EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS

Thesis

Submitted for the Degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

By

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2024

DECLARATION

I, Saritha A S, do hereby declare that this thesis entitled "**EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS**" is based on the original work done by me under the guidance of Prof. (Dr.) Vijayakumari. K, Professor (Retd.), Farook Training College and has not been included in any other thesis submitted previously for the award of any degree. The contents of the thesis are undergone plagiarism check using iThenticate software at C.H.M.K Library, University of Calicut, and the similarity index found within the permissible limit. I also declare that the thesis is free from AI generated contents.

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This is to certify that the thesis entitled **EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS** is an authentic record of research work carried out by **SARITHA A S,** for the degree of Doctor of Philosophy in Education, Farook Training College, Research Centre in Education, University of Calicut, under my supervision and guidance and that no part thereof has been presented before for any other Degree, Diploma, Associateship or other similar title of recognition in any other University.

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Place : Farook College ***Saritha A S***

Date :

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EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS

ABSTRACT

Art and Mathematics have been connected throughout the human history, and that such a connection represents an important area in the development of education system today. Integrating art into Mathematics instruction not only enriches the learning experience but also nurtures the holistic development of learners, fostering their cognitive, affective, and conative growth. Present study is an attempt to find out whether Art Integrated Information Processing Model (AIIPM), Information Processing Model (IPM) or Present method of teaching Mathematics is the most effective in bringing out Mathematical outcomes, viz., Problem Solving Ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and reduced Mathematics Anxiety among secondary school students. The experimental design used for the study is quasi-experimental pre-test-post-test comparison group design with three unequal groups. The study was conducted at two levels, for eighth and ninth standard students. For each standard (VIII & IX), among the three intact groups, two groups were selected randomly and were taught through Art Integrated Information Processing Model and Information Processing Model (IPM) and the third group was taught through the Present method of teaching followed in the school (Group 3), providing the usual classroom experiences. Statistical techniques, such as t test, ANOVA, MANOVA and MANCOVA have revealed significant findings. The study found that AIIPM and IPM significantly improve problem-solving ability, attitude towards Mathematics, and reduces Mathematics anxiety, showing a very large effect overall for eighth and ninth standard students. The effect of AIIPM on exploratory Mathematics belief is very large for ninth standard students, whereas it is large for eighth standard students. However, the influence of IPM on exploratory Mathematics belief is large for eighth standard students but moderate for ninth standard students. Present teaching method shows a very large effect on attitude and large effect in exploratory belief, and anxiety reduction for both grades. However, its effect on problem-solving ability varies, being very large for ninth standard students but moderate for eighth standard students. The three methods have equal and large effect on achievement in Mathematics for both grades. The findings show that AIIPM is effective in enhancing select Mathematical outcomes among secondary school students. Integrating art to systematic processing of information help students to engage with Mathematics in a multi-sensory way. The study provides valuable insights for educational interventions, emphasizing the importance of the effectiveness of combining different models and methods, suggesting that an integrated approach could offer benefits to Mathematics education, creating inclusive and enjoyable learning environment.

Key words: Art integration, Information processing, Mathematical outcomes, Problem solving ability, Mathematics belief, Attitude towards Mathematics, Mathematics anxiety, Academic Achievement.

സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികളിൽ ഗണിത പഠനനേട്ടങ്ങൾ കൈവരിക്കുന്നതിന് കലാസംയോജിത ഇൻഫർമേഷൻ പ്രോസസിംഗ് മോഡലിന്റെ ഫലപ്രാപ്തി

സംഗ്രഹം

കലയും ഗണിതവും മാനവ ചരിത്രത്തിൽ ഉടനീളം ചേർന്നു പോയിട്ടുള്ളതാണ്. കൂടാതെ ഈ ബന്ധം ഇന്നത്തെ വിദ്യാഭ്യാസ വ്യവസ്ഥയുടെ വികസനത്തിൽ ഒരു പ്രധാന മേഖലയാണ് പ്രതിനിധാനം ചെയ്യുന്നത്. കലയെ ഗണിതശാസ്ത്ര ബോധനവുമായി സമന്വയിപ്പിക്കുന്നത് പഠനാനുഭവത്തെ സമ്പന്നമാക്കുക മാത്രമല്ല, പഠിതാക്കളുടെ സമഗ്രവികസനത്തെ– വൈജ്ഞാനികവും, വൈകാരികവും, നൈപുണീപരവുമായ വളർച്ചയെ പരിപോഷിപ്പിക്കുകയും ചെയ്യുന്നു.

പ്രധാന ചില ഗണിത പഠന നേട്ടങ്ങളായ, പ്രശ്ന നിർദ്ധാരണ ശേഷി, ഗണിതശാസ്ത്രത്തെ കുറിച്ചുള്ള വിശ്വാസം, മനോഭാവം, അക്കാദമിക നേട്ടം, കുറഞ്ഞ ഉത്കണ്ഠ എന്നിവ നേടുന്നതിന് കലാ സംയോജിത ഇൻഫർമേഷൻ പ്രോസസിംഗ് മോഡൽ (AIIPM), ഇൻഫർമേഷൻ പ്രോസസിംഗ് മോഡൽ (IPM), നിലവിലെ ഗണിത അധ്യാപന രീതി, എന്നിവയുടെ ഫലപ്രാപ്തി പരിശോധിക്കുക എന്നതാണ് ഈ പഠനത്തിന്റെ ലക്ഷ്യം. മൂന്ന് അസമമായ ഗ്രൂപ്പുകളുള്ള ക്വാസി എക്സ്പെരിമെന്റൽ പ്രീ-ടെസ്റ്റ്-പോസ്റ്റ്-ടെസ്റ്റ് താരതമ്യ ഗ്രൂപ്പ് ഡിസൈനാണ് പഠനത്തിനായി ഉപയോഗിച്ചിരിക്കുന്ന പരീക്ഷണാത്മക രൂപകൽപ്പന. എട്ട്, ഒൻപത് ക്ലാസ് വിദ്യാർത്ഥികൾക്കായി രണ്ട് തലങ്ങളിലാണ് പഠനം നടത്തിയത്. ഓരോ സ്റ്റാൻഡേർഡിലും (VIII, IX) മൂന്ന് ഗ്രൂപ്പുകളെ ക്രമരഹിതമായി തിരഞ്ഞെടുത്ത് ആർട്ട് ഇന്റഗ്രേറ്റഡ് ഇൻഫർമേഷൻ പ്രോസസ്സിംഗ് മോഡൽ, ഇൻഫർമേഷൻ പ്രോസസ്സിംഗ് മോഡൽ, സ്കൂളിൽ പിന്തുടരുന്ന നിലവിലെ അധ്യാപന രീതി എന്നിവയിലൂടെ പഠിപ്പിച്ചു. ടി-ടെസ്റ്റ്, അനോവ, മനോവ, മൻകോവ തുടങ്ങിയ സ്റ്റാറ്റിസ്റ്റിക്കൽ ടെക്നിക്കുകളിലൂടെ പ്രധാന കണ്ടെത്തലുകളിലേക്ക് എത്തിച്ചേർന്നു. എട്ട്, ഒമ്പത് ക്ലാസുകളിലെ വിദ്യാർത്ഥികളിൽ പ്രശ്ന നിർദ്ധാരണ ശേഷി, ഗണിതത്തോടുള്ള മനോഭാവം, കുറഞ്ഞ ഉത്കണ്ഠ എന്നീ ഗണിത പഠന നേട്ടങ്ങളിൽ AIIPM, IPM അതിയായ ഫലം കാണിക്കുന്നതായി പഠനം കണ്ടെത്തി. AIIPM ഗണിത വിശ്വാസത്തിൽ ഒമ്പതാം ക്ലാസ് വിദ്യാർത്ഥികളിൽ അതിയായ ഫലവും, അതേസമയം എട്ടാം ക്ലാസ് വിദ്യാർത്ഥികളിൽ മെച്ചപ്പെട്ട ഫലവും കാണിക്കുന്നു . എന്നിരുന്നാലും, IPM ഗണിത വിശ്വാസത്തിൽ അതിന്റെ സ്വാധീനം എട്ടാം ക്ലാസ് വിദ്യാർത്ഥികളിൽ മെച്ചപ്പെട്ടതും, എന്നാൽ ഒമ്പതാം ക്ലാസ് വിദ്യാർത്ഥികളിൽ മിതമായതുമാണ്. നിലവിലെ അധ്യാപന രീതിയ്ക്ക് എട്ട്, ഒൻപത് ക്ലാസ്സിലെ വിദ്യാർത്ഥികളിൽ ഗണിത മനോഭാവത്തിൽ അതിയായ ഫലവും ഗണിത വിശ്വാസത്തിലും ഉത്കണ്ഠ കുറയ്ക്കുന്നതിനും മെച്ചപ്പെട്ട സ്വാധീനവും ഉണ്ട്. എന്നിരുന്നാലും, പ്രശ്ന നിർദ്ധാരണ ശേഷിയിൽ അതിന്റെ സ്വാധീനം വ്യത്യാസപ്പെടുന്നു, ഒമ്പതാം ക്ലാസ് വിദ്യാർത്ഥികൾക്ക് അതിയായതും, എന്നാൽ എട്ടാം ക്ലാസ് വിദ്യാർത്ഥികൾക്ക് മിതമായതുമാണ്. രണ്ട് ഗ്രേഡുകൾക്കും ഗണിതത്തിലെ അക്കാദമിക നേട്ടങ്ങളിൽ മൂന്ന് രീതികളും തുല്യവും മെച്ചപ്പെട്ടതുമായ സ്വാധീനം ചെലുത്തുന്നു. സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾക്കിടയിൽ, തിരഞ്ഞെടുത്ത ഗണിത പഠന നേട്ടങ്ങൾ പരിപോഷിപ്പിക്കുന്നതിന് AIIPM ഫലപ്രദമാണെന്ന് കണ്ടെത്തലുകൾ കാണിക്കുന്നു.

ഇൻഫർമേഷൻ പ്രോസസിങ്ങുമായി കലയെ സമന്വയിപ്പിക്കുന്നത് വിദ്യാർത്ഥികളെ ഗണിതശാസ്ത്രവുമായി ഒരു മൾട്ടി-സെൻസറി രീതിയിൽ ഇടപഴകാൻ സഹായിക്കുന്നു. വിവിധ മാതൃകകളും രീതികളും സംയോജിപ്പിക്കുന്നതിന്റെ ഫലപ്രാപ്തിയുടെ പ്രാധാന്യം ഊന്നിപ്പറയുകയും, ഒരു സംയോജിത സമീപനത്തിന് ഗണിതശാസ്ത്ര വിദ്യാഭ്യാസത്തിൽ നേട്ടങ്ങൾ കൈവരിക്കാനും, എല്ലാവരെയും ഉൾച്ചേർത്തുള്ളതും, ആസ്വാദ്യകരമായ പഠന അന്തരീക്ഷം സൃഷ്ടിക്കാനും കഴിയുമെന്ന് നിർദ്ദേശിക്കുകയും ചെയ്യുന്ന ഈ പഠനം വിദ്യാഭ്യാസ ഇടപെടലുകൾക്ക് മൂല്യവത്തായ ഉൾക്കാഴ്ചകൾ നൽകുന്നു.

പ്രധാന വാക്കുകൾ: കലാ സംയോജിതം, ഇൻഫർമേഷൻ പ്രോസസിംഗ്, ഗണിത പഠന നേട്ടങ്ങൾ, പ്രശ്നനിർദ്ധാരണശേഷി, ഗണിതശാസ്ത്രവിശ്വാസം, ഗണിതത്തോടുള്ള മനോഭാവം, ഗണിതശാസ്ത്ര ഉത്കണ്ഠ, അക്കാദമികനേട്ടം

Chapter 1

INTRODUCTION

- Need and Significance of the Study
- Statement of the Problem
- Definition of Key Terms
- Objectives
- Hypotheses
- Methodology of the Study
- Scope and Limitations of the Study
- Organization of the Report

Education opens the path to the future with numerous opportunities and ignites the mind of individuals. It has the potential to transform both lives and communities in ways that go well beyond the walls of the traditional classrooms. The importance of education in providing individuals with the skills and knowledge required to flourish in dynamic environments is increasingly recognized as societies evolve and navigate the complexities of the modern world.

The educational goals can be attained through appropriate teaching strategies which are to be related to the instructional objectives and the learner. Every child is unique in its experiences, beliefs, interests, skills etc., so differentiation requires varied teaching and learning strategies for students. Teaching strategies encompass a diverse array of methodologies, techniques, and approaches cater to the multifaceted needs of learners. These strategies serve as the pathway through which educational objectives are translated into meaningful learning experiences. By adopting innovative pedagogical practices, educators can design interactive educational settings that inspire, motivate, and enable students to achieve their greatest potential.

Within the realm of education, Mathematics holds a unique position as both a foundational discipline and a gateway to 21st century life skills. It is more vital than ever to have a solid foundation in Mathematics in a world that is changing rapidly due to advances in technology and interconnectivity. The language of science, technology, engineering, and economics, Mathematics supports developments in everything from sustainable development to artificial intelligence. By imparting a deep appreciation for Mathematics and cultivating a growth mindset, educators empower students to tackle complex challenges and contribute meaningfully to society.

Traditional approaches, centered around rote memorization and procedural fluency, have given way to more student-centered methodologies that prioritize conceptual understanding and real-world application. This evolution reflects a growing recognition of the diverse ways in which students learn and the need for adaptable teaching strategies to meet their individual needs. One of the key challenges in Mathematics education lies in addressing the diverse learning needs of students. By integrating various teaching strategies into Mathematics classrooms, teachers can create an interactive classroom in which diverse individual needs are catered properly.

Another major issue that educators face is the high rate of failure and disengagement in Mathematics education. The need for reform and intervention is urgently highlighted by statistics showing startlingly high rates of student failure and dropout in Mathematics courses. This phenomenon is caused by several factors, such as inadequate individualised support, poor teaching methods, and a generalised culture of fear and anxiety related to the subject. The problem is made worse for many students by the experience of consistently failing and struggling in Mathematics, which can undermine their confidence and motivation to learn.

In Mathematics classroom, learners need to engage mentally, socially and physically and they are encouraged to develop Mathematical thinking, a positive mind set towards the subject, and independent learning. Mathematics teachers are expected to be responsible to raise individuals who can solve the world problems effectively and use Mathematics successfully in their daily lives. The rapid development and transformation of society have led to new explorations in the field of education, making it necessary to adopt innovative strategies, techniques, and models.

To address these challenges effectively, educators must actively work to counteract negative perceptions of Mathematics and cultivate a positive attitude for the subject among students. This requires a shift away from traditional, formulaic approaches towards more innovative and student-centered teaching strategies. By incorporating real-world applications, hands-on activities, integrating different strategies and collaborative problem-solving tasks, educators can make Mathematics more accessible, engaging, and relevant to students' lives. Moreover, creating a nurturing, inclusive learning environment where mistakes are taken as opportunities for growth can help to alleviate anxiety and promote a growth mindset among learners.

In the realm of Mathematics education, the National Education Policy (2020) advocates for a shift towards experiential and inquiry-based learning approaches that prioritize conceptual understanding over rote memorization. By aligning teaching strategies with the principles outlined in the NEP, educators can create dynamic and engaging Mathematics classrooms that empower students to become lifelong learners and problem solvers.

All developments in teaching learning process are based on the need to organize classroom teaching as effective as possible. Researchers develop and experiment with new theories of learning for developing novel pedagogical and methodological approaches. When analysing the history of education, it is clear that trends in teaching and learning have evolved from behaviorism, through cognitivism, to constructivism. Mathematics education also have to be reformed in line with these changes and need new, creative, interactive pedagogical approaches promoting meaningful learning.

Over the decades, a number of student-centered pedagogies have been developed to teach various subjects. Co-operative learning (Entonado & Garcia, 2003) Inquiry-based learning (Bruce, 2010) Problem solving method (Ali, et al., 2010) Computer assisted instruction (Gururajan, 2013) Laboratory method (Baldevbhai, 2009) Brain based program (Godse, 2016) Problem based learning (Widyatiningtyas, et al., 2015) and Integration of arts (Mohalik & Basu, 2020) are some trends found to be effective in Mathematics learning.

Mathematics learning is essential for an individual's comprehensive development in today's complex society. However, many students develop negative attitude towards the subject. In this context, it is crucial to understand and analyze how students internalize beliefs and form either positive or negative evaluations of both the subject and themselves. These beliefs play a significant role in determining their success or failure in achieving their goals. What strategies can be adopted so that pupils become more mathematized in their thoughts is always a question for those engaged in Mathematics education.

Information processing is an approach to the study of human thought and behavior in 1950's as an alternative to the behavioral approaches. Information processing approach is a cognitive approach to understand how the human mind transforms sensory information. Information processing theory views human as information processing system, with memory systems sometimes referred to as cognitive architecture (Miller, 2011). It declares that whatever mental processes act upon may best be described as information. Information processing involves the cognitive abilities needed to analyze data, including the capacity to observe, make inferences, generate predictions, and provide explanations for events. The main objective of information processing theory is to help the individuals to develop the methods of processing information from the environment.

Art integration is just mixing and matching various art forms in transacting content areas within the classroom settings. An Art- integrated approach to teaching enhances the classroom experiences by providing opportunity to students for expressing their knowledge and comprehension. The NCF-2005 emphasizes the need for Art Education, both as a subject and a pedagogical tool to enrich the teaching and learning of other subjects.

According to National Education Policy 2020 (Ministry of Education, 2020), “Art-integration is a cross-curricular pedagogical approach that utilizes various aspects and forms of art and culture as the basis for learning of concepts across subjects. As a part of the thrust on experiential learning, art integrated education will be embedded in classroom transactions not only for creating joyful classrooms, but also for imbibing the Indian ethos through integration of Indian art and culture in the teaching and learning process at every level. This art-integrated approach will strengthen the linkages between education and culture.”

Art integration is possible at various levels of classroom teaching, as drawing on students prior knowledge, to solve problems in divergent ways, to enrich their understandings, engaging students in reflection about what they learned, how they learned it, and what it means to them, using student assessment of their own and peers' work as part of the learning experience, to revise and improve their work and share it with others, building a positive classroom environment (Silverstein & Layne, 2010).

