ്പെട്ടു.

a) ഭക്ഷണകാര്യങ്ങളിൽ ഞാൻ അത്ര ശ്രദ്ധാലുവല്ല.

b) എനിക്ക് മധുരം ഒഴിവാക്കാനാവില്ല. എല്ലാത്തിനും മധുരം വേണം.

36. ക്ലാസിലെ ഒരു പ്രവർത്തനം നിയന്ത്രിക്കാൻ ക്ലാസ് ടീച്ചർ ആവശ്യപ്പെട്ടു.

a) അതിനു സമാനമായ ഒരു പ്രവർത്തനം ഞാൻ വിജയകരമായി പൂർത്തിയാക്കിയിരുന്നു.

b) ഞാൻ നല്ലൊരു നിരീക്ഷകനാണ്.

37. നിങ്ങളും സുഹൃത്തും കുറച്ചുകാലമായി വഴക്കിലാണ്.

a) ഈയിടെയായി എന്റെ മനസ്സ് ഒട്ടും ശരിയല്ല.

b) കുറച്ചു കാലമായി എന്റെ സുഹൃത്ത് ഒരു ശത്രുമനോഭാവമാണ് കാണിക്കുന്നത്.

38. നിങ്ങൾ ഗണിത പരീക്ഷയിൽ തോറ്റുപോയി.

a) പരീക്ഷ വളരെ ബുദ്ധിമുട്ടായിരുന്നു.

b) എല്ലാ ചോദ്യങ്ങളും മനസ്സിലാക്കാൻ തന്നെ പറ്റാത്തതായിരുന്നു.

39. നിങ്ങളെ ക്ലാസ് ലീഡറായി നിയമിച്ചു.

a) ഞാൻ ക്ലാസിലെ ഒരു പ്രധാന പ്രശ്നം പരിഹരിച്ചു.

b) ഞാൻ ആയിരുന്നു ക്ലാസിലെ മികച്ച വിദ്യാർത്ഥി.

40. ഈ കഴിഞ്ഞ പരീക്ഷയിൽ കിട്ടിയ മാർക്ക് നിങ്ങളുടെ ഇതുവരെ ലഭിച്ചുവന്ന മാർക്കുകളിൽ ഏറ്റവും കുറഞ്ഞതാണ്.

a) ഇപ്പോഴത്തെ പരീക്ഷയെക്കുറിച്ച് നല്ലൊരു ധാരണ എനിക്കില്ലായിരുന്നു.

b) നിങ്ങൾ പ്രധാനപ്പെട്ടതാണ് എന്ന് കരുതി പഠിച്ചതൊന്നും പരീക്ഷയ്ക്ക് ചോദിച്ചില്ല.

41. സ്കൂളിൽ നടത്തിയ ഒരു നറുക്കെടുപ്പ് മത്സരത്തിൽ നിങ്ങൾക്ക് സമ്മാനം ലഭിക്കുകയാണെങ്കിൽ

a) അതിനുള്ള സാധ്യത വളരെ കുറവാണ്

b) അനുയോജ്യമായ ഒരു നമ്പറാണ് ഞാൻ തിരഞ്ഞെടുത്തത്

Appendix 3B

OPTIMISM INVENTORY (Final, Malayalam)
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Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

Instructions:

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ നിങ്ങൾ ഉൾപ്പെട്ടതാണെന്ന് സങ്കല്പിക്കുക. ഓരോ സന്ദർഭത്തിനും രണ്ട് വിശദീകരണങ്ങൾ വീതം നൽകിയിരിക്കുന്നു. ചിലപ്പോൾ ഈ സന്ദർഭങ്ങൾ നിങ്ങൾ നേരിടാത്തതാകാം. അല്ലെങ്കിൽ തന്നിരിക്കുന്ന വിശദീകരണങ്ങൾ നിങ്ങളെ സംബന്ധിച്ചിടത്തോളം അനുയോജ്യമാണെന്ന് തോന്നുന്നില്ലായിരിക്കും. എങ്കിലും ഏകദേശം നിങ്ങളെ സംബന്ധിച്ച് ശരിയെന്ന് തോന്നുന്നതിന് നേരെ (✓) രേഖപ്പെടുത്തുക.

1. നിങ്ങൾ നേതൃത്വം കൊടുക്കുന്ന പ്രവർത്തനം വൻവിജയമാണ്.
   a) ഞാൻ എല്ലാവരുടെ പ്രവർത്തനത്തെയും കൃത്യമായി മേൽനോട്ടം നടത്തിയിരുന്നു.
   b) എല്ലാവരും ഒരുപാട് സമയവും ഊർജ്ജവും ഇതിനായി ചെലവഴിച്ചു.
2. സുഹൃത്തുമായി വഴക്കിട്ടാലും പെട്ടെന്ന് ഇണങ്ങും.
   a) ഞാൻ സുഹൃത്തിനോട് വേഗം ക്ഷമിക്കും.
   b) ഞാൻ പൊതുവെ മറ്റുള്ളവരോട് ക്ഷമിക്കുന്നവനാണ്
3. സുഹൃത്ത് ഒരു സമ്മാനംതന്ന് നിങ്ങളെ അത്ഭുതപ്പെടുത്തി.
   a) സുഹൃത്തിന് പരീക്ഷയിൽ ഉയർന്ന മാർക്ക് ലഭിച്ചു.
   b) കഴിഞ്ഞ ദിവസം ഞാനും ഒരു സമ്മാനം നൽകിയിരുന്നു.

4. സുഹൃത്തിന്റെ പിറന്നാൾ നിങ്ങൾ മറുന്നുപോയി.

   a) ഞാൻ ഇങ്ങനെ ദിനങ്ങൾ ഓർത്തുവെക്കുന്നതിൽ പിറകോട്ടാണ്.

   b) ഞാൻ പല കാര്യങ്ങളാൽ തിരക്കിലായിരുന്നു.

5. നിങ്ങൾ സ്കൂളിലെ പ്രധാനപ്പെട്ട ഒരു പരിപാടി മറന്നുപോയി.

   a) ചില സമയത്ത് എന്റെ ഓർമ്മ ശക്തി പിറകോട്ടാണ്.

   b) ഞാൻ എന്റെ സ്കൂൾ ഡയറി നോക്കാൻ മറന്നുപോയി.

6. സ്കൂൾ തിരഞ്ഞെടുപ്പിൽ നിങ്ങൾ പരാജയപ്പെട്ടു.

   a) ഞാൻ നന്നായി പ്രചരണം നടത്തിയില്ല.

   b) ഇതിൽ വിജയിച്ച കുട്ടിക്ക് ഒരുപാട് കുട്ടികളുമായി നല്ലബന്ധം ഉണ്ടായിരുന്നു.

7. നിങ്ങൾ എപ്പോഴും വളരെ ആരോഗ്യവാനാണ്.

   a) അസുഖമുള്ളവരുമായി ഞാൻ അധികം അടുത്ത് ഇടപെടാറില്ല.

   b) ഞാൻ കൃത്യസമയത്ത് ഭക്ഷണവും വിശ്രമവും ഉറപ്പുവരുത്താറുണ്ട്.

8. നിങ്ങൾ പറഞ്ഞ ദിവസം ലൈബ്രറി പുസ്തകം തിരിച്ചുനൽകാത്തതിന് പിഴ അടക്കേണ്ടി വന്നു.

   a) വായനയിൽ മുഴുകിയപ്പോൾ പുസ്തകം തിരിച്ചു നൽകേണ്ട ദിവസം മറന്നു പോയി.

   b) പരീക്ഷയുടെ തിരക്കിലായിരുന്നു.

9. ഗണിതശാസ്ത്രമേളയിൽ നിങ്ങൾക്ക ഒന്നാം സമ്മാനം ലഭിച്ചു.

   a) പുതിയ കാര്യങ്ങൾ കണ്ടുപിടിക്കാൻ ഞാൻ ആഗ്രഹിക്കുന്നു.

   b) ഗണിത അധ്യാപകൻ വളരെ പ്രശസ്തനാണ്.

10. നിങ്ങൾ ഒരു അത്ലറ്റിക് മീറ്റിൽ വിജയിച്ചു.

   a) തോറ്റുകൊടുക്കാൻ ഇഷ്ടപ്പെടാത്ത വ്യക്തിയാണ് ഞാൻ.

   b) ഞാൻ ഒരുപാട് പരിശ്രമിച്ചു.

