Effectiveness of Experiential Learning on Problem Solving Ability in Mathematics of Class Eight Students

Dissertation submitted to N. V. K. S. D. College of Education (Autonomous), affiliated to Tamil Nadu Teachers Education University, Chennai, in partial fulfilment of the requirements for the award of the degree of

Master of Education

by

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DECLARATION

I hereby declare that this dissertation entitled Effectiveness of Experiential Learning on Problem Solving Ability in Mathematics of Class Eight Students submitted by me for the degree of Master of Education is the result of original and independent work carried out by me during the academic year 2021-2023 under the guidance and supervision of Dr Deepa R. P. Assistant Professor in Education, N.V.K.S.D College of Education, Attoor, Kanniyakumari District. This dissertation is not submitted on the basis for the award of any degree, diploma, associateship, fellowship to any other University or Institution.

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CERTIFICATE

This is to certify that this dissertation entitled Effectiveness of Experiential Learning on Problem Solving Ability in Mathematics of Class Eight Students submitted for the M.Ed. Degree by ABINA R. N. is an original record of research work done by her during the academic year 2021-2023 under my guidance and supervision. It is further certified that this work is free from any duplication. This dissertation is not submitted on the basis for the award of any degree, diploma, associateship, fellowship to any other University or Institution.

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Date: Signature of the Supervisor

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CHAPTER I

INTRODUCTION

Education is the key to success in the future and to have many opportunities in everyone's life. It mainly illuminates a person's mind and thinking. Having education in an area helps people think, feel, and behave in a way that contributes to their success, and improves not only their personal satisfaction but also their community's mind and thinking. In addition, education develops human personality, thoughts, and social skills. It also prepares people for life experiences (Al-Shuaibi, 2014).

The main objective of education is the fullest possible development of the child's personality, talents, and physical and mental abilities (Lansdown, G., Covell, K. & Vaghri, Z., 2022). It can be attained through proper learning approaches. Learning is a permanent change and it develops specific skills, brings changes in some attitudes and helps in understanding specific scientific law operating behind a learning environment (Sequeira, A., 2012). According to Crow and Crow defines, "Learning is the acquisition of habits, knowledge and attitude" (Panda, 2019).

The rapid and unexpected onset of the COVID-19 global pandemic has generated a great degree of uncertainty about the future of education (Bozkurt, A., et al, 2022). It was viewed as a dark phase for students in education because it primarily affected student's academic, listening and numerical skills. Since students attended classes through online during the pandemic, the pupils could only observe what their teacher taught to them. Due to online mode of learning, students have difficulty in writing, reading, or memorizing numbers and also cause errors in number additions, replacements, transpositions, omissions, and reversals. Roberg cited in Yuanita, P, Zulnaidi, H. & Zakaria, E. (2018) stated that traditional learning

focuses on skill and concept acquisition. Thus, this approach is unsuitable for improving problem solving skills. UNESCO (2021) suggested that there should be need for recovery of lost learning and also proposed some of the strategies. Thus the learning process needs change to a new learning experience so that the pupils can experience what they learn. Effective learning is possible only through the better learning experiences.

Mathematics is an area of study that holds a strong and unbreakable position as compared to other subjects. Due to this reason, Mathematics is more stable and important than other school subjects (Unnati Bishnoi, 2008). Fitriana and Supahar (2019) stated that learning Mathematics at school is the same as educating children to learn about life outside the school. Sidhu K.S (2008) stated that Mathematics helps the students in the development of many intellectual traits like power of thinking and reasoning, induction, analysis, synthesis, originality, generalization, discovery, etc. He even included the statement of Locke, "Mathematics is a way to settle in the mind a habit of reasoning". Pimta, Tayruakham and Nuangchalerm (2009) stated that mathematical problem is the tool that not only used to help students develop their thinking ability but also helps them to develop their basic skills of solving the problems especially problems in daily life. The experience in solving the problems of the subject is very important to develop students' thinking skills and help them gain more skills in solving the problem in daily life.

Problem solving is considered as one of the most important skills in the 21st century that a student should possess because of its many advantages. Therefore, problem solving should be considered an integral part of mathematics learning and it should not be viewed as exercises that students perform at the end of every topic from

the school textbook (Madihah Khalid et al., 2020). Smitha and Praveen (2018) viewed that Problem solving refers to the process of analyzing a problem and resolving it based on the situation. It ultimately helps in achieving the goal. So the ability of solving problem is considered as an important one for all learners. It develops the ability to learn from mistakes and make sure to avoid the same mistakes.

The ability of mathematical problem solving is very important for solving the problem and it is also the major purpose of teaching mathematics. Lu Sun and Longhai Xiao (2023) viewed that Problem solving ability is the ability to use the mathematical knowledge or methods learned to apply to real life and solve practical problems. He also stated that this basic ability is formed and developed gradually with the accumulation of life experience and continuous learning. Yulindar, Setiawan and Liliawati (2018) stated that problem solving was a complex skill that characterized one of the most intelligent human. They also stated that the ability of problem solving could be said very important for students because this ability would be used by students in daily life. This allows students to acquire a new complex rule and ability.

Problem solving involves application of thinking and reasoning to various kinds of problems encountered in life. It is an integral part of developmental activities and provides opportunities for children to practice what they have learned by applying their learning situations. The amount of practice needed by any learner is reduced if he understands the concepts and skills to be practiced. The whole purpose of teaching mathematics is to solve and resolve difficulties faced in daily life (Mehraj Ahmad Bhatto, 2014). Eviyanti, Surya & Syahputra (2017) stated that Problem solving in mathematics can be interpreted as: math learning goals concerning the reasons why math is taught, the process of applying knowledge previously obtained into a new and unknown situation, and basic skills are minimal skills in evaluation. Thus solving the

problem is not just a goal of learning mathematics but also a major tool to perform or work in mathematics. Chesimet, Githua & Ngeno (2016) stated that experiential learning offers a critical link between the classroom and real world. Mutmainah, Rukayah & Indriayu (2019) revealed that in Mathematics learning process, the learning which directly relates the material to the real daily experiences is required and he also emphasized that one of the teaching materials that can be used is the experiential learning-based teaching material in Mathematics.

Experiential Learning theory was proposed by David Kolb. He was influenced by the work of other psychologists which includes John Dewey, Kurt Lewin and Jean Piaget. Kolb (1984) defined Experiential Learning as, "a process where knowledge results from the combination of grasping and transforming an experience". Kolb's experiential learning theory includes whole learning process. Kolb & Kolb (2011) suggested that learning requires the acquisition of abstract concepts that can be applied to any situations and pointed out that learners must change something in order to learn something new. Veronica Villarroel, et al., (2020) revealed that experiential learning was a student-centered teaching method that improved student's perceived learning.

Experiential learning emphasizes the transformational process from experience to learning. In this learner of all levels carryout the real-world experiences into the classroom learning. Experiential learning involves the idea of active and reflective learning. It develops a feeling of ownership over their learning by taking an active role in it and reflection improves self-assistance and self-worth. Mutmainah, Rukayah and Indriayu (2019) suggested that experiential learning helped the learners in the process of knowledge construction and also provided them with deeper

understanding of a particular concept and helped them to withstand in any critical situations.

Experiential learning means learning through self-experience. It provides the learners to make their own learning meaningful through the experiences of a real life setting. The students using experiential learning-based teaching material in Mathematics tend to have the higher cognitive ability than the students that do not use experiential learning-based teaching material in Mathematics in their school. Heinrich, et al., (2015) found that strong critical thinking outcomes result from experiential learning with appropriately scaffold critical thinking exercises and processes. It clearly shows that the experiential learning has made great changes in the students' learning process. Hence the researcher took an initiative to check whether experiential learning develops problem solving ability in Mathematics.

NEED AND SIGNIFICANCE OF STUDY

Mathematics is the process of building knowledge and it can only be done with the exploration activities, justification, description, and discussion, elaboration, investigation, and problem solving (Countryman, 1992). Kusmaryono (2014) stated the essence of mathematics is a process of learning how to learn or do math. Learners considered the learning Mathematical problems as a difficult task. Moreover learning Mathematics is considered as a non-satisfactory learning because learners are learning the concepts through rote memorization. This way of learning has to be changed.

To learn Mathematics we need thorough practice and experience. There are many strategies in learning Mathematics. Most of the strategies of learning mathematics require higher order thinking process as well as many more effort from the part of students. Azuka Benard Festus (2013) stressed that the use of strategies

which includes discovery approach of teaching, appropriate practical work, use of teaching aids, cooperative learning or small group learning, and discussion in class helps in students' performances in mathematics and develops the problem solving skills.

Problem solving has a special importance in the study of mathematics. A primary goal of mathematics teaching and learning is to develop the ability to solve a wide variety of complex mathematics problems (Mehraj Ahmad Bhat, 2014). Eviyanti and Surya (2016) revealed that mathematical problem solving ability in students is comparatively low. Sharifah Osman, et al., (2018) viewed that there are many factors that affected students' achievement in problem-solving. One of the factors was different pedagogical ways of teaching. Although there are many techniques and strategies existed to develop students problem-solving ability, there are teachers who are still using the old teaching method and teacher-centered.

Due to these difficulties in developing problem solving ability, (Dyah Ayu Fitriana & Supahar, 2019) emphasized that to improve problem-solving skill in Mathematics, it is necessary to have the right learning method. It needs teachers' attention towards students to help the development of their problem-solving skills. Based on the results of Hulaikah, Degeng and Murwani (2020), it is found that the problem solving ability of students taught by experiential learning was different from those taught by direct instruction. Thus the students' problem solving ability could be improved by experiential learning than the direct instructed learning.

Experiential leaning is a drastic change in educational environment from teacher-centered to student-centered. In this approach, the students have control over their own learning which includes the pace of leaning, method of learning and also the

skills they utilize for their learning. It requires students to participate, engage and collaborate themselves in the learning process for better outcomes. It is mainly based on hands-on experience learning and evaluates students according to their prior experiences. This approach addresses the concept of how experience influences learning and emphasizes the significance of learners' participation in all learning processes.

According to Kolb and Kolb (2011), “Experiential learning is a dynamic holistic process of learning from experiences. It can be used for the process of learning. This can also serve as a tool to design and implement management of education program for better development. Thus considering the application of experiential learning approach helps to improve the learning”. Kolb and Kolb (2017) stated that experiential learning entails giving learners more authority and responsibility, as well as involving them directly in their learning process within the learning atmosphere. Rani and Tyagi (2023) highlighted the UNESCO’s saying that experiential learning as a process that creates knowledge, skills, and attitudes based on deliberate reflection on an experience. So, learning by doing, learning by action, learning through experience, and learning through discovery and exploration are the terms used to describe the experiential learning approach.

Experiential learning concerns more on process rather than the result. It helps the learners to develop new skills, attitudes and also a new way of thinking. When students start to learn through the approach of experiential learning, it helps the learners by providing a new platform which makes them to express their own innate abilities and also makes them to move forward for future learning (Mutmainah, Rukayah and Indriayu, 2019). Even Lu Sun and Longhai Xiao (2023) revealed that the use of experiential learning in mathematics can increase students’ learning

engagement in mathematics learning and positively influence mathematical attitudes and mathematical self-efficacy, thus positively influencing students' performance in basic mathematical competencies. Also Ayob, Hussain, Mustafa and Shaarani (2011) suggested that students' creativity dimensions have been nurtured and enhanced as a result of the problem solving process involved in the experiential learning activities. Thus the learning process done through experiential learning was more effective. This also helps in active engagement of learners through their own thoughts, feelings and also physical activity. Also Abdul Khaliq and Shafqat Rasool (2020) found that the experiential learning strategy significantly improves the mathematical creativity of secondary school students.

Experiential learning is a way of learning that mainly gives learners more authority and responsibility and makes the students involve directly in their learning process. Mutmainah, Rukayah and Mintasih Indriayu (2019) found that the use of experiential learning-based teaching in Mathematics was more effective and helped to improve cognitive ability. Thus learning through experiential learning approach in Mathematics improves Mathematical problem solving ability. Students who are studying mathematics through these methods are motivated by real-world applications. The investigator being a Mathematics prospective teacher educator is interested to investigate the problem solving ability in Mathematics of middle school students and wants to apply experiential learning approach. Hence an attempt is made to study the effectiveness of experiential learning on problem solving ability in Mathematics.

STATEMENT OF THE PROBLEM

Problem solving ability in Mathematics is considered as a highly difficult task for the students because as learners they did not try to understand and experience the concept of Mathematics. It leads the students to have rote memory and inability to solve problems in Mathematics. Due to this inability, they fear to learn Mathematics. So learners need support in learning Mathematics. It's the responsibility of the teachers to provide the better situation and support to develop their problem solving ability in Mathematics. The investigator tries to ensure that, "Whether experiential learning is effective in learning Mathematics?", "Whether experiential learning approach helps in developing problem solving ability in Mathematics?" To find the answers of these research questions, the study is entitled as, Effectiveness of Experiential Learning on Problem Solving Ability in Mathematics of Class Eight Students.

OPERATIONAL DEFINITION OF THE KEY TERMS

Effectiveness

Effectiveness here refers the outcome of the learning through experiential learning approach which can be measured through the students' response in problem solving ability test in Mathematics.

Experiential learning

Experiential learning here means the instructional material based on Kolb's Experiential Learning Model prepared by the investigator to teach Mathematics for class eight students.

Problem solving ability in Mathematics

In this study, the problem solving ability in Mathematics here refers to the scores obtained by the class eight students in the problem solving ability test in Mathematics which consist of Critical thinking skill, Values based problems, Creative thinking skill, Comprehensive skill and Art integration.

Class eight students

In this study, class eight students refers to the students who are having the age 13 to 14 and are studying in class eight in K. A. B. D. Matric Higher Secondary School, Painkulam during the academic year 2022-2023.

OBJECTIVES OF THE STUDY

1) To construct and validate the Problem Solving Ability Test in Mathematics for class eight students.
2) To develop the lesson transcripts based on experiential learning model for the lessons Direct and Inverse proportion, Algebra and Factorization for the experimental group.
3) To study the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students.
4) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of experimental and control group students
5) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.

6) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
7) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of experimental and control group students.
8) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
9) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.

HYPOTHESES FRAMED FOR THE STUDY

The hypotheses framed in respect to the objectives are given as follows,

1) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.
2) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
3) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.

4) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.
5) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
6) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
7) There will be significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students.
8) There will be significant difference in the mean adjusted post scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.

METHODOLOGY IN BRIEF

Method adopted

Experimental method was used for conducting the study. Pretest posttest non-equivalent group design was used.

Population

The present study was conducted on a population of class eight students who are studying in various schools of Kanniyakumari district in Tamil Nadu following State Board Syllabus during the academic year 2022-2023.

Sample

The present study was conducted on a sample of class eight students who are studying in K. A. B. D. Matric Higher Secondary School, Painkulam in Kanniyakumari District following state board syllabus. The size of the sample was 71 students. Simple random sampling technique was adopted to select the sample.

Tools used

The tool used in the study were,

i. Lesson transcripts based on experiential learning model for teaching Mathematics.
ii. Problem Solving Ability test in Mathematics was constructed and validated by the investigator and guide.
iii. Personal data sheet

Statistical Technique used

For the analysis of the data following statistical techniques were used.

i. Independent t test for large sample

An Independent t test also known as an unpaired t test is a statistical procedure that compares the averages/means of two independent or unrelated groups to determine if there is a significant difference between the two. Sharma R. A., (2007) noted the formula for calculating independent t test for large sample as;

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

Where

t = t test for the difference of two means

M_1= Mean of First sample.

M_2= Mean of Second sample.

σ_1= Standard Deviation of First sample.

σ_2= Standard Deviation of Second sample.

ii. Paired t test for small sample

A paired t test is also known as a dependent or correlated t test. It is a statistical test that compares the averages/means and standard deviations of two related groups to determine if there is a significant difference between the two groups. Sharma R. A., (2007) noted the formula for calculating paired t test for small sample as;

$$t = \frac{M_1 - M_2}{S_{ED}}$$

Where

$$S_{ED} = \sqrt{\frac{\sigma_1^2}{N} + \frac{\sigma_2^2}{N} - 2r\frac{\sigma_1\sigma_2}{N}}$$

r = Correlation coefficient between paired observation

σ_1= Standard Deviation of First observation.

σ_2= Standard Deviation of Second observation.

N = Size of the Sample.

iii. ANCOVA (Analysis of Covariance)

ANCOVA helps to found that the experimental group was better able to predict strong content from headlines after training than the control group. It also permits the investigator to statistically control for differences on the

pre test so that post test differences would not be due to initial differences before the training.

DELIMITATIONS OF THE STUDY

The scope of the present study is delimited on

1. The study is delimited to the geographic area of Kanniyakumari district only.
2. The sample is selected from one school only.
3. The selected chapters in Mathematics for Problem Solving Ability test was delimited to Direct and Inverse proportion, Algebra and Factorization.

ORGANIZATION OF THE REPORT

The present investigation of the study is reported in following chapters.

CHAPTER I deals with the introduction, need and significance of the study, statement of the problem, operational definition of the key terms, objectives of the study, hypotheses framed, methodology in brief and delimitation of the study.

CHAPTER II deals with introduction, theoretical overview of experiential learning and problem solving ability in Mathematics and review of related studies conducted in this area.

CHAPTER III explains the method used in the study, details of the sample selected, distribution of the sample, tools used for the study, administration of the tool and the statistical techniques used.

CHAPTER IV describes the details of analysis of the data and interpretation of the results.

CHAPTER V deals with the major findings, conclusion, educational implications of the study and suggestions for further research in this area.

CHAPTER II

REVIEW OF RELATED LITERATURE

- Introduction
- Theoretical overview
- Review of related studies
- Critical review

CHAPTER II

REVIEW OF RELATED LITERATURE

INTRODUCTION

An essential aspect of an investigation is the review of related literature that is an inclusive contemplative survey of previous writings referring to problems or issues. The term review means to organize the knowledge of the specific area of research to construct new knowledge and show that the proposed study would be a value addition to respective field. In research methodology, the term literature refers to the knowledge of a particular area of investigation of any discipline which includes theoretical, practical and its related research studies (Jagjit Kaur, 2021).

Best John. W (2004) defined review of literature as

> "A summary of the writings of recognized authorities and of previous research provides evidence that the researcher is familiar with what is already known and what is still unknown and untested. Since effective research is based upon past knowledge, this step helps to eliminate the duplication of what has been done and provide useful hypotheses and helpful suggestions for significant investigation."

Review of literature has a major role in shaping the research problem because it helps to understand the subject matter better and also helps in conceptualizing the research problem precisely and make it more relevant to that particular field. Analysing of past research records helps to eliminate the risk of duplication. It also helps to get more and more information from the perception of other researchers about the same subject area.

Usefulness of Review of literature

The review of literature is highly importance because the researcher has to synthesis the ideas which are available in the particular field in such a way to provide the clear information of the particular study. William Wiersma and Stephen G. Jurs (2009) has described the usefulness of review of related literature as,

i. More specifically limiting and identifying the research problem and possible hypotheses.
ii. Informing the researcher of what has already been done in the area.
iii. Providing possible research design and methodological procedures that may use in the research study.
iv. Providing suggestions for possible modifications in the research to avoid unanticipated difficulties.
v. Identifying possible gaps in the research.
vi. Providing a backdrop for interpreting the results of the research study.

THEORETICAL OVERVIEW

History of Experiential Learning Theory

Experiential Learning simply means “learning by doing”. Many educators are given more consideration to make learning to be experiential; it means that it needs to be structured in a way such that it allows the learner to explore the fact or to make them experience it directly or indirectly. Thus many educationist had an arguments based on the role of experience in education.

The German philosopher Immanuel Kant made an argument in his book “The critique of Pure Reason” in 1787 stated that both rationality and experience have a

great place in the construction of knowledge. It is mainly because of human mind that arrange orders based on the experience from the world they met through the process of perceiving. Therefore Kant concludes that experiences are mainly organized by structuring the mind (Bird, 2023).

Kurt Lewin, a psychologist describes about Experiential Learning in his "Field Theory of Learning" in 1930. In this he mainly emphasized that "the study of behavior as a function of the total physical and social situation" which means that the experience from the environment will influence the behavior of an individual (Smith, 2001).