> *"Just as fabric woven with many colors allows more interpretation than a fabric woven with one color, so does teaching with multiple sign systems" (Mantoine & Smead, 2002).*

The quote reminds the importance for teachers to reflect on their own approach, symbolized by a 'fabric woven with one color' and consider how they can better engage all students by incorporating a variety of 'colors' into teaching. Since students have diverse learning preferences, integrating the arts into the classroom allows learners to explore content in multiple ways. This provides opportunities for them to listen to and create music, sketch key concepts, act out character and emotions, and more. Here students are getting engaged, exploring more and more, and are developing their full potential. The arts, in its many forms and media, offer students alternatives to traditional classroom methods (Reif & Grant, 2010).

Neurologists like Sperry (1974) suggest that Mathematical thinking is left brained whereas art forms are mainly right brained, but is challenged by the latest brain studies, which emphasizes the collaborative role of both hemispheres in such process (Schechter, 2020). Mathematics is often viewed as a cognitive, rational, and logical activity associated with the left-brain, whereas Art is seen as an affective, creative, and expressive activity linked to the right brain. Stimulating both areas together enhances the number of neural connections across the brain, effectively leading to greater overall integration of the brain. Learning Mathematics and the Art together fosters this whole-brain development (De Leo, 2003). The use of Art based instruction is effective in improving cognitive and intellectual skills (Baker, 2013; Duma & Silverstein, 2014).

Need and Significance of the Study

The purpose of Mathematics education is to develop Mathematical outcomes among learners. Mathematical outcome is a unifying idea that brings together multiple and interrelated dimensions – cognitive, affective, and conative. That is Mathematical outcomes includes beliefs, values, emotions, cognitive abilities, and skills.

The Hand book of research on Mathematics teaching and learning (1992) reflects on the need of new methodologies and new explanatory frames for the development of beliefs and affects. Mathematics teaching-learning process is seriously influenced by affective issues, and there is a tendency to assign the active participation in Mathematics learning as an indication of cognitive development. The report of National Research Council (1989) underscores the need for changing the beliefs and attitude towards Mathematics of the public.

The primary central beliefs, which are formed by the experiences of the learner, play a filtering role for new experiences and information and thus moderate Mathematics learning. New activities giving rise to positive experiences and their reflection are essential for belief change. The complex and affective nature of beliefs demands a simple, linear, logical approach to belief and therefore issues of memory, practice, emotion and thought need to be attended in the process of belief change (Tillema, 2000).

Attitude refers to an internal disposition to assess an object in either positive or negative terms, accompanied by affective, cognitive, and behavioral reactions. Attitudes are complex and can have comprehensive impact on learning. They influence performance, and performance, in turn, can affect attitudes. Attitude towards Mathematics is influenced by characteristics of teacher, teaching, classroom, assessments, and individual perceptions. Attitude is considered as a contributing variable for achievement, but researches show inconsistent results in this regard (Mubeen, et al., 2013; Mutai, 2010; Ramierz, 2005).

The experience based on the absolutist epistemology at school, family and society develops among children a feeling of frustration in Mathematics learning. Reported consequences of being anxious toward Mathematics include the avoidance and decline in Mathematics achievement. A reciprocal relationship between learning and Math anxiety is reported by many researchers (Siebers, 2015; Karimi & Venkatesan, 2009).

Students' cognitive competencies influence their confidence in learning and their future performance. Problem solving ability and Achievement are some cognitive outcomes that determine learner's selection of future studies and careers. Affective factors like Mathematics belief, attitude, confidence, and anxiety are some other critical determinants of students' future learning of Mathematics and career selection.

For the development of science and technology and the entire world itself a learning society who are ready to engage in Mathematical activities and thinking is needed for which special attempts to improve Mathematical outcomes is needed.

Advances in research, technology, and a better knowledge of how students learn are driving a transformation in the field of Mathematics education. To make Mathematics more interesting, approachable, and significant for students from a variety of backgrounds, traditional teaching strategies are being reviewed and replaced by novel approaches. In this changing scenario, integrating art into Mathematics teaching has gained attention as a powerful tool for enhancing learning experiences. Using visual, kinesthetic, and creative learning modalities, art-based techniques promote positive classroom culture, and a deeper understanding of mathematical topics.

The Information Processing Model, when combined with art integration, offers a promising framework for improving mathematical outcomes. By engaging students through multisensory and holistic learning experiences, this model addresses diverse learning styles and promotes cognitive and affective outcomes of learners. This approach aligns with contemporary educational goals that emphasize not just the mastery of mathematical concepts but the development of transferable skills needed in an increasingly complex and interconnected world.

Given the increasing emphasis on student-centered and interdisciplinary learning, exploring the effectiveness of Art-integrated Information processing in attaining Mathematical outcomes is both timely and significant. This study holds the potential to provide valuable insights for educators and policymakers, offering evidence-based strategies to enhance Mathematics teaching in secondary schools. By fostering a deeper understanding of the role of art in Mathematics learning, the study aims to contribute to a more holistic and inclusive approach to Mathematics education, ultimately preparing students for success in academic, professional, and real-world contexts.

Secondary school students experience significant growth in cognitive abilities, like problem-solving, abstract thinking and information processing which are the key outcomes of Mathematics learning. As a shift from upper primary to secondary education, students are introduced to more advanced and complex Mathematical concepts, often at an abstract level. Majority feel Mathematics learning as a herculean task and keep away from Mathematics due to many reasons one among them being the abstract nature of the subject. Integrating art into their learning process may help in making these abstract concepts more concrete, enhancing their ability to grasp and retain them effectively.

Information Processing Model emphasizes how learners perceive, interpret, and organize information. Secondary school students are at a stage where these cognitive processes are being refined, making them an ideal group to explore the impact of art integration on learning strategies and Mathematical outcomes. Furthermore, the secondary school level serves as a gateway to higher education and career decision-making. Enhancing Mathematical outcomes at this stage could encourage students to pursue Mathematics as a subject in their future academic and professional endeavors. Hence it is important to study the effectiveness of Art Integrated Information Processing Model in enhancing Mathematical outcomes among secondary school students.

Statement of the Problem

A unique teaching strategy that caters to all students' needs and learning outcomes is unlikely. To cater to student need and learning outcomes innovative teaching strategies and their combinations are to be experimented. Information processing approach model is such an approach to attain a variety of learning outcomes in science subjects whereas art integration is a new strategy recommended to improve classroom learning by making learning more interactive, enjoyable, and meaningful.

Integrating art in the Information processing approach model is an attempt to facilitate Mathematics learning and ensure achieving relevant Mathematical outcomes.

Incorporating art into Mathematics instruction not only enriches the learning experience but also nurtures the holistic development of learners, fostering their cognitive, affective, and conative growth. By embracing this integrated approach, educators can create dynamic learning environments that inspire attitude, belief, and overall outcomes in mathematical exploration. Integrating Art in the Information Processing Model is such an attempt to attain Mathematical outcomes.

Present method of teaching in the schools under Government sector in Kerala has certain unique features compared to the traditional methods of teaching. Many innovative ideas and practices are already incorporated in the practicing method. Hence a comparison of effectiveness of the three methods to bring out Mathematics learning outcomes viz., Problem solving ability in Mathematics, Mathematics belief

(Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics is relevant to intensify the advantages of Mathematics learning.

The study is entitled as "**EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS"**

Definition of Key Terms

Definition of key terms used in the statement of the problem are given below.

Effectiveness

Effectiveness is defined as "the ability to be successful and produce the intended results" (Cambridge English Dictionary, 2023).

In the present study, effectiveness means the ability of Art Integrated Information Processing Model to bring out select Mathematical outcomes, measured by calculating effect size in each case. Its effectiveness is determined by comparing the effect size if art is not integrated with Information Processing Model and if the Present method of teaching Mathematics is used. Effectiveness of Art Integrated Information Processing Model to bring out select Mathematical outcomes, is also studied by comparing the average scores of select Mathematical outcomes among the groups taught with Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.

Art Integrated Information Processing Model

"Art integration is an approach to teaching in which students construct and demonstrate understanding through an Art form" (Kennedy Center, n.d.). Students engage in a creative process which connects an Art form and another subject area and meets evolving objectives in both (Silverstein & Layne, 2010).

Information Processing Approach Model is a model developed by Sukumar and Mohan (1995) and modified by Muthukumar and Mohan (2001) based on the seven models in Information processing family. In the present study, Art Integrated Information Processing Model stands for the instructional strategy in which Art is integrated with Information Processing Approach Model.

Mathematical Outcomes

As per Good's Dictionary of Education (1973) Outcome means change in behavior resulting from learning and instructional outcomes stands for outcomes that result from the instructional program.

Stanford University defines Learning outcomes as "statements of the knowledge, skills and abilities individual students should possess and can demonstrate upon completion of a learning experience or sequence of learning experiences" (Stanford University, n.d.).

Mathematical outcomes mean the learning outcomes of Mathematics under cognitive, affective and conative domains. In this study, Mathematical Outcomes stands for major cognitive and affective outcomes of Mathematics learning. The variables included under Mathematical outcomes are, Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics.

Secondary School Students

The term Secondary school students denote students enrolled in classes 8^{th}, $9^{th,}$ and 10^{th} in a recognized school**.**

In the present study Secondary school students are students studying in standard VIII, IX and X in schools following the Kerala state syllabus.

Objectives

Objectives set for the study are

1. To find out the effectiveness of Art Integrated Information Processing Model on select Mathematical outcomes among secondary school students.
2. To find out the effectiveness of Information Processing Model on select Mathematical outcomes among secondary school students.
3. To find out the effectiveness of Present method of teaching Mathematics on select Mathematical outcomes among secondary school students.

Hypotheses

Following hypotheses were formulated for the study

1. There will be significant difference in the average pre-test and post-test scores on select Mathematical outcomes for the three comparison groups.
2. There will be significant difference in the average post-test scores on select Mathematical outcomes among the three comparison groups.
3. There will be significant difference in the average gain scores on select Mathematical outcomes among the three comparison groups.

4. There will be significant difference in the average standard scores on select Mathematical outcomes among secondary school students taught through Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.

Methodology of the Study

A research design serves as a carefully crafted framework that portray the structure of a study, ensuring it aligns with research objectives and provides a comprehensive overview of the research endeavour.

To test the effectiveness of Information Processing Model (IPM), Art Integrated Information Processing Model (AIIPM) and Present method of teaching in bringing out select Mathematical outcomes among secondary school students, quasi-experimental pre-test-post-test comparison group design was used. The experiment was conducted at two levels, one for standard VIII and the other for standard IX students of an aided school in Thrissur district of Kerala.

Variables of the Study

The present study was an attempt to find out the effectiveness of Art Integrated Information Processing Model to bring out select Mathematical outcomes among secondary school students. The study was a quasi-experimental one, the experimental variables being Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.

The dependent variable is Mathematical outcomes which include a set of cognitive and affective outcomes of Mathematics learning viz., Problem solving ability in Mathematics, Achievement in Mathematics, Mathematics belief, Attitude towards Mathematics, and Mathematics anxiety.

Participants of the study

The population under study is secondary school students of Kerala. The sampling frame includes both 8^{th} and 9^{th} standard students. The experiment was conducted separately for 8^{th} and 9^{th} standard students of HSS Arimpur, an aided co-educational school in Thrissur district of Kerala.

For the conduct of the study, three comparison groups for each level (8^{th} and 9^{th} standard) were needed. The study was conducted on 215 students, 111 from 8^{th} standard and 104 from 9^{th} standard constituting three comparison groups for 8^{th} and 9^{th} standard respectively.

Instruments

The present study examined whether Art Integrated Information Processing Model, Information Processing Model or Present method of teaching is more effective to enhance Mathematical outcomes among secondary school students. Following tools and materials were used for collecting data.

a) Mathematics Belief inventory (Saritha & Vijayakumari, 2019)

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

c) Scale of Attitude towards Mathematics (Saheedali & Vijayakumari, 2013)

d) Mathematics Anxiety Scale (Malini & Sumangala, 1996; Re-standardized by Midhundas & Vijayakumari,2017)

e) Achievement tests in Mathematics (Saritha & Vijayakumari, 2019)

f) Teaching Manual based on Art Integrated Information Processing Model (Saritha & Vijayakumari, 2019)

g) Teaching Manual based on Information Processing Model (Saritha & Vijayakumari, 2019)

h) Teaching Manual based on Present Method of teaching (Saritha & Vijayakumari, 2019)

Statistical Techniques Used

In addition to the basic descriptive statistics, the following statistical techniques were used for analysis of data.

- One way ANOVA
- Kruskal-Wallis Test
- Paired t-test
- Multivariate Analysis
- Post-hoc Test (Tukey Method, Dwass-steel-Critchlow-Fliger pairwise comparison test)

Scope and Limitation of the Study

This study intended to find out the effectiveness of three instructional strategies viz., Art Integrated Information Processing Model, Information Processing Model and Present method of teaching on attaining Mathematical outcomes among secondary school students. Mathematical outcomes include Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics

This study aims to contribute to the field of Mathematics education by checking the advantage of integrating art into an instructional model.

For the present study investigator developed Mathematics Teaching manual for 8^{th} and 9^{th} standard students in Art Integrated Information Processing Model, Information Processing Model and Present method of teaching. This helps teachers and academicians to identify, plan for, and implement preventative techniques to minimize disruptive behaviours among students. The willingness to stretch traditional classroom settings to positive classroom culture, will result in the academic excellence of the students and will create true learners.

A model of teaching by integrating art with Information Processing Approach model is developed in which the elements of a model viz., Syntax, Support system, Principle of Reaction, Social system and Effects are clearly specified. Teaching Manual in each approach are developed for two units each of Mathematics textbook for standard VIII and IX.

A neglected but important variable that may influence performance of students in Mathematics learning is students' belief about Mathematics. An inventory to measure the belief pattern of students about Mathematics was constructed and validated as part of this study, which can be used to measure the belief of students and public about Mathematics.

Employing a quasi-experimental pre-test-post-test comparison group design, the investigator aims to provide valuable insights into the relationship between variables, laying the groundwork for future research and hypothesis generation. The study seeks to awaken curriculum specialists, educational administrators, and policymakers in education to re-evaluate Mathematics curriculum and textbooks.

The investigator endeavoured to conduct the study as accurately as possible; however, some limitations may have arisen. Some of them are

1. The experiment was done in three classes of standard VIII and three classes of standard IX of a single school. This may affect the performance of students, but the researcher is sure that sharing of information about the strategies followed in the class room will not affect the experiment as both models need teacher interaction for its implementation.

2. There will be many factors influencing the performance or attainment of learning outcomes, influence of which were not controlled in the present study.

3. Though rotation of the groups was planned, due to Covid 19, the experiment was conducted with three comparison groups without rotation of groups.

Despite the limitations, the study's reliability in determining the outcome remains unquestionable. The findings of this study are expected to aid in identifying new research avenues in the field of education.

Organisation of the Report

The report is organized under the following chapters.

Chapter 1

This chapter provides an introduction to the study, need and significance, statement of the problem, objectives and the hypotheses, a brief narration of methodology, statistical techniques used, and scope and limitations.

Chapter 2

This chapter details the theoretical overview of Art Integration and Information Processing Model and review of studies related to the variables of the study.

Chapter 3

A brief methodology including the details regarding the method, design, variables, participants, instruments and materials, data collection procedures and statistical techniques used for data analysis in the study comes under this chapter.

Chapter 4

A detailed statistical analysis of the data collected and the interpretation of results are included in this chapter.

Chapter 5

This chapter includes study in retrospect, major findings of the study, tenability of hypotheses and conclusion of the study.

Chapter 6

Educational implications of the study, recommendations, and suggestions for further research in the light of the present study are mentioned in this chapter.

The report is followed by comprehensive Reference and Appendices.

Chapter 2

REVIEW OF RELATED LITERATURE

- Theoretical Overview and Review of Related Studies on Art Integration
- Theoretical Overview and Review of Related Studies on Information Processing Model
- Review of Related Studies on Mathematical Outcomes

REVIEW OF RELATED LITERATURE

Review of related literature stands as an indispensable compass, guiding researchers through the vast expanse of prior investigations. This crucial phase in the research process serves multifaceted purposes, offering a comprehensive synthesis of existing knowledge while charting the historical trajectory of the subject matter.

A robust and expansive review stimulates confidence in the research endeavour, underscoring the relevance and necessity of the on-going study. By pinpointing the deficiencies or unexplored facets in prior studies, it rationalizes the need for further inquiry, propelling researchers toward adopting innovative methodologies and refining the research design. In essence, the review of related literature stands as a testament to the scholarly continuum, weaving together threads of past research to fortify the fabric of current investigation, elevating its uniqueness, and contributing to its intellectual depth.

This chapter describes the theoretical background and related studies of Art Integration and Information Processing Model and review of related studies on Mathematical outcomes. This chapter is organized into the following sections.

- Theoretical overview and Review of related studies on Art Integration
- Theoretical overview and Review of related studies on Information Processing Model
- Review of related studies on Mathematical Outcomes

Theoretical Overview and Review of Related Studies on Art Integration

Every child comes to the world with an innate power to learn. Learning not starts with the alphabets of language, but learning begins with the environment with the visuals and sound around it. The journey of exploration begins through these visuals and sounds and it is the beginning of learning in visual and performing arts.

Visual Arts

Visual arts are mainly created to evoke aesthetic appreciation, judged based on their beauty and significance. Artists use materials such as paper, canvas, clay, metal, paint, which can be shaped or transformed into physical artworks or objects. Visual art encompasses traditional fine arts like drawing, painting, designs, and sculptures as well as modern and contemporary forms of expression, including assemblage, collage, conceptual art, and Installation.

Performance Arts

This category encompasses live public performance events, traditionally including theatre, music, ballet, and similar art forms. Modern performance art broadens this scope by incorporating any activity where the artist's physical presence serves as the medium. It spans variety of artistic expressions such as dance, music, mimicry, mime, drama, and the like.

Literary Arts

Literature, in its essence, means "acquaintance with letters". Over time, the term has come to represent a collection of written works, including scripts, poems, stories, dramas, and similar art forms of expression.

Art Integration

"Art Integration is a teaching approach to teaching where students develop and express their understanding using an art form" (Kennedy Center, n.d.). Students engage in a creative process which connects an art form and another subject area and meets evolving objectives in both (Silverstein & Layne, 2010). Art integration is really just mixing and matching various art forms in transacting content areas within the classroom settings. Classroom activities are associated with art to teach the subject areas. An art integrated teaching approach adds significant value to the classroom by catering to diverse ways of interpreting and conveying knowledge.