11. നിങ്ങൾ സുഹൃത്തിന് ഒരു ചിത്രം വരച്ച് കൊടുത്തപ്പോൾ സുഹൃത്ത് അത് വേണ്ട വിധത്തിൽ ഗൗനിച്ചില്ല.

   a) ഞാൻ നല്ലൊരു ചിത്രകാരനല്ല.

   b) ഞാൻ തിരക്കുപിടിച്ചാണ് ആ ചിത്രം വരച്ചത്.

12. ഒരു ഗെയിം നടന്നുകൊണ്ടിരിക്കെ നിങ്ങളെ കളിയിലേക്ക് ക്ഷണിച്ചു.

   a) ഞാൻ മുൻനിരയിൽ ഇരിക്കുന്നുണ്ടായിരുന്നു.

   b) എന്നെയാണ് ഏറ്റവും ആവേശത്തോടെ കളികാണുന്ന ഒരാളായി അവർക്ക് തോന്നിയത്.

13. ഗാന്ധിജയന്തിയോടനുബന്ധിച്ചുള്ള സേവനവാരം പരിപാടിക്ക് നിങ്ങളോട് നേതൃത്വം നൽകാൻ ആവശ്യപ്പെട്ടു.

   a) ഞാൻ ആ പരിപാടിയിൽ നിന്നും വിട്ടുനിൽക്കും.

   b) ഞാൻ ആ പരിപാടി വളരെ കൃത്യമായി നിർവ്വഹിക്കും.

14. കുറച്ചു ദിവസമായി നിങ്ങൾ വളരെ ക്ഷീണിതനാണ്.

    a) വിശ്രമിക്കാൻ സമയം കിട്ടാറില്ല.

    b) ഈ ആഴ്ച ഞാൻ വളരെ തിരക്കിലായിരുന്നു.

15. നിങ്ങളുടെ മനസ്സ് വിഷമിപ്പിക്കുന്ന ഒരു കാര്യം നിങ്ങളുടെ സുഹൃത്ത് പറഞ്ഞു.

    a) മറ്റുള്ളവർ എന്ത് ചിന്തിക്കും എന്നു നോക്കാതെയാണ് എന്റെ സുഹൃത്ത് ഒരോ കാര്യങ്ങൾ വിളിച്ചുപറയുന്നത്.

    b) എന്റെ സുഹൃത്തിന്റെ മാനസികാവസ്ഥ ആ സമയം ശരിയല്ലായിരുന്നു. ആ ദേഷ്യം എന്നോട് കാണിച്ചു.

16. നിങ്ങളുടെ സുഹൃത്ത് ഒരു ഉപദേശം ആവശ്യപ്പെട്ടു

    a) എന്നോട് ചോദിച്ച കാര്യത്തിൽ ഞാൻ വളരെ സമർത്ഥനായിരുന്നു.

    b) നല്ല ഉപദേശങ്ങൾ കൊടുക്കുന്നതിൽ ഞാൻ സമർത്ഥനാണ്.

17. ഈ സ്കൂളിൽ നിങ്ങൾ വളരെ സന്തോഷവാനാണ്.

    a) എല്ലാവരും വളരെ സൗഹാർദ്ദത്തിലാണ്.

    b) ഞാൻ മറ്റുള്ളവരുമായി വളരെ സൗഹാർദ്ദത്തിലാണ്.

18. നിങ്ങളുടെ കായികാധ്യാപകൻ നിങ്ങൾ നല്ല ആരോഗ്യമുള്ളയാളാണ് എന്ന് പ റഞ്ഞു.

    a) ഞാൻ ഇടയ്ക്കിടെ വ്യായാമം ചെയ്യാറുണ്ട്.

    b) ഞാൻ ആരോഗ്യകാര്യത്തിൽ വളരെ ശ്രദ്ധാലുവാണ്.

19. സ്കൂളിൽ നിന്നും ഒരാഴ്ച്ചത്തെ വിനോദയാത്രയ്ക്ക് ഞാനും പോകുന്നു.

    a) കുറച്ച് ദിവസം എങ്ങനെയെങ്കിലും ചിലവഴിക്കണം എന്നുണ്ടായിരുന്നു.

    b) പുതിയ പുതിയ സ്ഥലങ്ങൾ കാണാൻ ഇഷ്ടമാണ്.

20. നിങ്ങളോട് അമിതമായി മധുരം കഴിക്കരുത് എന്ന് ഡോക്ടർ അഭിപ്രായപ്പെട്ടു.

    a) ഭക്ഷണകാര്യങ്ങളിൽ ഞാൻ അത്ര ശ്രദ്ധാലുവല്ല.

    b) എനിക്ക് മധുരം ഒഴിവാക്കാനാവില്ല. എല്ലാത്തിനും മധുരം വേണം.

21. ക്ലാസിലെ ഒരു പ്രവർത്തനം നിയന്ത്രിക്കാൻ ക്ലാസ് ടീച്ചർ ആവശ്യപ്പെട്ടു.

    a) അതിനു സമാനമായ ഒരു പ്രവർത്തനം ഞാൻ വിജയകരമായി പൂർത്തിയാക്കി യിരുന്നു.

    b) ഞാൻ നല്ലൊരു നിരീക്ഷകനാണ്.

22. നിങ്ങളും സുഹൃത്തും കുറച്ചുകാലമായി വഴക്കിലാണ്.

    a) ഈയിടെയായി എന്റെ മനസ്സ് ഒട്ടും ശരിയല്ല.

    b) കുറച്ചു കാലമായി എന്റെ സുഹൃത്ത് ഒരു ശത്രുമനോഭാവമാണ് കാണിക്കു ന്നത്.

23. നിങ്ങളെ ക്ലാസ് ലീഡറായി നിയമിച്ചു.

    a) ഞാൻ ക്ലാസിലെ ഒരു പ്രധാന പ്രശ്നം പരിഹരിച്ചു.

b) ഞാൻ ആയിരുന്നു ക്ലാസിലെ മികച്ച വിദ്യാർത്ഥി.

24. ഈ കഴിഞ്ഞ പരീക്ഷയിൽ കിട്ടിയ മാർക്ക് നിങ്ങളുടെ ഇതുവരെ ലഭിച്ചുവന്ന മാർക്കുകളിൽ ഏറ്റവും കുറഞ്ഞതാണ്.

a) ഇപ്പോഴത്തെ പരീക്ഷയെക്കുറിച്ച് നല്ലൊരു ധാരണ എനിക്കില്ലായിരുന്നു.

b) നിങ്ങൾ പ്രധാനപ്പെട്ടതാണ് എന്ന് കരുതി പഠിച്ചതൊന്നും പരീക്ഷയ്ക്ക് ചോദിച്ചില്ല.

25. സ്കൂളിൽ നടത്തിയ ഒരു നറുക്കെടുപ്പ് മത്സരത്തിൽ നിങ്ങൾക്ക് സമ്മാനം ലഭിക്കുകയാണെങ്കിൽ

a) അതിനുള്ള സാധ്യത വളരെ കുറവാണ്

b) അനുയോജ്യമായ ഒരു നമ്പറാണ് ഞാൻ തിരഞ്ഞെടുത്തത്

Appendix 3C

OPTIMISM INVENTORY (Final, English)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College
Research Centre in Education
Calicut

Midhundas A.M
Research Scholar
Farook Training College
Research Centre in Education
Calicut

Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

Instructions:

Imagine that you are involved in the following situations. Two explanations are given for each situations. Sometimes you may have encountered these situations or the explanations give may not seem appropriate to you. However mark (✓) against what seems to be almost correct about you.

1. The activities that you monitored are always a success
   a) I regularly monitored the activities of all.
   b) All of them spent a lot of time and energy for their work.
2. Though I quarrel with my friend, I can befriend him again shortly.
   a) I will forgive him soon.
   b) I am generous to forgive others.
3. My friend surprised me by giving a gift.
   a) Friend got high score in exam.
   b) I also gave a gift last day.
4. You forgot the birthday of your friend.
   a) I am very weak to remember those days.
   b) I was busy with other things.