John Dewey (1938) proposed a model for experiential learning. In this, he describes about the relationship that exist between the experience and learning and also he emphasizes that learning as a dialectic process which mainly helps in integrating experience and concepts, observation and action. According to him, "Experience is a natural phenomenon, not outside of the human species but completely inside of it as part of our evolutionary make-up" (Kolb and Kolb, 2013).

Jean Piaget (1950) has developed a theory after observing the children's growth. Based on this, he developed four key phases of cognitive development namely sensory-motor (0–2 years), pre-operational (2–7 years), concrete operations (7–11 years), and formal operations (11– above years). Piaget claimed that no amount of experience will cause a child to react in the desired way if they had not attained the developmental capabilities. According to him, the dimensions of experience and concept, reflection and action form a basic continuum for the development of adult thought (Kolb, 1984).

Based on these great educationist views on experiential learning, David Kolb developed the theory which describes about the learning process in different stages by which knowledge is created thorough experience.

Experiential Learning Theory

David Kolb, an educationist who is now well-known as the "Father of Experiential Learning". He developed Experiential Learning Theory in 1970 and published in 1984. He also developed an inventory called as Learning Style Inventory on the basis of this theory. According to Kolb, learning entails acquiring abstract notions that may be creatively used in a variety of contexts. Experiential learning theory offers the foundation for an approach to education and learning as a lifelong process that is soundly based in intellectual traditions of social psychology, philosophy, and cognitive psychology (Colin Beard John P Wilson, 2013). According to Kolb's view, different events serve as the catalyst for the innovation of new ideas. Based on these in this theory, he mainly describes the details about how a learner's experiences, thoughts and emotions made a great influence on their learning process.

Kolb and Kolb (2017) stated that Experiential learning theory is a dynamic, holistic theory of the process of learning from experience and a multi-dimensional model of adult development. The dynamic view of learning is based on a learning cycle driven by the resolution of the dual dialectics of action/reflection and experience/abstraction. It is a holistic theory that defines learning as the major process of human adaptation involving the whole person. He considered two main levels in which one is about the four stages of learning cycle and another one is of four different learning styles.

Kolb's learning cycle mainly describes about how an experience can be changed into concepts through the process of reflection, which in turn acts as a guide for learner for the choice of new experience. The learning cycle's most important feature is that it represents the learning process as a recursive circle or spiral as opposed to the linear, conventional information transmission model of learning that is typically utilized in education. Komal Rani and Tarun Kumar Tyagi (2023) described that Kolb's experiential learning cycle is divided into four stages that include concrete experiences are facilitated for learning followed by steps of reflective observation and abstract conceptualization. The last step of active experimentation taken up by students is based on the learning completed in the earlier three steps. Kolb's learning style describes about the preference of style of learning by different learner can vary as per the influence of different factors.

Kolb's learning cycle

Experiential Learning is a process of constructing knowledge that involves a creative tension among the four learning models that is responsive to contextual demands. This process is portrayed as an idealized learning cycle or spiral where the learner 'touches all the bases' – experiencing, reflecting, thinking and acting or doing (Jenkins and Clarke, 2017).

i. Concrete Experience

Kolb's learning cycle begins with concrete experience. In this learners mainly participate actively in every task to obtain new experience just by feeling it through all his senses. The ideas of the learners are mainly based on immersing in the experience and learning.

ii. Reflective Observation

After engaging in the concrete experience, the learners reflect their own view based on his present experience in connection to his past one. In this cycle the learners are allowed to ask questions regarding the experience they had and discusses about it. This stage mainly focuses on observing and perceiving.

iii. Abstract Conceptualization

Following the reflective observation, in this cycle the learners attempts to draw a conclusion of the experience they had by reflecting their previous knowledge and also using the ideas that received from their discussions with their peers. The learners begin to classify the concepts and form conclusion based on it. After this, the learners begin to interpret the experience they received and starts making comparison with their current concept through the experience which leads to the formation of new information by modifying the already exist ideas. In this cycle, the learner accumulates, examines, and forms inferences.

iv. Active Experimentation

This cycle is all about experimentation. In this the student applies what they have learned into practice to observe what happens. Based on this the learners can able to make predictions and create new plans to the similar situations in the future. The primary goal of this cycle is to act in connection with the experience. This final cycle largely emphasizes learning through experience.

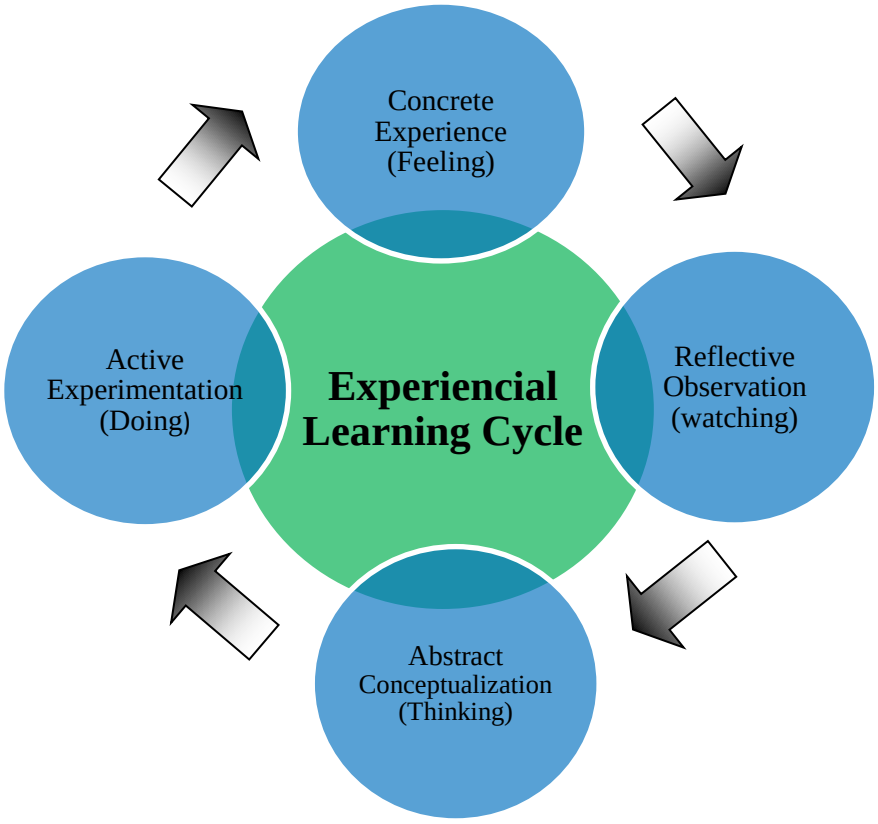
Effective learning is seen when a person progresses through a cycle of four stages: of

a. having a concrete experience followed by
b. observation of and reflection on that experience which leads to
c. the formation of abstract concepts (analysis) and generalizations (conclusions) which are then
d. used to test hypothesis in future situations, resulting in new experiences (Mcleod, 2017).

According to Kolb (1984), learning is a continuous process with each stage integrating into something and supporting the next one. This cycle can be entered at any point and followed through logically from there. Therefore, learning happens effectively when a pupil can carry out each of these four stages.

Figure 2.1

Kolb's Experiential Learning Cycle



Kolb’s Learning Styles

Four different learning styles are described in Kolb's learning theory (1974), which is mainly based on four-stages of learning cycle. These learning styles place an emphasis on flexibility in learning and broadening one's favored style to include all modes of learning for the whole learning cycle. Learning style is a dynamic state that results from interactions between a person and their environment rather than a fixed cognitive attribute. Kolb (2013) stated that Experiential Learning Theory posits that learning style is not a fixed psychological trait but a dynamic state resulting from synergistic transactions between the person and the environment. This dynamic state arises from an individual’s preferential resolution of the dual dialectics of experiencing/conceptualizing and acting/reflecting.

Individuals employ the learning cycle in different ways according to their learning styles. The four processes of experiencing, reflecting, thinking, and acting are dialectically opposed to one another rather than existing as distinct, independent units. They are in constant motion and determined by one another. This implies that there are numerous methods to travel through the various learning modes during the learning cycle, each of which is specific to a particular person and their learning objectives. It also translates the learning style as a persistent process of learning that prioritizes some learning modes over others rather than a distinct personality attribute. The challenge of full-cycle learning to build the capacity to engage all modes of the learning cycle in a holistic and fluid manner is opened up by the realization that a style preference emphasizes strengths in some teaching styles as well as some deficits in opposing modalities.

Kolb states that different persons have an intrinsic preference for a specific learning method. A person's favored style is influenced by a diverse range of things. In a standard representation of Kolb theory includes two important continuums, as the north-south axis is referred to as the Perception Continuum (emotional response with regard to what we think or feel), while the east-west axis is known as the Processing Continuum (doing something which mainly related to what we observe).

Kolb's learning styles is normally a two by two matrix. Each of the four learning styles is a combination of two preferable styles. There are two primary axes that lie behind the cycle: an ‘abstract-concrete’ dimension and an ‘active-reflective’ dimension. These lead to the main dimensions of the learning process, corresponding to two distinctive ways by which learning takes place.

The first refers to the ways in which new information or experience is grasped, and the second to how that which is perceived is then processed or transformed. Based on the learners’ preferences on these two dimensions – ‘abstract-concrete’ and ‘active-reflective’ – Kolb’s identifies four learning styles with specific characteristics: accommodating, diverging, assimilating and converging. Each learning style presents its own strengths and weaknesses (Almeida and Mendes, 2010).

Figure 2.2

Matrix of Kolb's Experiential Learning Style

	Active Experimentation (Doing)	**Reflective Observation (Watching)**
Concrete Experience (Feeling)	**Accommodating (CE/AE)**	**Diverging (CE/RO)**
Abstract Conceptualization (Thinking)	**Converging (AC/AE)**	**Assimilating (AC/RO)**

Kolb's Learning Styles

i. Accommodating (Doing and Feeling – CE/AE)

Accommodators grasp information concretely (CE) and process it through experimentation (AE). They are called accommodators because they easily adapt to new situations and apply knowledge in new ways (Kolb, 1981). Students of this learning style mainly use trial and error method. They mainly rely on others information and not interested in carrying out their own analysis.

ii. Diverging (Feeling and Watching – CE/RO)

Divergers perceive information through concrete experience (CE) and process it reflectively (RO). These learners are called divergers because they do extremely well at viewing an event from several perspectives and at generating different ideas. They prefer to work in groups, to brainstorm, to imagine implications and to share ideas (Kolb, 1984). Because of their great sense of creativity these learners are also known as 'creators'. They also

mainly emphasize both the innovative and imaginative approaches in learning. Especially the student who follows this style of learning has the ability to generate new ideas and also engage in brainstorming. They also like to enjoy gathering more information regarding a particular topic. They are open-minded and listen to other feedback. They are art oriented, highly imaginative and emotional and also possesses excellent in team work.

iii. Converging (Doing and Thinking – AC/AE)

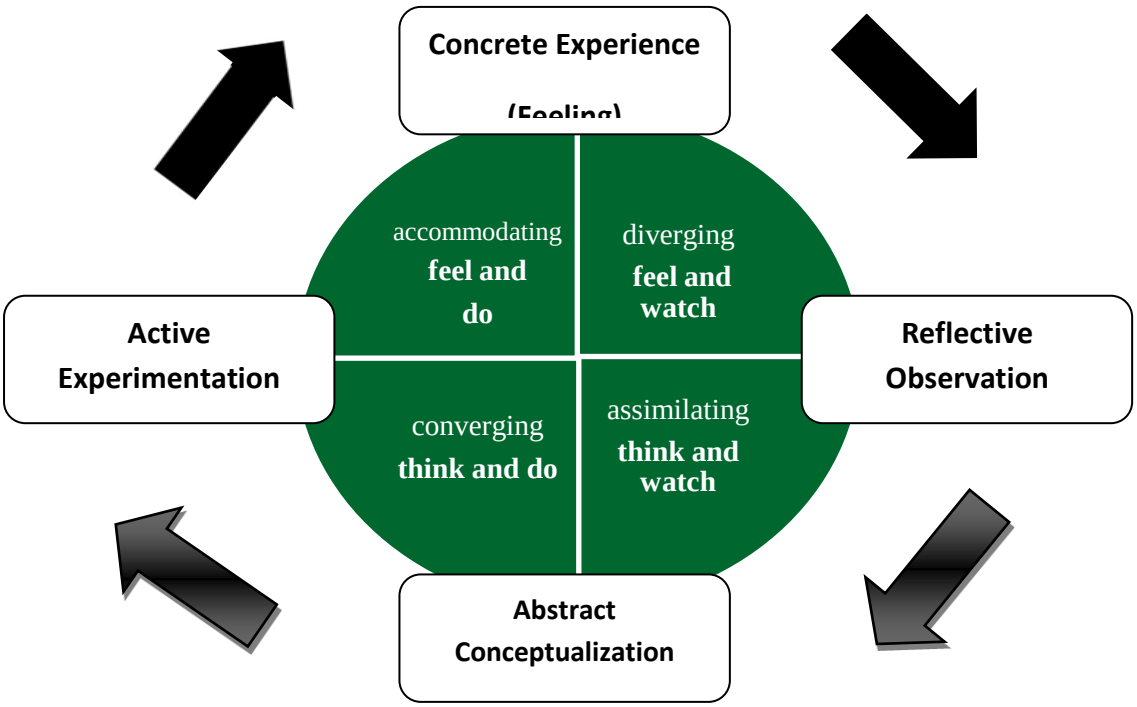
Convergers perceive information abstractly (AC) and process it through experimentation (AE). They are called convergers because they have the ability to converge rapidly to get to a conclusion (Kolb, 1981). The strengths of this learning style are mainly making decisions, defining problems and also reasoning deductively. Students are much interested in experimenting new ideas and its application in practical world. They are generally very good at using technology. But they don't give much importance to people around them.

iv. Assimilating (Watching and thinking – AC/RO)

Assimilators grasp information through abstraction (AC) and process it through reflection (RO). They learn preferentially by watching and thinking. These students are called assimilators because they have the ability to assimilate diverse data and incorporate it into integrated whole, creating easily theoretical models (Kolb, 1981). This is the reason why they are also called as 'planners'. They prefer to learn alone and appreciate traditional lectures (Kolb, 1984). The students of this learning style are less focused on people and more interested in ideas and abstract concepts.

Figure 2.3

Kolb's Experiential Learning Model



Experiential Learning based teaching approach

Kolb contends that the learning process is most effective when learners have the chance to relate to the concepts at each level mainly because of the instant or practical experience serves as the foundation for observation and reflection. In a cyclical process called experiential learning, students use their experiences to gain new knowledge, abilities, and/or attitudes. Setting goals, planning, experimenting, reflecting, watching, and reviewing are some of the processes that are involved. By engaging in these activities, the learner incorporates the emotional, cognitive, and physical aspects of learning into meanings that are personal to him or her.

The primary means of achieving the instructional objectives in mathematics is the teaching material. Effective teaching resources are required to carry out the mathematics learning process. The instructional materials can help the pupils learn new information. Effective teaching materials will develop the students' learning experiences, making mathematics learning more interesting and boosting students' cognitive abilities. It is necessary to learn mathematics in a way that directly connects the teaching materials to everyday life. The mathematics teaching material based on experience learning is one of the resources that can be employed. Mainly teachers need to teach in the ways that reflect their own learning styles and so that would implicit in all their students and they able learn that way. Kolb argued that teachers need to encourage students to engage with all four stages of the learning cycle. Mick Healey and Alan Jenkins (2000) stated that without reflection on experience, the students are in danger that they may keep making the same mistakes in learning.

Experiential learning emphasizes that learning should create certain life situations that are centered around facilitating the development of practical skills, allowing students to have rich experiences, and allowing students to learn to express their own experiences and know how to understand people’s expressions of their experiences, thus seeking to provide an environment that engages students in social practices, engages them in inquiry-based learning, and supports them in establishing a positive identity (Lu Sun and Longhai Xiao, 2023). The result of integrating and transforming experience is knowledge. Learning that is gained by direct interaction and exposure of experience is referred to as experiential learning.

Jacob Jenkins and Tracylee Clarke (2017) stated that developing assignments geared towards all four stages of the Experiential Learning Theory prepares learners for cultivating and directing personal growth by compelling them to plan for and

apply the insights and knowledge gained. Experiential learning-based teaching material uses student-centered approach that is started by the underlying principle that people learn best from the experience. It is in line with the research carried out by Llewellyn & Frame (2012) which state that experiential learning is designed to give the comprehensive learning experience.

Experiential learning-based teaching material in Mathematics consists of four stages: Concrete Experience (CE), Reflection Observation (RO), Abstract Conceptualization (AC) and Active Experimentation (AE). Those four principles aim to make the students have the experience to experience, observe, think, and act during Mathematics learning process (Mutmainah, Rukayah and Indriayu, 2019). In conclusion, the use of instructional materials that are focused on experiential learning aids in the development of students learning.

Principals of Experiential Learning

The following is a list of experiential learning principles as noted from the (Association for Experiential Education, 2011);

1. Experiential learning occurs when carefully chosen experiences are supported by reflection, critical analysis and synthesis.
2. Experiences are structured to require the student to take initiative, make decisions and be accountable for results.
3. Throughout the experiential learning process, the student is actively engaged in posing questions, investigating, experimenting, being curious and solving problems, assuming responsibility, being creative and constructing meaning.

4. Students are engaged intellectually, emotionally, socially, soulfully and/or physically. This involvement produces a perception that the learning task is authentic.
5. The results of the learning are personal and form the basis for future experience and learning.
6. Relationships are developed and nurtured: student to self, student to others and student to the world at large.
7. The instructor and student may experience success, failure, adventure, risk taking and uncertainty, because the outcomes of the experience cannot totally be predicted.
8. Opportunities are nurtured for students and instructors to explore and examine their own values.
9. The instructor's primary roles include setting suitable experiences, posing problems, setting boundaries, supporting students, insuring physical and emotional safety, and facilitating the learning process.
10. The instructor recognizes and encourages spontaneous opportunities for learning.
11. Instructors strive to be aware of their biases, judgments and pre- conceptions, and how these influence the student.
12. The design of the learning experience includes the possibility to learn from natural consequences, mistakes and successes.

Significance of Experiential Learning

The significance of Experiential Learning was stated as follows by Komal Rani and Tarun Kumar Tyagi (2023);

i. Experiential learning is the process of learning by doing. It is an effective strategy for involving students and ensuring that they are learning deeply. It allows real-world experience and a better ability to connect the knowledge learned in the classroom to real-world situations.

ii. Experiential learning allows reflection on the experiences the students have and builds deep connections with conceptual classroom topics. Such discussion renders the abstract ideas and knowledge taught in the classroom pertinent and relatable.

iii. Experiential learning allows the students to interact effectively, be curious and creative, verify their hypotheses, and actively apply their past knowledge to acquire new knowledge.

iv. Experiential Learning strives to place the student at the center of the learning environment. Students may think critically, make decisions, and master knowledge by constructing themselves.

Experiential Learning Process

Experiential learning involves a number of steps that offer student a hands-on, collaborative and reflective learning experience which helps them to "fully learn new skills and knowledge". The following describes the steps that comprise experiential learning as noted by Haynes, 2007 and UC Davis, 2011 cited in Association for Experiential Education, 2011;

a. Experiencing/Exploring ("Doing")

Students will perform or do a hands-on minds-on experience with little or no help from the instructor. Examples might include: Making products or models, role-playing, giving a presentation, problem-solving, playing a game.

A key fact of experiential learning is what the student learns from the experience rather than the quantity or quality of the experience.

b. Sharing/Reflecting (“What Happened?”)

Students will share the results, reactions and observations with their peers. Students will also get other peers to talk about their own experience, share their reactions and observations and discuss feelings generated by the experience. The sharing equates to reflecting on what they discovered and relating it to past experiences which can be used for future use.

c. Processing/Analyzing (“What’s Important?”)

Students will discuss, analyze and reflect upon the experience. Describing and analyzing experiences allow students to relate them to future learning experiences. Students will also discuss how the experience was carried out, how themes, problems and issues emerged as a result of the experience. They will discuss how specific problems or issues were addressed and to identify recurring themes.

d. Generalizing (“So What?”)

Students will connect the experience with real world examples, find trends or common truths in the experience, and identify “real life” principles that emerged.

e. Application (“Now What?”)

Students will apply what they learned in the experience (and what they learned from past experiences and practice) to a similar or different situation. Also, students will discuss how the newly learned process can be applied to other situations. Students will discuss how issues raised can be useful in future

situations and how more effective behaviors can develop from what they learned. The instructor should help each student to feel a sense of ownership for what they learned.