In Art Integration, various art forms are incorporated to teach subjects beyond the arts, such as language arts, math, science, and social studies. Art integration refers to an approach that uses the fine and performing arts as primary tools to enhance learning across multiple disciplines. By integrating art with academic content, students are encouraged to think critically and creatively.

Art integration is possible at various levels of classroom teaching as, drawing on students prior knowledge, solving problems in divergent ways, enriching their understandings, engaging students in reflection about what they learned, how they learned it, and what it means to them, using student assessment of their own and peers' work as part of the learning experience, to revise and improve their work and share it with others, building a positive classroom environment (Silverstein & Layne, 2010).

Howard Gardner's Multiple intelligence theory (Gardner,1983) provides teachers with a valuable framework for integrating the arts into regular classroom activities. Gardner identifies several types of intelligences, such as logical-mathematical, linguistic, musical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal. These intelligences provide teachers with effective strategies for planning and implementing art integration activities in the classroom. The Multiple intelligence approach has been extended well beyond the arts and has been the impetus for designing whole schools around approaches that address students' capacities (Burnaford, et al., 2007).

Teachers can use effective classroom strategies that can help to enhance overall classroom environment suitable for the learners. Art is an ideal vehicle to develop a positive classroom culture. Art has the ability to bridge both creative and analytical thinking, as well as connect empirical and abstract ideas. It offers effective and impactful ways to communicate academic concepts in a way that is both engaging and meaningful. Suitable arts forms like visual art and performing art can be integrated with teaching-learning process according to the need and capabilities of the students, classroom settings, nature of the content, resources available, etc. Learning, communicating, and questioning in conjunction with the arts develops a dynamic classroom environment where the students and teachers alike are excited and engaged in the process (Rabkin & Redmond,2006). Effective art integration requires classrooms teachers to evaluate whether, how, and to what extent the arts can be incorporated into their teaching practices.

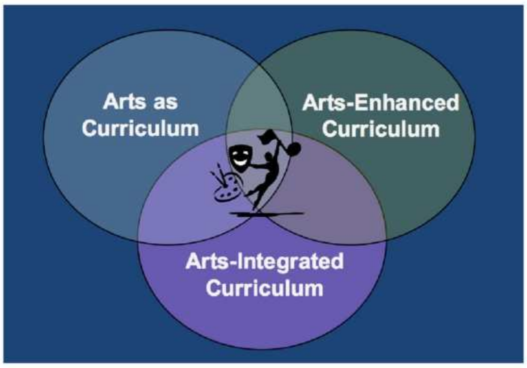
Brown (2007) suggests a set of questions to consider before initiating art integration. What is the content? What instructional methods are appropriate? Who delivers the instruction? What strategies will be used? How will assessment be conducted? She emphasizes that, "Arts integration is like a weaving wherein the design may repeat a pattern or be variable. Just as the warp and weft strings are integral parts of a woven whole, the arts are an integral part of the curriculum and are valuable in all aspects of teaching and learning."

Krug and Cohen-Evron (2000) examine four approaches to arts curriculum: employing the arts as a tool for other disciplines; expanding organizing centers through the study of the arts; utilizing the arts to interpret concepts or themes from other subjects, and exploring real-life issues through a blend of the arts and other subjects.

The art can be integrated into teaching in different ways and can be categorized unto three main categories which is given as figure 1.

Figure 1

Art Integration Variations (Image Source the Kennedy Centre, n.d)



Arts as Curriculum

If a school employs teachers for music, art, drama, or dance, their primary focus is likely centered on the Arts as curriculum, where students focus on developing expertise and skills within a specific art form

Arts-Enhanced Curriculum

When the arts are utilized as a tool or strategy to support other curriculum areas without setting explicit objectives in the art form itself, this approach is known as Arts-enhanced curriculum. It serves as a "hook" to capture students' interest and facilitate engagement with the content. This approach requires minimal or no training in the art form for teachers. However, Arts-enhanced curriculum is often confused with Arts-integrated curriculum, or the distinction between the two is overlooked.

Arts-Integrated Curriculum

In Arts-integrated curriculum, the arts become the vehicle for learning, guiding the approach to teaching and fostering student engagement. Through the creative process, students achieve dual learning objectives by exploring the connections between an art form and another subject, deepening their understanding of both. For this approach to foster meaningful learning in both areas, teachers must participate in professional development to understand arts standards and effectively integrate the arts with their subject matter

Another classification for art integration by Burnaford, et al. (2007) are arts integration as learning “through” and “with” the arts; arts integration as a curricular connection process; and arts integration as collaborative engagement.

In the Brain and Learning (2008), Eisner states that the arts provide children with experience, meaning, and development of thought. Children make meaningful connections to the concepts they learn through engaging activities. These experiences also develop critical and complex forms of thinking by using multiple brain areas.

Neurosciences say art experiences activate and strengthen key brain regions, thereby enhancing a child's multiple intelligences.

The National Council for Teacher Education (NCTE, 2014) regulations for two year B.Ed program, focus on preparing professionally empowered teachers. B.Ed curriculum includes Enhancing Professional Capacities (EPC) activities for teacher trainees for the purpose of a hands on experiences in arts and drama.

The regulation highlighted the benefits of including arts in two year B.Ed curriculum as follows,

- Drama-based activities foster empathy and emotional understanding, helping students relate to others through experiences, emotions, and interpretation. Arts also empower learners by recognizing their agency, promoting transformational action.
- Drama as 'critical pedagogy' extends beyond traditional classroom boundaries, sparking collective consciousness and encouraging community participation in both educational and social change initiatives.
- Teachers are encouraged to explore diverse genres of street theatre, engaging with both folk and contemporary traditions. This exploration allows for improvisation, critique, and the fostering of transformative action.
- Drama and Art in Education contribute to self-awareness and serve as powerful tools for self-expression. These experiences nurture creativity, which is essential for personal and intellectual development.

- Art related activities foster a sense of responsibility, trust, and cooperation among students. They encourage collaborative work, helping learners pursue tasks collectively while exploring diverse perspectives.
- Whether through visual or performing arts, the practice of art enhances children's abilities to perceive, reflect, and express themselves. The arts provide alternative forms of communication, allowing children to experience and express their thoughts and emotions in a variety of ways.

The National Curriculum Framework (NCF, 2005) recommends art education as a subject as well as a pedagogical tool to make teaching and learning of other subjects more meaningful. It reminds that "the school curriculum must integrate various domains of knowledge, so that the curriculum encompasses all, and is not separated from the co-curricular or extra-curricular. This has significant implications for the role of art, music, and drama in education, to nurture children's creativity and aesthetic sensibilities."

Major recommendations of NCF (2005) on integration of art in school curriculum are,

- Efforts should focus on enhancing aesthetic and personal awareness while fostering the ability to express oneself in various forms.
- The significance of India's heritage crafts, both in their aesthetic and economic value, should be recognized as relevant to school education through the integration of arts.

- Education should create opportunities for children to develop creative expression and an appreciation for aesthetics.
- Art-integrated education should reflect and preserve the country's unique cultural identity, embracing its diversity and richness.
- Visual and performing arts should play a key role in the learning process and be integrated as a vital component of the curriculum.
- Students should be introduced to the extensive and diverse artistic traditions of the country through an arts-based curriculum.
- Arts education should be a compulsory subject in schools up to class X, with appropriate facilities provided to support its teaching and learning.
- Children can better understand language, nature, and their sense of self and relationships with others by engaging in various forms of art.
- The curriculum should allocate sufficient time to incorporate a variety of artistic activities.
- The focus should not be on meeting adult standards of "perfect art," but on nurturing children's creativity and individual expression through exposure to materials, skills, and techniques without overemphasis.
- Over time, teachers should guide children toward independently designing and completing their own art projects with persistence and dedication while developing a sense of aesthetic quality and excellence.

- Arts education should encourage students to express emotions, fostering emotional intelligence and self-awareness through creative processes.
- Artistic practices should be integrated into subjects like science, mathematics, and languages to encourage interdisciplinary learning and creative problem-solving.
- Schools should promote understanding and respect for cultural diversity through exposure to different art forms, emphasizing the richness of India's and the world's artistic heritage.
- Students should engage with local art forms and folk traditions to connect their learning with their cultural roots and community practices.
- Art activities can provide inclusive learning opportunities for children with special needs, enabling equal participation and creative expression.
- Artistic expression should be used as a medium to raise awareness about environmental sustainability and social issues, fostering responsible citizenship.
- Teachers should be equipped with training and resources to implement arts education effectively, ensuring they can guide and inspire students creatively.
- Collaboration with local artists and artisans can enrich the arts curriculum, providing students with practical exposure and a deeper appreciation of the creative process.

- The curriculum should prioritize the creative process over the product, allowing students to explore, experiment, and grow personally and artistically.

Art and Mathematics

Mathematics is often viewed as a cognitive, rational, and logical activity associated with the left-brain, while art is viewed as an affective, creative, and expressive activity linked to the right brain. Stimulating both areas together enhances the number of neural connections across the brain, fostering greater overall brain integration. Learning Mathematics and the art together fosters this whole-brain development (De Leo, 2003). The use of Art integrated instruction is effective in improvement of cognitive and intellectual skills (Baker, 2013; Duma & Silverstein, 2014). Art and Mathematics integration helps bridge the gap between concrete and abstract Mathematical ideas. It meets the needs of diverse learning styles and multiple intelligences. It helps to enjoy math more or to alleviate math anxiety.

Arts and Mathematics seem to be separate domain, but they share some features that make them capable of integration and interdependence. The complex cognitive and creative skills required for Mathematics learning are typical of art learning too. Both Mathematics and arts can be considered as born from the very human desire to comprehend and re-create experience and hence can be used to observe, describe, and imitate the natural world.

Benefits of Art Integration into Mathematics

- Students' increased interest, motivation, and curiosity in learning.
- Better achievement in curricular and co-curricular areas.

- Improvement classroom discipline.
- Develops creative thinking, critical thinking, perception, problem solving and self-expression.
- Better collaboration with classmates
- More efficient in processing of information by strengthening connections.
- Develops interest in math makes more attentive
- Students become more actively engaged in the math lessons.
- Discipline issues during math sessions are significantly reduced.
- Students' spare time can be effectively utilized for productive learning activities
- Make math class interactive, interesting, enjoyable, and fun
- Encourages independent learning, builds self-esteem, and strengthens the concentration and discipline.
- Appreciate folk art and the rich Indian culture and traditions,
- Learning through art nurtures a child's creativity, unlocking broader professional avenues for the future.
- Caters the need of special children
- Apply knowledge and skills to their daily lives
- Cultivate multiple intelligence and student's individual learning styles
- Create a positive classroom culture.

Studies Related to Art Integration

Agarwal (2024) investigated the impact of art-integrated learning strategies on students' knowledge retention abilities. The primary objective was to assess how these strategies influenced students' capacity to retain information. An experimental research method was employed to fulfil this objective. The findings indicated that incorporating art-integrated learning strategies significantly enhanced students' knowledge retention. The study recommended that educators implement these strategies in their teaching practices to improve students' retention abilities in social sciences and to facilitate their expression of competencies across various educational contexts.

Chacko (2024) analyzed a variety of studies, records, and research articles that explore the complexities of arts-integrated learning and its many advantages for improving instruction for both students and teachers. According to the review's findings, arts-integrated learning is a very successful approach that needed to be implemented in all schools. But it also emphasizes how crucial it is to create a supportive environment to guarantee that this strategy is implemented successfully. In the future, arts-integrated learning could revolutionize education by encouraging experiential learning and using fun, interesting teaching methods.

Mishra (2024) conducted qualitative research in arts integrated Mathematics learning: an innovative and joyful learning, utilizing a thematic approach and schematic research design. The study emphasizes that art-integrated Mathematics and creativity are not just supplementary elements but essential components of a vibrant educational environment. The integration of joy and creativity in learning prepares students to become well-rounded, resilient, and innovative thinkers, equipping them for a world that highly values these traits.

Velayutham and Raman (2024) investigated the substantial effects of combining visual arts, music, dance, and theatre with traditional academic subjects in primary school. The study highlighted key strategies for success, including curriculum mapping, professional development, collaboration across disciplines, adaptability in lesson structure, alternative forms of assessments, involvement of local stakeholders, and continuous support. By addressing challenges and applying these methods, teachers can harness the transformative potential of the arts in primary education, equipped with the skills for a future rich in creativity and critical thinking.

A study conducted by Yadav and Joshi (2024) examined how expressive arts affected the mood and anxiety levels of college students. Self-report questionnaires were used to gather data from 102 participants, and analysis showed that reading, writing, and colouring were among the activities that had a positive effect on mood and decreased anxiety. Based on these findings, introducing expressive arts into college settings may support students' mental health.

Srivastava (2023) emphasized that Art Integrated Learning (AIL) represents a progressive, inclusive approach to education. The study underlines the significance of AIL in fostering inclusivity within the classroom, highlighting its role not only as a teaching method but also as a facilitator of an inclusive environment that embraces diverse learning styles and abilities.

Yildizhan and Cezikturk (2022) investigated how teaching with art-themed activities affected fifth-grade students' performance in Mathematics as well as their attitudes towards the teaching process. The study carried out with the quasi-experimental research method. The Study revealed that using art-themed activities to teach Mathematics was effective in improving math achievement compared to conventional teaching methods.

Heiman (2020) reviewed literatures related to benefits of art integration in academic coursework. This review of the literature summarises evidence on the academic, social, and emotional advantages of arts integration and makes suggestions for using these strategies in the classroom. Teachers of any discipline can use the arts as a teaching tool in their classrooms through the process of arts integration. Arts integration offers a way to incorporate creative experiences into classrooms while supporting academic growth and social-emotional learning as schools expand learning options.

Mohalik and Basu (2020) compared the effectiveness of Art Integrated Learning in creating conceptual understanding in geography. According to the study, utilising AIL in classroom instruction considerably increases students' conceptual grasp of geography compared to teaching with the traditional method, and AIL was equally beneficial for both boys and girls. Additionally, it demonstrates that AIL was much more successful in helping high achievers develop their conceptual knowledge than it was for poor achievers.

The effect of creative dramatics instruction on fourth-grade students' vocabulary achievement in a language arts classroom was examined by Joseph (2019).

Two experimental groups in the study used Creative Dramatics and Vocabulary Words and Creative Dramatics and Story-Retelling, while the control group followed the Readers' Theatre approach recommended by the school district. According to the results, both experimental groups' vocabulary success was noticeably higher than that of the control group, demonstrating the value of creative dramatics interventions in enhancing vocabulary acquisition and retention.

Arjun and Niranjana (2017) studied the effectiveness of Art Integrated Strategy on Achievement in Mathematics among Secondary school students. The study employed a quasi-experimental pre-test post-test non-equivalent group design. The sample consisted of two divisions of the eighth standard in a single school located in Kozhikode District. The results suggest that art integration may serve as a supplementary approach to enhance Mathematics learning but does not surpass constructivist methods in terms of effectiveness.

Hardiman et al. (2017) investigated the effects of arts-integrated instruction on memory for science content. The purpose of this study was to ascertain how science-related long-term memory was affected by arts-integrated instruction. The study results provide strong correlational evidence indicating that participation in the arts enhances students' academic outcomes and retention of learning experiences.

Holmes and Hallam (2017) investigated the impact of participation in music on learning Mathematics using a quasi-experimental design. The results revealed that music instruction positively influenced the development of spatial–temporal skills.

Baird (2015) used a best practice approach and semi-structured interviews of four educators in various locations across Ontario to find the advantages of integrating Art in Mathematics teaching. Student engagement and participation was found to be increased as a result of Art integration in Mathematics class room.

Brezovnik (2015) conducted an experimental study involving two different ways of teaching fifth-grade students: the control group was taught Mathematics in a traditional way, while the experimental group was taught with the integration of fine art content into the Mathematics lessons. The study found that integrating fine art into Mathematics had a positive effect.

Inoa et al. (2014) studied the relationship between theatre arts and student literacy and Mathematics achievement of sixth and seventh grade students. The impact of incorporating process drama into a conventional language arts curriculum was examined in this study utilising a multi-stage cluster randomised design. The study findings showed that students in arts-integrated classrooms typically perform better than their peers in both language arts and maths.

An et al. (2013) conducted an exploratory study to find out how teachers incorporate music into their normal math classes and how music-Mathematics interdisciplinary sessions affect primary school pupils' modelling, strategy, and application of Mathematics. This study involved two classrooms of first- and third-grade students (N=46) and two teachers. The findings showed that both teachers combined a range of musical exercises with various Mathematics topics. Several areas of mathematical proficiency benefited from the music-math interdisciplinary sessions.

Gullatt (2008) emphasized the significant role of the arts in enhancing teaching and learning across academic disciplines in PK-12 education. Beyond developing specific artistic skills, learning through the arts allows students to engage meaningfully with content through visual, theatrical, and musical forms. These approaches foster creativity, critical thinking, and a deeper understanding of the material. The arts also offer valuable opportunities within the curriculum to explore multiculturalism and diversity. Despite challenges such as funding constraints and resource limitations, research underscores the importance of the arts in boosting academic achievement and supporting the holistic development of students.

Skoning (2008) investigated the benefits of integrating dance and creative movement as teaching strategies in inclusive classrooms, which include increased student comprehension of the material, better classroom conduct, and the creation of new evaluation methods. The findings showed that incorporating these activities into the classrooms will more effectively address the requirements of a range of students, particularly kinaesthetic learners.

Wandell, et al. (2008) investigated the relationship between reading fluency and music training. The experiment was carried out on forty-nine children between the ages of seven and twelve. The findings showed that students reading fluency is enhanced by music instruction.

Theoretical Overview and Review of Related Studies on Information Processing Model

Based on the theory of Information processing, Information Processing Model for teaching design and create suitable environment for learning. “Information

Processing Models emphasize ways of enhancing the human beings innate drive to make sense of the world by acquiring and organizing data, sensing problems and generating solutions to them, and developing concepts and language for conveying them" (Joyce, et al., 2015). In Information-Processing Model, the main emphasis is the learner and the environment. Models in this family are inductive thinking, concept attainment, advance organizer, scientific inquiry, synectics, mnemonics, etc. Some models focus on delivering information and concepts to learner; while others prioritize concept formation, hypothesis testing, creative thinking, and intellectual ability. Most of the Information Processing Models are also beneficial for understanding self and society, contributing to the attainment of educational goals in personal and social development.