5. You forgot an important event at school.
    a) Sometimes my memory is backwards.
    b) I forgot to look at my school diary.
6. You failed the election.
    a) I did not make a good campaign.
    b) The student who win the election had good relationship with many studnets.
7. You are always healthy.
    a) I used to keep distance from sick persons.
    b) I used to maintain food and rest on time.
8. As I couldn't return the book on due date from the library, I had to pay fine.
    a) Forgot myself in reading.
    b) I was busy with exam preparation.
9. You got first prize in mathematics fair.
    a) I like to explore new ideas.
    b) Maths teacher is very famous.
10. You won an athletic meet.
    a) I never like to give up.
    b) I tried a lot.
11. You drew a picture and gave it to your friend, but he didn't give much attention to it.
    a) I am not a good artist
    b) I drew the picture in a hurry
12. You were invited to a game which was going on.
    a) I was sitting in the front row
    b) They found me as an enthusiastic audient.
13. I am asked to take leadership on Gandhijayanti labour week programme.
    a) I will abstain from the programme.
    b) I will participate and complete the programme effectively.
14. You have been very tired for a few days.
    a) Not get enough time for rest
    b) I was so busy in this week.
15. Your friend told something that hurt you.
    a) My friend used to talk without concerning what others will think.

b) My friend's mind was not good at that time and showed his anger towards me.

16. Your friend asked for an advice

a) I was an expert in that matter.

b) I am an expert in giving advices

17. You are happy in this school.

a) All are very friendly.

b) I am friendly with others.

18. Your physical trainers said that you are very healthy.

a) I often do exercises.

b) I am very conscious in my health.

19. I am going to the one week vecation trip from school.

a) Anyway I want to spend some days.

b) I like to see new places.

20. Doctor adviced you not to eat too much sweets.

a) I am not careful in my food habits.

b) I can not avoid sweets, everything needs to be sweet.

21. The class teacher was asked to control an activity in the class.

a) I have successfully completed a similar activity.

b) I am a good observer.

22. You and your friends have been at loggerheads for some time.

a) Now a days my mind is not well.

b) My friend shows enemity towards me for few days.

23. You are appointed as the class leader.

a) I solved a major problem in the class.

b) I was the best student in the class.

24. The marks you got in this last exam are the lowest marks you have got yet.

a) I did not have clear idea about this examination.

b) Those content which you considered as important were excluded in the exam.

25. If you win a prize in a draw held at school.

a) Chances for that is very small.

b) I chose a suitable number.

Appendix 4A

SCALE ON ACADEMIC STRESS (Final, Malayalam)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College

Sajmadas K.K
Research Scholar
Farook Training College

Midhundas A.M
Research Scholar
Farook Training College

Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

നിർദ്ദേശങ്ങൾ

നിങ്ങളുടെ പഠനവുമായി ബന്ധപ്പെട്ട ചില പ്രസ്താവനകളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഓരോ പ്രസ്താവനയും വായിച്ച് നിങ്ങൾ അതിനോട് എത്രത്തോളം യോജിക്കുന്നു അല്ലെങ്കിൽ വിയോജിക്കുന്നു എന്ന് താഴെ കൊടുത്തിരിക്കുന്ന സൂചിക ഉപയോഗിച്ച് പ്രസ്താവനക്ക് നേരെ കൊടുത്തിരിക്കുന്ന സ്ഥലത്ത് നമ്പറിട്ട് രേഖപ്പെടുത്തുക. നിങ്ങളുടെ ഉത്തരങ്ങൾ ഗവേഷണാവശ്യത്തിന് മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളു എന്ന് ഉറപ്പ് തരുന്നു. നിങ്ങളുടെ പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസിൽ രേഖപ്പെടുത്തുക.

ക്രമ നമ്പർ	പ്രസ്താവന
1	ചില അധ്യാപകർ പഠിപ്പിക്കുന്ന പാഠഭാഗത്തിലെ ഉള്ളടക്കം തീരെ മനസിലാകുന്നില്ല.
2	ചില അധ്യാപകരുടെ പരിശീലന പദ്ധതിയും റിപ്പോർട്ടുകളും വളരെ കർശനമാണെന്ന് എനിക്ക് അനുഭവപ്പെടുന്നു.
3	ചെറുതും വലുതുമായ പരീക്ഷകൾക്ക് ഞാൻ കൂടുതൽ സമയം ചിലവഴിക്കുന്നു.
4	അടുത്തിടെ നടന്ന ക്ലാസ് പരീക്ഷാഫലങ്ങളിൽ ഞാൻ പൂർണ്ണ തൃപ്തനല്ല.

ക്രമ നമ്പർ	പ്രസ്താവന
5	പരീക്ഷകളെക്കുറിച്ചുള്ള ഉത്കണ്ഠ കാരണം എനിക്ക് നന്നായി ഉറങ്ങാൻ സാധിക്കാറില്ല.
6	പരീക്ഷാഫലവുമായി ബന്ധപ്പെട്ട് രക്ഷിതാക്കളുമായി എനിക്ക് തർക്കിക്കേണ്ടി വരാറുണ്ട്.
7	എന്റെ ഇപ്പോഴുള്ള പരീക്ഷാഫലം യു.പി. സ്കൂൾ പരീക്ഷാഫലവുമായി വളരെ അധികം വ്യത്യാസമുള്ളതായി എനിക്ക് തോന്നുന്നു.
8	എന്റെ പഠനത്തെക്കുറിച്ച് എനിക്ക് ഗൗരവമില്ലെന്ന് മാതാപിതാക്കൾ കരുതുന്നു എന്ന് എനിക്ക് തോന്നുന്നു.
9	ചില പ്രബന്ധങ്ങളുടെ വസ്തുക്കളും വിവരങ്ങളും ശേഖരിക്കുന്നതിന് കൂടുതൽ സമയം ചിലവഴിക്കേണ്ടി വരുന്നു.
10	ചില അധ്യാപകർ നൽകുന്ന നിർദ്ദേശങ്ങളുടെ വേഗതയ്ക്കൊത്ത് എത്താൻ എനിക്ക് കഴിയുന്നില്ല.
11	ചില അധ്യാപകരുടെ അധ്യാപനരീതിയുമായി പൊരുത്തപ്പെടാൻ എനിക്ക് സാധിക്കാറില്ല.
12	ചില അധ്യാപകർ നൽകുന്ന വിവരങ്ങളുടെ ആധിക്യം പഠനം പൂർത്തിയാക്കുന്നതിനും ഉള്ളടക്കം ഹൃദ്യസ്ഥമാക്കുന്നതിനും തടസ്സമാകുന്നു.
13	പരീക്ഷാവേളയിൽ പഠിച്ചകാര്യങ്ങൾ ഓർത്തെടുക്കാൻ എനിക്ക് കഴിയുന്നില്ല.
14	പൊതുപരീക്ഷയിൽ പരാജയപ്പെട്ടാൽ, പരാജയപ്പെട്ട വിഷയങ്ങൾ വീണ്ടും എഴുതേണ്ടി വരുമല്ലോ എന്ന ഉത്കണ്ഠ എനിക്കുണ്ട്.
15	ക്ലാസ് പരീക്ഷയും വിഷയങ്ങളുടെ ഉള്ളടക്കവും ഇടയ്ക്കിടെ മാറുന്നത് കാരണം എനിക്ക് കൃത്യമായി പഠിക്കാനും പരിശീലനം നടത്തുവാനും കഴിയുന്നില്ല.
16	പഠനപ്രവർത്തനങ്ങൾ സഹപാഠികളോടൊപ്പം ചെയ്യുമ്പോൾ പ്രശ്നങ്ങൾ ഉണ്ടാവാറുണ്ട്.
17	പ്രസംഗിക്കുമ്പോഴും പാഠഭാഗം അവതരിപ്പിക്കുമ്പോഴും എന്റെ കഴിവില്ലായ്മ കണ്ട് സഹപാഠികൾ പരിഹസിക്കുമോ എന്ന ചിന്ത എനിക്ക് ഉണ്ടാകാറുണ്ട്.
18	സദസ്സിനെ അഭിമുഖീകരിക്കുമ്പോൾ ഉൾഭയം ഉണ്ടാവാറുണ്ട്.
19	അക്കാദമിക പ്രകടനങ്ങളുടെ ഭാഗമായി സഹപാഠികളുമായി നേരിട്ടും അല്ലാതെയും തർക്കങ്ങളുണ്ടാവാറുണ്ട്.