Role of teacher in Experiential Learning

Colin Beard and John P Wilson (2013) stated experiential learning as, 'synthesizes knowledge from practices of experiential learning, adult learning and organizational development'. They also described the key roles as

i. Relationship development

It's a service that enhances interactions and motivates the individuals through short-term events. Examples include energizing, incentive/reward, networking and celebration events. These events are purposeful and incorporate elements of reflection, transfer and support.

ii. Performance enhancement

It involves training in skills and competencies that result in improvement of personal, team and organizational effectiveness. Examples include communication skills, executive coaching, performance management and conflict resolution.

iii. Consultation/intervention

It includes the service of addressing the interaction between behavior (individual, leadership and team) and business setting elements. Activities may include analyzing misalignments among these pieces, advising on possible growth/change initiatives, and coaching.

Problem Solving Ability in Mathematics

Problem is the gap between expectations with reality and also between what they want or what is intended with, what is happening or facts. A problem usually contains situations that encourage someone to solve it, but do not know at firsthand what is to be done to solve the problems. To obtain the ability in problem solving, one must have a lot of experience in solving various problems. A question or a math problem is said to be a problem if the solution requires some creativity, understanding and thinking / imagination of everyone facing the problem. The mathematical problem is usually a matter of the story, proving, create or find a mathematical pattern (Cut Yuniza Eviyanti, 2017).

Problem solving is regarded as the core of mathematics education. It entails using reasoning and critical analysis to solve various life challenges. It also emphasises the development of thinking skills as well as subject knowledge. Since the procedures for solving mathematical problems are comparable to those for tackling general problems, learners can use their understanding and problem-solving abilities to be beneficial in daily life.

According to Skinner (1968), "Problem solving is a process of overcoming difficulties that appear to interfere with the attainment of a goal. It is a procedure of making adjustment in spite of interferences" (Joshi & Prashanth, 2021).

Mainly the Problem Solving Ability was the cognitive capability of the problem solver to perform physical or mental operations based upon his knowledge so as to achieve the goal of solving a problem. This is measured as the score of the Problem Solving Ability with three components namely, comprehending the problem,

clarifying the problem and finding solution to the problem (Manoj, 2006 sited in Manoj Praveen, 2018).

Theories of Problem solving

The term problem solving is normally an intentional process that uses higher-order thinking and systematically organized procedures to accomplish the goal. Many psychologist and educationist even consider the importance of problem solving abilities in daily life so that some have developed theories for it.

In 1913, Thorndike has propounded a theory named “Trail and Error theory”. It mainly explains about how an individual uses a technique for learning where different answers are hesitantly tested and some are rejected until a solution is achieved. This theory defines mental exploration or reflective thinking as problem solving.

Wolfgang Kohler in 1917 conducted a research by doing a classical experiment using chimpanzees which is named as “Insight Learning theory”. In this he observed how chimpanzees try to solve the problem (here problem in the sense obtaining bananas that have been placed out of reach). It explains that the solution of a particular problem can be achieved through insight in to the particular situation.

Later the Gestalt theory of problem solving was first described by Karl Duncker (1945) and Max Wertheimer (1959), which holds that problem solving occurs with insight. Gestalt theory informs educational programs aimed at teaching students how to represent problems. Gestalt psychologists typically studied the problem solving by using verbal protocols. They were more interested in the process

of problem solving than the solution and verbal protocols are away of studying the process.

In 1956, Robert Gagne has proposed an approach for problem solving. This theory mainly organized in eight levels of learning. At this the highest level of learning is problem solving. This theory mainly describes that educational programs only aim to teach the students how to represent the problem. This theory concluded that the object requires to be rearranged into a new structure in order to solve the problem.

In 1972, Allen Newell and Herbert A. Simon jointly discovered a theory called as “Information Processing theory of Learning”. This approach highlights the importance of elements including memory tasks, long-term memory organization, and cognitive retrieval of information. Under this a basic problem solving idea along with artificial intelligence (AI), a theory was developed by Newell's and his colleagues. Then it is named as “Theory of Human Problem solving”. This AI programs support the assertion that effectiveness in problem-solving is closely correlated with general problem-solving ability. In his idea of human problem solving, Newell highlighted the parallels between human and AI problem solving. This theory mainly concentrates on creating a new problem space and discovering a solution within that problem space.

Steps in Problem solving

In the twenty-first century, problem-solving abilities are considered as a necessary for learners. Problem-solving abilities are crucial for students' daily life, since they encourage curiosity, focus, perseverance, and confidence as well as an interest in mathematics. For increasing problem-solving abilities, George Polya who

is considered as the “Father of Problem Solving” has developed four steps to overcome problems in his book “How to solve it”(1957).

The steps are as follows,

Step 1: Understanding the Problem

Understanding a problem was a primary issue. The solution for this is one must thoroughly read the problem in order to understand it. After reading the problems, one can definitely able to formulate what is asked, whether the information is sufficient and what should be met. Based on these, the individual will restate the original problem in more understandable way.

Step 2: Devising the problem

Polya stated that there are numerous rational approaches to resolve problems. The best way to resolve the problem is to develop or select an effective approach. The process of selecting a strategy will mainly get simpler. Then draw up the resolution procedures for the problem.

Step 3: Carrying out the plan

This step is to frame the procedure for a problem to perform. If an individual have the requisite abilities, he need to be patience to follow the procedures to solve the problem without mislead it.

Step 4: Looking back

According to Polya, there are many benefits to pausing to think back regarding what have done, what has worked, and what has not. It will help to foresee what approach to take to address difficulties in the future by doing this.

REVIEW OF RELATED STUDIES

Lu Sun and Longhai Xiao (2023) investigated about learning engagement and basic mathematical competencies based on experiential learning using SEM Model for a sample of 263 primary school students and revealed that based on the developed structural model that experiential learning in mathematics can increase students' learning engagement in mathematics learning and positively influence mathematical attitudes and mathematical self-efficacy, thus positively influencing students' performance in basic mathematical competencies.

Yangtao Kong (2021) studied the role of experiential learning on student's motivation and classroom management. He found that experiential learning activities could bring considerable effect on the learner's motivation and achievement. Also experiential learning helped in improving the values of education.

Joshi & Prashanth (2021) studied about the effect of connectivism based strategies on critical thinking ability, problem solving ability and achievement in science among secondary school students for the sample of 120 school students of ninth standard and found that Connectivism Based Strategies of teaching science was more effective in enhancing Critical thinking ability, Problem solving ability and Achievement in science among secondary school students when compared to traditional method of teaching science.

Kumar (2020) studied the problem-solving ability and creativity among higher secondary students in Nagapattinam District for the sample of 141 boys and 159 girls in which the students of XI and XII standard were included and revealed that there exists no correlation between creativity and problem-solving ability among the higher secondary students.

Hobri, Ummah, Irma Khoirul, Yuliati Nanik & Dafik (2020) examined the effectiveness of jumping task application based on creative problem solving (CPS) in improving students problem solving abilities and the result showed that the students of the three classes differed in problem solving abilities after the implementation of jumping task based on Creative Problem Solving (CPS). Also revealed that the students problem solving abilities in mathematics learning with jumping task based on CPS was better than students problem solving abilities in mathematics learning with sharing task based on CPS, and students problem solving abilities in mathematics learning with sharing task based on CPS was better than students problem solving abilities in conventional model.

Madihah Khalid, Supiah Saad, Siti Rafiah Abdul Hamid, Muhammad Ridhuan Abdullah, Hasniza Ibrahim and Masitah Shahrill (2020) investigated about the enhancement of creativity and problem solving skills through creative problem solving in teaching Mathematics for the sample of 172 students and revealed that students' creativity increases from moderate to high and also their problem solving skill had effective change through creative problem solving in teaching Mathematics.

Hulaikah, Degeng, Sulton & Murwan (2020) found that a sample of 120 vocational college students taught through experiential learning had different problem-solving skills from those taught through direct instruction. Also found that students' ability to solve problems depended largely on how much difficulty they have encountered, and the interactions between experiential learning and difficulty quotients aid in students' improvement of problem-solving abilities.

Abdul Khaliq and Shafqat Rasool (2020) studied the effectiveness of the experiential learning approach on students' mathematical creativity at the secondary level schools in province Punjab, Pakistan of sample of 60 secondary level students

and found that the experiential learning strategy significantly improved the mathematical creativity of secondary school students.

Veronica Villarroel, Mariavictoria Benavente, Maria Josefina Chuecas and Daniela Bruna (2020) viewed experiential learning as student-centered teaching method that improved perceived learning in higher education and found a positive perception from the students, teachers and beneficiaries regarding experiential learning as a means to reach the goals.

Sreevidhya Nair. N (2019) studied effectiveness of teaching – assisted learning package based on experiential learning for enhancing communicative competence in English of students at higher secondary level of a sample of 500 high school students and revealed that teaching using experiential learning package helped the students to enhance the communicative competence in English at higher secondary level.

Mutmainah, Rukayah and Mintasih Indriayu (2019) found that experiential Learning-based teaching material in Mathematics was more effective and helped to improve the Mathematics cognitive ability of the fifth-grade student in elementary school.

Tambunan (2019) viewed the effectiveness of teaching through problem solving strategy and scientific approach on students' mathematical abilities in high order thinking skills for the total of 177 samples from the tenth grade of public and private high schools in Medan-Indonesia and the result revealed that learning through problem solving strategy was more effective to develop student’s mathematical abilities.

Johari A H and Muslim (2018) studied the application of experiential learning model using simple physical kit to increase attitude toward physics student senior high school in fluid and found that the influence of experiential learning model using simple physics kit could improve attitude toward physics compared to experiential learning without using simple physics kit.

Yulindar, Setiawan and Liliawati (2018) examined the enhancement of problem solving ability of high school students through learning with real engagement in active problem solving (REAPS) model on the concept of heat transfer for a sample of 35 Pontianak high school students and revealed that the improvement of problem solving ability of students with the provision of REAPS learning model was effectively high.

Sharifah Osman, Che Nurul Azieana Che Yang, Mohd Salleh Abu, Norulhuda Ismail, Hanifah Jambari and Jeya Amantha Kumar (2018) investigated the students' mathematical problem-solving skills through Bar Model Visualisation Technique for the sample of 32 students and resulted that student's performance has drastic improvement after the implementation of the Bar Model in mathematical problem-solving.

Shemeena Hussain (2018) investigated the development of Experiential Learning Model (ELM) in Environmental chemistry enhancing reflective capacity of secondary school students and found that Experiential Learning Model was effective for enhancing reflective capacity in Environmental Chemistry at secondary level.

Jenkins. J. Jacob and Tracylee Clarke (2017) studied about Engaged Journalism: Using Experiential Learning Theory (ELT) for In-Class Journaling Activities. It mainly focuses on the use of experiential learning approach to the field

of journalism and found that with Experiential Learning Theory (ELT), engaged journaling could be possible both inside and outside the classroom. Also revealed that use of learning styles through several modes of creative expression improved the engaged journaling and it allowed students to be engaged in four different stages learning cycle.

Alice Y. Kolb & David A. Kolb (2017) studied about Experiential Learning Theory as a guide for experiential educators in higher education and explained the important core concepts of experiential learning such as the learning cycle, learning style, and learning space. He also found the latest ideas regarding these three concepts and high lightened their applications based on many disciplinary applications of experiential learning in higher education level.

Caroline Satur and Parvinder Hanspal (2017) examined about whether experiential learning method improves students' communication skills in English in comparison to traditional learning method for a sample of 60 class eight students from different government schools and found that experiential learning method improve students' communication skills better than traditional method.

Mulyono and Hadiyanti (2017) studied the analysis of mathematical problem-solving ability based on metacognition on problem-based learning and found that Problem-based learning has a better quality to promote problem-solving ability and also revealed that the level of students' metacognition is directly proportional to students' mathematics problem-solving ability.

Cut Yuniza Eviyanti, Edy Surya, Edi Syahputra and Maruli Simbolon (2017) examined the students' mathematical problem solving ability by applying problem based learning model in VII Grade at SMPN 1 Banda Aceh Indonesia and revealed that students who used a problem-based learning model experienced greater growth in

their ability to solve mathematical problems than students who used more traditional learning options.

William F. Heinrich, Geoffrey B. Habron, Heather L. Johnson, and Lissy Goralnik (2015) investigated critical thinking assessment across four sustainability related to experiential learning settings and found that strong critical thinking outcomes result from experiential learning with appropriately scaffold critical thinking exercises and processes.

Afida Ayob, Aini Hussain, Mohd Marzuki Mustafa and Muhd Fauzi Aminuddin Shazi Shaarani (2011) investigated about nurturing creativity and innovative thinking through experiential learning for the sample of students and instructors from the Faculty of Engineering and Built Environment and the Faculty of Information Science and Technology who participated in the Malaysian ROBOCON 2010 and found that students' creativity could be nurtured and enhanced as a result of the problem solving process involved in the experiential learning activities.

Patricia Albergaria Almeida and Rita Mendes (2010) examined the Learning Style Preferences across Disciplines which includes the Kolb's learning styles of Experiential Learning Theory for the sample of 186 students of University of Aveiro, Portugal from different disciplines. This study mainly aimed to examine the relationship between university students' learning styles and their academic field and revealed that all the students except educational students possess the dominancy in accommodating with the learning styles.

Nancy Oldenburg & Wei-Chen Hung (2010) investigated the problem solving experience of students in an online problem-based learning environment and the result revealed that the student's perspectives towards problem solving experience had more positive effect under problem-based environment..

Jung-Hoon (2008) investigated the application of experiential learning cycle in learning with a business simulation game for the of 57 students who enrolled in the Entrepreneurship course in the semester of 2006 and revealed that the students who learned through the Reflective Observation and Abstract Conceptualization steps of Kolb's experiential learning cycle have better game play strategies and they performed well in the business stimulation game than those leaned only through Reflective Observation steps.

Mick Healey and Alan Jenkins (2000) investigated about Kolb's experiential learning theory and its application in geography in higher education in relation to Kolb's Learning cycles and learning styles and found that the use of experiential learning and its application in geography has more effective for the students of higher education.

CRITICAL REVIEW

The investigated reviewed Indian and foreign studies for this study. The investigator reviewed 27 studies related to experiential learning and problem solving ability. Most of the studies showed the experiential learning has better achievement in learning all subjects. The investigator also went through the tools and techniques used in these studies. The studies related to experiential learning and problem solving ability are useful in making the teaching learning process effective. Only few studies are available for experiential learning and problem solving ability, so to fill the gap the investigator conducted the study on effectiveness of experiential learning on problem solving ability in mathematics of class eight students.

CHAPTER III

METHODOLOGY

- Introduction
- Method used in the present study
- Administration of the tool
- Statistical techniques used

CHAPTER III

METHODOLOGY

INTRODUCTION

Research is an academic activity and as such the term should be used in a technical sense. According to Clifford Woody research comprises defining and redefining problems, formulating hypothesis or suggested solutions; collecting, organizing and evaluating data; making deductions and reaching conclusions; and at last carefully testing the conclusions to determine whether they fit the formulating hypothesis (Kothari, 2004).

According to Best and Khan (2002), "Research may be defined as the systematic and objective analysis and recording of controlled observations that may lead to the development of generalizations, principles, or theories, resulting in prediction and possibly ultimate control of events".

Research methodology involves the systematic procedures by which the researcher starts from the initial identification of the problem to its final conclusions. The role of the methodology is to carry on the research work in a scientific and valid manner. The methodology consists of procedures and techniques for conducting a study. Research methodology involves such general activities as identifying problems, review of the literature, formulating hypotheses, procedure for testing hypotheses, measurement, data collection analysis of data, interpreting results and drawing conclusions. Thus, research methodology consists of all general and specific activities of research (Yogesh Kumar Singh, 2006).

The scope of research methodology is wider than that of research methods. Thus, research methodology not only consider the research methods but also consider

the logic behind the methods that used in the context of a research study and explain why a particular method or technique are chosen for this study and why not using other methods. The researcher chose certain methodology for his problem as the same may differ from problem to problem.

METHOD USED IN THE STUDY

The type of data that the research topic seeks upon must be considered while choosing a method and a specific design for a particular problem. However, the methodology chosen must be consistent with scientific principles and sufficiently enough to enable reliable generalization.

According to Paul E, Green and Tull, "a Research Design is the specification of methods and procedures for acquiring the information needed. It is the overall operational pattern or framework of the project that stipulates what information is to be collected from which sources by what procedures. If it is a good design, it will ensure that the information obtained is relevant to the research questions and that it was collected by objective and economical procedures (Shraddha Bhome et al., 2013).

The present study is concerned with investigating the "Effectiveness of the Experiential Learning on Problem Solving Ability in Mathematics of class Eight students". Therefore the investigator followed experimental method for the study.

Design of experimental study

Experimental study is mainly an organized and logical approach for testing hypotheses. According to Best and Khan (2002), "Experimentation is the classic method of the science laboratory, where elements manipulated and effects observed

can be controlled. It is the most sophisticated, exacting and powerful method for discovering and developing an organized body of knowledge".

According to William Wiersma and Stephen G. Jurs (2009) described that experimental design is a preconceived plan for conducting an experiment. More specifically, an experimental design is the structure by which variables are positioned, arranged or built into the experiment.

In an experiment, the results of one treatment are contrasted with those of another treatment or with no treatment at all. In a simple conventional experiment, the terms experimental group and control group are used. These groups are as closely compared and it is practical. The control group is not exposed to the effect of the specific treatment, but only for the experimental group.

The design selected for the present study was Pretest-Posttest Nonequivalent Groups Design. Best and Khan (2009) described that Pretest-Posttest Nonequivalent Groups Design is often used in classroom experiments when experimental and control groups are naturally assembled groups as intact classes, which may be similar. The pretest is applicable for both the groups. Post test has been applied to both the experimental group after the treatment and control group without the treatment. Best and Khan (2009) illustrated the Pretest-Posttest Nonequivalent Group Experimental Design as,

O_1 X O_2

O_3 C O_4

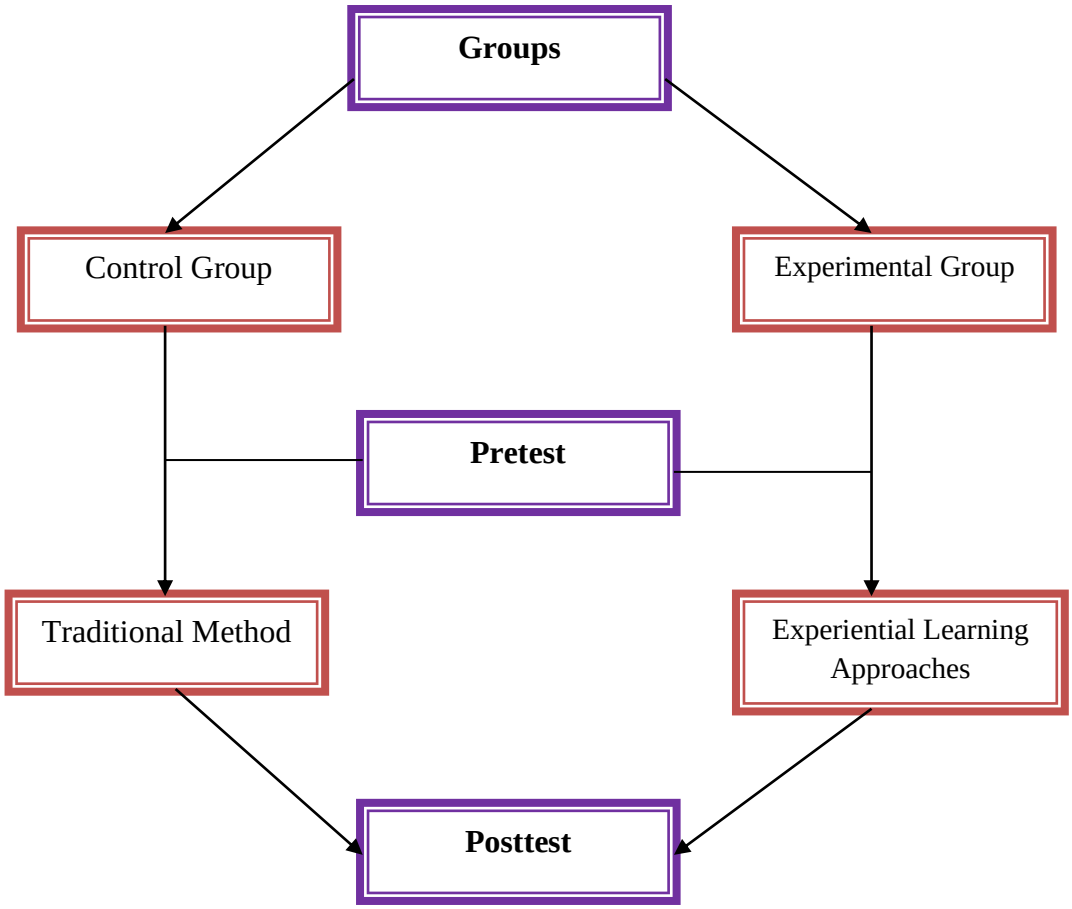
Where

O_1 & O_3 – Pretest

O_2 & O_4 - Posttest

Figure 3.1

Pre test - Post test Nonequivalent Experimental Group Design



Variables of the study

Variables are referred as the condition or characteristics that the experimenter manipulates controls or observes (Best & Khan, 2002). If the hypothesis and its implications are thoroughly considered, then two specific factors can be distinguished. They are

a) Independent variable

b) Dependent variable

Independent variable

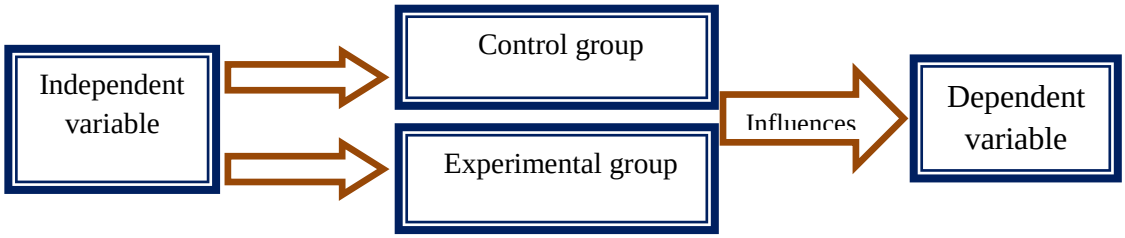
In an experiment, the manipulated variable is referred to as the independent variable. It is directly under the experimenter's control, which has the power to change it to fulfill any goal. In this study, the method of teaching is independent variable. The experimental group was treated with the approaches of experiential learning in teaching. The control group was not administrated with any specific special programmes. The control group was treated by traditional method of teaching. These were the two main strategies adopted by the investigator for the independent variable.