Most of the models in Information processing family are based on 'how information is being processed.' Each model has its own syntax, social system, principle of reaction, support system and instructional and nurturant effects. A teacher has to develop a skill by applying any one of the models along with its syntax for a single learning situation at a time and he/she has to adopt another model with its phases to develop another skill. But no single model of this Information processing family would be suitable for all learning situation. Hence it is better to develop a model of Information processing which could be suitable for all learning situations.

The authors (Joyce, et al., 2015) claim that each model is developed with specific objectives and for specific content. Sukumar and Mohan (1995) have attempted a synthesized model including the major aspects of certain models under information processing family. The models considered are

Inductive Thinking Model is designed to foster inductive thinking in learners by guiding them through inductive process.

Inquiry Training Model is designed to develop critical thinking and scientific reasoning by raising questions and searching for answers from curiosity.

Concept Attainment Model is designed to develop inductive reasoning by guiding learners to identify and form concept through exemplars.

Advance Organiser Model is designed to help learners integrate new information with existing knowledge for meaningful learning.

Cognitive Growth Model is designed to develop cognitive development.

Memory Model is designed to enhance the retention and recall of concepts and facts.

Biological Science and Inquiry Model is designed to develop critical thinking and scientific reasoning.

Information Processing Approach Model

The Information Processing Approach Model was created by Sukumar and Mohan (1995) for enhancing learners problem solving ability in Mathematics. They put together ideas from seven different information processing models to develop this approach. The steps they outlined are as follows

1. Teacher initiates
2. Presents appropriate examples, charts etc.
3. Helps to familiarize the presented materials

4. Presents related simpler problems
5. Probes students' response
6. Presents the problem
7. Helps to analyze the variables presented in the problem
8. Helps learner to explore the relationship among the variables
9. Enables students to formulate hypothesis
10. Facilitates testing of the hypothesis
11. Leads learner to the solution
12. Enables students to verify the solution

When applied to physics problem-solving, Saminathan (1997) found the original 12 steps to be quite comprehensive. He condensed the first 5 steps into two: (i) teacher initiates, and (ii) verifies previous knowledge, while maintaining the combined effectiveness of all 5 steps. The restructured Information Processing Approach Model now consists of 8 steps, as follows:

1. Teacher initiates
2. Verifies the learner's previous knowledge
3. Presents the problem
4. Helps to analyse the variables in the problem
5. Facilitates to explore the relationships among the variables
6. Enables students to formulate hypothesis
7. Helps to test the hypothesis
8. Enables students to verify the solution

Reviewing the steps outlined in previous studies of the Information Processing Approach Model, Muthukumar and Mohan (2001) further restructured and streamlined the process, reducing the steps to 6. The steps suggested by Muthukumar and Mohan (2001) are as follows:

1. Teacher initiates
2. Presents the problem
3. Helps students to explore relationship among the variables
4. Enables students to formulate hypothesis or possible solution
5. Facilitates to test the hypothesis or possible solution
6. Helps to verify the accepted conclusion

Teacher Initiates

In any subject, it is crucial for the teacher to begin the lesson, ensuring it relates to what students already know. Teacher can highlight the lesson's importance to grab students' attention and guide them towards their learning outcomes.

Presents the Problem

Teacher simplifies the presentation of the problem, ensuring students grasp its essence. Repeating the problem helps the students to get in depth knowledge about it and its variables. Through repeated exposure, students gather additional insights into these variables, facilitating their retention and organization in memory. Consequently, this enhances their ability to reconstruct and organize problem-related information effectively.

Helps Students to Explore Relationship among the Variables

After presenting the problem, students compare the identified variables with their existing knowledge to assimilate and confirm their understanding. They classify and categorize these variables based on the problem's nature, recognizing associations and distinctions. Teachers should guide students in creating information maps using available resources. This enables students to manipulate the variables as needed to solve the problem.

Enables Students to Formulate Hypothesis or Possible Solution

As students manipulate the variables, their working memory engages in the chunking process. Subsequently, constructed memory undergoes adjustments to accommodate new information and discard irrelevant details, involving the reconstruction of stored information in long-term memory. Students develop and adapt their plans based on the problem's requirements. The modified plan undergoes verification, and thorough checking is crucial before its application. If the learner is content with the plan, it can be implemented; otherwise, the plan should be revised accordingly.

Facilitates to Test the Hypothesis or Possible Solution

Solutions are derived through deductive reasoning or inference based on general principles. In some cases, results can be inferred through logical induction from the available information. Monitoring is essential during arithmetic computations and remains necessary throughout the entire process.

Helps to Verify the Accepted Conclusion

The process of verifying the solution can differ based on the nature of the problem. The solution may yield specific results that require interpretation. It may also lead to forming opinions or judgments about the situation.

Studies Related to Information Processing Model

Fourie and Schlebusch (2022) examined how the brain processes information and identified factors influencing learners' information-processing abilities in classrooms. Using a quantitative design, they gathered data through a questionnaire administered to Grade 11 learners. The study showed that factors like age, home language, the language of instruction, and class size had a significant effect on learners' ability to process information. The study recommended to teachers for fostering efficient information processing, aiming to support meaningful learning and improved understanding among students.

Shahid et al. (2022) reviewed the Information Processing Approach, examining its application to memory, language, and working memory. The results demonstrate how useful the Information Processing Approach is for comprehending how information is processed by the mind. The study also highlights the crucial connection between language and memory, stressing the part language processing plays in memory processes. The effects of variables including age, distraction, and cognitive load were among the key elements and constraints of working memory that were uncovered. This research sheds important light on how various cognitive processes are interrelated.

Majeed (2021) conducted an experimental study to find out the effects of Advance Organizer teaching approach on student's academic performance in Mathematics in Secondary School and found that Advance Organizer teaching approach significantly influenced students' academic performance in Mathematics in secondary school.

A classroom action research study was carried out by Chasanah (2019) for assessing students' mathematical critical thinking skills in solving differential calculus problems. The research utilized indicators of mathematical critical thinking skills within the framework of the cognitive growth model. The study involved 30 first-semester students from a higher education institution in Magelang, Indonesia. The findings indicated significant improvement in the students' mathematical critical thinking abilities when addressing differential calculus problems, as measured by the established indicators, and facilitated through the cognitive growth model approach.

Darmuki et al. (2017) conducted a study to evaluate the effectiveness of an information-processing-based cooperative learning model in improving speaking skills. Using a mixed-methods approach, the researchers carried out an experimental study involving lecturers and students from the Indonesian Language and Literature Education Department in Bojonegoro Residency. The findings revealed that the cooperative learning model had a significantly greater impact on enhancing students' speaking abilities compared to the traditional method.

An experimental study was conducted by Kapri (2017) to evaluate the effectiveness of the Advance organizer model in comparison to conventional teaching techniques in secondary science education. The results showed that compared to traditional teaching methods, the Advance organizer model was more successful at promoting the learning of scientific concepts. Additionally, the study highlighted that student in the experimental group found the Advance organizer model highly engaging, which fostered their interest and motivation to learn the subject matter presented during the experiment.

Saminathan (2017) in a study on developing Problem Solving Ability in Physics through Information Processing Approach included eight steps for information processing approach as (i) Teacher initiates (ii) – Verifying the previous knowledge (iii) Presents the problem (iv) Analysing the variables (v) Relating the variables (vi) Formulating hypotheses (vii) Testing the hypothesis and (viii) Verifying the solution. The study found that the Information Processing Approach Model effectively improves students' problem solving ability in Physics.

Kaur and Kumar (2016) conducted a study to compare the effectiveness of the Inquiry Training Model (ITM) and the Advance organizer model (AOM) in teaching life sciences to 9th-grade students. The results indicated that both ITM and AOM were equally effective and significantly outperformed the traditional teaching methods in enhancing students' learning of life sciences

Namjoshi (2015) in a Study on the effectiveness of memory techniques and memory model for memorizing spellings found that program based on Memory techniques and Memory model is effective in memorizing English spellings.

Nivedita and Rani (2015) conducted an experimental study titled "A Comparative study of effectiveness of Concept attainment model and Memory model on Students' Achievement in English grammar”. The study involved two experimental groups: one taught using the Concept attainment model, and the other using the Memory model along with a control group taught using conventional strategy. The findings showed that, in comparison to the traditional teaching approach, both the Concept attainment model and the Memory model were more successful in raising students' proficiency in English grammar. Furthermore, compared to the group taught using the Concept attainment model, the Memory model group showed noticeably greater increase in grammar achievement.

Babu and Reddy (2012) investigated the impact of the Advance organizer model on the academic achievement of ninth standard students in Mathematics. The study involved a randomly selected sample of 60, ninth standard students. The findings revealed that the Advance organizer model was significantly more effective in improving students' Mathematics achievement compared to conventional teaching methods.

When an experimental group was taught ninth biology concepts using biological science inquiry model and the control group using the conventional method of teaching, Dhaaka (2012) found that biological Science Inquiry Model was more effective than conventional method of teaching.

Studies by Anjum (2014), Angraini et al. (2017) on Concept attainment model, that of Neeru (2001) and Brune (2010) on Inquiry training model and that of Raj (2007) on Advance organizer model revealed these models’ effectiveness in fostering Mathematics learning.

Mani (2007) conducted an experimental study on the application of information processing models in teaching Mathematics at the secondary level. The study focused on three Information processing models: the Concept attainment model, the Advance organizer model, and the Inductive thinking model. The study concluded that instruction using Information processing models was more effective than the Activity-oriented method in improving Mathematics achievement.

Muthukumar and Mohan (2001) conducted a study to evaluate the effectiveness of the Information processing approach model in teaching statistics at the college level. The model incorporates a structured sequence of steps: Teacher initiates, presents the problem, helps students to explore relationship among the variables, enables students to formulate hypothesis or possible solution, facilitates to test the hypothesis or possible solution and helps to verify the accepted conclusion. The study demonstrated that the Information processing approach model not only enhances the effectiveness of teaching statistics but also made the learning process more engaging and interesting for students. These findings suggest that this model holds significant potential for improving the teaching of complex subjects like statistics in higher education.

Review of Related Studies on Mathematical Outcomes

Bala and Sood (2024) examined the impact of Mathematics anxiety, language of teaching, and achievement in Mathematics among eighth grade students. The findings challenged conventional views, revealing that higher Mathematics anxiety levels correlated with better academic performance, suggesting a motivational aspect for some students. Additionally, students instructed in English medium outperformed those in Hindi medium, highlighting the significant impact of language on Mathematics learning. The study emphasized the need for educational strategies that addressed the dual influence of Mathematics anxiety and medium of instruction to optimize student outcomes in Mathematics.

Cabanero et al. (2023) conducted a study to explore the relationship between math anxiety and academic performance among Grade 6 students from elementary school. The research revealed significant differences in students' experiences of math anxiety, influenced by various social, cognitive, and academic factors. The findings emphasized the pivotal role of elementary teachers in shaping students' attitudes towards Mathematics and effectively managing math anxiety through appropriate teaching strategies. The study also highlighted the necessity of early and tailored interventions to reduce math anxiety, promoting a more positive and productive learning environment for young learners.

Arup and Bijoyasaha (2019) studied Mathematics anxiety and prevention strategies: An attempt to improvement of Mathematics performance of Secondary school students in West Bengal. The results showed significant differences in mathematics anxiety and performance based on gender and school type, but no significant difference was found between mathematics related habitat anxiety and performance.

An action research study by Kyli and McCoy (2019) examined the use of game-based learning in a brief unit on ordered pairs for fifth-grade mathematics students. Data on student attitudes and achievement were collected through surveys, content tests, student interviews, and field notes. The teacher-researcher's analysis also incorporated classroom photographs, videos, and student work samples. The findings showed that students' attitudes toward the lessons and mathematics in general improved. In addition, achievement levels rose for all students across the unit

Tahir et al. (2019) conducted a classroom action research study to improve students' Mathematics learning outcomes through the implementation of the Think-Pair-Share cooperative learning model. The study, conducted cyclically, involved 25 tenth-grade students, and followed four stages in each cycle: planning, action, observation and evaluation, and reflection. Data collection included observations of student activities, response questionnaires, and Mathematics learning outcomes tests. Qualitative analysis was used for observational and questionnaire data, while descriptive statistics were employed for learning outcomes. The findings revealed that the Think-Pair-Share model effectively enhanced students' performance in Mathematics, demonstrating its potential as a valuable cooperative learning strategy in the classroom.

Wang et al. (2019) examined the relationships between Mathematics teachers' praise and students' Mathematics-related beliefs and their perceived Mathematics achievement rank in their respective classes. Students' beliefs about Mathematics are positively influenced by teachers' praise, as well as students' perceptions on their achievement. Although a relatively low percentage of students reported receiving praise from their teachers, the study found that increased praise was associated with more positive mathematics-related beliefs. Additionally, students who received more praise tended to perceive their achievement as higher. The results suggested that teachers' praise can foster more favourable mathematics-related beliefs and improve achievement.

Kusumawardani et al. (2018) employed a combination of qualitative and quantitative methods to investigate the impact of Mathematical reasoning based on belief in problem-based learning with a dyadic interaction approach. The qualitative findings included insights into the learning quality and responses from a mathematical belief questionnaire. The quantitative results were based on data from reasoning ability assessments. The main conclusion was that the use of problem-based learning with a dyadic interaction approach proved effective in enhancing students' mathematical reasoning abilities.

Kanmani and Nagarathinam (2017) conducted a study to explore the relationship between problem-solving ability and achievement in Mathematics among higher secondary students. A sample of 55 students was randomly selected, and the survey method was employed for data collection. The study found that higher secondary students had an average level of problem-solving ability and established a significant positive correlation between problem-solving ability and achievement in Mathematics

Prabawanto (2017) investigated the improvement of students' mathematical problem-solving skills through instruction using a metacognitive scaffolding approach in a quasi-experimental design with pre-service elementary school teachers. The results revealed a significant difference in the improvement of problem-solving skills between students taught with the metacognitive scaffolding approach and those taught using a direct teaching approach. Additionally, no significant interaction was found between teaching methods and students' prior mathematical abilities in enhancing problem-solving skills.

Hughes (2016) conducted a qualitative study to examine the relationship between Mathematics anxiety, mathematical beliefs, and instructional practices among 153 elementary Mathematics teachers. The results revealed statistically significant correlations between these factors. Regression analyses showed that mathematical beliefs were a significant predictor of instructional practices, while Mathematics anxiety was not a significant predictor.

The major objective of a study by Rattanatumma and Puncreobutr (2016) was to compare the effectiveness of teaching methods in improving Mathematics learning achievement and problem solving ability of students at an international college. The results showed that students taught using the STAD (Student-Teams Achievement Divisions) cooperative learning model was more effective compared to those who taught using problem-based learning.

Senthamarai et al. (2016) attempts to study on problem solving ability in Mathematics of standard IX students in Dindigul district, Tamil Nadu. The study was conducted with ninth-grade students using a survey method. The results indicated that their problem-solving ability in Mathematics was at an average level for ninth standard students.

Uysal and Dede (2016) investigated the relationship between Mathematics anxiety and beliefs of Turkish Pre-service elementary Teachers. The results showed that the pre-service teachers had high scores on their beliefs about teaching Mathematics, while their levels of Mathematics anxiety were generally low.

Lai et al. (2015) explored the impact of Mathematics anxiety and mathematical metacognition on word problem solving in children with and without mathematical learning difficulties (MLD). The participants were categorized into four achievement groups: high, typical, low, and MLD. The results revealed that children with MLD had a lower self-image and higher levels of learning Mathematics anxiety compared to achievement in high and typical children, Additionally, MLD children had higher anxiety than the low group. The study emphasized the role of anxiety in poor word problem solving and suggested that addressing learning Mathematics anxiety is essential for effective interventions in mathematical learning difficulties.

The Relation between Mathematics beliefs, conceptual knowledge and mathematical experience among pre-service teachers was explored by Adnan, Zakaria and Maat (2012). The study's results showed that teachers' overall mathematical beliefs are high, their conceptual knowledge is strong, and their mathematical experience is moderate. Further analysis revealed a significant correlation between these three variables

Memnun et al. (2012) Main aim of the study was to report the results of the statistical analysis that was performed to determine the beliefs about mathematical problem solving of the Mathematics, science and elementary school pre-service teachers and the results of whether gender and the teaching field they studied have any effect on problem solving beliefs. The study concluded that there were no significant differences in problem-solving beliefs based on either the participants' gender or their area of study.

Ozturk and Erden (2011) investigated preschool teachers' beliefs about integrated curriculum and, more specifically, their beliefs about integration of visual arts with other activities. The findings showed that while teachers generally held positive views about integrated curriculum, they tended to use visual arts activities primarily as a way to reinforce other subjects rather than integrating them directly.

Tarmizia and Tarmizi (2010) conducted an analysis of mathematical beliefs among secondary school students in Malaysia. The study aimed to examine students' beliefs related to Mathematics, focusing on their confidence in their mathematical abilities and their perceptions of their teachers' attributes in Mathematics instruction. The findings revealed a significant impact on students' beliefs in their mathematical competency, with three key factors influencing these beliefs: students' views on their teachers' qualities in Mathematics teaching, their Mathematics grades, and their gender.

Ignacio et al. (2006) examined the beliefs, attitudes, and emotional responses that students experience while learning mathematics. The study aimed to show that positive attributes, beliefs, and attitudes about oneself as a learner can serve as a source of motivation and foster expectations of success in studying the subject. The findings revealed that neither gender nor the students’ grade level had an impact on their self-concept regarding mathematics.

White et al. (2006) conducted three surveys involving pre-service primary teachers. These surveys included an achievement test on the Mathematics they were expected to teach, a survey assessing their beliefs about Mathematics, teaching, and learning, and a survey on their attitudes towards Mathematics. The study presented the findings from these three assessments and explores the relationships between them. The results revealed some connections between the three factors, although these relationships were relatively weak.

A study titled "Descriptive Study of Primary School Students' Beliefs about Mathematics" was conducted by Aksu et al. (2002). The results indicated that students' beliefs about Mathematics differed significantly according to their grade level and Mathematics achievement. However, no significant differences were found in the beliefs related to the nature of Mathematics, the learning process, and its application when comparing male and female students.