ക്രമ നമ്പർ	പ്രസ്താവന
20	പരീക്ഷഫലങ്ങളുടെ കാര്യത്തിൽ സഹപാഠികളുടേതിനേക്കാൾ മോശമാകുമോ എന്റേതെന്ന ഉത്കണ്ഠ എനിക്കുണ്ട്.
21	പഠനവും പാഠ്യേതര പ്രവർത്തനങ്ങളും ഒരുമിച്ച് കൊണ്ട് പോകുന്നതിൽ പ്രയാസം അനുഭവപ്പെടുന്നു.
22	പഠനത്തിനും പാഠ്യേതര പ്രവർത്തനങ്ങൾക്കുമുള്ള സമയം ക്രമീകരിക്കാൻ എനിക്ക് കഴിയുന്നില്ല.
23	പരീക്ഷകളിൽ സമയനിഷ്ഠ പാലിക്കാൻ കഴിയാത്തത് എന്നെ അലട്ടാറുണ്ട്.
24	എന്റെ പഠന നിലവാരം സഹപഠികളുടേതുപോലെ മികച്ചതല്ലെന്ന് തോന്നുന്നു.
25	പല പരീക്ഷകളും പഠനപ്രവർത്തനങ്ങളും എന്നെ ശ്വാസം മുട്ടിക്കുന്നു.
26	ചില പഠനവിഷയങ്ങളിൽ എനിക്ക് തീരെ താൽപര്യമില്ല.
27	ഹൈസ്കൂളിൽ ചേർന്ന ശേഷം ഞാൻ പ്രതീക്ഷിച്ചതു പോലുള്ള ഒരു പ്രകടനം കാഴ്ചവെയ്ക്കാൻ എനിക്ക് സാധിച്ചിട്ടില്ല.
28	എന്റെ ഹോംവർക്കുകളും റിപ്പോർട്ടുകളും മെച്ചപ്പെട്ടുവെന്ന് ഞാൻ പ്രതീക്ഷിക്കുന്നു.
29	എന്റെ പ്രതീക്ഷയ്ക്കൊത്ത പ്രകടനം കാഴ്ചവയ്ക്കാൻ സാധിക്കാതെ വരുമ്പോൾ ഞാൻ നിരാശനാകാറുണ്ട്.
30	എന്റെ പരീക്ഷാഫലത്തെ മറ്റുള്ള കുട്ടികളുമായി താരതമ്യം ചെയ്യുന്നത് എന്നെ അസ്വസ്ഥനാക്കാറുണ്ട്.
31	പഠന നിലവാരത്തെ കുറിച്ചറിയാൻ മാതാപിതാക്കൾ ശ്രമിക്കാത്തത് എന്നിൽ വിഷമം ഉണ്ടാക്കാറുണ്ട്.
32	മാതാപിതാക്കളുടെ പ്രതീക്ഷക്കൊത്ത് പരീക്ഷാഫലങ്ങളിൽ ഉയരാൻ സാധിക്കുമോ എന്ന ചിന്ത എന്നെ അസ്വസ്ഥനാക്കാറുണ്ട്.

സ്വരം	പൂർണമായും ശ്രദ്ധിക്കുന്നു	ശ്രദ്ധിക്കുന്നു	അടിപ്രാധാന്യമില്ല	വിട്ടുപോകുന്നു	പൂർണമായും വിട്ടുപോകുന്നു
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സ്വരം	പൂർണമായും ശ്രദ്ധിക്കുന്നു	ശ്രദ്ധിക്കുന്നു	അടിപ്രാധാന്യമില്ല	വിട്ടുപോകുന്നു	പൂർണമായും വിട്ടുപോകുന്നു
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Appendix 4B

SCALE ON ACADEMIC STRESS (Final, English)
Farook Training College, Calicut

Dr. K. Vijayakumari
Associate Professor
Farook Training College

Sajmadas K.K
Research Sholar
Farook Training College

Midhundas A.M
Research Scholar
Farook Training College

Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

Instructions:

The following are some statements related to your study. Read each statement and record how much you agree or disagree with it, numbered in the space provided against the statement. Assures that your answers will be used for research purposes only. Write your answers on the answer sheet given.

Item No	Statements
1	The content taught by some teachers are not completely understood.
2	I feel that the instructional plan and reports of some teachers are very strict.
3	I spend more time on exams.
4	I am not completely satisfied with the results of the recent class exams.
5	I can't sleep well because of anxiety about exams.
6	I have to argue with my parents on the exam results.
7	My current exam result seems to be very different from the UP school exam results.
8	I feel like my parents think I am not serious about my studies.
9	Some essays require more time to gather material and information.

Item No	Statements
10	I can't keep up with the speed of the instructions given by some teachers
11	I can not pace with the teaching style of some teachers
12	Excessive amount of information provided by some teachers hinders the completion of the study and memorization of the content.
13	During the exam, I could not remember what I had learned.
14	I am worried about re-writing the exams if I fail in it.
15	I am not able to study and practice accurately because the class exams and the content of the subjects change from time to time.
16	While doing learning activities with classmates, issues are commen.
17	I am afraid of my incompetence while presenting something.
18	I am anxious while facing an audience.
19	Disputes are there among classmates regarding academic activities.
20	I am worried about my exam results getting worse than my classmates.
21	I feel difficulty in managing time for curricular and co-curricular activities.
22	I can't schedule time for study and extracurricular activities.
23	Inability to keep in time during exam worries me.
24	My level of learning does not seem to be as good as that of my classmates.
25	Many exams and learning activities make me gasp.
26	I am not interested in some subjects of study.
27	In high school I failed to perform as I expected.
28	I hope my homeworks and reports have improved.
29	I am frustrated when I fail to perform well.
30	Comparing my exam results with other children makes me uncomfortable.
31	Negligence of parents on my academic level bothers me.
32	I am anxious on whether I could perform as my parents expect.

Appendix 5

TEST OF PROBLEM SOLVING ABILITY IN MATHEMATICS
(Malayalam)
University of Calicut

Dr. V. Sumangala
Professor
Department of Education
University of Calicut

Rinsa P.V
Department of Education
University Calicut

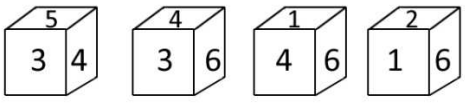
Personal Information

Name of the Student	:	
Name of the School	:	
Class	:	
Gender	:	Male / Female
Type of School	:	Govt. / Aided
Locality	:	Rural / Urban

നിർദ്ദേശങ്ങൾ

ഈ പരീക്ഷയിൽ ആകെ 25 ചോദ്യങ്ങളുണ്ട്, ഒരോന്നിനും a, b, c, d എന്നീ 4 ഉത്തരങ്ങൾ കൊടുത്തിട്ടുണ്ട്. ഓരോ ചോദ്യവും ശ്രദ്ധിച്ച് വായിച്ചതിനുശേഷം ശരിയുത്തരം മനസ്സിലാക്കി നിങ്ങളുടെ ഉത്തരങ്ങൾക്കുനേരെ ശരി (✓) അടയാളം രേഖപ്പെടുത്തുക. തന്നിട്ടുള്ള സമയത്തിനുള്ളിൽ എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം രേഖപ്പെടുത്തുക.