Dependent variable

In an experiment, the variable being tested and measured is known as the dependent variable since it depends upon independent variable. In this study, problem solving ability is dependent variable.

Figure 3.2

Design of experimental study



Population

The term "population" describes the complete group of people from whom the observer seeks to draw any conclusions. A population is any group of individuals who have one or more characteristics in common that are of interest to the researcher. The population may be all the individuals of a particular type or more restricted part of that group (Best & Khan, 2007). For the present study the population of class eight

students who are studying in various schools of Kanniyakumari district in Tamil Nadu following State Board Syllabus during the academic year 2022-2023.

Sample

A sample is a discrete segment of the population chosen for research and observation. One can draw conclusions about features of the population it is derived from by analyzing at the details of the sample. For the present study, sample consists of 71 students studying in eight standard students.

Sampling

Sampling is a technique for choosing certain individuals or a small portion of the population in order to draw conclusions about the overall population and to evaluate its characteristics. The investigator adopted simple random sampling technique to select as sample and 71 class eight students from K. A. B. D. Matric Higher Secondary School, Painkulam were selected as sample. Among the 71 students through random selection 35 students were assigned in experimental group and 36 students were assigned in control group.

TOOLS USED FOR THE STUDY

The tool used in the study were,

I. Lesson transcripts based on experiential learning model for teaching Mathematics.
II. Problem Solving Ability Test in Mathematics was constructed and validated by the investigator and guide.
III. Personal data sheet

I. Lesson Transcripts

Lesson transcripts are basically the plan of action for teaching and learning process. For this study, the investigator constructed the lesson transcripts for teaching Mathematics of class eight students which includes the chapters such as Direct and Inverse proportion, Algebra and Factorization using the experiential learning model.

II. Problem Solving Ability Test

The investigator constructed and validated the tool and employed the Problem Solving Ability test as the tool for collecting the data.

Construction & validation of Problem Solving Ability Test

Problem solving ability Test was prepared by R.N. Abina and Dr R.P.Deepa. For the construction of the test, the investigator adopted the following steps,

1) Planning of the test
2) Items writing
3) Items editing
4) Preliminary tryout
5) Pilot study
6) Scoring
7) Item analysis
8) Item selection
9) Final draft
10) Establishment of Reliability and Validity

1) Planning of the test

Problem solving ability test prepared by R.N. Abina and Dr R.P. Deepa, aims at measuring the problem solving ability of class eight students. In order to prepare the test, various literature related to problem solving ability were reviewed and selected relevant dimensions. The investigators plan to select the dimensions namely Critical thinking, Value based problems, Creative thinking, Comprehensive skill and Art Integration.

a) Critical thinking

Critical thinking is defined as an awareness of own thinking (self-reflection) and the ability (foundation skills) and willingness (willingness to question) to clarify and improve understanding which aids in drawing appropriate conclusions and making the best decisions possible within a context (knowledge base). Analysis, interpretation, inference, synthesis, and evaluation are some of the sub skills included in critical thinking (Paul Chambers and Robert Timlin, 2018). Syafril, 2019 described that the critical-thinking skill in mathematics can be interpreted as the ability to include prior knowledge, cognitive strategies to generalize, prove or evaluate mathematical situations which include: testing, questioning, and connecting every aspect that exists in mathematical problems.

Indicators of mathematical critical thinking ability consist of focusing on one question, problem and theme, checking the truth of arguments, statements and solution processes, asking and answering with reasons, observing with criteria, identifying assumptions, understanding well, and identify relevant and irrelevant data, reduce and induce, make

judgments, assess thoroughly and find alternatives (J. B. Baron and R. J. Sternberg, 1987).

b) Value based problems

Values play a vital role in the development and cohesion of society; they qualify it to meet the challenges of all times and help it to anticipate the behavior of its members in the light of their values and responses in different situations. They are also considered one of the most important cultural elements of individual and social life, and they are a pillar of the educational process in which they represent a crucial goal and function of education in general. Therefore, the educational system is aimed at constructing positive values and eliminating negative ones from the minds and behavior of emerging members of society through various means and methods. Mathematical Values are the values that reflect the nature of mathematical knowledge depends on ideas based on theory, logic and hypothesis (Yousef Methkal Abd Algani and Jmal Eshan, 2019).

To improve the values among students, the investigator has framed some items which are mainly based on values such as value of money, sharing, time, saving, helping, equality, charity and being wise.

c) Creative thinking

Creative thinking is mathematical thinking in solving mathematical problems. She also concluded that if in solving math problems routine, and students can complete in a manner different from that taught by teachers in the classroom, then these students can be said to be creative in mathematics (Ranak Lince, 2016).

According to Briggs and Davis (2008) viewed that creative in mathematics is not a solution that is completely new, but it means the creativity that infuses the learner to find a new answer. Mainly creative thinking is the thinking that resulted in the discovery of novel insights, strategies, viewpoints, or methods of knowing. It has the components of fluency, flexibility, originality and elaboration (Damsir Ali et al., 2020).

According Ruseffendi (2006), to come up with creative abilities students need activities in which there are: exploration for the broadest study material in accordance with the will of the students, the invention positioned students to find their own theory learned or finds their own ways of solving the problem, discussion of means to position students in groups so they can share their opinions and knowledge and the project is a task to be completed and a problem solving activity in completing a given project.

d) Comprehensive skill

Comprehension is defined as the active process of building an adequate mental representation of a text. Texts in mathematics often include discontinuous elements such as tables, figures, or formulae. If the text is accompanied by pictures, an integrated mental representation is built on the basis of the text and pictures. To solve mathematical problems, students must translate real-world situations, which are typically presented in text form. To complete the translation process, the problem-solver must first understand the real-world situation. Therefore, comprehension can be considered an essential part of solving problems (Janina Krawitz, 2021). Alvin Vista (2013) found that reading comprehension skill helps problem solving ability and growth in mathematics achievement.

e) Art integration

Arts integration is “an approach to teaching in which students construct and demonstrate understanding through an art form. Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both”. In Mathematics, art is useful as a complement to and illustration of mathematical content: diagrams, the golden ratio, trigonometric functions, etc. Inserting art into mathematics classes makes the learning experience more inwardly active and the subject matter more comprehensible. This connection enables different views and approaches to knowledge, deepening and personalizing the learning experience. Such a perspective in mathematics opens opportunities for exciting discussions in which students enthusiastically report the different methods they have found leading to the same solution. Students enjoy participating in artistic activities, irrespective of their abilities (Anja Brezovnik, 2015).

2) Item writing

Prepared items were categorized and written carefully under each dimensions. After writing all the items in the dimension wise, it was subjected to editing.

3) Items editing

Item editing was done with the help of the research supervisor in order to check the ambiguity, irrelevant items, spelling errors, misconceptions and redundancy. As per suggestion of the research supervisor irrelevant and ambiguous items were removed and certain items were modified. After removing the ambiguous and irrelevant items the final tool consist of 10 items under each dimension. The

investigator arranged all the edited items carefully under each dimension. The test consisted of a total 50 items.

4) Preliminary tryout

To determine the test's strengths and limitations, a preliminary try-out was organized. A rough estimate of the time limit for replying to the items was made, along with the difficulty in each of the items. This time frame for replying to the questions was noted. In this stage the supervisor assisted the investigator in revising certain ambiguous and uncertain items.

5) Pilot study

The draft form of Problem Solving Ability test consists of 5 dimensions. Totally the draft Problem Solving Ability test consists of 50 items. The copy of the rough draft was attached in Appendix A**.** The investigator visited various schools of Kanniyakumari. The investigator administrated the tool individually to the class eight students. Proper guidance was given to the students about the tool. After making their responses, the investigator collected all tool. The investigator collected the sample of 100 class eight students for the purpose of item analysis after the scoring the response sheets.

6) Scoring

The scoring key consists of answers for all the items along with its marks. The total of 50 items included in this test in which each item carries 1 mark for correct answer and 0 for wrong answer. After the completion of scoring the data was subjected for analysis and interpretation. The scoring key of rough draft was enclosed in Appendix B.

7) Item analysis

Item analysis is a process in which the students' responses to individual test items are assessed in order to identify the quality of those items and for the whole test. For analyzing, the investigator used the method of the Difficulty Index and Discriminative Power method of item analysis. For this, the answer sheets of respondents were arranged in the descending order, from the top to the bottom. Then the top 27% of the answer scripts from the top was considered as 'Upper Group' and 27% of the answer script from the bottom was considered as 'Lower Group'.

The difficulty index and discriminative power of each item can be calculated by using the formula,

$$\text{Difficulty Index, } D_L = \frac{R_H + R_L}{N_1 + N_2}$$

$$\text{Discriminative Power,} = \frac{R_H - R_L}{N}$$

Where,

R_H – Number of correct responses in the upper group

R_L – Number of correct responses in the lower group

N – Number of students in the upper or lower group

The details of item analysis were given,

Table 3.1

Selected items in the Problem Solving Ability Test

Item No.	Discriminative Power	Difficulty index
1	0.41	0.69
2	0.15	0.19
3	0.56	0.65
4	0.3	0.52*
5	0.33	0.61*
6	0.15	0.29
7	0.52	0.56*
8	0.15	0.74
9	0.15	0.44
10	0.41	0.59*
11	0.59	0.59*
12	0.33	0.39*
13	0.37	0.3
14	0.15	0.3
15	0.37	0.52*
16	0.15	0.31
17	0.26	0.80
18	0.41	0.42*
19	0.19	0.42
20	0.22	0.44
21	0.3	0.44*
22	0.41	0.43*
23	0.3	0.59*
24	0.56	0.5*
25	0.3	0.52*

26	0.04	0.28
27	0.07	0.70
28	0.41	0.57*
29	0.26	0.13
30	0.3	0.67
31	0.3	0.5*
32	0.37	0.60*
33	0.07	0.48
34	0.22	0.67
35	0.33	0.54*
36	0.37	0.51*
37	0.22	0.62
38	0.41	0.61*
39	0.04	0.65
40	0.15	0.55
41	0.55	0.5*
42	0.19	0.46
43	0.44	0.63*
44	0.19	0.31
45	0.19	0.61
46	0.67	0.52*
47	0.19	0.5
48	0.48	0.69
49	0.74	0.37*
50	0.52	0.52*

8) Item selection

Item selection means testing the items for selection in which the investigator selects the items for testing from the original responses of the students and then based on the Difficulty Index and Discriminative Power the items was selected. Items having difficulty level between 0.30 and 0.60 and the discriminating power above

0.25 are selected for the final test. In the **Table 3.1,** the symbol **'∗'** denotes the item which had been selected for the final draft.

9) Final draft

The final draft of the Problem Solving Ability test consists of 24 items and it was attached in Appendix C.

10) Establishing Validity and Reliability

Reliability

Reliability mainly signifies the consistency of the measurement of the instrument which remains the same whenever it is used. The reliability of a test can be assessed in different ways. For this study the reliability coefficient of tool was found using Split half method. Using Pearson product moment correlation stated by Sharma (2003),

$$r = \frac{N\sum xy - \sum x \sum y}{\sqrt{N\sum x^2 - (\sum x)^2}\sqrt{N\sum y^2 - (\sum y)^2}}$$

Where,

r = Reliability coefficient of split half test

x = Total score of odd items

y = Total score of even items

xy = Estimated reliability of the whole test

N = total number of students in the group

Reliability coefficient, $R = \frac{2r}{1+r}$

Where

R = Reliability Coefficient

r = Reliability coefficient of split half test

Table: 3.2

Reliability result for Problem Solving Ability test

Contents	Percentage
Number of sample	100
Number of items	24
Correlation between odd half and even half items	0.69
Reliability Coefficient	0.82

The split half reliability coefficient has calculated. From the table, it shows that correlation between odd half and even half items has 0.69 reliability. This reveals that the Problem Solving Ability test possess 0.82 reliability.

Validity

A test is valid if it achieves the goal for which it was intended. The problem-solving ability test of this study had two primary types of validity that had been established: face validity and content validity. Face validity describes that the given tool appears or seen to measure what it is to measure. The tool was

presented to specialists, and their insights that are relevant to the tool's goals were taken into consideration. Content validity was established by verifying the comprehensiveness coverage of the content of the test by using reliable sources of information and the opinions of professionals or experts. To check the content validity, the investigator provided the tools to the experts were includes the supervisor, a School Mathematics teacher and a Mathematics teacher educator. As per the opinions of the experts the test possesses adequate face and content validity. The tool's relevance to the content is thus established.

III. Personal Data Sheet

The personal sheet was framed to collect the necessary details related to students. Based on the back ground variables selected for the study, the information sheet was constructed. It was constructed separately and collected along with the other tool. The present study collected the details regarding their sex, locale, type of school, nature of school and syllabus from all the students. A copy of the personal data sheet was given in Appendix E.

Procedure adopted for experimentation

The investigator followed four steps for conducting experiment using experiential learning of class eight students. The four steps are as follows,

i. Formation of the group for the study

The investigator selected two intact classes of grade eighth students. The two groups were assigned randomly as experimental group and control group. From the total 71 sample of students, 35 students are assigned randomly in experimental group and 36 students are assigned in the control group.

ii. Administration of pre-test

After having enough introductions about the purpose of the study, the investigator formed a rapport with the students. The pre-test was administrated to the students of two groups by the investigator before the commencement of the experiment. The filled in Problem solving Ability Test was scored using the scoring key and the scores were subjected to statistical analysis.

iii. Treatment

After the administration of the pre-test, the experimental group was taught using the experiential learning approach for 20 days. The lesson transcripts are enclosed in Appendix F. The control group was taught using traditional method.

iv. Administration of post-test

After teaching Mathematics for both the experimental and control groups, the post-test was administrated to measure the problem solving ability of the students. The same Problem solving Ability Test tool was used for the pre-test and post-test of the both experimental and control group in adjacent periods.

STATISTICAL TECHNIQUES USED

Statistical techniques are crucial for all types of research. The appropriate statistical method aids the researcher in analyzing and interpreting the study's data in a useful way.

For the analysis of the data following statistical techniques were used.

i. Independent t test for large sample

An Independent t test also known as an unpaired t test is a statistical procedure that compares the averages/means of two independent or unrelated groups to determine if there is a significant difference between the two. Sharma R. A., (2007) noted the formula for calculating independent t test for large sample as;

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

Where

t = t test for the difference of two means

M_1= Mean of First sample.

M_2= Mean of Second sample.

σ_1= Standard Deviation of First sample.

σ_2= Standard Deviation of Second sample.

ii. Paired t test for small sample

A paired t test is also known as a dependent or correlated t test. It is a statistical test that compares the averages/means and standard deviations of two related groups to determine if there is a significant difference between the two groups. Sharma R. A., (2007) noted the formula for calculating paired t test for small sample as;

$$t = \frac{M_1 - M_2}{S_{ED}}$$

Where

$$S_{ED} = \sqrt{\frac{\sigma_1^2}{N} + \frac{\sigma_2^2}{N} - 2r\frac{\sigma_1\sigma_2}{N}}$$

r = Correlation coefficient between paired observation

σ_1= Standard Deviation of First observation.

σ_2= Standard Deviation of Second observation.

N = Size of the Sample.

iii. ANCOVA (Analysis of Covariance)

ANCOVA helps to found that the experimental group was better able to predict strong content from headlines after training than the control group. It also permits the investigator to statistically control for differences on the pretest so that post test differences would not be due to initial differences before the training.

CHAPTER IV

ANALYSIS AND INTERPRETATION

- Analysis of data
- Interpretation of data
- Pre test analysis
- Post test analysis
- ANCOVA analysis

CHAPTER IV

DATA ANALYSIS AND INTERPRETATION

Analyzing the data statistically means summarizing the large form of data into meaningful form. Analysis helps to make possible data to an exact formation. It helps to identify the casual factors which process complex phenomena. It mainly aims to determine the measures relationships that exist among the data group.

According to Willinson and Bhandarkar, “Analysis of data involves a number of closely related operations that are performed with the purpose of summarizing the collected data and organizing these in such a manner that they will yield answer to the research questions or suggest hypothesis or questions”(Shraddha Bhome et al., 2013.

Data analysis requires a researcher to have a deep and thorough level of knowledge because it is such a highly skilled and technical task. The purpose of data analysis is unique in and of itself. It is employed to give sense to the study's raw data and produce important findings.

Interpretation is the process of making deductions from the facts gathered after doing an analytical investigation. According to C. William Emory, “Interpretation has two major aspects namely establishing continuity in research through linking the results of a given study with those of another and the establishment of some relationship with they collected data” (Shraddha Bhome et al., 2013).Interpretation serves as a tool for better understanding the variables that appear to explain what the researcher has noticed throughout the course of the investigation. An interpretation offers a theoretical framework that can direct subsequent investigation.

The analysis and interpretation of data are the two most significant phases of research. It is regarded as a very technical and highly skilled job. For data analysis, the researcher should have a clear understanding of data, better judgment, skills, generalization and familiarity with the background goals and hypotheses of the study.

In this study the analysis was done using the statistical techniques t-test and Analysis of Co-Variance (ANCOVA). Best and Khan (2009) described that using ANCOVA helps to found that the experimental group was better able to predict strong content from headlines after training than the control group. They also suggested that ANCOVA permits the investigator to statistically control for differences on the pretest so that post test differences would not be due to initial differences before the training. The analysis of data was the computed result which was done through the SPSS software.

The details of analysis are given below in the following heads;

1. Comparison of the pretest mean scores in the problem solving ability of the experimental group and the control group with respect to the total students, Male and Female.
2. Comparison of the post test mean scores in the problem solving ability of the experimental group treated with the Experiential Learning method and the control group with respect to the total students, Male and Female.
3. Comparison of the mean adjusted post test scores in the problem solving ability of the experimental group and the control group with respect to the total students, Male and Female.

PRE TEST ANALYSIS

Comparison of Problem Solving Ability scores of Experimental and Control groups at pretest level

$H_0$1 Null Hypothesis

There is significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.