Stipek et al. (2001) explored the beliefs and teaching practices of fourth- to sixth-grade teachers concerning Mathematics instruction. The study assessed teachers' views on various aspects of Mathematics teaching and learning at both the start and end of the school year. The results indicated a strong connection between the teachers' beliefs and their instructional practices, with a notable relationship between their self-confidence in teaching Mathematics and their students' self-confidence in learning the subject.

Conclusion

Review of related studies in Art integration, Information processing Models and Mathematical outcomes reveals that many studies are conducted in these areas in India and abroad across primary to higher education levels.

The reviewed studies on Art integration reported positive impact on students' learning and classroom atmosphere in different subjects and grades. Most of the studies reports its impact on achievement (Yildizhan & Cezikturk, 2022; Mohalik & Basu, 2020; Joseph, 2019; Hardiman et al., 2017) and reduced anxiety in students (Yadav &Joshi, 2024). Art integration helps to develop different skills and abilities, retention ability (Agarwal,2024); Spatial temporal skill (Holmes & Hallam, 2017) and reading fluency (Wandell et al., 2008). Studies have reported that art integration enhances student active participation and is suitable for inclusive classroom (Mishra, 2024; Srivastava, 2023; Chacko, 2024; Heiman, 2020; Baird, 2015; Gullatt, 2008; Skoning, 2008)

Studies on Information processing model reported teaching models like Inductive thinking model, Concept attainment model, Advance organizer model, Scientific inquiry model, Mnemonics, Memory model, Biological science inquiry model are all beneficial for different subjects and grades, and these models are able to develop different skills and abilities in learners and enhance academic achievement. Many studies reported as Advance organizer model enhances achievement in Mathematics (Majeed, 2021; Babu & Reddy, 2012; Mani, 2007; Raj, 2007) achievement in Science subjects (Kapri, 2017; Kaur & Kumar, 2016), Inquiry model effective in students learning life sciences (Kaur & kumar, 2017), Cognitive growth model develops mathematical critical thinking skill (Chasanah, 2019), Mathematics achievement enhanced through Inductive thinking model (Mani, 2007), Memory training model is effective in memorizing English spellings and proficiency English grammar (Namjoshi, 2015; Nivedita & Rani, 2015), Concept attainment model fostering Mathematics learning (Mani, 2017; Anjum, 2014); Angraini,et al.,2017) and English learning (Nivedita & Rani, 2015), Biological science inquiry model is effective in biology learning (Dhaaka, 2012).

Each model in the Information processing family is developed with specific objectives and for specific content. Information processing approach model was developed by including the major aspects of certain models under information processing family. Effectiveness of Information processing approach model was reported in statistics learning (Muthukumar and Mohan, 2001), and Problem solving ability in Physics (Saminathan, 2017).

Many studies reported different teaching strategies (game-based teaching, meta cognitive scaffolding approach, STAD, PBL with dyadic interaction approach and cooperative learning) effective for math classroom (Kyli & McCoy, 2019; Prabawanto, 2017; Rattanatumma & Puncreobutr, 2016; Isnarto & Junaed, 2018) which have effect on students' Mathematics attitude, achievement, and performance. Several studies report relation between Math achievement with Mathematics anxiety, belief, attitude, problem solving ability (Bala & Sood, 2024; Cabanero, et al., 2023; Wang et al., 2019; Arup & Bijoyasaha, 2019; Kanmani & Nagarathinam, 2017; Uysal & Dede, 2016; Senthamarai et al., 2016; Aksu et al., 2002)

Review of studies made the investigator to conclude that art integration is an effective way to attain learning outcomes and Information processing approach model is effective to develop problem solving ability among students. Integration of art forms into the structured frame work of information processing approach model will be suitable to a wide range of students in their abilities and skills to learn Mathematics.

No studies are found to be reported in this approach and hence finding effectiveness of Art Integrated Information Processing Model in attaining mathematical outcomes is relevant to be explored.

Chapter 3

METHODOLOGY

- Design of the Study
- Variables
- Participants
- Instruments
- Procedure of Data Collection
- Statistical Techniques Used

METHODOLOGY

Methodology means the specific, scientific procedure carried out in research. The vehicle of research cannot perform its function without methodology as its engine. The worthiness of research outcome is determined by the methodology adopted. The method adopted should always be appropriate to the nature of the problem under investigation and the kind of data that the problem demands. The method adopted in research helps one to critically evaluate the validity and reliability of the study.

In the present study an attempt was made to find the effectiveness of Art Integrated Information Processing Model, Information Processing Model and Present method of teaching in bringing out select Mathematical outcomes among secondary school students. The methodology adopted in the study is detailed in this chapter under the major headings viz.,

Design of the study

Variables

Participants

Instruments

Procedure of data collection

Statistical techniques used

Design of the Study

Research design is a well-planned blueprint outlining the final shape of the study which fulfils the objectives of the research and it gives a bird's eye view of the study.

An experimental design helps the investigator to find out the causal effect of an intervention on the dependent variable by controlling other factors affecting the outcome.

The present study followed quasi-experimental pre-test-post-test comparison group design with three unequal groups. A comparison design uses two or more variations of the independent variable and can use two or more groups (McMillian & Schumacher, 2010). To know the effect of integrating Art into Information Processing Model to bring out select Mathematical outcomes, comparison of performance of three groups taught with Art Integrated Information Processing Model (AIIPM), Information Processing Model (IPM) and the Present method of teaching was done. Hence the effectiveness of Art Integrated Information Processing Model (AIIPM) was tested by testing the effect of AIIPM, IPM and Present method of teaching for bringing out Mathematical outcomes among secondary school students using quasi experimental pre-test - post-test non-equivalent comparison group design. The design used in this study is denoted as figure 2.

Figure 2

Quasi- Experimental Pre-test-Post-test Non-equivalent Comparison Group Design

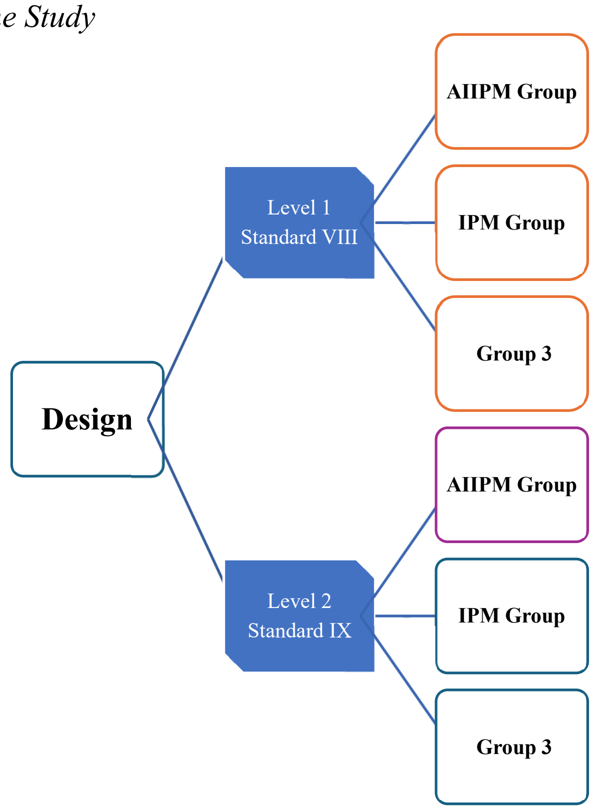
Group		Pre-test		Intervention		Post-test
A	→	O	→	X_1	→	O
B	→	O	→	X_2	→	O
C	→	O	→	X_3	→	O
						Time

X_1 -Treatment 1(AIIPM), X_2- Treatment 2(IPM), X_3- Treatment 3(Present method)

Experiment was conducted at two levels, one for standard eight students and the second for standard nine students each with three comparison groups, to make the study more generalizable to secondary school students. The pictorial representation of the design is given as figure 3.

Figure 3

Outline of Design of the Study



Variables

Present study focuses on finding the effectiveness of teaching strategies: Art Integrated Information Processing Model, Information Processing Model and Present method of teaching in the attainment of select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and reduced Mathematics Anxiety among Secondary school students. Variables involved in the study are discussed below.

Independent Variable

In experimental research, the independent variable is the experimental variable which the investigator manipulates. In the present study, the experimental variable is the instructional strategy which has three levels, viz., Art Integrated Information Processing Model, Information Processing Model and Present method of teaching. Three groups were selected randomly among which the first group was exposed to Art Integrated Information Processing Model, the second group to Information Processing Model and the third group was exposed to the usual method of teaching followed in the schools to teach Mathematics.

Dependent Variable

The dependent variable is that on which the experimental variables have some effect. In the present study, Mathematical outcomes is taken as the dependent variable which is a construct defined as cognitive, and affective outcomes of Mathematics learning. The major outcomes considered are Problem solving ability in Mathematics, Achievement in Mathematics, Mathematics belief, Attitude towards Mathematics, and reduced Mathematics anxiety.

Rationale of including each of these variables under Mathematical outcomes is discussed below.

Problem Solving Ability in Mathematics

A major aim of education is to equip children to solve problems independently for better adjustment in the future complex society. Problem solving is a higher order cognitive process that directs at achieving a goal while facing a perplexing situation. Problem solving allows the students to experience a range of affective, cognitive and conative dimensions associated with various stages in the solution process. Mathematics is a subject aimed to develop problem solving ability among its learners. Any approach to Mathematics education can be evaluated based on its power to develop problem-solving ability among students. Problem solving ability is also included as an important 21st century skill by WHO (2020). Considering its importance in Mathematics education, Problem solving ability in Mathematics is taken as one element of Mathematical outcomes.

Mathematics Belief

The affective outcomes of Mathematics learning are often overlooked during teaching and assessment, the most neglected one being Mathematics belief. Mathematics belief system is the conscious and unconscious subjective conceptions learners hold to be true about Mathematics. Every learner holds a Mathematics belief (as systematic/exploratory/utilitarian) which influences the overall behaviour of the learner in Mathematics learning. An upgraded belief system in students can be achieved through effective teaching strategies. To explore the impact of instructional strategies, Mathematical belief as a Mathematical outcome would be significant.

Mathematics Anxiety

Mathematics anxiety is a general fear or tension associated with anxiety-provoking situations that involve interaction with math (Legg & Locker, 2009). Mathematics anxiety is found to be a negative correlate of student's performance, attitude, and achievement (Kundu & Kar, 2018; Tartaro, 2023)

Many factors inside and outside classroom contribute to Mathematics anxiety, the instructional strategies adopted being a remarkable one. The classroom experiences also create anxiety among students (Musa & Maat, 2021; Marks, 2022; Tartaro, 2023). Introducing novel teaching methodologies in Mathematics classrooms holds promise for alleviating Mathematics anxiety, consequently promoting a positive shift in learners' overall Mathematics acquisition. Given the substantial negative association between math anxiety and students' performance, in the present study Mathematics anxiety is incorporated as an affective variable under Mathematical outcomes.

Attitude towards Mathematics

Attitudes of students play an important role in the process of learning. Positive attitudes towards the subject makes the learner involve in learning and achieve better (Hwang & Son, 2021; Mensah et al., 2013). The methods and strategies adopted by the teacher influence the attitude of students towards the subject. The experiences received by the learners determines their attitudes. Teaching of Mathematics intends to develop a positive attitude towards Mathematics among students (NCF, 2023). Hence Attitude towards Mathematics is considered as a Mathematical outcome for the present study.

Achievement in Mathematics

Achievement in Mathematics is positively associated not only with cognitive abilities but also with affective and conative abilities (Abin et al., 2020; Ayebale et al., 2020; Khine et al., 2015). Students' Mathematical achievements have an influential effect on their performance in future courses and careers. Proficiency in Mathematics is always essential to succeed in every walk of life in the past, present and future. It is a cliche that success of a teaching strategy is determined by analyzing students' test scores. The formal education system is always following the practice of taking students' scores in examinations as the primary measure of quality. One cannot neglect the importance of achievement scores of learners in the present education system. So, achievement in Mathematics was also included as a Mathematical outcome.

Participants

The population under study is Secondary school students of Kerala. Secondary school students are students studying in 8^{th}, $9^{th,}$ and 10^{th} standards. In order to generalize the findings of the study, one is expected to experiment with representative groups of each level. As it is practically difficult to conduct experiment with 10^{th} standard students it was decided to conduct experiment with 8^{th} and 9^{th} standard students. The investigator expects that conducting experiment at two levels, among

8^{th} and 9^{th} standard students, will improve the generalizability of application of the model. The rationale for selecting 8^{th} and 9^{th} standard students for the experiment can also be explained as the nature of students in 8^{th} and 9^{th} are expected to be different, 8^{th} standard students being fresh ones and 9^{th} standard students being adopted to the approaches and goals of secondary school education. Thus, the sampling frame includes both 8^{th} and 9^{th} standard students.

The experiment was conducted separately for students of 8^{th} and 9^{th} standard. For the conduct of the study, three groups for each level (8^{th} and 9^{th} standard) were needed. For experimentation, the investigator opted for Thrissur district and then listed Government and aided co-educational schools in Thrissur educational district. (The list of schools is appended as Appendix I).

The investigator contacted the school authorities in person and sought permission to conduct the study. The investigator obtained permission to conduct the study at HSS Arimpur, a co-educational aided institution under Thrissur educational district. As three classes are to be handled simultaneously, three divisions of 8^{th} standard were selected randomly from the same school. Among these three divisions, one was allotted as comparison group 1, the second as comparison group 2, and the last as comparison group 3 randomly. The same procedure was followed for 9^{th} standard also. Participants of the study were 215 students, 111 from 8^{th} standard and 104 from 9^{th} standard constituting 3 comparison groups for 8^{th} and 9^{th} standard respectively. The details of the sample are given in table 1.

Table 1

Break- up of the Sample Selected for Study

Comparison Group	Experimental levels	Level I	Level II	Total
		Standard VIII	Standard IX	
Group 1	AIIPM	36	34	**140**
Group 2	IPM	36	34	
Group 3	Present method of teaching	39	36	**75**
Total		**111**	**104**	**215**

Instruments

Any scientific investigation needs certain instruments that help the investigator to collect relevant data from the participants. Selection of the appropriate instruments for collecting data is an integral part of Methodology. The present study examines the effect of Art Integrated Information Processing Model, Information Processing Model and Present method of teaching in attaining select Mathematical outcomes. Following tools and materials were used in the experimental phase of the present study.

a) Mathematics Belief inventory (Saritha & Vijayakumari, 2019)

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

c) Scale of Attitude towards Mathematics (Saheedali & Vijayakumari, 2013)

d) Mathematics Anxiety Scale (Malini & Sumangala, 1996; Re-standardized by Midhundas & Vijayakumari,2017)

e) Achievement tests in Mathematics (Saritha & Vijayakumari, 2019)

f) Teaching Manual based on Art Integrated Information Processing Model (Saritha & Vijayakumari, 2019)

g) Teaching Manual based on Information Processing Model (Saritha & Vijayakumari, 2019)

h) Teaching Manual based on Present method of teaching (Saritha & Vijayakumari, 2019)

Among the above instruments/materials, Mathematics belief inventory, Achievement test in Mathematics, and Teaching Manuals were developed by the investigator. Test of Problem-Solving Ability in Mathematics, Scale of Attitude towards Mathematics, and Mathematics Anxiety Scale were adopted.

Mathematics Belief Inventory (Saritha & Vijayakumari, 2019)

Mathematics belief inventory was constructed and standardized by the investigator with the help of supervising teacher to measure Mathematics belief of Secondary school students.

The inventory was developed based on Daskalogianni and Simpson (2001) categorization of beliefs about Mathematics as a discipline based on the theory of Rokeach (1975), which considers the organization of individuals' beliefs within a central peripheral dimension. This suggests the existence of a central belief system (macro beliefs) and inner structure of peripheral belief system (micro beliefs) which vary in depth and stability among individuals.

Daskalogianni and Simpson (2001) categorized beliefs about Mathematics into three macro belief systems viz., systematic, exploratory, and utilitarian and four micro belief systems viz., nature of Mathematics, focus of exercises, working in Mathematics and didactical contract.

Macro-beliefs along with their peripheral micro-belief characteristics of students about Mathematics are presented in table 2.

Table 2

Categorization of Beliefs about Mathematics by Daskalogianni and Simpson (2001)

		MACRO – BELIEFS		
		Systematic	**Exploratory**	**Utilitarian**
MICRO BELIEFS	**Nature of Mathematics**	methodical, logical	problem-solving, linking things	tool for other subjects, applied in life
	Focus of exercises	follow a series of steps	understand different ways of thinking	obtain correct exam answer
	Working in Mathematics	exact answer, similar exercises	explore things, enjoy challenge	known algorithms, study techniques
	Didactical contract	dependence on notes and teacher	dependence on own abilities	dependence on teacher

Note. Table reproduced from Daskalogianni, K., & Simpson, A. (2001). A categorisation of upper sixth-form students' beliefs about mathematics. In T. Rowland (Ed.), *Proceedings of the British Society for Research into Learning Mathematics* (Vol. 21, No. 1, pp. 13–18). British Society for Research into Learning Mathematics.

Learners who categorize their belief system as "systematic" tend to view Mathematics as a static subject with a focus on exercises that require the use of established methods and strategies. They see mathematics as a logical, methodical discipline where problems have clear, exact solutions. The problem-solving process is seen as a series of steps, and learners often refer back to notes and rely heavily on the teacher for guidance.

Learners with an "exploratory" belief system view Mathematics as a dynamic subject where multiple correct answers may exist for a problem. They enjoy tackling new challenges and actively seek connections between different concepts. These learners place a strong emphasis on self-reliance and depend on their own abilities to learn and solve mathematical problems.

Learners who adopt a "utilitarian" belief system see Mathematics primarily as a practical tool that can be applied to other subjects or real-life situations. They focus on using study techniques to solve problems, aiming for correct answers in exercises and exams. These learners typically rely on well-known algorithms and numerical methods for problem-solving and often depend on the teacher for guidance.

Preparation of the Inventory

Based on the Macro belief system explained by Daskalogianni and Simpson (2001), Mathematics belief inventory was constructed. Items are written with a phrase and three options, each representing macro belief system in the order systematic, exploratory and utilitarian. The phrases are written based on the micro belief systems and the characteristics under each category.

Each belief system in the inventory is described below.

Nature of Mathematics.

Example. When solving a new Mathematics problem

A.	Follow previous math problem solving steps	(Systematic Belief)
B.	Carefully analyze, then find a suitable method	(Exploratory Belief)
C.	Use Memorized easy methods	(Utilitarian Belief)

Focus of Exercises.