1. ഒരു ചതുരക്കട്ടയെ വിവിധ ദിശയിൽ നിന്ന് നോക്കുമ്പോൾ ലഭിക്കുന്ന ചിത്രങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. താഴെ പറയുന്നവയിൽ ഏത് ജോഡിയാണ് എതിർമുഖങ്ങളിൽ വരുന്നത്?



a) 1,3 b) 1, 4 c) 2, 3 d) 4, 5

2. ക്രമനമ്പറിന്റെ അടിസ്ഥാനത്തിൽ അടുക്കിവെച്ചിരിക്കുന്ന 100 രൂപയുടെ 35 നോട്ടുകൾ രാജീവിന്റെ കയ്യിലുണ്ട്. ആദ്യനോട്ടിന്റെ ക്രമനമ്പർ 12965 ആയാൽ അവസാനത്തെ നോട്ടിന്റെ ക്രമനമ്പർ എത്രയായിരിക്കും?

a) 13999 b) 13000 c) 12999 d) 13001

3. രാമൻ കൃഷ്ണന്റെ മുന്നിലും, രാജൻ രാമന്റെ മുന്നിലും, സേതു രാജന്റെ മുന്നിലും സീത രാമന്റെ മുന്നിലും നടക്കുന്നു. ആരാണ് ഏറ്റവും പുറകിലുള്ളത്?

   a) സീത b) കൃഷ്ണൻ c) സേതു d) രാജൻ

4. ഒരു ക്ലോക്ക് 12.00 മണി എന്ന സമയം കാണിക്കുമ്പോൾ മിനുട്ട് സൂചിയും മണിക്കൂർ സൂചിയും തമ്മിലുള്ള കോണളവ് എത്ര?

   a) 30^0 b) 31^0 c) 29^0 d) 30.5^0

5. 3, 2, 7, 6, 11 . . . അടുത്ത സംഖ്യ ഏത്?

   a) 8 b) 4 c) 10 d) 2

6. 50 ഉദ്യോഗാർത്ഥികൾക്ക് വേണ്ടി പബ്ലിക് സർവ്വീസ് കമ്മീഷൻ നടത്തിയ പരീക്ഷയിൽ ഒരാൾക്ക് 20 ാമത്തെ റാങ്ക് കിട്ടി. താഴെ നിന്നും അയാളുടെ റാങ്ക് എത്രയാണ്?

   a) 31 b) 30 c) 29 d) 28

7. ഒരു ക്ലാസിലെ 4 കുട്ടികൾ ഒരു ബഞ്ചിലിരിക്കുന്നു. സുനിൽ മാത്യുവിന്റെ ഇടത് വശത്തും, റഹീമിന്റെ വലതു വശത്തുമായിട്ട് ഇരിക്കുന്നു. അനിലിന്റെ ഇടത് വശത്താണ് റഹീം. എന്നാൽ ആരാണ് ഏറ്റവും ഇടത്തേ അറ്റത്ത് ഇരിക്കുന്നത്?

   a) സുനിൽ b) മാത്യു c) റഹീം d) അനിൽ

8. ഇപ്പോൾ സമയം 12.00 മണിയാണെങ്കിൽ 12.30 ആകാൻ ആകെ എത്ര സെക്കന്റ് കഴിയണം?

   a) 30 b) 3600 c) 1800 d) 60

9. മനീഷ് ഒരു ഫുട്ബോൾ കളിക്കാരനാണ് എല്ലാ ഫുട്ബോൾ കളിക്കാരും ഉയരുമുള്ളവരാണ്. എങ്കിൽ താഴെ പറയുന്നവയിൽ ഏത് നിഗമനമാണ് എല്ലായ്പ്പോഴും ശരിയാകുന്നത്?

   a) മനീഷ് ഉയരമുള്ളവനാണ്

   b) ഉയരമുള്ളവരെല്ലാം ഫുട്ബോൾ കളിക്കാരാണ്

   c) ഉയരമുള്ളവരെല്ലാം ഫുട്ബോൾ കളിക്കാരനല്ല

   d) മനീഷ് ഉയരമുള്ളവനല്ല.

10. വ്യുൽക്രമങ്ങളുടെ തുക എണ്ണൽ സംഖ്യയായി വരുന്ന മൂന്ന് വ്യത്യസ്ത സംഖ്യകളേതെല്ലാം?

    a) 1,2,3 b) 2,56 c) 1,3,6 d) ഇവയൊന്നുമല്ല

11. $(a+b)^2$ ന്റെ വിപുലീകരണത്തിൽ 3 പദങ്ങളുണ്ട്

$(a+b)^3$ ന്റെ വിപുലീകരണത്തിൽ 4 പദങ്ങളുണ്ട്

$(a+b)^4$ ന്റെ വിപുലീകരണത്തിൽ 5 പദങ്ങളുണ്ട്.

എങ്കിൽ $(a+b)^n$ ന്റെ വിപുലീകരണത്തിൽ എത്ര പദങ്ങളുണ്ട്?

a) n പദങ്ങൾ b) n-1 പദങ്ങൾ c) n +1 പദങ്ങൾ d) n^2 പദങ്ങൾ

12. $1+2+3+4+5 = \frac{5\times(5+1)}{2}$, $1+2+3+4+5+6 = \frac{6\times(6+1)}{2}$, $1+2+3+4+5+6+7 = \frac{7\times(7+1)}{2}$ ആണെങ്കിൽ 1+2+3+4+5+6+7+8 +9+10= ⁻⁻2 എത്രയായിരിക്കും?

a) $\frac{8\times(8+1)}{2}$ b) $\frac{[5\times(5+1)]}{4}$ c) $\frac{10\times(10+1)}{2}$ d) $\frac{10+(10+1)}{2}$

13. $1^3=1^2$, $1^3+2^3=3^2$, $1^3 + 2^3 + 3^3 + 4^3 =10^2$ ആണെങ്കിൽ $1^3 + 2^3 + 3^3 + 4^3 + 5^3 + 6^3$ = എത്രയായിരിക്കും?

a) 21^2 b) 15^2 c) 6^2 d) 21

14. 3x=2y, 2y=z ആയാൽ കൂടുതൽ വിലയുള്ള ചരം ഏത്?

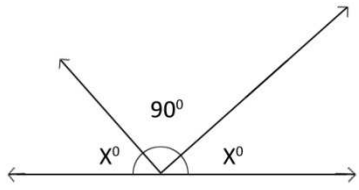
a) x b) y c) z d) എല്ലാ ചരത്തിനും തുല്യ വില.

15. താഴെ തന്നിരിക്കുന്നവയിൽ എല്ലായ്പ്പോഴും ഇരട്ടസംഖ്യയായി വരുന്ന ക്രിയയേത്?

a) ഇരട്ടസംഖ്യ x ഒറ്റസംഖ്യ b) ഇരട്ടസംഖ്യ + ഒറ്റസംഖ്യ

c) ഒറ്റസംഖ്യ x ഒറ്റസംഖ്യ d) ഇരട്ടസംഖ്യ % ഇരട്ടസംഖ്യ

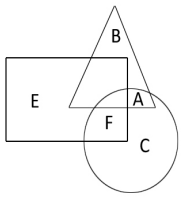
16. താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് സമവാക്യം ഉപയോഗിച്ചാൽ X^0 ന്റെ വില കാണാം?



a) $180^0=90$ X $2x^0$ b) $180^0=90^0 + x^2$

c) $90^0 + x^2 = 180^0$ d) ഇവയൊന്നുമല്ല

17. താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ ചതുരം വാർത്താവായനക്കാരേയും ത്രികോണം അവതാരകരേയും, വൃത്തം പാട്ടുകാരേയും സൂചിപ്പിക്കുന്നു. എങ്കിൽ A എന്ന അക്ഷരം എന്തിനെ സൂചിപ്പിക്കുന്നു?



a) പാട്ടുകാരായ അവതാരകരെ

b) വർത്താവായനക്കാരായ അവതാരകരെ

c) പാട്ടുകാരായ വാർത്താവായനക്കാരെ

d) അവതാരകരെ

18. ഒരു സംഖ്യയോട് അതേ സംഖ്യ തന്നെ കൂട്ടി കിട്ടിയ തുകയിൽ നിന്നും ആ സംഖ്യ കുറച്ചു കിട്ടിയ ശിഷ്ടത്തെ സംഖ്യയുമായി ഗുണിച്ചു. ഗുണനഫലം 100 ആയാൽ സംഖ്യയേത്?

a) 100 b) 50 c) 20 d) 10

19. ഒരു സംഖ്യയുടെ 6 മടങ്ങും, 8 മടങ്ങും തമ്മിലുള്ള വ്യത്യാസം 40 ആയാൽ സംഖ്യയേത്?

a) 240 b) 320 c) 40 d) 20

20. രണ്ട് സംഖ്യകളുടെ തുക 30 ഉം വ്യത്യാസം 20 ഉം ആയാൽ സംഖ്യകളേത്?

a) 15, 15 b) 38,10 c) 25, 5 d) 28,2

21. തുടർച്ചയായ 4 സംഖ്യകളുടെ തുക 50 ആണ്. അവയിലെ ഏറ്റവും വലിയ സംഖ്യയേത്?

a) 14 b) 24 c) 21 d) 11

22. ഒരു ക്ലാസിലെ പെൺകുട്ടികളുടെ എണ്ണം ആൺകുട്ടികളുടെ എണ്ണത്തിന്റെ 5 ഇരട്ടിയാണ് എങ്കിൽ ആ ക്ലാസ്സിലെ ആകെ കുട്ടികളുടെ എണ്ണമായി വരാൻ സാധ്യതയില്ലാത്തത് താഴെ പറയുന്നവയിൽ ഏത് സംഖ്യയാണ്?