Table 4.1

Summary of Mean, SD and t scores of Problem Solving Ability test scores of class eight students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	10.09	2.49	35				
Control	10.28	2.31	36	0.19	0.337	0.737	NS

Table 4.1, revealed that the t value is 0.337, p>0.01, and it is not significant at any level. Also from the mean it is clear that there is no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in both experimental and control groups. Therefore the null hypothesis is rejected. Therefore it is concluded that before the experiment, students of two groups have more or less same level of problem solving ability.

$H_0$2 Null Hypothesis

There is significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.

Table 4.2

Summary of Mean, SD and t scores of Problem Solving Ability test scores of male students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	9.17	2.64	18				
Control	9.78	2.39	18	0.61	0.728	0.472	NS

Table 4.2 showed that the t value is 0.728, p>0.01, and it is not significant at any level. Also from the mean it is clear that there is no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in both experimental and control groups. Therefore the null hypothesis is rejected. Therefore it is concluded that before the experiment, male students of two groups have more or less same level of problem solving ability.

$H_0$3 Null Hypothesis

There is significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.

Table 4.3

Summary of Mean, SD and t scores of Problem Solving Ability test scores of female students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	11.06	1.95	17	0.28	0.401	0.691	NS
Control	10.78	2.18	18				

Table 4.3 showed that the t value is 0.401, p>0.01, and it is not significant at any level. Also from the mean it is clear that there is no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in both experimental and control groups. Therefore the null hypothesis is rejected. Therefore it is concluded that before the experiment, female students of two groups have more or less same level of problem solving ability.

POST TEST ANALYSIS

Comparison of Problem Solving Ability scores of Experimental and Control groups at post test level

$H_0$4 Null Hypothesis

There is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.

Table 4.4

Summary of Mean, SD and t scores of Problem Solving Ability test scores of class eight students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	21.74	1.74	35	6.57	16.888	0.000	0.01
Control	15.17	1.54	36				

Table 4.4 revealed that the t value is 16.888, $p \leq 0.01$, and it is significant at 0.01 level. Also from the mean it is clear that there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in both experimental and control groups. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of class eight students.

$H_0$5 Null Hypothesis

There is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.

Table 4.5

Summary of Mean, SD and t scores of Problem Solving Ability test scores of male students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	21.33	1.88	18	6.55	12.430	0.000	0.01
Control	14.78	1.22	18				

Table 4.5 showed that the t value is 12.430, $p \leq 0.01$, and it is significant at 0.01 level. Also from the mean it is clear that there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in both experimental and control groups. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of male students.

$H_0$6 Null Hypothesis

There is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.

Table 4.6

Summary of Mean, SD and t scores of Problem Solving Ability test scores of female students of experimental and control group

Group	Mean	SD	N	Mean Difference	t	p	Sig.level
Experimental	21.18	1.51	17	6.62	11.927	0.000	0.01
Control	15.56	1.76	18				

Table 4.6 revealed that the t value is 11.927, $p \leq 0.01$, and it is significant at 0.01 level. Also from the mean it is clear that there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in both experimental and control groups. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of female students.

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$H_0$7 Null Hypothesis

There is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students.

Table 4.7

Summary of Mean, SD and t scores of Problem Solving Ability test scores of class eight students

	Mean	SD	N	Mean Difference	Paired t	p	Sig.level
Pre test	10.09	2.49	35	6.62	11.927	0.000	0.01
Post test	21.74	1.74	35				

Table 4.7 revealed that the t value is 11.927, $p \leq 0.01$, and it is significant at 0.01 level. Also from the mean it is clear that there is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of class eight students.

Null Hypothesis

There is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of male students.

Table 4.8

Summary of Mean, SD and t scores of Problem Solving Ability test scores of male students

	Mean	SD	N	Mean Difference	Paired t	p	Sig.level
Pre test	9.17	2.64	18	12.16	15.26	0.000	0.01
Post test	21.33	1.88	18				

Table 4.8 showed that the t value is 15.26, $p \leq 0.01$, and it is significant at 0.01 levels. Also from the mean it is clear that there is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of male students in both experimental and control groups. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of male students.

Null Hypothesis

There is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of female students.

Table 4.9

Summary of Mean, SD and t scores of Problem Solving Ability test scores of female students

	Mean	SD	N	Mean Difference	Paired t	p	Sig.level
Pre test	11.06	1.95	17				
Post test	22.18	1.51	17	11.12	18.36	0.000	0.01

Table 4.9 revealed that the t value is 18.36, $p \leq 0.01$, and it is significant at 0.01 level. Also from the mean it is clear that there is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of female students in both experimental and control groups. Therefore the null hypothesis is accepted. Therefore it is concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of male students.

ANCOVA ANALYSIS

Comparison of Problem Solving Ability scores of class eight students in experimental and control groups.

$H_0$8 Null Hypothesis

There is significant difference in the mean adjusted post test scores of problem solving ability of students in the experimental and control groups

Table 4.10

Summary of Mean, Sum of squares, Mean squares and F values of pre, post and adjusted post Problem Solving Ability scores of experimental and control groups

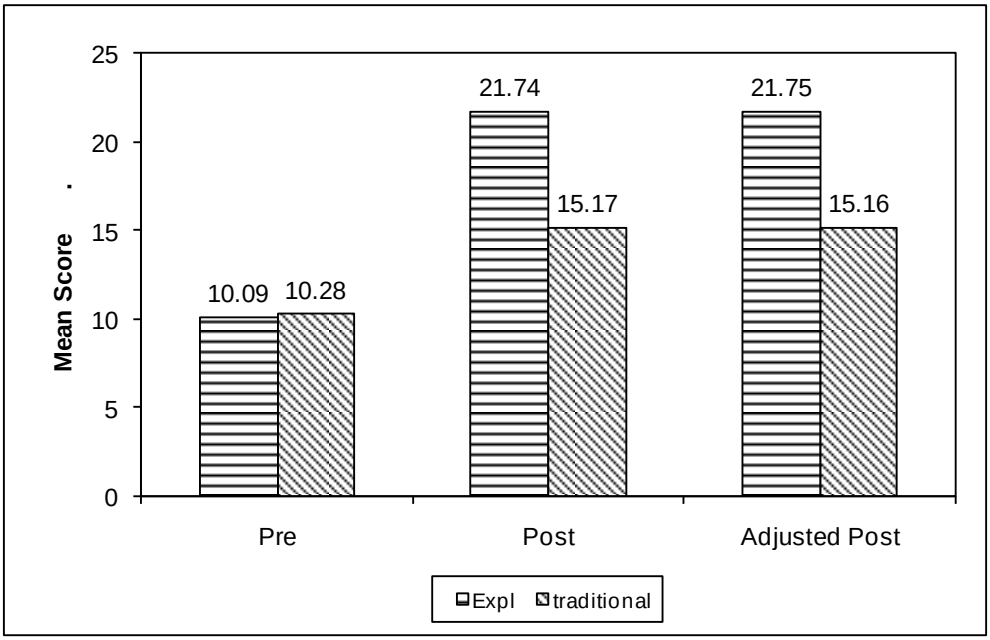
	Mean		Source	Sum of Squares	df	Mean Square	F	*p*	Sig.level
	Expl	Control							
Pre-test (X)	10.09	10.28	Between Groups	0.65	1	0.65			
			Within Groups	397.97	69	5.77	0.114	*0.272*	*NS*
			Total	398.62	70				
Post-test (Y)	21.74	15.17	Between Groups	767.47	1	767.47			
			Within Groups	185.69	69	2.69	285.188	*0.000*	*Sig. at 0.01 level*
			Total	953.15	70				
Adjusted Post-test (Y.X)	21.75	15.16	Between Groups	769.60	1	769.60			
			Within Groups	183.41	68	2.70	285.334	*0.000*	*Sig. at 0.01 level*
			Total	953.01	69				

Table 4.10 revealed that Fy.x value is 285.334, $p<0.01$, and it is significant at 0.01 level. It indicates that adjusted post mean problem solving ability scores of class

eight students in the experiment and control groups differs significantly after using Experiential Learning method. Hence the null hypothesis is accepted. So it can be concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of class eight students.

Figure 4.1

Unadjusted and adjusted mean scores of pre and post problem solving ability test of experimental and control groups



In order to know the exact groups which differs significantly in the adjusted post mean problem solving ability scores, the data was further analyzed with the help of Post-Hoc test test and the result are given in the table below.

Table 4.11

Summary of adjusted means, SD, and t values adjusted post problem solving ability test scores of experimental and control groups

	Adjusted mean	**$SD_{(yx)}$**	**$SE_{D(yx)}$**	**t**	***p***	***Sig. Level***
Experimental	21.75					
Control	15.16	1.64	0.39	16.79	*0.000*	*0.01*

A Post-Hoc test was applied for pair wise comparison of the adjusted means of problem solving ability of experimental and control groups. Since t value is 16.79, $p<0.01$, and it is significant at 0.01 level. So it can be concluded that the Experiential Learning method is significantly more effective than traditional method in enhancing problem solving ability of class eight students.

Comparison of Problem Solving Ability scores of male students in experimental and control groups.

Null Hypothesis

There is significant difference in the mean adjusted post test scores of problem solving ability of male students in the experimental and control groups

Table 4.12

Summary of Mean, Sum of squares, Mean squares and F values of pre, post and adjusted post Problem Solving Ability scores in both experimental and control group of male students

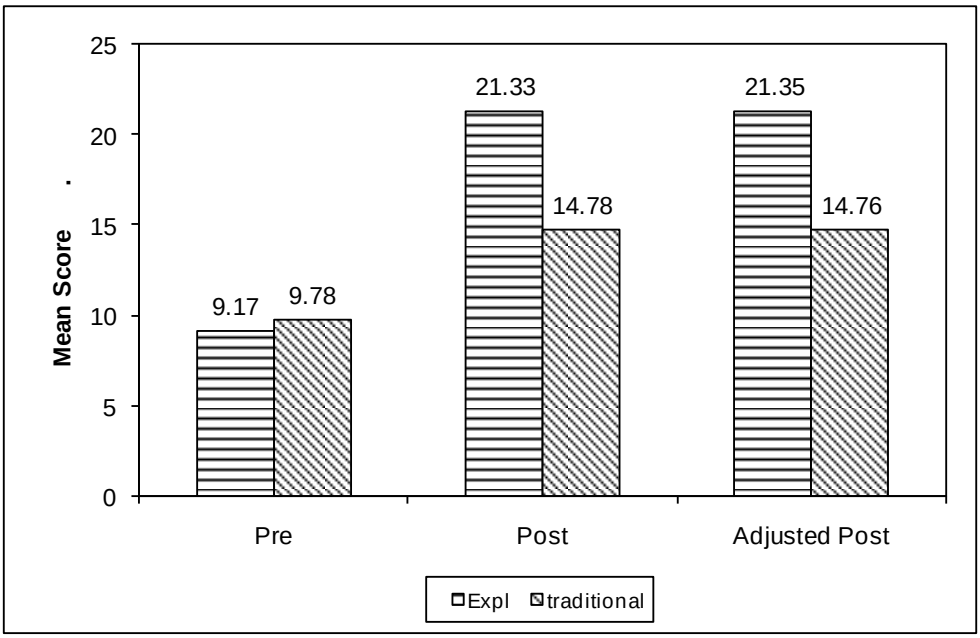
	Mean		Source	Sum of Squares	df	Mean Square	F	*p*	*Sig. level*
	Expl	Control							
Pre-test (X)	9.17	9.78	Between Groups	3.36	1	3.36	0.530	*0.472*	*NS*
			Within Groups	215.61	34	6.34			
			Total	218.97	35				
Post-test (Y)	21.33	14.78	Between Groups	386.78	1	386.78	154.509	*0.000*	*Sig. at 0.01 level*
			Within Groups	85.11	34	2.50			
			Total	471.89	35				
Adjusted Post-test (Y.X)	21.35	14.76	Between Groups	385.17	1	385.17	150.754	*0.000*	*Sig. at 0.01 level*
			Within Groups	84.31	33	2.55			
			Total	469.48	34				

Table 4.12 showed that Fy.x value is 150.754, $p<0.01$, and it is significant at 0.01 level. It indicates that adjusted post mean problem solving ability scores of male students in both experiment and control groups differs significantly after using Experiential Learning method. Hence the null hypothesis is accepted. So it can be

concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of male students.

Figure 4.2

Unadjusted and adjusted mean scores of pre and post problem solving ability test of experimental and control groups for male students



In order to know the exact groups which differs significantly in the adjusted post mean problem solving ability scores, the data was further analyzed with the help of Post-Hoc test test and the result are given in the table below.

Table 4.13

Summary of adjusted means, SD, and t values adjusted post problem solving ability test scores of experimental and control groups for male students

	Adjusted mean	**$SD_{(yx)}$**	**$SE_{D(yx)}$**	**t**	***p***	***Sig.Level***
Experimental	21.35					
Control	14.76	1.60	0.53	12.37	*0.000*	*0.01*

A Post-Hoc test was applied for pair wise comparison of the adjusted means of problem solving ability of experimental and control groups for male students. Since t value is 12.37, $p<0.01$, and it is significant at 0.01 level. So it can be concluded that the Experiential Learning method is significantly more effective than traditional method in enhancing problem solving ability of male students.

Comparison of Problem Solving Ability scores of female students in experimental and control groups.

Null Hypothesis

There is significant difference in the mean adjusted post test scores of problem solving ability of female students in the experimental and control groups

Table 4.14

Summary of Mean, Sum of squares, Mean squares and F values of pre, post and adjusted post Problem Solving Ability scores in both experimental and control group

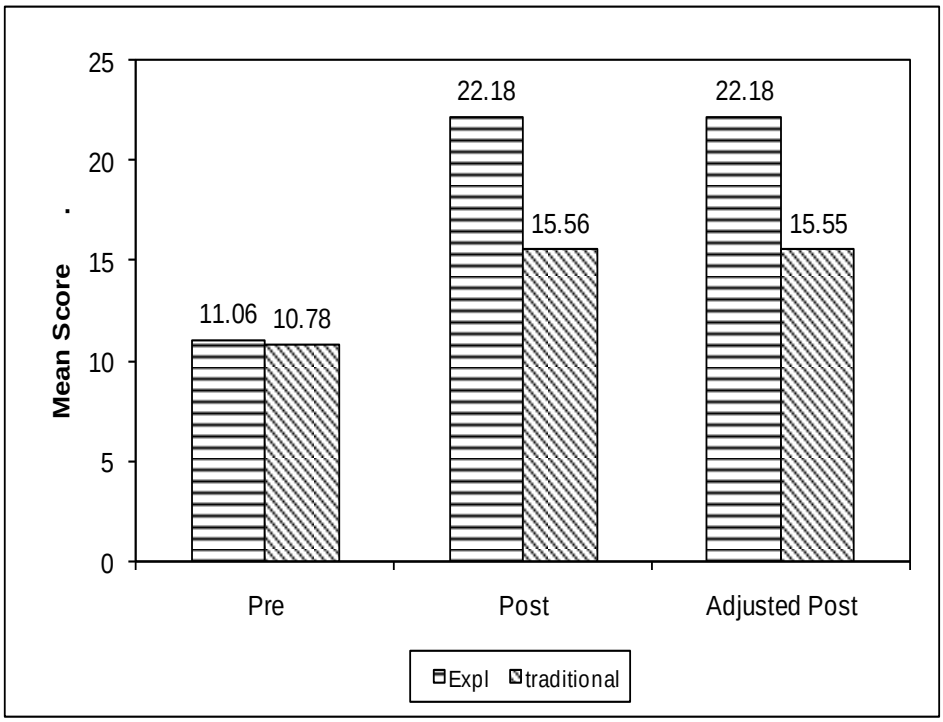
	Mean		Source	Sum of Squares	df	Mean Square	F	*p*	*Sig. Level*
	Expl	Control							
Pre-test (X)	11.06	10.78	Between Groups	0.69	1	0.69	0.160	*0.691*	*NS*
			Within Groups	142.05	33	4.30			
			Total	142.74	34				
Post-test (Y)	22.18	15.56	Between Groups	386.26	1	386.26	142.242	*0.000*	*Sig. at 0.01 level*
			Within Groups	88.92	33	2.69			
			Total	472.17	34				
Adjusted Post-test (Y.X)	22.18	15.55	Between Groups	382.30	1	382.30	137.760	*0.000*	*Sig. at 0.01 level*
			Within Groups	88.80	32	2.78			
			Total	471.11	33				

Table 4.14 showed that Fy.x value is 137.760, p<0.01, and it is significant at 0.01 level. It indicates that adjusted post mean problem solving ability scores of female students in both experiment and control groups differs significantly after using Experiential Learning method. Hence the null hypothesis is accepted. So it can be

concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of female students.

Figure 4.3

Unadjusted and adjusted mean scores of pre and post problem solving ability test of experimental and control groups for female students



In order to know the exact groups which differs significantly in the adjusted post mean problem solving ability scores, the data was further analyzed with the help of Post-Hoc test test and the result are given in the table below.

Table 4.15

Summary of adjusted means, SD, and t values adjusted post problem solving ability test scores of experimental and control groups for female students

Adjusted	mean	$SD_{(yx)}$	$SE_{D(yx)}$	t	*p*	*Level*
Experimental	22.18					
Control	15.55	1.67	0.57	11.60	*0.000*	*0.01*

A Post-Hoc test was applied for pair wise comparison of the adjusted means of problem solving ability of experimental and control groups for female students. Since t value is 11.60, $p<0.01$, and it is significant at 0.01 level. So it can be concluded that the Experiential Learning method is significantly more effective than traditional method in enhancing problem solving ability of class eight female students.

Tenability of hypotheses

1) The first null hypothesis, there exist no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups is rejected.
2) The second null hypothesis, there exist no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups is rejected.
3) The third null hypothesis, there exist no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups is rejected.

4) The fourth null hypothesis, there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups is accepted.
5) The fifth null hypothesis, there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups is accepted.
6) The sixth null hypothesis, there is significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups is accepted.
7) The seventh null hypothesis, there is significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students is accepted.
8) The eighth null hypothesis, there is significant difference in the mean adjusted post scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups is accepted.
9) The ninth null hypothesis, there is significant difference in the mean adjusted post scores of Problem Solving Ability in Mathematics of class eight male students in the experimental and control groups is accepted.
10) The tenth null hypothesis, there is significant difference in the mean adjusted post scores of Problem Solving Ability in Mathematics of class eight female students in the experimental and control groups is accepted.

CHAPTER V

FINDINGS AND CONCLUSIONS

- Study of retrospect
- Major findings
- Educational implications of the study
- Conclusion
- Suggestions for further study

CHAPTER V

FINDINGS AND CONCLUSIONS

STUDY IN RETROSPECT

Problem solving is considered as the heart of understanding mathematics. The whole purpose of teaching the various concepts which make up mathematics as a tool is to give the learner the tools and the building blocks with which he can actually solve problems that is, resolve difficulties which he wants to resolve (Mehraj Ahmad Bhatto 2014). UNESCO (2021) suggested that there should be need for recovery of lost learning and also proposed some of the strategies. Thus the learning process needs a change to a new learning experience so that the pupils can experience what they learn. Mutmainah, Rukayah and Indriayu (2019) revealed that in Mathematics learning process, the learning which directly relates the material to the real daily experiences is required. One of the teaching materials that can be used is the experiential learning-based teaching material in Mathematics. They also suggested that experiential learning help the learners in the process of knowledge construction and also provide them with deeper understanding of a particular concept and helps them to withstand in any critical situations. Thus David Kolb's Experiential Learning Theory had greater benefit in students learning by making them experience it. Relating this idea the present study had been conducted by entitled as, Effectiveness of Experiential Learning on Problem Solving Ability in Mathematics of class eight students.

Objectives of the study

1) To construct and validate the Problem Solving Ability Test in Mathematics for class eight students.
2) To develop the lesson transcripts based on experiential learning model for the lessons Direct and Inverse proportion, Algebra and Factorization for the experimental group.
3) To study the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students.
4) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of experimental and control group students
5) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
6) To study the significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
7) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of experimental and control group students.
8) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
9) To study the significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.

Hypotheses framed

The hypotheses framed in respect to the objectives are given as follows,

1) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.
2) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
3) There will be significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
4) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.
5) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
6) There will be significant difference in the mean post test scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
7) There will be significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students.
8) There will be significant difference in the mean adjusted post scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.