Example. Mathematical Problems are

A.	Based on textbooks	(Systematic Belief)
B.	Interesting and thought provoking	(Exploratory Belief)
C.	Possible to arrive at the answer easily	(Utilitarian Belief)

Working in Mathematics.

Example. Solving Problems in Mathematics means

A.	To find out the correct answer	(Systematic Belief)
B.	Find a systematic approach to problem solving	(Exploratory Belief)
C.	Use formulae	(Utilitarian Belief)

Didactical Contract.

Example. The focus in studying Mathematics should be on

A.	Class notes	(Systematic Belief)
B.	Self-Practice	(Exploratory Belief)
C.	Easy Methods/ Formulae	(Utilitarian Belief)

The draft inventory consisted of 26 items under the three macro belief systems and micro beliefs under four areas viz., nature of Mathematics, focus of exercises, working in Mathematics and didactical contract.

Distribution of items in the inventory under the Micro belief systems are presented in table 3.

Table 3

Distribution of Items in Mathematical Belief Inventory (Draft) under Four Micro Belief Systems

Sl. No.	Micro belief System	Item Numbers	Total items
1	Nature of Mathematics	1,2,3,4,17,18,	6
2	Focus of exercises	5,6,7,9,11,20,25	7
3	Working in Mathematics	8,10,15,16,22,23,24	7
4	Didactical contract	12,13,14,19,21,26	6

The draft inventory, consisting of 26 items, has undergone scrutiny by expert in the field (Certificate from expert is given as Appendix II). After incorporating the suggestions by the expert, pilot testing of the draft inventory was done. The draft inventory is appended as Appendix III.

Pilot Testing

A sample of 370 Secondary school students from Thrissur and Kozhikode districts was selected using stratified sampling technique for pilot testing. After obtaining permission from the concerned authorities, the investigator gave necessary instructions to the students and administrated the inventory. The response sheets were collected back after responding.

Then the responses were scored for systematic, exploratory, and utilitarian belief separately. This was done by assigning a score of 1 for a response related to systematic belief and a score of zero for the other two responses; a score of 1 for a response in the exploratory belief and a score of zero for the other two responses and for scoring under utilitarian belief, one score was given for a response related to utilitarian belief and zero score for other two responses. Then the total score for each belief was calculated separately by adding the scores in each belief category.

Item Analysis

Item analysis was done at three stages: one for systematic belief, second for exploratory belief and third for utilitarian belief.

The response sheets were arranged from highest to lowest score three times, one for systematic, second for exploratory and the third for utilitarian. The top 27 percentage and lowest 27 percentage were separated and the number of correct responses for each belief in the upper and lower groups were counted and the discriminating power of each item was calculated for systematic, exploratory, and utilitarian belief separately using the formula.

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

where, U is the total score of the upper group for an item, L is the total score of the lower group for that item and N, the size of one group.

Discriminating power of items measuring systematic, exploratory, and utilitarian belief systems are presented in table 4.

Table 4

Discriminating Power of Items in Mathematics Belief Inventory Measuring Systematic, Exploratory and Utilitarian Belief System

Item No.	Systematic	Exploratory	Utilitarian	Remarks
1	0.509	0.471	0.594	Accepted
2	0.424	0.302	0.371	Rejected
3	0.472	0.454	0.432	Accepted
4	0.461	0.307	0.362	Rejected
5	0.529	0.578	0.547	Accepted
6	0.580	0.345	0.353	Rejected
7	0.551	0.57	0.641	Accepted
8	0.686	0.603	0.633	Accepted
9	0.533	0.592	0.504	Accepted
10	0.468	0.462	0.352	Rejected
11	0.586	0.558	0.574	Accepted
12	0.469	0.425	0.487	Accepted
13	0.489	0.402	0.551	Accepted
14	0.611	0.54	0.534	Accepted
15	0.615	0.548	0.62	Accepted
16	0.488	0.526	0.541	Accepted
17	0.593	0.588	0.598	Accepted
18	0.572	0.508	0.488	Accepted
19	0.557	0.598	0.669	Accepted
20	0.511	0.468	0.413	Accepted
21	0.585	0.585	0.598	Accepted
22	0.629	0.589	0.580	Accepted
23	0.653	0.649	0.656	Accepted
24	0.399	0.531	0.484	Accepted
25	0.602	0.659	0.644	Accepted
26	0.562	0.536	0.491	Accepted

Items having discriminating power greater than .4 for the three belief systems, systematic, exploratory and utilitarian are included in the inventory. If for any belief system, the value is less than .4, that item is deleted from the inventory. Item number

2,4,6 and 10 are rejected as the discriminating power is less than .4 for one or more belief systems. The final inventory contains 22 items, the details of which are given in table 5.

Table 5

Distribution of Items in Mathematical Belief Inventory (Final) under Four Micro Belief Systems

Sl.No.	Micro belief System	Item Numbers	Total items
1	Nature of Mathematics	1,2,13,14	4
2	Focus of exercises	3,4,6,7,16,21	6
3	Working in Mathematics	5,11,12,18,19,20	6
4	Didactical contract	8,9,10,15,17,22	6

Scoring Procedure

The Mathematics belief inventory contains 22 items, each with a set of three responses corresponding to three belief systems. The responses were scored separately for systematic, exploratory, and utilitarian belief. A score of 1 was assigned to a response related to systematic belief, while the other two responses received a score of 0. Similarly, a score of 1 was assigned to a response related to exploratory belief, with the other two receiving a score of 0. For utilitarian belief, a score of 1 was given for a response related to utilitarian belief, and 0 for the other two responses. The total score for each belief category was calculated separately by adding the scores within each category.

Reliability

Internal consistency of items in the inventory was calculated by using Cronbach's Alpha. The reliability coefficients obtained for three belief systems, Systematic, Exploratory and Utilitarian are .92, .91 and .92 respectively. Consistency over time was established by test-retest method. The reliability coefficients obtained for each belief system are .79, .69, and .71. Therefore, the scores obtained from the inventory can be considered as highly reliable.

Validity

The inventory was developed on the macro and micro belief systems suggested by Daskalogianni and Simpson (2001) based on the theory of Rokeach (1975). Items for the inventory were selected based on the recommendations of expert in the field, and each item has three responses belonging to the three systems, Systematic, Exploratory and Utilitarian. Hence the inventory has construct and face validity. A copy of Mathematics belief inventory is appended in Appendix IV.

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

In order to measure Problem solving ability in Mathematics of students, test of Problem solving ability in Mathematics developed by Rinsa and Sumangala (2008) was adopted. The test consists of 25 multiple choice items based on six types of problems viz., Logical problems, Algorithmic Problems, Story problems, Rule using problems, Troubleshooting problems and Situated case problems. Each type of problem is described below.

Logical Problems

Logical problems measure mental acuity, clarity, and logical reasoning of the learners. Reasoning method will lead the learner to find the specific solution.

Example. Rajeev has 35 notes of Rs.100 stacked on the basis of serial number. If the serial number of the first 100-rupee note is 12965, what is the serial number of the last note?

A. 13999 C. 12999

B. 13001 D. 13000

Algorithmic Problems

In algorithmic problems, the learners select and apply the correct sequence of operations for finding its solutions.

Example. $1+2+3+4+5 = \frac{5\times(5+1)}{2}$: $1+2+3+4+5+6 = \frac{6\times(6+1)}{2}$, $1+2+3+4+5+6+7 = \frac{7\times(7+1)}{2}$ then what is 1+2+3+4+5+6+7+8+9+10 ?

A. $\frac{8\times(8+1)}{2}$ C. $\frac{10\times(10+1)}{2}$

B. $\frac{5\times(5+1)^2}{2}$ D. $\frac{10+(10+1)}{2}$

Story Problems

Story problems are usually narrative or situation type problems which need a more complex cognitive process for solving it.

Example. The father decided to give his eldest son half of his property, to the second son half of the remaining and to the youngest one the rest. What portion of the property is supposed to give the third son?

A. One fourth of his property
B. Half of his property
C. One third of his property
D. One eighth of his property

Rule Using Problems

A rule using a problem has multiple solution paths/ways or rules to arrive at a solution. The learner identifies the most accurate information in a minimum amount of time.

Example. Which of the following is always an even number?

A. Even number × Odd number
B. Even number + Odd number
C. Odd number × Odd number
D. Even number ÷ Even number

Troubleshooting Problems

Troubleshooting problems are familiar types of problems in everyday problem solving. To find the solution, the learner must integrate and organize some skills and strategies like search and replace, serial elimination, space splitting, experience, etc.

Example. In a class, the number of girls is five times greater than that of boys. Which of the following would not be a possible number of girls in that class?

A. 36
B. 48
C. 54
D. 62

Situated Case Problems

Situated case problems require the learner to identify the nature of the problem and the different perspectives of the problem before suggesting solutions. Before reaching the final process, the solver must go through the process of justifying the decision.

Example. A soap measures 5cm×4cm×1.5cm. Find how many soaps a cardboard box can contain, which measures 55cm×48cm×15cm.

A. $\frac{5\times4\times1.5}{55\times48\times15}$ C. $\frac{55\times48\times15}{5\times4\times1.5}$

B. $\frac{.5\times.4\times.15}{55\times48\times15}$ D. $\frac{55\times48\times15}{.5\times.4\times.15}$

Scoring Procedure

Test of Problem-solving ability in Mathematics contains 25 items of multiple-choice type. Each item in the test is followed by four responses- A, B, C and D. The students have to select the correct answer from the given four alternatives among which one is the correct response and the other three are the distractors. Each correct response will get a score of 'one' and for a wrong answer the score is 'zero.' The sum of scores on all the items of the test provides the score on Problem-solving ability in Mathematics of the respondent. The maximum score obtainable is 25 and minimum is zero.

Reliability

The reliability of the test was established by the test- retest method. The reliability coefficient obtained is .75. Hence the test can be considered as a reliable one.

Validity

Concurrent validity of Test of Problem-Solving Ability in Mathematics was established by the developers using another test of Problem-Solving Ability in Mathematics developed by Vijayakumari and Sumangala (2000). A positive value of Correlation (0.59) indicates that the test is valid to measure Problem Solving Ability in Mathematics.

Scale of Attitude Towards Mathematics (Saheedali & Vijayakumari, 2013)

Scale of Attitude towards Mathematics developed by Saheedali and Vijayakumari (2013) was used to measure the variable Attitude towards Mathematics. It is a five-point Likert scale with 32 items based on eight dimensions of Attitude towards Mathematics viz., value of learning Mathematics, practicality of Mathematics in life, anxiety and motivation in Mathematics, attitude towards teachers of Mathematics, use of Mathematics to learn other subjects, attitude towards mathematicians, universalization of Mathematics and aesthetics of Mathematics. Among these, nine statements are positively stated and 23 are negatively stated.

Example

Value of Learning Mathematics. Mathematics is quite essential for success in life.

Practicality of Mathematics in life. It is easy to get job for those who learnt Mathematics

Anxiety and Motivation in Mathematics. I don't attend the Mathematics classes since they are tough and dull.

Attitude towards Teachers of Mathematics. Mathematics teachers are noble.

Use of Mathematics to Learn Other Subjects. Mathematics learning helps the learning of art.

Attitude towards Mathematicians. The biography of Mathematicians promotes motivation among students to learn Mathematics.

Universalization of Mathematics. The findings of Mathematics are useful to people of all countries.

Aesthetics of Mathematics. Mathematics is useful in the creation of art forms.

Scoring Procedure

Each statement in the scale has five responses: Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree. The responses to each positive item has to be scored as 5, 4, 3, 2, and 1 respectively for the responses Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree respectively. For negative items the scoring is in the reverse order. The total score obtained for a respondent stands for the score on Attitude towards Mathematics of that individual. The maximum score obtainable in the scale is 160 and minimum is 32.

Reliability

Reliability of the scale was ensured by calculating Cronbach alpha coefficient and test-retest method. Cronbach alpha coefficient obtained is .78 and in test-retest method, the correlation coefficient is .89. Thus, the instrument can be considered as a reliable one.

Validity

The developers claim for face validity and criterion related validity of the scale. Face validity of the scale was ensured by consulting with experts in the field of education in the construction of the scale. The criterion related validity of the scale was established by correlating the scores of Scale of Attitude towards Mathematics with that of the scores obtained in Scale of Attitude towards Mathematics developed by Sunny and Sumangala (1987). The validity coefficient obtained for the scale is .84 (N=30). The value shows that the scale is valid to measure Attitude towards Mathematics.

Mathematics Anxiety Scale (Malini & Sumangala, 1996; Re-standardized by Midhundas & Vijayakumari, 2017)

The scale was developed by Malini and Sumangala (1996) and re-standardized by Midhundas and Vijayakumari (2017) to measure the extent of anxiety in working with Mathematics. The original scale is a five-point Likert-type scale with 29 items, the possible responses being Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD). Among the 29 items, 23 items measure debilitating anxiety, while 6 items measure facilitating anxiety. The re-standardized scale contains 24 items, with 23 items measuring debilitating anxiety and one item measuring facilitating anxiety.

Example

Facilitating Anxiety. To excel in Mathematics, I am ready to confront any difficulties.

Debilitating Anxiety. I failed to answer the questions of my Mathematics teacher due to my anxiety.

Scoring Procedure

The Mathematics anxiety scale is a five-point Likert type scale with responses SA, A, U, D, and SD. For debilitating anxiety items, the scores assigned are 5, 4, 3, 2, and 1 for these responses respectively. For facilitating item, the scores assigned are 1, 2, 3, 4, and 5 for the responses SA, A, U, D, and SD respectively. The sum of scores for all items yields the score on the Mathematics anxiety scale. This scale contains 24 items, with the minimum score obtainable as 24 and the maximum score 120.

Reliability

The developers of the original scale claimed a test-retest reliability coefficient as .86 (N=35) and the Cronbach's Alpha coefficient as .80 (N=100). The internal consistency of the revised scale was established by Cronbach's Alpha coefficient (.85), indicating that the scale is reliable.

Validity

In the original scale the statements were phrased in the least ambiguous way and hence the scale is a good measure of Mathematics Anxiety. So, the scale ensures face validity.

Construct validity of the scale was ensured by testing the following hypotheses.

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

ii. The measures of the scale will be negatively related to measures of the scale of Self Concept in Mathematics.

These hypotheses were confirmed by testing on a sample of 30 students selected randomly (t-value 38.207 and r = -.632).

The criterion related validity was ensured by correlating the scores with that of Kerala Examination Anxiety Scale (Nair, 1976) and Mathematics achievement scores from school records. The correlation coefficients obtained are .57 and -.64 respectively. Hence the scale is valid to measure Mathematics anxiety among students.

In the revised version no change in the structure of the scale or wording was made and hence no change in validity of the scale is expected, so the scale is valid to measure Mathematics anxiety of secondary school students.

Achievement Tests in Mathematics

Topics considered for the Achievement test in Mathematics (Standard VIII) are Money maths and Construction of quadrilaterals. For standard IX, the topics are Real numbers and Prisms. These topics were considered because as per the year plan and unit plan of school, these topics are to be taken in months expected for the experiment.

The two achievement tests in Mathematics, for standard VIII and IX were constructed following the same procedures. The details of construction of the tests are given under the headings.

- Achievement test in Mathematics for Standard VIII
- Achievement test in Mathematics for Standard IX

Achievement test in Mathematics for Standard VIII

To measure Achievement in Mathematics of students in Standard VIII, an achievement test was developed by the investigator with the help of supervising teacher.

Steps followed in the construction of the Achievement test are discussed below

Planning of the Test. Achievement test in Mathematics (Standard VIII) is intended to measure achievement of standard VIII students in the selected units viz., Money maths and Construction of quadrilaterals. A one-hour test based on Revised Bloom's Taxonomy (RBT) (Anderson & Krathwohl, 2001) was planned for a maximum of 25 marks. The investigator carefully analyzed the text book and teacher text to list the learning outcomes of the selected units before preparing the test.

Learning outcomes of the unit, Money maths are listed below.

The learner

1. Explains the method of computing interest by simple interest and compounding interest for interest.
2. Explains the method of computing amounts under interest compounded, half yearly, quarterly or in any frequencies.
3. Solves other practical problems, using the method of compound interest.

Learning outcomes outlined in the unit, Construction of Quadrilaterals are listed below

The learner

4. Finds the measurements needed to specify a parallelogram.
5. Draws parallelogram according to specifications.
6. Finds the measurements needed to specific trapezium.
7. Explains the methods of drawing trapezium according to specification.
8. Draws quadrilateral according to specifications

Preparation of the Design. The test was designed to assess the achievement of students in the cognitive domain. Due weightage was given to units and learning outcomes, thinking skills, form of questions and difficulty level of questions. The details of each are given below.

Weightage to Units and Learning Outcomes. The weightage given for the units and learning outcomes are given in table 6.

Table 6

Weightage to Units and Learning Outcomes (Standard VIII)

Sl. No.	Units	Learning Outcomes	Marks	Percentage
1	Money Maths	1,2,3	12	48
2	Construction of quadrilaterals	4,5,6,7	13	52
	Total		25	100

Weightage to Thinking Skills. Items are expected to be based on Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating, aiming to assess students' achievement levels aligned with the selected units. The weightage given to thinking skills are given in table 7.

Table 7

Weightage to Thinking Skills (Standard VIII)

Sl. No.	Thinking Skills	Marks	Percentage
1	Remembering	3	12
2	Understanding	3	12
3	Applying	9	36
4	Analyzing	4	16
5	Evaluating	2	8
6	Creating	4	16
	Total	25	100

Weightage to Form of Questions. The weightage given to form of questions are given in table 8.

Table 8

Weightage to Form of Questions (Standard VIII)

Sl. No.	Form of Questions	No. of questions	Marks	Percentage
1	Objective	3	3	12
2	Short answer	6	14	56
3	Essay	2	8	32
	Total		25	100

Weightage to Difficulty Level. Due weightage was given to the easy, average and difficult questions. The weightage given to difficulty levels are given in table 9.

Table 9

Weightage to Difficulty Level (Standard VIII)

Sl. No.	Difficulty level	Marks	Percentage
1	Easy	5	20
2	Average	15	60
3	Difficult	5	20
	Total	25	100

Preparation of the Blue Print. Blue print makes the test construction systematic and it also ensures the content validity of the test. Here, the blueprint is prepared in the form of a three-dimensional chart that outlines the distribution of questions based on Thinking skills and Content-wise.