a) 36 b) 48 c) 54 d) 62

23. ഒരച്ഛൻ തന്റെ മൂത്തമകന് സ്വന്തം സ്വത്തിന്റെ പകുതിയും രണ്ടാമത്തെ മകന് ബാക്കിയുള്ളതിന്റെ പകുതിയും മൂന്നാമത്തെ മകന് പിന്നെയും ബാക്കിവരുന്നതും കൊടുക്കുവാൻ തീരുമാനിച്ചു. പിതാവ് മൂന്നമത്തെ മകന് കൊടുക്കുവാൻ തീരുമാനിച്ചത്?

a) സ്വന്തം സ്വത്തിന്റെ നാലിലൊരു ഭാഗമാണ്.

b) സ്വന്തം സ്വത്തിന്റെ രണ്ടിൽ ഒരു ഭാഗമാണ്.

c) സ്വന്തം സ്വത്തിന്റെ മൂന്നിൽ ഒരു ഭാഗമാണ്.

d) സ്വന്തം സ്വത്തിന്റെ എട്ടിൽ ഒരു ഭാഗമാണ്.

24. അതിരാവിലെ സൂര്യോദയത്തിനുശേഷം ബിമൽ നടക്കാൻ ഇറങ്ങി. കുറച്ച് കഴിഞ്ഞപ്പോൾ എതിർദിശയിൽ വരികയായിരുന്ന സ്റ്റീഫനുമായി കണ്ടുമുട്ടി. സ്റ്റീഫനുമായി സംസാരിച്ചുകൊണ്ടിരുന്നപ്പോൾ സ്റ്റീഫന്റെ നിഴൽ ബിമലിന്റെ വലത് വശത്ത് കാണുകയുണ്ടായി. എങ്കിൽ ബിമൽ ഏത് ദിശക്കഭിമുഖമായാണ് നിന്നത്?

a) കിഴക്ക് b) പടിഞ്ഞാറ് c) തെക്ക് d) വടക്ക്

25. ഒരു സോപ്പിന്റെ അളവുകൾ 5 cm X 4 cm X1.5 cm ആണ്. ഇത്തരത്തിലുള്ള എത്ര സോപ്പുകൾ 55 cm X 48 cm X 15 cm അളവോടുകൂടിയ കാർഡ് ബോർഡ് പെട്ടിയിൽ കൊള്ളുമെന്ന് കണ്ടുപിടിക്കുന്നതിന് താഴെ കൊടുത്തിരുന്നവയിൽ ഏത് ക്രിയ ഉപയോഗിക്കാം?

a) $\frac{5\times4\times1.5}{55\times48\times15}$ b) $\frac{5\times4\times1.5}{55+48+15}$ c) $\frac{55\times48\times15}{5\times4\times1.5}$ c) $\frac{55\times48\times15}{5\times4\times1.5}$

Appendix 6

Mathematics Anxiety Scale (Modified-Malayalam)
University of Calicut

Dr. V Sumangala
Professor
Department of Education
University of Calicut

Malini P.M
Department of Education
University of Calicut

Personal Information

Name of the Student :

Name of the School :

Class :

Gender : Male / Female

Type of School : Govt. / Aided

Locality : Rural / Urban

Instructions:

നിർദ്ദേശങ്ങൾ: ഗണിതശാസ്ത്രപഠനത്തിൽ നിങ്ങൾ നേരിടുന്ന പ്രശ്നങ്ങൾ ആണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഓരോ പ്രസ്താവനയും വായിച്ച് അതിന് നേരെ നൽകിയിട്ടുള്ള 'പൂർണമായും യോജിക്കുന്നു', 'യോജിക്കുന്നു', 'അഭിപ്രായമില്ല', 'വിയോജിക്കുന്നു', 'പൂർണമായും യോജിക്കുന്നു' നേരെ നിങ്ങളുടെ പ്രതികരണം രേഖപ്പെടുത്തുക.

1. കണക്ക് ചെയ്യുമ്പോൾ ടീച്ചർ എന്നെ ശ്രദ്ധിക്കുകയാണെങ്കിൽ എനിക്ക് ബുദ്ധിമുട്ട് തോന്നാറുണ്ട്.
2. ടീച്ചർ ചോദ്യം ചോദിക്കുമ്പോൾ ഉത്കണ്ഠ കാരണം എനിക്ക് ഉത്തരം പറയാൻ കഴിയാറില്ല.
3. അതതു ദിവസങ്ങളിലെ ഗണിതഭാഗങ്ങൾ പഠിക്കാനിരുന്നാൽ എനിക്ക് അസ്വസ്ഥത അനുഭവപ്പെടാറുണ്ട്.
4. തെറ്റിപ്പോകും എന്ന് പേടിയുള്ള കാരണം ചില സമയങ്ങളിൽ എനിക്ക് കണക്ക് ചെയ്യാൻ കഴിയാറില്ല.
5. എളുപ്പമായി എനിക്ക് തോന്നാറുള്ള ചോദ്യങ്ങൾ പോലും ചില സമയങ്ങളിൽ ഞാൻ തെറ്റിക്കാറുണ്ട്.
6. ജ്യാമിതീയ കണക്കുകളിൽ ഞാൻ എടുക്കുന്ന അളവുകൾ തെറ്റാണോ എന്നുള്ള തോന്നൽ എന്നെ അലട്ടാറുണ്ട്.
7. ടീച്ചറുടെ ശ്രദ്ധ കിട്ടാതിരിക്കാൻ വേണ്ടി ഞാൻ ക്ലാസിലെ പുറകിലെ ബഞ്ചിൽ ആണ് ഇരിക്കാറുള്ളത്.
8. നല്ലവണ്ണം പഠിച്ചാലും എനിക്ക് ഗണിത പരീക്ഷ നന്നായി എഴുതാൻ കഴിയാറില്ല.
9. ഗണിതപഠനം മികവുറ്റതാക്കാനുള്ള ശ്രമത്തിൽ എനിക്ക് ബുദ്ധിമുട്ട് തോന്നാറില്ല.

10. എത്ര തവണ പാഠഭാഗങ്ങൾ പഠിച്ചാലും പരീക്ഷ നന്നായി എഴുതാൻ കഴിയുമോ എന്ന ആശങ്ക എനിക്ക് തോന്നാറുണ്ട്.
11. ഞാൻ മോശപ്പെട്ട കുട്ടിയാവും എന്ന ഭയത്താൽ ഗണിതത്തിലെ സംശയങ്ങൾ ഒന്നും ദൂരീകരിക്കാറില്ല.
12. കണക്കുകൾ ചെയ്യുന്ന വഴി തെറ്റായി പോകുമോ എന്ന പേടി കാരണം ഞാൻ ഒറ്റയ്ക്ക് കണക്കുകൾ ചെയ്യാറില്ല.
13. ടീച്ചർ ഗണിത പ്രശ്നങ്ങൾ ബോർഡിൽ ചെയ്തു തരുന്നത് നോക്കി എഴുതുന്നതിൽ ഞാൻ സംതൃപ്തനാണ്.
14. ദിവസേന ഉപയോഗിക്കുന്ന ഗണിതക്രിയകൾ വരെ ക്ലാസിൽ ചെയ്യുന്ന സമയത്ത് എനിക്ക് ബുദ്ധിമുട്ട് അനുഭവപ്പെടാറുണ്ട്
15. ഉത്തരം തെറ്റിപ്പോയാൽ ടീച്ചർ വഴക്കുപറയുമോ എന്ന പേടിയുള്ളതിനാൽ അടുത്തുള്ള കുട്ടിയുടെ നോട്ട്ബുക്ക് നോക്കി എഴുതാറുണ്ട്.
16. ഉത്തരം അറിയാമെങ്കിൽ പോലും ഗണിതക്രിയകൾ ചെയ്യുമ്പോൾ എനിക്ക് ബുദ്ധിമുട്ട് അനുഭവപ്പെടാറുണ്ട്.
17. പണമിടപാടുകളിൽ എന്റെ കണക്കുകൂട്ടലുകൾ തെറ്റിപ്പോകുമോ എന്ന പേടി കാരണം അത്തരം അവസരങ്ങളിൽ ഞാൻ മാറിനിൽക്കാറുണ്ട്.
18. കണക്കുപരീക്ഷയുടെ സമയമാകുമ്പോൾ സാധാരണയായി പനി, വയറുവേദന എന്നിങ്ങനെയുള്ള ദേഹാസ്വസ്ഥതകൾ എനിക്ക് ഉണ്ടാകാറുണ്ട്.
19. ശരിയായ ഉത്തരം പറയാൻ സാധിക്കില്ല എന്ന പേടി കാരണം ഞാൻ ക്വിസ് മത്സരങ്ങളിൽ പങ്കെടുക്കാറില്ല.
20. ഓരോ പുതിയ പ്രശ്നങ്ങൾ ചെയ്യുമ്പോഴും മുൻപത്തെപ്പോലെ തെറ്റിപ്പോകും എന്ന് ഞാൻ അസ്വസ്ഥനാകാറുണ്ട്.
21. ഉത്കണ്ഠ കാരണം എനിക്ക് എപ്പോഴും കണക്കിൽ കുറവ് മാർക്കാണ് ലഭിക്കാറുള്ളത്.
22. കണക്കിലുള്ള എന്റെ ഉത്കണ്ഠ തരണം ചെയ്യാതെ കണക്കിൽ എനിക്ക് പ്രതീക്ഷിച്ച നിലവാരം കൈവരിക്കാൻ സാധിക്കാറില്ല.
23. ഗണിതത്തിൽ വ്യക്തമായ അറിവില്ലാതെ മത്സരപരീക്ഷകൾ ജയിക്കാൻ സാധിക്കില്ല എന്നതിൽ എനിക്ക് ഉത്കണ്ഠയുണ്ട്.
24. സമവാക്യങ്ങൾ നന്നായി പഠിച്ചിട്ടുണ്ടെങ്കിലും പരീക്ഷാ പേടി കാരണം ഞാൻ മറന്നുപോകാറുണ്ട്.