METHODOLOGY IN BRIEF

Method adopted

Experimental method was used for conducting the study. Pretest posttest non-equivalent group design was used.

Population

The present study was conducted on a population of class eight students who are studying in various schools of Kanniyakumari district in Tamil Nadu following State Board Syllabus during the academic year 2022-2023.

Sample

The present study was conducted on a sample of class eight students who are studying in K. A. B. D. Matric Higher Secondary School, Painkulam in Kanniyakumari District following state board syllabus. The size of the sample was 71 students. Simple random sampling technique was adopted to select the sample.

Tools

The tool used in the study were,

i. Lesson transcripts based on experiential learning model for teaching Mathematics.
ii. Problem Solving Ability test in Mathematics was constructed and validated by the investigator and guide.
iii. Personal data sheet

Statistical Technique used

For the analysis of the data following statistical techniques were used.

i. Independent t test for large sample

An Independent t test also known as an unpaired t test is a statistical procedure that compares the averages/means of two independent or unrelated groups to determine if there is a significant difference between the two. Sharma R. A., (2007) noted the formula for calculating independent t test for large sample as;

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

Where

t = t test for the difference of two means

M_1= Mean of First sample.

M_2= Mean of Second sample.

σ_1= Standard Deviation of First sample.

σ_2= Standard Deviation of Second sample.

ii. Paired t test for small sample

A paired t test is also known as a dependent or correlated t test. It is a statistical test that compares the averages/means and standard deviations of two related groups to determine if there is a significant difference between the two groups. Sharma R. A., (2007) noted the formula for calculating paired t test for small sample as;

$$t = \frac{M_1 - M_2}{S_{ED}}$$

Where

$$S_{ED} = \sqrt{\frac{\sigma_1^2}{N} + \frac{\sigma_2^2}{N} - 2r\frac{\sigma_1\sigma_2}{N}}$$

r = Correlation coefficient between paired observation

σ_1= Standard Deviation of First observation.

σ_2= Standard Deviation of Second observation.

N = Size of the Sample.

iii. ANCOVA (Analysis of Covariance)

ANCOVA helps to found that the experimental group was better able to predict strong content from headlines after training than the control group. it also permits the investigator to statistically control for differences on the pretest so that post test differences would not be due to initial differences before the training.

MAJOR FINDINGS

1. There exists no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of class eight students in the experimental and control groups.
2. There exists no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups.
3. There exists no significant difference in the mean pretest scores of Problem Solving Ability in Mathematics of female students in the experimental and control groups.
4. There exists significant difference in the mean post test scores of Problem Solving Ability in Mathematics of class eight students in the experimental and

control groups. So it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of class eight students.

5. There exists significant difference in the mean post test scores of Problem Solving Ability in Mathematics of male students in the experimental and control groups. So it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of male students.
6. There exists significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of female students. So it is concluded that Experiential Learning method is significantly effective than the traditional method in enhancing problem solving ability in Mathematics of female students.
7. There exists significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of class eight students. So it is concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of class eight students.
8. There exists significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of male students. So it is concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of male students.
9. There exists significant difference in the effectiveness of experiential learning on Problem Solving Ability in Mathematics of female students. So it is

concluded that Experiential Learning method is significantly more effective than the traditional method in enhancing problem solving ability in Mathematics of female students.

10. There exist significant difference in the mean adjusted post test scores of problem solving ability of students in the experimental and control groups. So it can be concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of class eight students.
11. There exist significant difference in the mean adjusted post test scores of problem solving ability of male students in the experimental and control groups. So it can be concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of male students.
12. There exist significant difference in the mean adjusted post test scores of problem solving ability of female students in the experimental and control groups. So it can be concluded that Experiential Learning method is significantly effective than traditional method in enhancing problem solving ability in Mathematics of female students.

EDUCATIONAL IMPLICATIONS OF THE STUDY

The application of Experiential Learning Model was far superior to traditional method in developing problem solving ability in Mathematics among the students was proved. The following educational implications are suggested based on the findings of the study.

1. The Experiential Learning Model is more effective than the traditional Method in developing problem solving ability in Mathematics. Therefore, Experiential Learning approach could be introduced in all schools to teach Mathematics and all other subjects.
2. Training the students in Experiential Learning would help them to enhance cognitive, affective and psychomotor domain competencies.
3. Intensive training could be given to school teachers to develop lesson transcripts and to use experiential learning approach.
4. Teacher Training Institutions can incorporate the techniques of experiential learning in their training procedure and curriculum and thereby, they would be able apply it on the future for the betterment of the students.
5. Experiential Learning approach could make learning a satisfying and enjoyable experience to the student for those teachers could give opportunity for the students to choose the learning styles.
6. Experiential Learning approach was found to be effective in developing Problem solving ability and also enhancing Achievement in Mathematics among male and female students. Hence it could be made an integral part of all science subject curriculums in schools and teachers should be encouraged to employ this approach appropriately in both male and female secondary school students.
7. Teachers could recognize each student's preferred learning style and support it by implementing the experiential learning style.
8. To enable the students to increase their learning, the teacher should provide appropriate learning materials and activities that draw skills from each stage of the experiential learning cycle and lead the students through it in proper order.

9. Experiential learning makes learning more effective and meaningful by providing concrete experience and active experimentation.
10. Assimilation and distillation of students' "observations and reflections" into "abstract concepts" was a result of experiential learning. So that it could be implemented in both teaching and learning.
11. Experiential learning encourages student’s curiosity about learning at the stage of reflective observation, so the learners able to remember the learned concepts for life long.

CONCLUSION

The study concluded that the students of class eight who have learned Mathematics through Experiential Learning approach has better problem solving ability than the students who have learned through traditional Method. The study also revealed that the students of two groups have more or less same level of problem solving ability during pre-test while in post test the students of experimental group has comparatively high problem solving ability than control group. The pre test shows that the male students of experimental group and control group has similar problem solving ability but in post test the male students of experimental group has better problem solving ability than the control group. Similarly the pre test shows that the female students of experimental group and control group has similar problem solving ability in Mathematics but in post test the female students of experimental group has better problem solving ability than the control group. The application of experiential learning approach to the current syllabus will not be more effective, so that there should be a need for curriculum transmission and also the availability of teaching learning materials need to be ensured. Thus the study concluded that the application of Experiential Learning approach can provide a successful way to enhance Problem

Solving Ability in students which creates better opportunity for their learning in Mathematics.

SUGGESTIONS FOR FURTHER RESEARCH

The suggestion for the further research is given as follows,

i. The study on awareness of Experiential Learning among Prospective Teachers can be done for further research.
ii. The study on the effectiveness of Experiential Learning approach in developing critical thinking ability can be done for research.
iii. The study on the effectiveness of Experiential Learning approach based instructional material of developing self-confidence in learning Mathematics can be done for research.

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APPENDICES

APPENDIX - A

N.V.K.S.D COLLEGE OF EDUCATION (AUTONOMOUS), ATTOOR

PROBLEM SOLVING ABILITY TEST

Prepared by **R.N.Abina** & **Dr.R.P.Deepa**

Draft Form

2021-2023

Instructions

Problem Solving Ability Test is designed to check the problem solving ability of the students. The problems are selected under five dimensions namely Critical thinking skill, Value based problems, Creative thinking skill, Comprehensive skill and Art Integration. Read the following questions carefully and select the most suitable answer among the given alternatives in the response sheet. Please answer all the questions without fail.

Time: 90 minutes **Total marks: 50**

Section - A

- If $x \propto y$ from the following table is,

x	72	84	a	126
y	12	14	18	21

a) 96 b) 102 c) 108 d) 121

- If y is directly proportional to x, given that $y = 225$ and $x = 15$, find the value of y if $x = 11$.

a) 174 b) 192 c) 128 d) 165

- The scale of a map is given as 2 : 225. Two cites are 6 km apart on the map. Then the actual distance between them is _____.

a) 675 km b) 792 km c) 668 km d) 665 km

- Select any of the following pairs which have the same answer for the variable *x*?

  a) $(1.5x - 10) and\ (\frac{1}{2}x - 15)$ b) $\left(\frac{1}{20}x - \frac{1}{2}\right) and\ (50x - 15)$

  c) $(10x - 1.5) and\ (\frac{1}{20}x - \frac{3}{4})$ d) $\left(\frac{1}{20}x - \frac{1}{4}\right) and\ (\frac{1}{20}x - 1.5)$

- 18 pipes are required to fill a tank in 1 hour and 30 minutes. If we use 9 such types of pipes, how much time it will take to fill the tank?

  a) 160 minutes b) 120 minutes c) 180 minutes d) 220 minutes

- If one of the zero of the polynomials $6x^2 - 17x + 12$ is $\frac{4}{3}$. Which is the other number?

  a) $\frac{3}{2}$ b) 4 c) $\frac{1}{2}$ d) 8

- Let *k* be a constant and *u*, *x*, *y* and *z* be the positive real number. In which of the following equation does *u* vary directly with *x*, directly with square of *z* and inversely with *y*?

  a) $x = \frac{kuz^2}{y}$ b) $x = \frac{uzk^2}{y}$ c) $x = \frac{kzu^2}{y}$ d) $x = \frac{ku^2z^2}{y}$

- If $x + \frac{1}{x} = 12$ then the value of $x^2 + \frac{1}{x^2} =$ _____.

  a) 144 b) 142 c)168 d) 212

- If $2x + 4y = 6$ and $xy = 10$ then the value of $8x^2 + 64y^3$.

  a) 144 b) 142 c) 168 d) 212

- Check whether the statements A and B are true.

  Statement A: $4x^2 + 8x - 20 = \frac{4}{2^{-2}}(0.5x^2 + x - 2.5)$

  Statement B: $(2m - 5) + (5 - 2m) = (2m - 5)(2m + 5)$

  a) Both A and B are false b) both A and B are true

  c) A is true but B is false d) A is false but B is true

Section - B

- A shopkeeper stopped using plastic bags and asked his customers to bring their own carry bags due to his sales reduced by 10 units. If the squares of new reduced by 100 gives 45 times the original sales. Find his original units of savings?

  a) 2 units b) 4 units c) 5 units d) 6 units

- A can do a piece of work in 10 days and B can do in 5 days. How long will they help each other to do the same work?

  a) $3\frac{9}{5}$ b) $3\frac{1}{5}$ c) $3\frac{1}{3}$ d) $3\frac{1}{7}$

- The monthly earnings and monthly savings of suji are in the ratio 4:1. If suji's monthly salary is Rs. 7500. How much is her annual savings?

  a) Rs. 22,500 b) Rs. 24,500 c) Rs. 25,000 d) Rs. 28500

- A motorist drives on a road for 200 km for helping his friend to reach the airport. He follows a road map which shows a scale of 1 cm representing 25 km by showing the way to reach the destination. Determine his distance covered in the map.

  a) 5 cm b) 6 cm c) 7 cm d) 8 cm

- Geetha works hard to earn money, if she earns Rs. 2500 in 10 days. How much will she earn in 31 days.

  a) Rs. 6650 b) Rs. 6780 c) Rs. 7720 d) Rs. 7750

- Rajesh distributed chocolates in an orphanage on his birthday. He gave chocolate to each child and 25 chocolates to adults. If the total number of chocolates distributed is 145, how any children are there in the orphanages?

  a) 40 b) 50 c) 60 d) 70

- Raghu can revise his work in 5 days. How much does he revise in 1 day?

  a) $\frac{1}{25}$ b) $\frac{1}{5}$ c) 5 d) 1

- A man can do exercise daily. If the man walks 28km daily in 6 hours. Then how long will he take to walk for 24 hours?

  a) 4 hours b) 8 hours c) 2 hours d) 10 hours

- A test contains 'true' or 'false' questions. One mark is awarded for answer and $\frac{1}{4}$ mark is deduced for wrong answer. A student knew some questions and rest of them were done by cheating. He answered 140 questions and got 100 marks. He answered 90 questions correctly. Find the number of questions that he attempted by cheating?

  a) 10 question b) 25 question c) 35 questions d) 50 questions

- Eight children were eating pizza at a bakery having 4 slices of pizza each. All of sudden one friend came and they shared pizza slices equally among the three. How many slices of pizza would each get?

  a) 2.5 slices b) 3 slices c) 3.5 slices d) 3.8 slices

Section C

- A man hires a taxi to cover a certain distance. The fare is Rs, 50 for first kilometer and Rs.35 for the subsequent kilometer. If the man covered a distance of 20 km and gave Rs.850 to driver, find the correct fare.

  a) Rs. 685 b) Rs. 700 c) Rs. 715 d) Rs. 745

- If Madhan's age is three times less than his father's age. Find his age if his father's age is 22 years?

  a) 7.5 years b) 4 years c) 3.5 years d) 7 years

- A cistern has two taps attached to it. Tap B can empty the cistern in 40 minutes. But tap A can fill the cistern in just 30 minutes. Raj started both the taps unknowingly but realized mistakes after 30 minutes. He immediately closed tap B. After this, how much time will be need to fill the cistern?

  a) 10 minutes b) 12.5 minutes c) 15 minutes d)17.5minutes

- A and B are buying a mobile together. If A has the amount 8 of 10 is equal to B's amount 2 of 5. Then find the ratio of amount spend by A and B?

  a) 2:5 b) 1:5 c) 1:2 d) 2:3

- The efficiency of A, B and C is 2:3:4. A alone can complete a work in 60 days. They all work together for 7 days and C left the work. In how many days A and B together can complete the remaining work?

  a) 10 days b) 12 days c) 15 days d) 18 days

- A can do a piece of work in 18 days and B can finish it in 20 days. They work together for 3 days and then A leaves. In how many days will B finish the remaining work?

  a) 7 days b) 14 days c) 16 days d) 19 days

- Father is six times the age of his daughter. If after 4 years, he would be four times of daughter's age, then after 5 years what will be the father's age?

  a) 42 years b) 46 years c) 48 years d) 50 years

- Pipes A and B can fill a tank in 5 hours and 6 hours respectively. Pipe C can empty it in 12 hours. If all the 3 pipes are opened together, then the tank will be filled in _____.

  a) $3\frac{11}{37}$ b) $3\frac{9}{15}$ c) $3\frac{9}{17}$ d) $3\frac{9}{21}$

- If you take away a number 25 from fifty times another number then you will get 425. Find the number?

a) 25 b) 16 c) 12 d) 9

- A girl wants to do well in her classes so she is budgeting her time for each class she takes. She expects to spend $2\frac{1}{2}$ hours each week working on homework. If she has 19 hours in each week to complete work then find how many hours does she spend on the whole week to do homework?

a) $7\frac{2}{7}$ b) $7\frac{5}{3}$ b) $7\frac{3}{5}$ d) b) $7\frac{4}{7}$

Section D

- The value $\frac{(-225m^{-4}n^3p)(\quad ?\quad)}{25m^{-2}np^6} = 297m^2n^4p^2$. Find the missing term.

a)$123\ m^6n^{-3}p^7$ b) $36m^6n^2p^5$ c) $33m^6n^2p^7$ d) $53m^6n^2p^{-7}$

- Frame the question for the statement "Vijay is a hard work person. He will able to complete one by seventh part of the total project in five days".

a) How many amount of work will Vijay complete in 7 days?

b) Will Vijay able to complete the work in 5 days?

c) How many parts of work can Vijay able to complete in 5 days?

d) Will Vijay complete the work in $\frac{1}{7}$ days?

- "The sum of the squares of the negative term and positive term will always positive". From the following which one will be correct or the given statement?

a) $(-8x)^2 + (-(2x)^2 = (68x)^2$ b) $(-8x)^2 - (-(2x)^2 = (68x)^2$

c) $(-8x)^2 + (2x)^2 = 68x^2$ d) $(-8x)^2 + (-(2x)^2 = 68x^2$

- Frame a question in relation to direct proportion based on the area of land and its cost. Here areas of land are 120 cm and 250 cm and its cost as Rs. 10500 and *x*?

a) The area of land 120 cm will cost Rs.105000 and what will be the cost of the area 250cm?

b) The area of land 120 cm will cost Rs.10500 and what will be the cost of the area 250cm?

c) The area of land 250 cm will cost Rs.10500 and what will be the cost of the area 120cm?

d) The area of land 120 cm will cost Rs.10000 and what will be the cost of the area 250cm?

- y is directly proportional to x. If $y = 116$ when $x = 8$. Frame the formula to represent this relation of x and y.

  a) $y = \frac{1}{4}$ b) $y = 18x$ c) $y = 14x$ d) $y = 4x$

- In which of these tables x and y are inverse proportions?

a)

x	3.5	5.5
y	2.2	32.2

b)

x	1.11	11.11
y	3.55	35.5

c)

x	1.5	0.3
y	2	4.4

d)

x	6.67	6.68
y	20	4

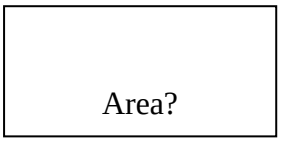
- The missing terms in the product $-3m^2n \times 9(\_\_\_) = -27m^4n^2$.

  a) m^2n^2 b) mn c) mn^2 d) $m^{-4}n^2$

- The y percent of battery power remains 39 hours after you turn on a laptop computer if $y = \frac{1}{2}x + 2.5$. Find the value of y percent?

  a) 22 b) 21.7 c) 20.76 d) 19.67

- Velan has brought a gift box is shown in the figure with its dimensions. Frame the questions based on the given figure?



$4pq^2$

$-3p^2q$

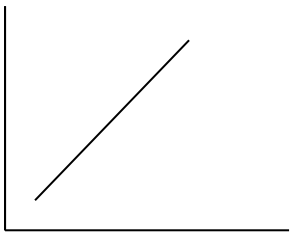
  a) Velan has brought a gift box which is square in shape where its sides are $4pq^2$ and $-3p^2q$ then find its area?
  b) Velan has brought a gift box which is rectangle in shape where its sides are $4pq^2$ and $3p^2q$ then find its outer area?
  c) Velan has brought a gift box which is s rectangle in shape where its length and breadth are $4pq^2$ and $-3p^2q$ then find its area?
  d) Velan has brought a gift box which is square in shape where its sides are $-4pq^2$ and $3p^2q$ then find its area?

- "Riya's mother prepares lunch for her with pickle. While cooking, she unknowingly added more salt". From this, frame a statement by expressing it in proportion.
  a) The amount of salt increases in the food as the taste of food also increases.
  b) The amount of salt decreases as the taste of food decreases.
  c) The amount of salt increases as the taste of the food decreases.
  d) The amount of salt does not influence on the taste of food.

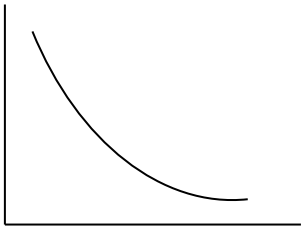
Section E

- Identify which of the following graph represents the inverse proportion?

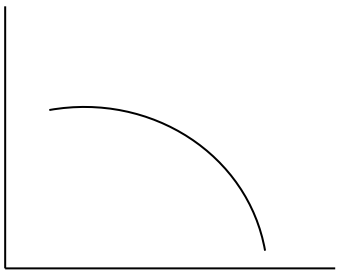
a)



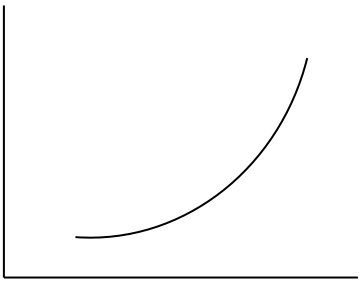
b)



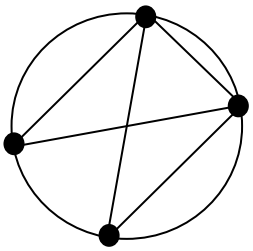
c)



d)



- Choose the correct statement from the following based on the given figure.



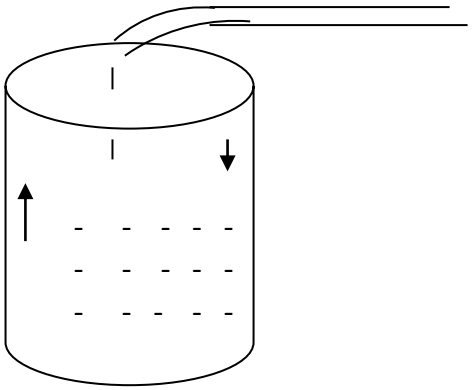
a) The number of points decreases to one the number of line increases.

b) The number of point increases as the line decreases.

c) The number of points increases as the line increases.

d) The number of point and line remains same.