The design and blueprint of the test are given in table 10.

Table 10

Blueprint for Achievement test in Mathematics for Standard VIII

Thinking Skills	Remembering			Understanding			Applying			Analyzing			Evaluating			Creating			Total
Form of Question / Content	O	S	E	O	S	E	O	S	E	O	S	E	O	S	E	O	S	E	
Money Maths				1(1)	2(1)			2(1), 3(1)	4(1)										12
Construction of Quadrilaterals	1(2)	1(1)									2(2)			2(1)				4(1)	13
Total		3			3			9			4			2			4		25

- The number inside the bracket indicate the number of questions and that outside indicate the mark to each question.
- O,S,E indicates Objective, Short answer and Essay type test items respectively.

Writing of Items. A pool of items was constructed based on the content. Finally, 11 questions selected based on the blueprint, which consist of three objective type questions, five short answer types and two essay type questions. Care was taken to make the items simple, clear, and specific.

Evaluation of the Draft Test. After preparing the draft test, the investigator discussed these items with experienced Mathematics teachers for ensuring the quality of the test. Suggestions given by the experts were incorporated by the investigator into the test.

Item Analysis. Item- total correlation coefficient was calculated for each item to ensure the quality of items. The values are given as Appendix V.

As all the items are found to have sufficient correlation with the total score, all the 11 items were selected for the final test.

Reliability. Reliability of the test was established by test-retest method on 35 eighth standard students. After two weeks of the first test, the same test was administered on the same students. The correlation between students' scores on the first and second test was calculated. The test-retest reliability coefficient was found to be 0.82. Hence the test can be considered as reliable.

Validity. Content validity of the test was ensured by covering major concepts and learning objectives in each unit, a process that underwent scrutiny by Mathematics teaching and assessment experts. Irrelevant items were eliminated, and ambiguous ones were revised based on the expert's recommendations. The test has face validity as the questions are framed based on the design and blue print of the test.

Preparation of Scoring Key and Marking Scheme. The test contains objective, short answer and essay type questions. Scoring key was prepared for objective type questions and marking scheme for descriptive type questions. A copy of Achievement test in Mathematics for Standard VIII and scoring key and marking scheme are given as Appendix VI and VII.

Achievement Test in Mathematics for Standard IX

The investigator, with guidance from the supervising teacher, developed an achievement test to assess achievement in Mathematics of Ninth standard students on selected topics.

Steps followed in the construction of the achievement test are discussed below.

Planning of the Test. Achievement test in Mathematics (Standard IX) is intended to measure achievement in Mathematics of ninth standard students in the selected units viz., Real Numbers and Prisms. A one-hour test based on Revised Bloom's Taxonomy (RBT) (Anderson & Krathwohl, 2001) was planned for a maximum of 25 marks. The investigator carefully analyzed the text book and teacher text to list the learning outcomes of the selected units before preparing the test.

Learning outcomes of the unit 'Real Numbers' are listed below.

The learner

1. Draws a number line and explains its properties.
2. Describes the method to find distance between two points.
3. Computes the midpoints of two points.
4. Identifies absolute value of numbers.

Learning outcomes outlined in the unit 'Prism' are listed below

The learner

5. Describes the method of finding volume of prisms.
6. Explains the method to find the area of prisms.
7. Describes the method to calculate the volume and area of a cylinder.
8. Solves practical problems related to prisms.

Preparation of the Design. The test was designed to assess the achievement of students in the cognitive domain. Due weightage was given to units and learning outcomes, thinking skills, form of questions and difficulty level of questions. The details of each are given below.

Weightage to Units and Learning Outcomes. The weightage given for the units and learning outcomes are given in table 11.

Table 11

Weightage to Units and Learning Outcomes (Standard IX)

Sl. No.	Units	Learning Outcomes	Marks	Percentage
1	Real Numbers	1,2,3,4	13	52
2	Prisms	5,6,7,8	12	48
	Total		25	100

Weightage to Thinking skills. The test is expected to cover Remembering, Understanding, Applying, Analyzing, Evaluating, and Creating, aiming to assess students' achievement levels aligned with the selected units. The weightage given to thinking skills are given in table 12.

Table 12

Weightage to Thinking Skills (Standard IX)

Sl. No.	Thinking Skills	Marks	Percentage
1	Remembering	1	4
2	Understanding	3	12
3	Applying	11	44
4	Analyzing	3	12
5	Evaluating	4	16
6	Creating	3	12
	Total	25	100

Weightage to Form of Questions. Weightage given to the form of questions are given in table 13.

Table 13

Weightage to Form of Questions (Standard IX)

Sl. No.	Form of Questions	No. of questions	Marks	Percentage
1	Objective	5	5	20
2	Short answer	6	16	64
3	Essay	1	4	16
	Total		25	100

Weightage to Difficulty Level. Due weightage was given to easy, average and difficult questions. The weightage given to difficulty level is given in table 14.

Table 14

Weightage to Difficulty Level (Standard IX)

Sl. No.	Difficulty level	Marks	Percentage
1	Easy	5	20
2	Average	16	64
3	Difficult	4	16
	Total	25	100

Preparation of the Blue Print. Based on the design of the test, blue print was developed which is given as table 15.

Table 15

Blueprint for Achievement Test in Mathematics for Standard IX

Thinking Skills	Remembering			Understanding			Applying			Analyzing			Evaluating			Creating			
Form of Question / Content	O	S	E	O	S	E	O	S	E	O	S	E	O	S	E	O	S	E	Total
Real Numbers	1(1)			1(1)			1(1)	2(2)			3(1)						3(1)		13
Prisms				1(2)				3(2)							4(1)				12
Total	1			3			11			3			4			3			25

- The numbers inside the bracket indicate the number of questions and those outside indicate the mark to each question.
- O, S, E indicates Objective type test items, short answer type test items and essay type test items respectively.

Writing of Items. Based on the blue print 12 questions were prepared, five objective type questions, six short answer type and one essay type question. Care was taken to make the items simple, clear, and specific.

After item preparation, they were undergone scrutiny by experienced Mathematics teachers for ensuring the quality of the test. Suggestions given by the experts were incorporated by the investigator into the test.

Item Analysis. The test was administered for a group of 42 ninth standard students and the item- total correlation was calculated for each item. Items with sufficient correlation were selected for the final test. All 12 questions satisfied the criteria and hence were included in the final test. The correlation table is given as Appendix VIII.

Reliability. Reliability of the test was established by test-retest method on 42 ninth standard students. After two weeks of the first test, the same test was administered on the same students. The correlation between students' scores on the first and second administration of the test was calculated. The test-retest reliability coefficient was found to be 0.73. Hence the test can be considered as reliable.

Validity. Content validity of the test was ensured by preparing items based on the design and blue print, covering major concepts and learning outcomes in each unit, a process that underwent scrutiny by Mathematics teaching and assessment experts. Irrelevant items were eliminated, and ambiguous ones were revised based on the expert's recommendations. Hence the test was face validity.

Preparation of Scoring Key and Marking Scheme. Scoring key for objective type questions, and marking scheme for descriptive type were prepared. A copy of Achievement test in Mathematics for Standard IX and scoring key and marking scheme are given as Appendix IX and X.

Teaching Manual Based on Information Processing Model (IPM)

Information Processing Model was developed by Sukumar and Mohan (1995) for enhancing learners' problem solving ability in Mathematics by putting together ideas from seven different Information Processing Models viz., Inductive thinking model, Inquiry training model, Concept attainment model. Advance organizer model, Cognitive growth model, Memory model and Biological science and inquiry model. They identified 12 steps for the model.

Saminathan (1997) re-structured the model by reducing the 12 steps into eight and tested the model on Problem solving ability in Physics. Later Muthukumar and

Mohan (2001) modified the steps into six major phases to make the steps of the model more appropriate and systematic.

In the present study, the Teaching Manuals based on Information Processing Model were prepared based on the steps suggested by Muthukumar and Mohan (2001). One more step was added by the investigator for increasing the efficiency of the model to develop the ability to process information.

The steps identified in these three studies are presented and summarized in figure 4, table 16, and table 17.

Figure 4

Details of Steps Involved in Information Processing Model

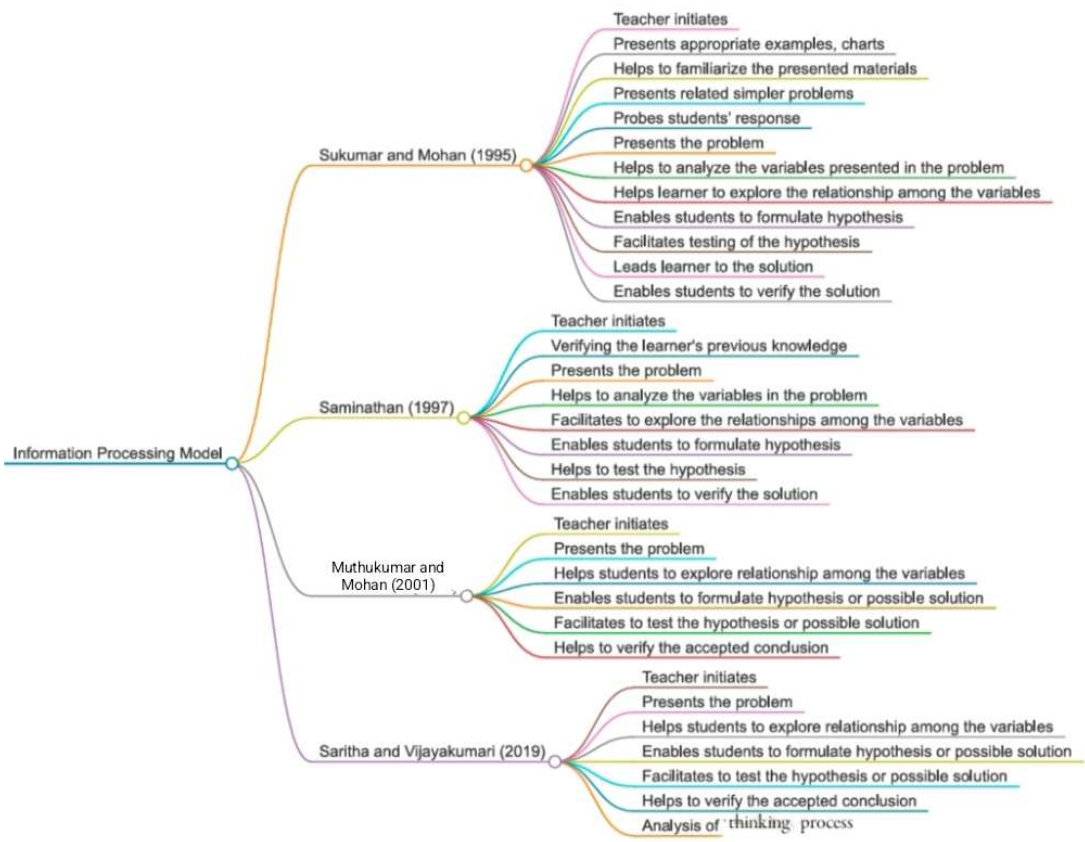


Table 16

Details of Steps Involved in Information Processing Model

Sukumar and Mohan (1995)	Saminathan (1997)	Muthukumar and Mohan (2001)	Saritha and Vijayakumari (2019)
1. Teacher initiates 2. Presents appropriate examples, charts 3. Helps to familiarize the presented materials 4. Presents related simpler problems 5. Probes students' response 6. Presents the problem 7. Helps to analyze the variables presented in the problem 8. Helps learner to explore the relationship among the variables 9. Enables students to formulate hypothesis 10. Facilitates testing of the hypothesis 11. Leads learner to the solution 12. Enables students to verify the solution	1. Teacher initiates 2. Verifying the learner's previous knowledge 3. Presents the problem 4. Helps to analyse the variables in the problem 5. Facilitates to explore the relationships among the variables 6. Enables students to formulate hypothesis 7. Helps to test the hypothesis 8. Enables students to verily the solution	1. Teacher initiates 2. Presents the problem 3. Helps students to explore relationship among the variables 4. Enables students to formulate hypothesis or possible solution 5. Facilitates to test the hypothesis or possible solution 6. Helps to verify the accepted conclusion	1. Teacher initiates 2. Presents the problem 3. Helps students to explore relationship among the variables 4. Enables students to formulate hypothesis or possible solution 5. Facilitates to test the hypothesis or possible solution 6. Helps to verify the accepted conclusion 7. Analysis of thinking process

Table 17

Summary of Various Phases of the Information Processing Model Used in this Study

Phases	Explanation
1. Teacher initiates	Introduction to the activities, setting learning objectives and activating prior knowledge, establishing a learning environment.
2. Presents the problem	Presents data through its attributes, presents discrepant event, presents advance organizer, presents puzzling situation, poses the investigation area
3. Helps students to explore relationship among the variables	Compares attributes, gathers data for verification, arranges learning material into logical order, elicits students responses, structures the problem
4. Enables students to formulate hypothesis or possible solution	Generates hypotheses, forms definition based on the attributes, makes inferences, isolates relevant variables, speculates on ways for solving problems
5. Facilitates to test the hypothesis or possible solution	Confirms hypothesis with the help of teacher, Identifies additional examples, restates definition, explains or supports prediction/hypotheses, formulates an explanation
6. Helps to verify the accepted conclusion	Verifies the solution, expands sensory images, practices, strengthens cognitive organization
7. Analysis of Thinking Process	Analyses thinking strategies and inquiry process

The investigator made the model more systematic by adding the components of the model other than syntax.

The structure of the model is given below.

Structure of the Model

Structure of the model with its syntax, social system, principle of reaction, support system, instructional and nurturant effects are described below.

Syntax. Information Processing Model consists of seven phases arranged in an integrated and sequential manner. These phases are sequenced in the order given below:

Phase 1: Teacher initiates

Phase 2: Presents the problem

Phase 3: Helps students to explore relationship among the variables

Phase 4: Enables students to formulate hypothesis or possible solution

Phase 5: Facilitates to test the hypothesis or possible solution

Phase 6: Helps to verify the accepted conclusion

Phase 7: Analysis of Thinking Process

Social System. In the IPM framework, teachers assume multifaceted roles essential for fostering holistic learning experiences. Beyond mere instructional delivery, they serve as mentors, guiding students through the process of problem-solving, critical thinking, and collaborative learning. The social system is democratic in nature. While the structure exists to provide a framework for learning, it remains flexible, allowing for adaptation to the diverse needs and preferences of learners. The model is moderately structured.

Principle of Reaction. Teacher motivates the students to explore the problem, concept or event through information processing and lead the learners to the goal.

Through strategic information processing, educators not only ignite curiosity but also instil a sense of purpose, guiding learners towards the attainment of their learning outcomes.

Support System. The support system is adaptable, varying according to the content being taught and the information processing required. This ensures that the support provided is tailored to meet the specific needs of learners and the objectives of the instructional activity. Teachers can utilize a range of tools and resources to enhance the learning process and support student information processing. This may include charts, models, physical objects, multimedia materials and other instructional aids. By providing appropriate support and resources, teachers can help students effectively engage with the content, develop essential skills, and achieve the desired learning outcomes through information processing.

Instructional and Nurturant effect.

Instructional Effects. The model develops the ability to

- Generate hypothesis and test the hypothesis
- Form new concepts and conceptual systems and their application
- Use different strategies in unfamiliar situations
- Master facts and ideas
- Think critically and divergently

Nurturant Effects. The model develops

- Independence or autonomy in learning
- Tolerance of ambiguity
- Self-reliance and self-understanding
- Problem solving ability, abstract thinking and deductive thinking
- Logical thinking

A sample Teaching Manual based on IPM is given in Appendix XI.

Teaching Manual Based on Art Integrated Information Processing Model (AIIPM)

For developing Art Integrated Information Processing Model investigator blended two strategies. i.e. Information processing model and art integration. In this study the Art Integrated Information Processing Model is designed by combining visual-, performance-, and literary art forms in different phases of Information Processing Approach Model.

A brief account of the structure of AIIPM of Instruction is given below.

Structure of the Model

Structure of the model with its syntax, social system, principle of reaction, support system, instructional and nurturant effects are described below.

Syntax. Syntax of AIIPM consists of the same seven phases as in IPM with one or more art form integrated to any of these phases. The selection of art form is determined by the ability of the teacher, students, nature of the content and infra structural facilities.

Social System. In AIIPM, teacher plays different roles, ranging from planner, designer, facilitator, and challenger to manager. Social system is democratic in nature. Teacher distributes the activity equally between teacher and students by encouraging a great deal of social intellectual independence. In AIIPM, students are given freedom to interact among themselves. The model has moderate structure.

Principle of Reaction. Teacher is responsively connecting art form with content and helping to promote a critical approach to knowledge. Here the teacher is the designer of art integrated learning material and a facilitator for students to design appropriate art form, which is content related. Teacher motivates the students to explore the problem, concept or event and lead the learners into the goal.

Support System. The AIIPM lessons require art forms that have been designed so that concepts are embedded in the material. Support system consists of carefully selected and organized materials with suitable art forms. Teacher is not expected to be an expert in all fine and performing arts for integrating arts in the teaching, but needs an open mind and readiness to use this approach.

Instructional and Nurturant effect.

Instructional Effects. The model develops the ability to

- generate hypothesis and test the hypothesis
- use different strategies for creative inquiry
- form new concepts and conceptual systems and their application
- use different strategies in unfamiliar situations
- master facts and ideas
- think critically and divergently

Nurturant Effects. The model develops

- independence or autonomy in learning
- tolerance of ambiguity
- self-reliance and self-understanding
- problem solving ability, intellectual development, abstract and deductive thinking
- logical thinking
- spirit of creative thinking

Teaching Manuals based on AIIPM were prepared for the chapters Money Math and Construction of Quadrilaterals of standard VIII and Real numbers and Prisms from standard IX of Mathematics text book following Kerala state syllabus. The list of chapters with art forms used are appended in Appendix XII.

A sample Teaching Manual based on AIIPM is given in Appendix XIII.

Teaching Manual based on Present Method of Teaching

Teaching manual for the same topics based on the Present method of teaching were prepared for the third comparison group. The investigator prepared Teaching manuals as per teacher text followed by Mathematics teachers working under the General Education Department of Kerala State. Teaching Manual is given as Appendix XIV.