നമ്പർ	പൂർണമായും ശരിയല്ലെന്നു	ശരിയല്ലെന്നു	അഭിപ്രായമില്ല	വിശ്വാസിക്കുന്നു	പൂർണമായും വിശ്വാസിക്കുന്നു
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Appendix 7A

LOCUS OF CONTROL SCALE (Malayalam)
Department of Psychology
University of Calicut

നിർദ്ദേശങ്ങൾ: ദൈനംദിന ജീവിതവുമായി ബന്ധപ്പെടുന്ന ഏതാനും പ്രസ്താവനകൾ ഈ ചോദ്യാവലിയിൽ കൊടുത്തിരിക്കുന്നു. ഓരോ പ്രസ്താവനയും നിങ്ങളെ സംബന്ധിച്ചിടത്തോളം ശരിയാണോ, അഥവാ, നിങ്ങൾ പ്രസ്താവനയോട് യോജിക്കുന്നുവോ ഇല്ലയോ എന്നതാണ് ഉത്തരക്കടലാസ്സിൽ രേഖപ്പെടുത്തേണ്ടത്. നിങ്ങളുടെ അഭിപ്രായം പ്രത്യേകം തന്നിരിക്കുന്ന ഉത്തരക്കടലാസ്സിൽ ശരി/തെറ്റ് എന്നിവയ്ക്കായുള്ള ഏതെങ്കിലും ഒരു ബ്രാക്കറ്റിൽ പ്രസ്താവനയുടെ ക്രമനമ്പർ അനുസരിച്ച് അധിക ചിഹ്നം (+) ഉപയോഗിച്ച് രേഖപ്പെടുത്തുക. പ്രസ്താവനകൾ വായിച്ച് ഉടൻതന്നെ മനസ്സിൽ തോന്നുന്ന ഉത്തരങ്ങളാണ് അടയാളപ്പെടുത്തേണ്ടത്.

ചോദ്യാവലിയിൽ കൊടുക്കുന്ന ഉത്തരങ്ങൾ ഗവേഷണ പഠനങ്ങൾക്ക് മാത്രം ഉപയോഗിക്കാനുള്ളതാണ്. അവ തികച്ചും സ്വകാര്യമായി സൂക്ഷിക്കുന്നതാണ്. നിങ്ങളുടെ സഹകരണത്തിന് പ്രത്യേകം നന്ദി പറയുന്നു. ചോദ്യപുസ്തകത്തിൽ യാതൊന്നും അടയാളപ്പെടുത്താതിരിക്കാൻ ശ്രദ്ധിക്കുക.

1. ഒരു ദിവസം നന്നായി ആരംഭിക്കാൻ കഴിഞ്ഞാൽ അന്നത്തെ മറ്റെല്ലാ പ്രവൃത്തികളും നന്നായിരിക്കും.

2. നമ്മുടെ ഇഷ്ടമനുസരിച്ച് സുഹൃത്തുക്കളെ തിരഞ്ഞെടുക്കുവാൻ നമുക്ക് ധാരാളം അവസരങ്ങൾ ഉണ്ട്.

3. മറ്റുള്ളവർ ഏതുവിധത്തിൽ നമ്മെ ഇഷ്ടപ്പെടുന്നു എന്നത് നമ്മുടെ പെരുമാറ്റത്തെ ആശ്രയിച്ചാണിരിക്കുന്നത്.

4. ആകസ്മിക സംഭവങ്ങൾ ജീവിതത്തെ എത്രമാത്രം സ്വാധീനിക്കുന്നു എന്നത് മിക്കവർക്കും അറിയില്ല.

5. എന്തിന് വേണ്ടി പരിശ്രമിക്കുന്നുവോ അതിനുള്ള അംഗീകാരം നമുക്ക് ജീവിതത്തിൽ ലഭിക്കാതിരിക്കില്ല.

6. യാദൃശ്ചിക സംഭവങ്ങൾ തങ്ങളുടെ പരീക്ഷാഫലത്തെ എത്രമാത്രം സ്വാധീനിക്കുന്നുവെന്ന് മിക്കവാറും വിദ്യാർത്ഥികൾ മനസ്സിലാക്കിയിട്ടില്ല.

7. മറ്റുള്ളവരുമൊത്ത് ഇണങ്ങിക്കഴിഞ്ഞുപോകാൻ കഴിയാത്തവർക്ക് മറ്റുള്ളവരെ തങ്ങളെ ഇഷ്ടപ്പെടുന്നവരാക്കാൻ കഴിയില്ല.

8. പരീക്ഷയ്ക്ക് നന്നായി തയ്യാറായിട്ടുള്ള ഒരു വിദ്യാർത്ഥിയുടെ കാര്യത്തിൽ അനുചിതമായ പരീക്ഷ എന്നൊന്നില്ല.

9. മറ്റൊരാൾ നിങ്ങളെ ആത്മാർത്ഥമായും ഇഷ്ടപ്പെടുന്നുണ്ടോ ഇല്ലയോ എന്ന് കൃത്യമായും അറിയാൻ വളരെ പ്രയാസമാണ്.

10. ഒരുവിധത്തിലും നാം ഉദ്ദേശിക്കുന്നതുപോലെ കാര്യങ്ങൾ നടക്കുകയില്ലാത്തതുകൊണ്ട് നാം കഠിനമായി പ്രയത്നിക്കേണ്ട ആവശ്യമില്ല.

11. ഭാഗ്യത്തേക്കാൾ പ്രോത്സാഹനമാണ് ഒരു ടീമിന്റെ വിജയത്തിന് വഴിയൊരുക്കുക.

12. നമ്മുടെ മാതാപിതാക്കൾക്ക് ഏതിനോടുള്ള അഭിപ്രായം മാറ്റിയെടുക്കുക അസാദ്ധ്യമാണ്.

13. നമ്മൾ ആവശ്യപ്പെട്ടാൽ സുഹൃത്തുക്കൾ സാധാരണയായി നമ്മെ സഹായിക്കും.

14. എന്റെ സമപ്രായക്കാരിൽ അധികവും എന്നേക്കാൾ ശക്തരാണ്.

15. മിക്ക പ്രശ്നങ്ങളും നല്ല രീതിയിൽ കൈകാര്യം ചെയ്യാനുള്ള ഏറ്റവും നല്ല വഴികളി ലൊന്ന് അവയെക്കുറിച്ച് ചിന്തികാതിരിക്കലാണ്.