43) A figure is given below. Based on the given figure choose the right statement from the following.



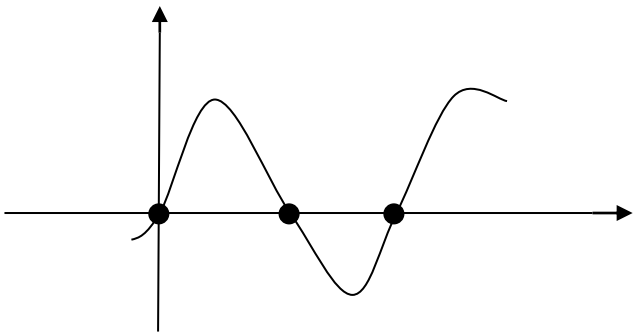
a) As the water flows inside the tank, it gets emptied

b) As the water flows inside the tank, it gets increases

c) As the water flows inside the tank, it will be as same as always.

d) As the water flows inside the tank, it level gets decreases

44) Identify which type of polynomial shown in the given graphical representation.



a) Monomial b) Binomial c) Cubic polynomial d) linear polynomial

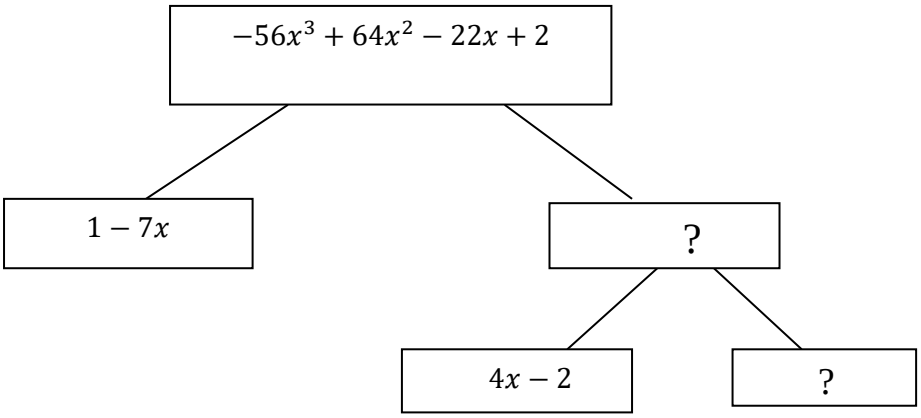
45) Consider two baskets of numbers. One containing constant terms and the other contains the monomial terms. Pick the constant and a term to form a expression whose factor is $x = 3.5$.

-1	3	5
14		8
	17	

$35x$	$7x$
$5x$	$16x$
$9x$	

a) $5x - 14$ b) $5x - 17$ c) $7x - 17$ d) $9x - 17$

46) Complete the figure by choosing the best choice.

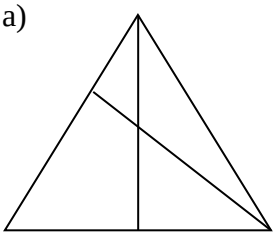


a) $34x^2 - 21x + 2$ and $2x - 5$ b) $4x^2 - 24x + 7$ and $1 - 5x$

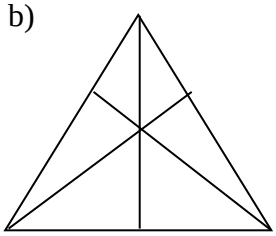
c) $6x^2 - 32x + 3$ and $4x - 5$ d) $8x^2 - 18x + 2$ and $2x - 1$

47) Considering the shape of triangle in which the number of lines divides and creates more parts in it. Find out which of the following figure represents direct proportion?

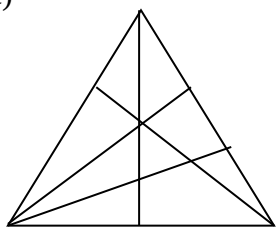
a)



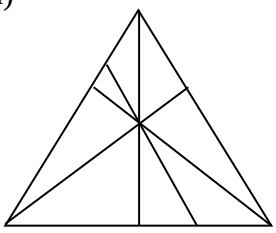
b)



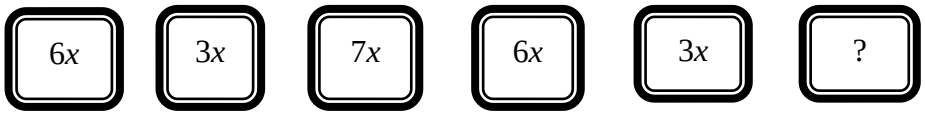
c)



d)



48) Six squares are given below. In five squares filed with a variable and sixth square is empty. Fill the sixth square by adding the 3 variables in 3 squares orderly but the answer will always the same.



a) $6x$ b) $5x$ c) $7x$ d) $9x$

49) Identify the correct choice by adding the variables in a box which lead to get 80*x*.

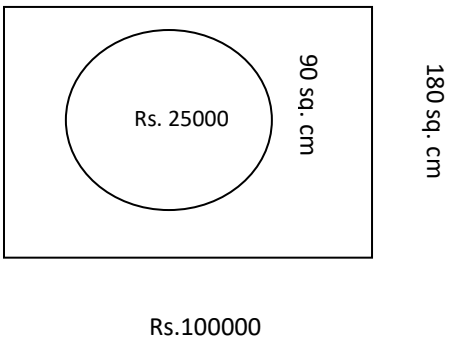
a) $\frac{22}{3}x, -52x, 25x, -\frac{3}{9}x$

b) $32x, \frac{0.5}{3}x, 72x, 1.5x$

c) $\frac{2}{3}x, 2.5x, 37x, -\frac{6}{3}x$

d) $-62x, 7.2x, \frac{22}{3}x, 2x$

50) Ram brought a circular field then again he brought the land around the circular field. The given statement is expressed in a figure. From this figure identify the type of proportion.



a) Direct b) Inverse c) Variation d) Indirect

APPENDIX – B

N.V.K.S.D COLLEGE OF EDUCATION (AUTONOMOUS), ATTOOR

PROBLEM SOLVING ABILITY TEST

2021-2023

SCORING KEY FOR DRAFT TEST

Section A **10 x 1 =10**

1) c) 108
2) d) 165
3) a) 675km
4) c) $(10x - 1.5)$and $(\frac{1}{20}x - \frac{3}{4})$
5) c) 180 minutes
6) a) $\frac{3}{2}$
7) a) $x = \frac{kuz^2}{y}$
8) b) 142
9) c) 1440
10) c) A is true but B is false

Section B **10 x 1 =10**

11) c) 5 units
12) c) $3\frac{1}{3}$
13) a) Rs.22,500
14) d) 8cm
15) d) Rs 7750
16) a) 40

17) b) $\frac{1}{5}$

18) a) 4 hours

19) d) 50 questions

20) c) 3.5 slices

Section C **10 x 1 =10**

21) c) Rs.715

22) a) 7.5 years

23) b) 12.5 minutes

24) c) 1 : 2

25) c) 15 days

26) a) 7 days

27) c) 48 years

28) c) $3\frac{9}{17}$

29) d) 9

30) c) $7\frac{3}{5}$

Section D **10 x 1 =10**

31) c) $33m^6n^2p^7$

32) c) How many parts of work completed by Vijay in 5 days?

33) d) $(-8x)^2 + (-(2x)^2 = 68x^2$

34) The area of land 120 cm will cost Rs.10500 and what will be the cost of the area 250cm?

35) c) $y = 14x$

36) c)

x	1.5	0.3
y	2	4.4

37) b) mn

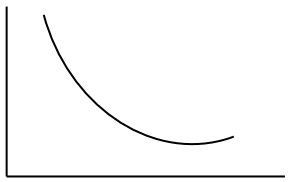
38) a) 22

39) c) Velan has brought a gift box which is rectangle in shape where it's length and breadth are then find its area?

40) c) The amount of salt increases as the taste of the food decreases.

Section E **10 x 1 =10**

41) b)



42) c) The number of points decreases as the link line increases.

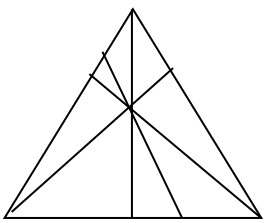
43) b) As the water flows inside the tank, it gets increases.

44) c) cubic polynomials

45) b) $5x - 17$

46) d) $8x^2 - 18x + 2$ and $2x - 1$

47) d)



48) c) $7x$

49) a)

$$\frac{22}{3}x, -52x, 25x, -\frac{0.3}{0.9}$$

50) a) Direct

APPENDIX – C

N.V.K.S.D COLLEGE OF EDUCATION (AUTONOMOUS),

ATTOOR

PROBLEM SOLVING ABILITY TEST

Prepared by **R.N.Abina** & **Dr.R.P.Deepa**

Final draft

2021-2023

Instructions:

Problem Solving Ability Test is designed to check the problem solving ability of the students. The problems are selected under five dimensions namely Critical thinking skill, Value based problems, Creative thinking skill, Comprehensive skill and Art Integration. Read the following questions carefully and select the most suitable answer among the given alternatives in the response sheet. Please answer all the questions without fail.

Time: 45 minutes **Total marks: 24**

Section - A

1) Select any of the following pairs which have the same answer for the variable *x*?

   a) $(1.5x - 10)$and $(\frac{1}{2}x - 15)$ b) $\left(\frac{1}{20}x - \frac{1}{2}\right)$ and $(50x - 15)$

   c) $(10x - 1.5)$and $(\frac{1}{20}x - \frac{3}{4})$ d) $\left(\frac{1}{20}x - \frac{1}{4}\right)$ and $(\frac{1}{20}x - 1.5)$

2) 18 pipes are required to fill a tank in 1 hour and 30 minutes. If we use 9 such types of pipes, how much time it will take to fill the tank?

   a) 160 minutes b) 120 minutes c) 180 minutes d) 220 minutes

3) Let *k* be a constant and *u, x, y* and *z* be positive real numbers. In which of the following equation does *u* vary directly with *x*, directly with square of *z* and inversely with *y*?

a) $x = \frac{kuz^2}{y}$ b) $x = \frac{uzk^2}{y}$ c) $x = \frac{kzu^2}{y}$ d) $x = \frac{ku^2z^2}{y}$

4) Check whether the statements A and B are true.

Statement A: $4x^2 + 8x - 20 = \frac{4}{2^{-2}}(0.5x^2 + x - 2.5)$

Statement B: $(2m - 5) + (5 - 2m) = (2m - 5)(2m + 5)$

a) Both A and B are false b) Both A and B are true

c) A is true but B is false d) A is false but B is true

Section - B

5) A shopkeeper stopped using plastic bags and asked his customers to bring their own carry bags due to his sales reduced by 10 units. If the squares of new reduced by 100 gives 45 times the original sales. Find his original units of savings?

a) 2 units b) 4 units c) 5 units d) 6 units

6) X can do a piece of work in 10 days and Y can do in 5 days. How long will they help each other to do the same work?

a) $3\frac{9}{5}$ b) $3\frac{1}{5}$ c) $3\frac{1}{3}$ d) $3\frac{1}{7}$

7) Geetha works hard to earn money, if she earns Rs. 2500 in 10 days. How much will she earn in 31 days?

a) Rs. 6650 b) Rs. 6780 c) Rs. 7720 d) Rs. 7750

8) A man can do exercise daily. If the man walks 28 km daily in 6 hours. Then how long will he take to walk for 24 hours?

a) 4 hours b) 8 hours c) 2 hours d) 10 hours

Section – C

9) A man hires a taxi to cover a certain distance. The fare is Rs, 50 for first kilometer and Rs.35 for the subsequent kilometer. If the man covered a distance of 20 km and gave Rs.850 to driver, find the correct fare.

a) Rs. 685 b) Rs. 700 c) Rs. 715 d) Rs. 745

10) Madhan's age is three times less than his father's age. Find his age if his father's age is 22 years?

a) 7.5 years b) 4 years c) 3.5 years c) 7 years

11) A cistern has two taps attached to it. Tap B can empty the cistern in 40 minutes. But tap A can fill the cistern in just 30 minutes. Raj started both the taps unknowingly but realized mistakes after 30 minutes. He immediately closed tap B. After this, how much time will be need to fill the cistern?

a) 10 minutes b) 12.5 minutes c) 15 minutes d) 17.5 minutes

12) A and B are buying a mobile together. If A has the amount 8 of 10 is equal to B's amount 2 of 5. Then find the ratio of amount spend by A and B?

a) 2:5 b) 1:5 c) 1:2 d) 2:3

13) The efficiency of A, B and C is 2:3:4. A alone can complete a work in 60 days. They all work together for 7 days and C left the work. In how many days A and B together can complete the remaining work?

a) 10 days b) 12 days c) 15 days d) 18 days

14) Pipes A and B can fill a tank in 5 hours and 6 hours respectively. Pipe C can empty it in 12 hours. If all 3 pipes are opened together, then how many hours will be required for the tank to be filled?

a) $3\frac{11}{37}$ b) $3\frac{9}{15}$ c) $3\frac{9}{17}$ d) $3\frac{9}{21}$

Section – D

15) The value $\frac{(-225m^{-4}n^3p)(\quad ?\quad)}{25m^{-2}np^6} = 297m^2n^4p^2$. Find the missing term.

a) $123\ m^6n^{-3}p^7$ b) $36m^6n^2p^5$ c) $33m^6n^2p^7$ d) $53m^6n^2p^{-7}$

16) Frame the question for the statement “Vijay is a hard work person. He will able to complete one by seventh part of the total project in five days”.

a) How many amount of work will Vijay complete in 7 days?

b) Will Vijay able to complete the work in 5 days?

c) How many parts of work can Vijay able to complete in 5 days?

d) Will Vijay complete the work in $\frac{1}{7}$ days?

17) y is directly proportional to x. If $y = 116$ when $x = 8$. Frame the formula to represent this relation of x and y.

a) $y = \frac{1}{4}$ b) $y = 18x$ c) $y = 14x$ d) $y = 4x$

18) In which of these tables x and y are inverse proportions?

a)

x	3.5	5.5
y	2.2	32.2

b)

x	1.11	11.11
y	3.55	35.5

c)

x	1.5	0.3
y	2	4.4

d)

x	6.67	6.68
y	20	4

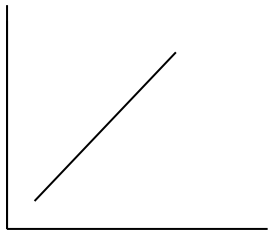
19) The y percent of battery power remains 39 hours after you turn on a laptop computer if $y = \frac{1}{2}x + 2.5$. Find the value of y percent?

a) 22 b) 21.7 c) 20.76 d) 19.6

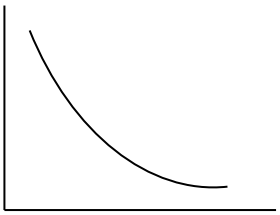
Section – E

20) Identify which of the following graph represents the inverse proportion?

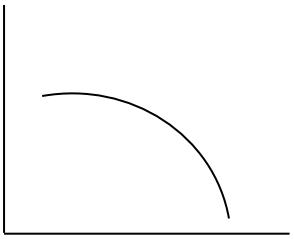
a)



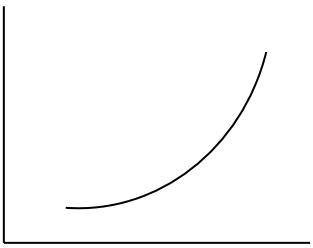
b)



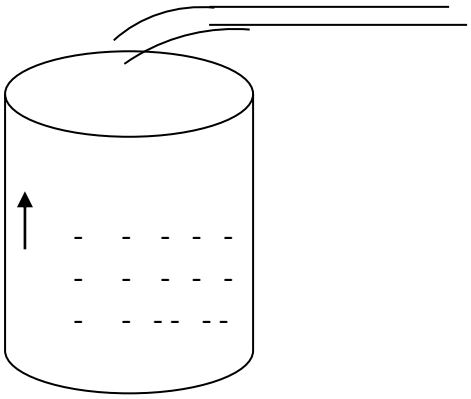
c)



d)



21) A figure is given below. Based on the given figure choose the right statement.



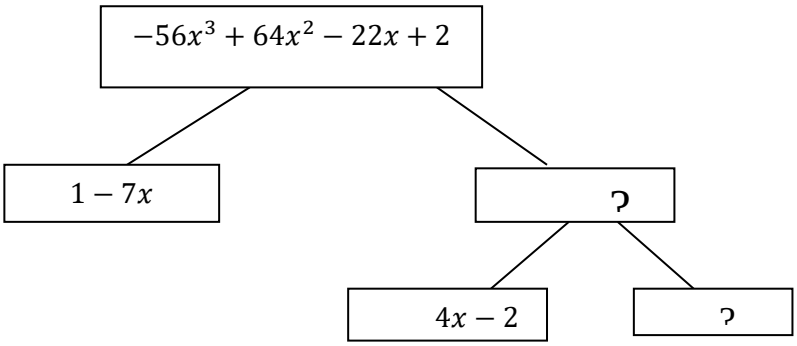
a) As the water flows inside the tank, it gets emptied

b) As the water flows inside the tank, it gets increases

c) As the water flows inside the tank, it will be as same as always.

d) As the water flows inside the tank, it level gets decreases

22) Complete the figure by choosing the best choice.

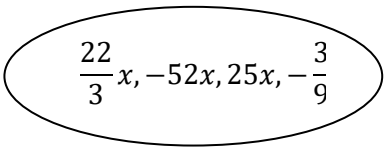


a) $34x^2 - 21x + 2$ and $2x - 5$ b) $4x^2 - 24x + 7$ and $1 - 5x$

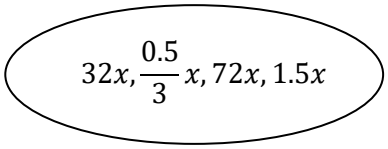
c) $6x^2 - 32x + 3$ and $4x - 5$ d) $8x^2 - 18x + 2$ and $2x - 1$

23) Identify the correct choice by adding the variables in a box which lead to get 80*x*.

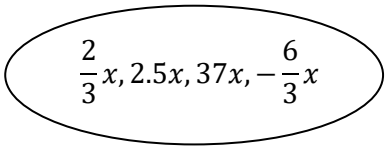
a)



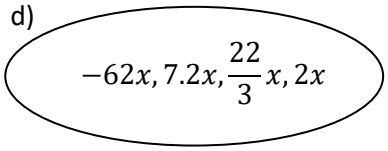
b)



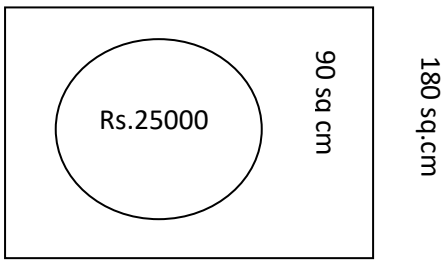
c)



d)



24) Ram brought a circular field then again he brought the land around the circular field. The given statement is expressed in a figure. From this figure identify the type of proportion.



a) direct b) inverse c) variation d) fill up

APPENDIX – D

N.V.K.S.D COLLEGE OF EDUCATION (AUTONOMOUS), ATTOOR

PROBLEM SOLVING ABILITY TEST

2021-2023

SCORING KEY FOR DRAFT TEST

Section A **10 x 1 =10**

1) c) $(10x - 1.5)$and $(\frac{1}{20}x - \frac{3}{4})$

2) c) 180 minutes

3) a) $x = \frac{kuz^2}{y}$

4) c) A is true but B is false

Section B **10 x 1 =10**

5) c) 5 units

6) c) $3\frac{1}{3}$

7) d) Rs 7750

8) a) 4 hours

Section C **10 x 1 =10**

9) c) Rs.715

10) a) 7.5 years

11) b) 12.5 minutes

12) c) 1 : 2

13) c) 15 days

14) c) $3\frac{9}{17}$

Section D **10 x 1 =10**

15) c) $33m^6n^2p^7$

16) c) How many parts of work completed by Vijay in 5 days?

17) c) $y = 14x$

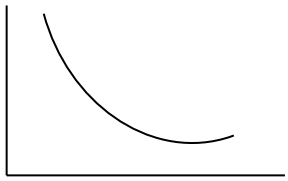
18) c)

x	1.5	0.3
y	2	4.4

19) a) 22

Section E **10 x 1 =10**

20) b)



21) b) As the water flows inside the tank, it gets increases.

22) d) $8x^2 - 18x + 2$ and $2x - 1$

23) a)

$\frac{22}{3}x, -52x, 25x, -\frac{0.3}{0.9}$

24) a) Direct

APPENDIX – E

N.V.K.S.D COLLEGE OF EDUCATION (AUTONOMOUS), ATTOOR

GENERAL DATA SHEET

2021 – 2023

Dear students

Your participation is indispensable for my dissertation entitled 'Effectiveness of Experiential Learning on Problem solving ability in Mathematics of class eight students'. Some of your personal details are needed for my research. Your details will be kept confidential and used for research purpose only.

Thank you.

Yours faithfully,
R.N.Abina
M.Ed student

PERSONAL INFORMATION

Name of the student :

Age :

Sex : Male / Female

Locale : Rural / Urban

Type of School : Coeducation / Boys / Girls

Type of Management : Government / Aided / Unaided

Syllabus : State Board / CBSE / ICSE

APPENDIX - E

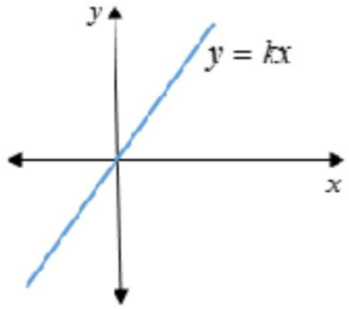
Lesson Plan 1

Topic: Direct Proportion

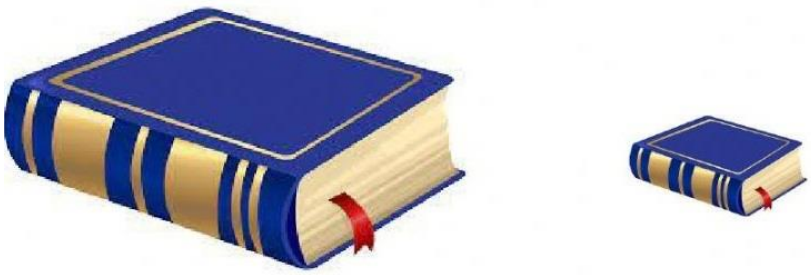
Learning Outcomes	Students, ➢ Describes the primary characteristics of direct proportion. ➢ Illustrates some examples of direct proportion. ➢ Discovers some situations in other contexts which are direct proportion. ➢ Applies the problem in new situation. ➢ Improves the skill of calculation.

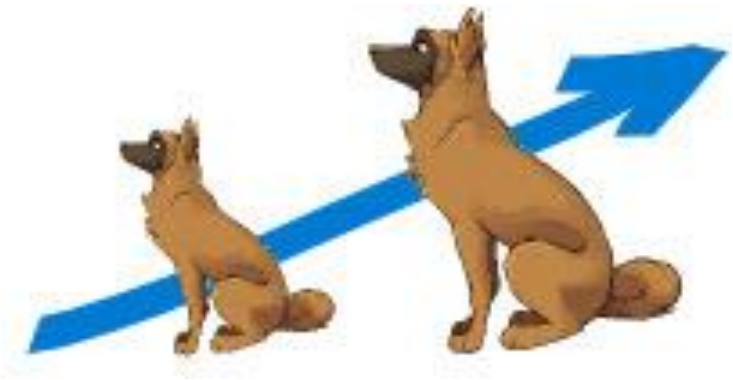
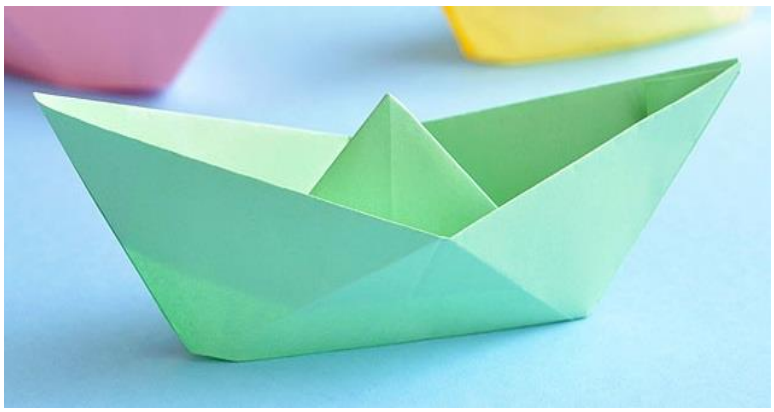
A) Setting the stage for learning / start the lesson:

i) Check the prior knowledge (Understands)	Teacher let the students to start an activity in relation to numbers and makes the students to write the numbers as much as they could within 2 minutes. Then the teacher asked the questions as, ➢ Check how many numbers have you written in the given time? ➢ Is there any difference in the numbers that the students have written? ➢ What is the difference found between the students regarding the numbers that they have written?
ii) Pre-activity Phase (Applies)	Teacher shows a chart which having the graphical representation of direct proportion.

	 Teacher asked the students as, ➢ What does the given graph represent? ➢ Check whether the x and y value increases or decreases. ➢ From this describe the definition of direct proportion? Teacher asked the students to discuss about the different examples which represent direct proportion in real life.
iii) Resources required	Chart, books, flash card, papers

B) Implementation of lesson plan:

i) Sparking curiosity [the lesson will be introduced to create interest] (Analyzes)	Teacher show two books with different in size (small and big).  Then teacher asks the following questions,

	➢ What is the difference between these two books? ➢ Is the space occupy by small book is as same as the big one? ➢ From this if the size of the book increases then what about the space occupy it? Teacher shows a flashcard contain a picture which represents the example of direct proportion and teacher asks students to explain it. 
ii) Providing the experiences (provide any one experiential learning tasks)	Teacher provides an activity, to prepare the paper boats (issued 5 papers each) within 7 minutes.  Teacher asks the questions as, ➢ Is all the students have completed the activity? ➢ How many students have prepared the total of 5 boats? ➢ What is the difference that occurs between the students in preparation of the paper boats?

iii) Drawing inferences (students are asked to record and document the observation) (Evaluates)	Students have noted down their findings regarding how much paper boats can be able to prepare in 5 minutes and also for 4 minutes duration.

C) Conclusive phase [subject enhancement, Real life connect and subject connect]

i)Conceptualization [Teacher assimilates the key aspects of learning from the inferences drawn by the students]	Teacher asks the students the following questions, ➢ From the inferences, is it possible that all the students can get the same results? ➢ Why did all the students couldn't able to get the same results?
ii) Connecting with real life	Teacher asked some questions related to direct proportion, ➢ If the car travels in 50km/hr then what will be the distance covered by the car? ➢ If y is directly proportional to x, then find the value of y if $x = 3$.
iii)Extended learning	Teacher asked the students to check the shadow and the height of objects during day time as much as they could at different time.

Assessment

Conduct an activity as throwing the ball continuously. Check each time the distance it covered. Repeat the process for 6 times and record the results. Find whether the distances increases/decreases as the speed of the ball increases/decreases.

Lesson Plan 2

Topic: Inverse Proportion

Learning Outcomes	Students, ➢ Compares the concept of inverse proportion with direct proportions. ➢ Determines the values of inverse proportions from the given table. ➢ List out the examples of inverse proportion. ➢ Interprets the missing values in the given table of inverse proportion. ➢ Develops the skill of critical thinking. ➢ Solve the word problems of inverse proportion.

A) Setting the stage for learning / start the lesson:

i) Check the prior knowledge (Understands)	Teacher let the students to start an activity by split a chocolate for 2 students and then she again ask them to split a chocolate for 5 students. The teacher asked the questions as, ➢ Is the quantity of splitting the chocolate under these two situation remains same? ➢ Is the students receives the same amount of chocolate in these situation? ➢ What is the difference found between these two situations?

ii) Pre-activity Phase (Applies)	Teacher shows a flashcard contains picture which represents an example of inverse proportion.  Teacher asked the students as, ➢ What is the difference between the images in the given picture? ➢ Frame a table based on the details given in the picture? ➢ From this describe the definition of inverse proportion? Teacher asked the students to discuss about the different situations which represent inverse proportion in real life.
iii)Resources required	Flash card, ICT, black board.

B) Implementation of lesson plan:

i) Sparking curiosity [the lesson will be introduced to create interest] (Analyzes)	Teacher shows a video which consist of different situational examples of inverse proportion. ➢ https://www.youtube.com/watch?v=xEFyfL9YdHA&t=481s Then teacher asks the following questions, ➢ What is the result you got while observing these three situations? ➢ Check whether x increases as y decreases or x decreases as y increases? Teacher shows a chart which contains a picture of see–saw which represents the figure in relation to inverse proportion and asks the students to explain it. 

ii) Providing the experiences (provide any one experiential learning tasks)	Teacher provides an activity, as to make 6 groups with 5 members in each group. Then ask each one from a group to stand to last. Then view the black board to identify what is written (vary in size) in it. Again next batch students to stand to the middle and next batch to stand to the front. Later, the teacher asks the questions as, ➢ How many students have able to see the words if it is small when you stand last to the class? ➢ How many of the students who stand to the middle and later the first can able to see the black board? ➢ What is the difference that occurs between the students based on each group with regard to the visualization of words written in the black board?
iii) Drawing inferences (students are asked to record and document the observation) (Evaluates)	Students have noted down their findings regarding how many words can be able to view by different group based on different distance.

C) Conclusive phase [subject enhancement, Real life connect and subject connect]

i) Conceptualization [Teacher assimilates the key aspects of learning from the inferences drawn by the students	Teacher asks the students the following questions, ➢ Is everyone gets the same result? ➢ Why did the variation occur in the result of each student?
ii) Connecting with real life	Teacher asked some questions related to inverse proportion, ➢ A man brought a house for some amount before 5 years. Now he decides to sell the house. What will be the amount he receives? ➢ 3 people do the work for 2 hours, then the 5 persons takes 1 hour and 15 minutes to complete the same work. Then observe what is the variation occurs here?
iii) Extended learning	Teacher gave an activity to the students to demonstrate the relationship between volumes and pressure by considering a container and placing it with multiple holes (Identify the relation between the volume of water and the pressure in the container).

Assessment

Conduct an activity as an arrangement of 12 marbles in the form of rows and columns. By changing the arrangement of columns and rows find out if the column increases/decreases then what about its rows?

Lesson Plan 3

Topic: Time and Work

Learning Outcomes	Students, ➢ Outlines the general rules to solve time and work problems. ➢ Compares the relation between time and work. ➢ Combines the concept of time and work in relation to variation. ➢ Constructs the real life examples of time and work. ➢ Applies the rules to solve real life problems. ➢ Recognizes the values of time and work from the given problem.

A) Setting the stage for learning / start the lesson:

i) Check the prior knowledge (Understands)	Teacher let the students to start an activity as to arrange the cards of different colors in an order of rainbow (VIBGYOR) within 2 minutes duration. The teacher asked the questions as, ➢ What is the order of rainbow? ➢ What is the work done by the students in the given time? ➢ What is variation/proportion involved in this task?

ii) Pre-activity Phase (Applies)	Teacher shows the chart to describe the general rules to solve the work and time problem. Teacher asked the students as, ➢ What is the work done by the person in the given picture and time taken to complete the work? ➢ How do you represent the work done and its time from the given picture? ➢ Based on this describe the general rules? Teacher asked the students to discuss about the different examples in relation to work done and time.
ii) Resources required	Colour cards, ICT, Picture card.

B) Implementation of lesson plan:

i) Sparking curiosity [the lesson will be introduced to create interest] (Analyzes)	Teacher shows a video which consist of different examples which describe the work done and time taken. ➢ https://www.youtube.com/watch?v=isJ4oh_et7U Then teacher asks the following questions, ➢ What is the difference between the first two examples based on your observation from the given video? ➢ Based on these examples identify whether it in direct or inverse proportion? Teacher provides a task by asking a student to move the

ii) Providing the experiences (provide any one experiential learning tasks) **iii) Drawing inferences (students are asked to record and document the observation)** (Evaluates)	desk and ask other students to check the time. Then the same work is done by 2 students in some time. Based on this observation check out the work done and time and also find out its proportion/variation. Teacher suggested an activity in two phases. For the first phase is to read the given two pages within 5 minutes by a pair of students (one page by one student) as a group. Then as for the second phase the teacher considers 4 students as group to read the 3 pages by the required time. Later, the teacher asks the questions as, ➢ How many groups have completed the task by reading the given pages during both the phases? ➢ What was the date that you obtain during first and second phase? ➢ What is the rule applicable for this activity? Students have noted down their findings regarding the time taken during both the first and second phases.

C) Conclusive phase [subject enhancement, Real life connect and subject connect]

i) Conceptualization [Teacher assimilates the key aspects of learning from the inferences drawn by the students **ii) Connecting with real life** **iii) Extended learning**	Teacher asks the students the following questions, ➢ How do you find out the time taken for second phase based on the obtained results? ➢ What is the proportion/variation occur in this activity? Teacher asked some questions related to work and time, ➢ If a person takes 3 days to complete a job, then how much work he can complete in one day? ➢ If a person can paint a wall in 4 days, then what will be the fraction of the wall he can paint in 2 days? ➢ If James can complete a project in 6 days. How many parts will be complete in 3 days? Teacher gave an activity to the students as to assemble everyone separately in the play ground and then provide time (three different duration) to each students to touch as much as students they could within the given time.

Assessment

Conduct an activity by considering two people with the total of 40 books. Check how much books can a person can able to carry to a distance. Then check if the 2 person lift it together, how many books can be carried by them and how man distance have they covered.

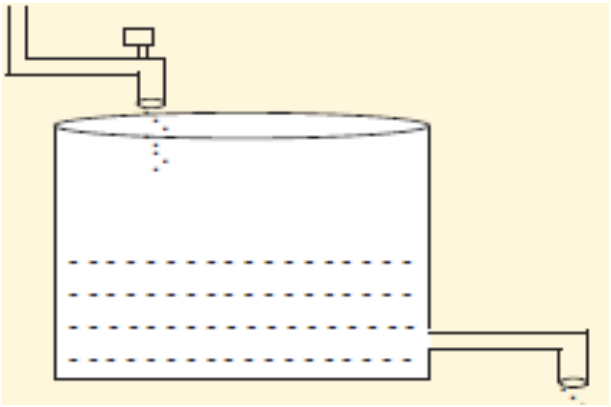
Lesson Plan 4

Topic: Pipes and cistern

Learning Outcomes	Students, ➢ Defines the concept inlet and outlet. ➢ Differentiates the primary characteristics of inlet and outlet. ➢ Constructs the examples of real life situations regarding inlet and outlet. ➢ Applies the concept of inlet and outlet to solve problems. ➢ Measures the time taken for both the inlet and outlet of the given problem.

A) Setting the stage for learning / start the lesson:

i) Check the prior knowledge (Understands)	Teacher let two students to start an activity as to fill a bottle (hole on the bottom) with water. Then the teacher enquired that, ➢ Is the bottle filled with water? ➢ What is happening when the water flows into the bottle? ➢ What is the two process identified from this task?

ii) Pre-activity Phase (Applies)	Teacher shows a picture card which consist of the image of pipes and cistern.  Teacher asked the students as, ➢ What does the term cistern represent in this given image? ➢ Check whether water increases or decreases according to the given picture. ➢ From this describe, what is mean by outlet and inlet? Teacher asked the students to discuss about the different possible events which represent pipes and cistern in real life.
iii) Resources required	Picture card, bottles, water.

B) Implementation of lesson plan:

i) Sparking curiosity [the lesson will be introduced to create interest] (Analyzes)	Teacher shows a picture as given below,  Then teacher asks the following questions, ➢ What is shown in this picture? ➢ Based on this picture, if a pipe A and B have taken some time to fill the container together then what about the time taken to empty the container by pipe C and D ? ➢ Identify whether the flow of water from the container to outside will always be positive/negative? Teacher shows two picture which represents the pipes and cistern and asks students to explain it. 

	 Teacher provides an activity as a pair of students. Two bottles should to fill with water by each student.
ii) Providing the experiences (provide any one experiential learning tasks)	Teacher asks the questions as, ➢ Is each group have completed the task of filling the water in to the bottle? ➢ How many groups of students had completed this task successfully? ➢ Is any difference occurring between the students of same group in terms of time?
iii) Drawing inferences (students are asked to record and document the observation) (Evaluates)	Students have noted down their findings regarding how much time they used for filling the water in to the bottle based on each group.

C) Conclusive phase [subject enhancement, Real life connect and subject connect]

i) Conceptualization [Teacher assimilates the key aspects of learning from the inferences drawn by the students	Teacher asks the students the following questions, ➢ From the inferences, what makes the process to have differences? ➢ What type of variation/proportion occurs based on your result? ➢ How could you describe the result based on your observation?
ii) Connecting with real life	Teacher asked some questions related to direct proportion, ➢ Pipes A and B can fill a tank in 2 hours and 4 hours respectively. Pipe C can empty it in 8 hours. If all the 12 pipes are opened together, then how long will the tank will be filled.
iii) Extended learning	Teacher asked the students to check the difference of time occurs in the flow of water from the bottle with multiple holes (open each hole simultaneously) and note its result.

Assessment

Conduct an activity as filling a tank by using the pipes (at least 3). Note the time taken to fill the tank by the pipes (adding each pipes simultaneously). Also check how much time requires emptying the tank after filling it.

Lesson Plan 5

Topic: Factorisation (introduction)

Learning Outcomes	Students, ➢ Defines about factors of an algebraic expression. ➢ Constructs the algebraic expressions based on different degrees. ➢ Compares the characteristics of reducible and irreducible factors. ➢ Differentiates the differences between reducible and irreducible factors. ➢ Develops the skill of finding the factors of an algebraic equation. ➢ Plans the solutions of given problems creatively.

A) Setting the stage for learning / start the lesson:

i) Check the prior knowledge (Understands)	Teacher let the students to start an activity by a set of cards with some variables along with coefficient and also some numbers. Then the teacher enquired the students that, ➢ What is the variable among the given cards? ➢ Identify the coefficient of the given variable? ➢ What is meant by a constant term?
ii) Pre-activity Phase (Applies)	Teacher gives three cards. Each card contains some terms given to each group (contains at least 3).

	Teacher asked the students as, ➢ Is it possible to frame the given terms into algebraic expressions? ➢ Identify whether the given terms can be reducible or not. ➢ From this, what is meant by reducible factors? Teacher asked the students to frame some terms which are reducible factors.
iii) Resources required	➢ Cards of variables with coefficient and constants. ➢ Cards with some factors (reducible/irreducible).

B) Implementation of lesson plan:

i) Sparking curiosity [the lesson will be introduced to create interest] (Analyzes)	Teacher asks three students to come forward and each student hold a card which contains factors $[5, (x-3)$ and $(x+3)]$ with them. Then teacher asks the following questions, ➢ What are the factors given in these three cards? ➢ Identify whether it is a reducible/irreducible factor. ➢ If it is an irreducible factor, is it possible to frame the algebraic expression? ➢ Frame an algebraic expression from the given any two cards of reducible factors?

ii) Providing the experiences (provide any one experiential learning tasks) **iii) Drawing inferences (students are asked to record and document the observation)** (Evaluates)	Teacher suggested a group activity which should contain three members. Each group is given with cards (5 cards of x, 2 cards of x^2 and 1 card of number 6). Each card consists of a factor. Then the teacher ask some questions to the students as, ➢ Identify the algebraic equation from the given cards? ➢ Is the given factors are reducible/irreducible factors. Students have arranged the cards based on its degree and noted down the factor.

C) Conclusive phase [subject enhancement, Real life connect and subject connect]

i) Conceptualization [Teacher assimilates the key aspects of learning from the inferences drawn by the students	Teacher asks the students the following questions, ➢ From the inferences, what is the factor has obtained from the given algebraic equation. ➢ Is the obtained factor can again reducible?

ii) Connecting with real life	Teacher asked some questions, ➢ If Ram's age is two times less than his father's age. Find his age if his father's age is 32 years?
iii) Extended learning	Teacher asks the students to check the expressions $17x, 4, (x^2 - 5)$ are reducible/ irreducible factors.

Assessment

Conduct an activity as arrange the cards of an expression $3x^2 + 5x + 2$ and find out the factors of the given algebraic equation.