16. കഠിനാദ്ധ്വാനം കൊണ്ടാണ് നല്ല കാര്യങ്ങൾ നടക്കുന്നത്.

17. എന്റെ സമപ്രായത്തിൽ ഒരുവൻ എന്റെ ശത്രുവായാൽ അവന്റെ മനഃസ്ഥിതി മാറ്റിയെ ടുക്കുവാൻ എനിക്ക് ഒന്നുംതന്നെ ചെയ്യാൻ കഴിയില്ല.

18. സാധാരണയായി ഒരു കാരണവും കൂടാതെയാണ് മറ്റുള്ളവർ എന്നോട് സംസ്കാര ശൂന്യമായി പെരുമാറുന്നത്.

19. ഒരാൾക്ക് എന്നെ ഇഷ്ടമില്ലാതെവന്നാൽ അതിനെതിരായി എനിക്കൊന്നും തന്നെ ചെയ്യാൻ കഴിയില്ല.

20. ജീവിതത്തിൽ എന്തുമാത്രം പ്രയത്നിക്കുന്നു എന്നതനുസരിച്ച് മാത്രമാണ് എന്തു കിട്ടുന്നു എന്ന് നിർണ്ണയിക്കപ്പെടുന്നത്.

21. ആഗ്രഹിക്കുന്നതും യഥാർത്ഥത്തിൽ കിട്ടുന്നതും തമ്മിൽ കാര്യമായ ബന്ധം ഉണ്ടാ കാറില്ല.

22. നമ്മുടെ കഴിവില്ലായ്മയുടെ, അറിവില്ലായ്മയുടെയും മടിയുടെ അല്ലെങ്കിൽ ഇവ മൂന്നിന്റെയും അനന്തരഫലമാണ് നമുക്കുണ്ടാകുന്ന മിക്ക ദൗർഭാഗ്യങ്ങളും.

23. മറ്റുള്ളവരുടെ ഇഷ്ടം നേടിയെടുക്കാനായി കഠിനപ്രയത്നം ചെയ്യുന്നതിൽ അർത്ഥ മില്ല. അവർ നമ്മെ ഇഷ്ടപ്പെടുന്നെങ്കിൽ ഇഷ്ടപ്പെടുകതന്നെ ചെയ്യും.

24. ദേശീയടിസ്ഥാനത്തിലും പ്രദേശികാടിസ്ഥാനത്തിലും ദുഷിച്ച സർക്കാരുണ്ടാവുന്ന തിന്റെ ഉത്തരവാദിത്തം അവിടത്തെ ജനങ്ങൾക്ക് തന്നെയാണ്.

25. വിവാഹം സ്വർഗ്ഗത്തിൽ നടക്കുന്നുവെന്ന് ഞാൻ വിശ്വസിക്കുന്നു.

26. എന്റെ സമപ്രായക്കാരായ ആരെങ്കിലും എന്നെ ഉപദ്രവിക്കാൻ തീരുമാനിക്കയാണെ ങ്കിൽ അവരെ അതിൽ നിന്നും പിന്തിരിപ്പിക്കാൻ എനിക്കൊന്നും തന്നെ ചെയ്യാൻ കഴിയില്ല.

27. എന്നെ സംബന്ധിച്ചിത്തോളം എനിക്ക് വേണ്ടത് കിട്ടുന്നതിൽ ഭാഗ്യത്തിന് യാതൊരു സ്ഥാനവുമില്ല.

28. എന്തെങ്കിലും തീരുമാനങ്ങൾ എടുക്കേണ്ട മിക്ക സന്ദർഭങ്ങളിലും ഞാൻ എന്റെ ഭാഗ്യനിലയെ ആശ്രയിക്കാറില്ല.

29. മനുഷ്യർക്ക് നിർഭാഗ്യം ഉണ്ടാവുന്നത് അവരുടെ തെറ്റായ പ്രവർത്തികൾക്കൊണ്ടാ ണ്.

30. അനിയന്ത്രിതമായ ബാഹ്യശക്തികളാണ് മനുഷ്യർക്കുണ്ടാവുന്ന പല ദുഃഖ സംഭവ ങ്ങൾക്കും ഭാഗികമായിട്ടെങ്കിലും കാരണമാവുന്നത്.

31. ആർക്കാണ് ശരിയായ പദവിയിൽ ആദ്യം എത്തിച്ചേരാനുള്ള ഭാഗ്യം ഉണ്ടാവുന്നത് എന്നതിനെ ആശ്രയിച്ചാണ് ആരാണ് വലിയവൻ എന്ന് നിശ്ചയിക്കപ്പെടുന്നത്.

32. പരിപാടികൾ, ആസൂത്രണം ചെയ്യുമ്പോൾ അവ പ്രാബല്യത്തിൽ കൊണ്ടുവരാൻ കഴിയുന്നവയായിരിക്കുമെന്ന് എനിക്ക് തീർച്ച ഉണ്ടായിരിക്കും.

33. ഒരാളുടെ ആഗ്രഹങ്ങളും കഴിവുകളുമാണ് അയാളുടെ ജീവിതത്തിന്റെ ഗതി നിർണ്ണയിക്കുന്നത്.

34. എന്റെ മാതാപിതാക്കളാണ് എനിക്കുവേണ്ടി കാര്യങ്ങൾ തീരുമാനിക്കുന്നത്.

35. ഓരോ വ്യക്തിയിലും അയാളുടെ ഭാവിതീരുമാനിക്കാനുള്ള കഴിവ് കുടികൊള്ളുന്നുണ്ട്.

36. സാധാരണ പൗരന്റെ വിജയം കഠിനാദ്ധ്വാനത്തെ ആശ്രയിച്ചാണിരിക്കുന്നത്; ഭാഗ്യത്തിന് അതിൽ കാര്യമായ പങ്ക് ഒന്നും തന്നെയില്ല.

37. ഭാഗ്യം എന്നൊന്ന് ആർക്കും ഇല്ല.

38. സംഭവിക്കാനുള്ളത് സംഭവിക്കുകതന്നെ ചെയ്യുമെന്ന് മിക്കപ്പോഴും ഞാൻ കണ്ടിട്ടുണ്ട്.

39. ഭാഗ്യനിർഭാഗ്യങ്ങൾക്കനുസരിച്ച് കാര്യങ്ങൾ മാറുമെന്നുള്ളതുകൊണ്ട് വളരെ മുൻകൂട്ടി കാര്യങ്ങൾ പ്ലാൻ ചെയ്യുന്നത് ബുദ്ധിയല്ല.

40. വേണ്ടത്ര പരിശ്രമിച്ചാൽ രാഷ്ട്രീയാഴിമതികൾ തുടച്ചുമാറ്റാൻ നമുക്ക് കഴിയും.

41. എനിക്കു സംഭവിക്കുന്ന പല കാര്യങ്ങളുടെമേലും എനിക്കു വളരെ കുറച്ചു സ്വാധീനം മാത്രമേയുള്ളു എന്ന് മിക്കപ്പോഴും തോന്നാറുണ്ട്.

42. വാദിച്ച് എന്നെ വിഡ്ഢിയാക്കാൻ മറ്റുള്ളവർക്കെളുപ്പം കഴിയുന്നു.

43. നേതൃത്വം നിശ്ചയിക്കപ്പെടുന്നത് പരിശീലനത്തിലൂടെയോ കഠിന പ്രയത്നത്തിലൂടെയോ അല്ല മറിച്ച് ജന്മസിദ്ധിയിലൂടെയാണ്.

44. പ്രവർത്തന പദ്ധതികളേക്കാൾ ഗ്രഹനിലയാണ് ഒരാളുടെ ജീവിതത്തെ കൂടുതൽ നിയന്ത്രിക്കുന്നത്.

45. ഞാൻ ജാതകഫലങ്ങൾ വായിക്കുകയും ആ പ്രവചരങ്ങളിൽ ധാരാളം സത്യം അടങ്ങിയിരിക്കുന്നുവെന്ന് വിശ്വസിക്കുകയും ചെയ്യുന്നു.

46. നാളെ നടന്നേക്കാവുന്ന ഒട്ടുമിക്ക സംഭവങ്ങളെയും ഇന്നത്തെ നമ്മുടെ പ്രവർത്തികൊണ്ട് നിയന്ത്രിക്കാൻ കഴിഞ്ഞേക്കും.