Sample teaching manuals are validated by experts in the field (Certificates from experts are given as Appendix XV).

Procedure of Data Collection

The experiment was conducted in HSS Arimpur, which is a co-educational, rural aided school in Thrissur. Approval and cooperation from the school authorities and Mathematics teachers were secured from the outset. Preliminary discussions about the study were held with them. The experiment was carried out for a period of four months (October to January) in the academic year 2019-2020 (Certificate is appended as Appendix XVI).

Experimental Procedure: Level 1

The investigator began the first level of experimentation phase by selecting three intact classes of standard VIII (Number of students in Group 1 is 38, Group 2 is 38 and Group 3 is 40). As the initial step, pre-tests were administered to three groups to assess variables such as Problem-solving ability in Mathematics, Mathematics belief, Attitude towards Mathematics, Mathematics anxiety and Achievement in

Mathematics. Clear instructions were provided in advance to each group regarding the response procedure of each instrument before its administration.

During the next phase, the three comparison groups received instruction based on the instructional strategies AIIPM, IPM and Present method of teaching focusing on the chapters 'Money Maths' and 'Construction of Quadrilaterals' in the Mathematics textbook of standard VIII by SCERT, Kerala.

Upon completion of the topics in all three comparison groups, post-tests were conducted to assess the variables related to Mathematical outcomes. After eliminating incomplete responses, 111 sets of response sheets, with thirty-six in first two comparison groups and thirty-nine in the comparison group 3 were considered. Response sheets were scored according to the respective scoring procedures, data were consolidated and subjected to statistical analysis using SPSS.

Experimental Procedure: Level 2

To test the applicability of the models, experimentation was repeated for ninth standard students too.

The investigator initiated the second level of the experimentation phase by selecting three intact classes of standard IX (Number of students in Group 1 is 36, Group 2 is 36 and Group 3 is 38). As the initial step, pre-tests were administered to each three comparison groups to assess variables such as Problem-solving ability in Mathematics, Mathematics belief, Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics. Clear instructions were provided to the groups in advance regarding the response procedure of each instrument before its administration.

During the subsequent phase, the first two groups received instruction based on the instructional strategies AIIPM and IPM, focusing on the chapters 'Real Numbers' and 'Prisms' in the Mathematics textbook of standard IX by SCERT, Kerala. Simultaneously, the comparison group 3 received instruction based on conventional instructional strategies covering the same content area.

Following the completion of the intervention with AIIPM, IPM and Present method of teaching in the three groups, post-test was conducted to assess select Mathematical outcomes in all three groups. After eliminating incomplete response sheets, a total of 104 sets of sheets were finalized, with thirty-four each in first two comparison groups and thirty-six in the comparison group 3. Response sheets were scored according to the respective scoring procedures, data were consolidated and subjected to statistical analysis using SPSS.

Statistical Techniques Used

The data, systematically tabulated and consolidated, underwent suitable statistical analysis. This section provides an in-depth description of the statistical methods utilized to evaluate the tenability of the hypotheses formulated for the current study.

Statistical techniques used for the present study are

- Preliminary Analysis
- One way ANOVA
- Kruskal-Wallis Test
- Paired t-test
- Multivariate Analysis
- Post-hoc Test (Tukey Method, Dwass-steel-Critchlow-Fliger pairwise comparison test)

Preliminary Analysis

In preliminary analysis, important statistical constants such as measures of central tendency, standard deviation, skewness, and kurtosis of the variables were calculated for pre-test, post-test and gain scores of eighth standard and ninth standard students.

One-Way ANOVA

One- Way ANOVA was used to compare the mean scores of pre- test scores of the select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief, Attitude towards Mathematics, and Mathematics anxiety in the three comparison groups of both eighth and ninth standard students.

Kruskal-Wallis Test

Kruskal-Wallis test, the non- parametric test parallel to ANOVA, was executed to know whether the groups differ in their initial level of Achievement in Mathematics in the comparison groups of both eighth and ninth standard students.

Paired t-test

To know the effectiveness of the instructional models to improve select Mathematical outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety of eighth and ninth standard students, paired t-test was used.

Wilcoxon Signed- Rank Test

Wilcoxon signed- rank test, the non-parametric test alternative to paired t-test was used for the comparison of pre- and post-tests scores on Achievement in Mathematics of the three groups for eighth and ninth standard students.

Multivariate Analysis

Multivariate analysis was used to examine the differences between groups across multiple variables simultaneously, thereby reducing the risk of Type I error.

MANOVA (Multivariate Analysis of Variance) was executed to find out whether the three comparison groups differ significantly in their select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety for the post-test (eighth standard students) and gain scores (eighth and standard students) and mean standard scores of the total sample.

MANCOVA (Multivariate Analysis of Covariance) was executed to find out whether the three comparison groups differ significantly in their select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety for the post-test scores (ninth standard students) with pre-test scores on Achievement in Mathematics as covariate, as the comparison groups are found to significantly differ in pre- test achievement scores.

Kruskal-Wallis test, the non- parametric test parallel to ANOVA, was also executed to compare the variable Achievement in Mathematics (post-test and gain scores) of eighth and ninth standard students.; Achievement in Mathematics and Attitude towards Mathematics (mean standard scores) among comparison groups.

Post-hoc Test

To determine which groups do differ in their entry level with regard to Problem solving ability in Mathematics and Mathematics anxiety (for eighth standard students) Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety (for ninth Standard students) Post-hoc comparison using Tukey method was done.

Post-hoc comparison (Dwass-Steel-Critchlow-Fligner pairwise comparison) was used to know which groups differ in Achievement in Mathematics (pre-test, post-test and gain scores).

To determine which of the comparison groups showed statistically significant difference in their standard scores with regard to Attitude towards Mathematics and Achievement in Mathematics, Dwass-Steel-Critchlow-Fligner pairwise comparison as post-hoc was done.

Chapter 4

ANALYSIS AND INTERPRETATION

- ❖ Analysis of Data Based on Experimentation Conducted on Eighth Standard Students
- ❖ Analysis of Data Based on Experimentation Conducted on Ninth Standard Students
- ❖ Analysis of Standard Scores of Both Eighth and Ninth Standard Students

ANALYSIS AND INTERPRETATION

Present study is an attempt to find out whether Art Integrated Information Processing Model, Information Processing Model or Present method of teaching Mathematics is the most effective in bringing out Mathematical outcomes, viz., Problem Solving Ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and reduced Mathematics Anxiety among secondary school students. The experimental design used for the study is quasi-experimental pre-test-post-test comparison group design with three unequal groups. The study was conducted at two levels, for eighth and ninth standard students.

For each standard (VIII & IX), among the three intact groups, two groups were selected randomly and were taught through Art Integrated Information Processing Model (AIIPM Group) and Information Processing Model (IPM Group) and the third group was taught through the Present method of teaching followed in the school (Group 3), providing the usual classroom experiences. The collected data for both eighth and ninth standard students were analysed separately based on the objectives set for the study.

Effectiveness of the three teaching strategies were tested using multiple statistical techniques. For this mean comparison of pre-test and post-test scores of each group was done using paired t-test, mean comparison of post-test scores of the three groups and mean comparison of the three groups on gain scores of the variables for both eighth and ninth standard students were done separately using MANOVA and MANCOVA. To make the generalization of the results to secondary school students more accurate, mean comparison of standard scores of the variables was done for students of both eighth and ninth standard using MANOVA.

Details of analysis of the data are presented under three major headings viz.,

- Analysis of data based on experimentation conducted on eighth standard students
- Analysis of data based on experimentation conducted on ninth standard students
- Analysis of standard scores of both eighth and ninth standard students.

Analysis of Data Based on Experimentation Conducted on Eighth Standard Students

Pre-test and post-test scores on select Mathematical outcomes of the three comparison groups of eighth standard were analysed. Gain scores were also calculated by subtracting the pre-test scores from the post-test scores on the respective variables. Analysis of the data are described under the sections

- Descriptive statistics of pre-test, post-test and gain scores on select Mathematical outcomes of eighth standard students
- Comparison of mean pre-test scores on select Mathematical outcomes among the three groups of eighth standard students

- Pairwise comparison of average pre-test and post-test scores on select Mathematical outcomes for the three groups of eighth standard students
- Multiple comparison of average post-test scores on select Mathematical outcomes among the three groups of eighth standard students
- Multiple comparison of average gain scores on select Mathematical outcomes among the three groups of eighth standard students

Descriptive Statistics of Pre-test, Post-test and Gain Scores on Select Mathematical Outcomes of Eighth Standard Students

Descriptive statistics of the variables Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics were calculated for pre-test scores, post-test scores and gain scores.

Descriptive Statistics of Pre-test Scores on Select Mathematical Outcomes of Eighth Standard Students

The mean, median, mode, standard deviation, skewness and kurtosis of the pre-test scores on the variables Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics of eighth standard students are presented in table 18.

Table 18

Statistical Constants of the Pre-test Scores on Select Mathematical Outcomes (Standard VIII)

Variable	Mean	Median	Mode	S D	Skewness	Kurtosis
Problem Solving Ability in Mathematics	7.11	7	8	2.82	0.18	-0.46
Mathematics Belief (Exploratory)	7.19	7	7	2.79	0.16	-0.51
Attitude Towards Mathematics	91.7	90	80	10.1	0.005	-0.79
Mathematics Anxiety	91.2	93	99	15.6	-0.38	-0.44
Achievement in Mathematics	0.126	0	0	0.36	2.86	8.01

Table 18 shows that the values of mean, median and mode of Problem-solving ability in Mathematics are almost equal (Mean=7.11, Median=7, Mode=8). The standard deviation of the variable shows that the scores are not much dispersed from the central value. The distribution is slightly positively skewed with a value of 0.18, which indicates that there is a tendency for the scores to accumulate at the lower end. But a low value of skewness indicates the distribution is almost symmetric. The negative value of kurtosis (-0.46) indicates a slight platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of pre-test scores on Problem Solving Ability in Mathematics can be considered as normal.

For Mathematics belief (Exploratory), the obtained values of mean, median and mode are 7.19, 7, and 7 respectively. The standard deviation of the variable (2.79) shows that the scores are not much dispersed from the central value. The value of skewness is positive but a low value (0.16) indicates the distribution of Mathematics belief (Exploratory) scores (pre-test) is symmetric. A negative value of kurtosis (-0.51) indicates a slightly platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of pre-test scores on Mathematics belief (Exploratory) is normal.

The mean, median and mode of pre-test scores on Attitude towards Mathematics are 91.7, 90 and 80 respectively with standard deviation 10.1. Mean and median of the scores are almost equal, but the mode is lower than the other two values. The value obtained for standard deviation shows the possibility of the scores to be widely spread from the mean score. A negligible value of skewness (0.005) indicates the symmetry of the distribution. The value of kurtosis (-0.79) is negative but a small value indicates the distribution is mesokurtic. Hence the distribution of the pre-test scores on Attitude towards Mathematics can be considered as not highly deviating from normality.

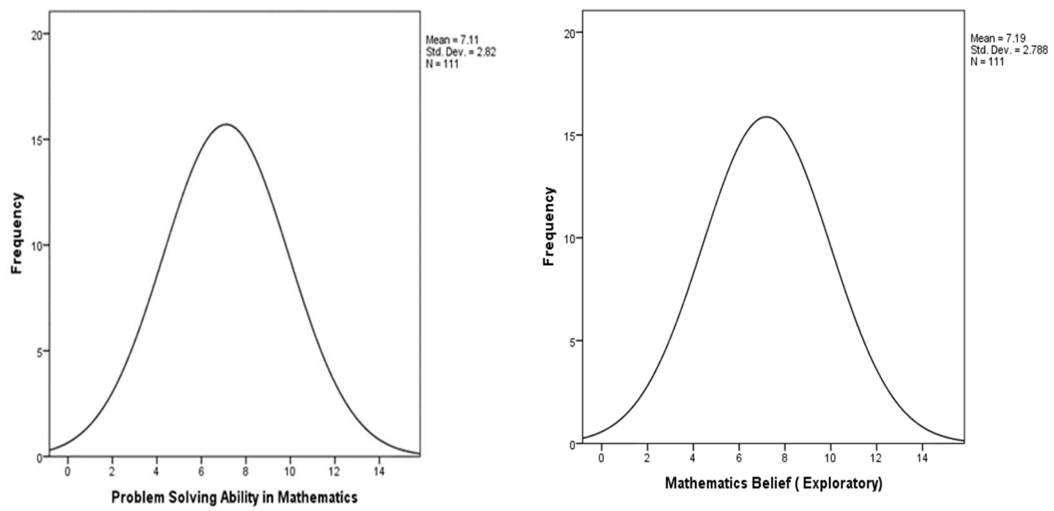
The measures of central tendency of pre-test scores on Mathematics Anxiety are Mean=91.2, Median=93 and Mode=99. The standard deviation of the variable (15.6) shows that the scores are dispersed to some extent from the central value. The distribution is slightly negatively skewed with a value of -0.38, the low value indicates negligible skewness of the distribution. The negative value of kurtosis (-0.44) indicates a slight platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of pre-test scores on Mathematics anxiety can be considered as not highly deviating from normality.

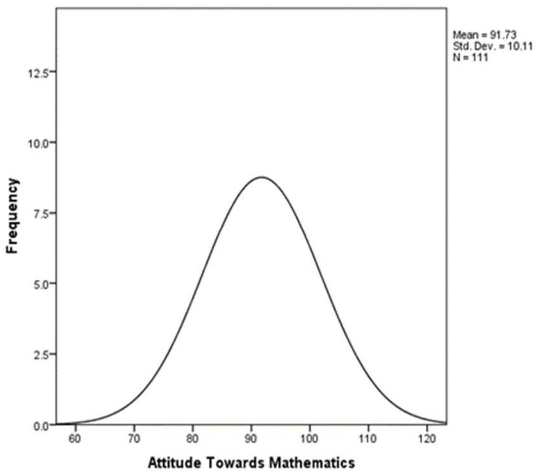
The measures of central tendency of pre-test scores on Achievement in Mathematics (Mean=0.126, Median=0, Mode=0) are almost equal. Standard deviation of the variable (0.36), shows that the scores tend to be closer to the mean. The value of skewness (2.86) and kurtosis (8.01) are high. The distribution is positively skewed and leptokurtic. From the above discussion it is clear that the distribution of pre-test scores on achievement in Mathematics deviates from normality.

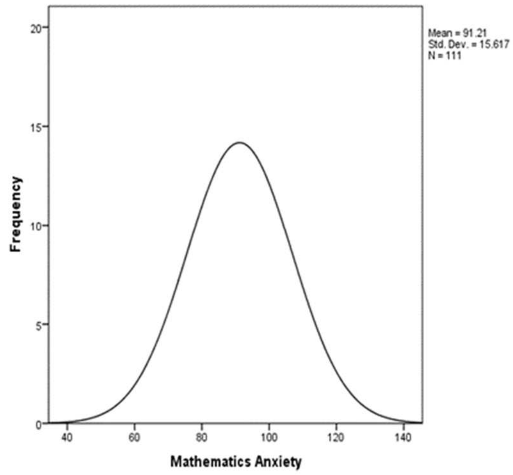
Findings of the descriptive analysis done for pre-test scores on select Mathematical Outcomes of eighth standard students are supported by the smoothed frequency curves drawn for the data which is presented as figure 5.

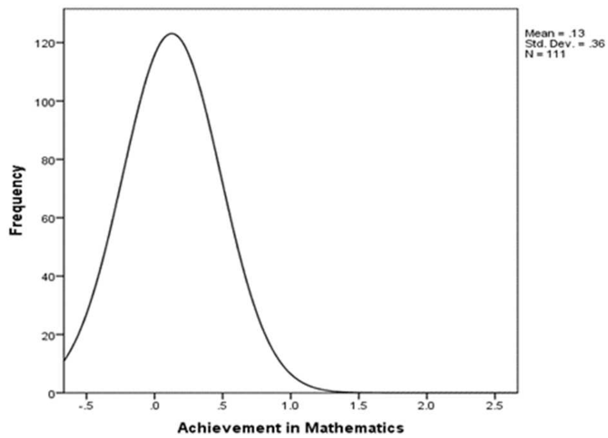
Figure 5

Smoothed Frequency Curves of the Distribution of Pre-test Scores on Select Mathematical Outcomes of Eighth Standard Students









Distribution of all the select Mathematical outcomes except Achievement in Mathematics (Pre-test) are normal, but Achievement in Mathematics (Pre-test) is not normally distributed, it is positively skewed and leptokurtic.

Descriptive Statistics of Post-test Scores on Select Mathematical Outcomes of Eighth Standard Students

The mean, median, mode, standard deviation, skewness, and kurtosis of the post-test scores on the variables were calculated and are presented in table 19.

Table 19

Statistical Constants of the Post-test Scores on Select Mathematical Outcomes (Standard VIII)

Variable	Mean	Median	Mode	SD	Skewness	Kurtosis
Problem Solving Ability in Mathematics	9.72	10	8	3.02	0.27	-0.77
Mathematics Belief (Exploratory)	9.38	9	9	3.05	-0.13	-0.32
Attitude Towards Mathematics	106	104	100	12.2	0.20	-0.43
Mathematics Anxiety	78.8	81	90	14	-0.36	-0.40
Achievement in Mathematics	11.6	11	10	4.61	0.25	-0.53

Table 19, shows that the measures of central tendency of post-test scores on Problem-solving ability in Mathematics are almost equal (Mean=9.72, Median=10, Mode=8). The standard deviation of the variable (3.02) shows that the scores are not much deviated from the central value. The distribution is slightly positively skewed with a value of 0.27, low value of skewness indicates the distribution is almost symmetric. The negative value of kurtosis (-0.77) indicates a slightly platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of post-test scores on Problem Solving Ability in Mathematics can be considered as normal.

For Mathematics belief (Exploratory), the obtained value of mean, median and mode are 9.38, 9 and 9 respectively which are almost equal. Standard deviation of the variable (3.05) shows that the scores are not much dispersed from the central value.

The value of skewness is negative (-0.13), but a low value of skewness indicates the distribution of Mathematics belief (Exploratory) is approximately normal. A negative value of kurtosis (-0.32) indicates a slightly platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Hence the distribution of post-test scores on Mathematics belief (Exploratory) is approximately normal.

The mean, median and mode of post-test scores on Attitude towards Mathematics are 106, 104 and 100 respectively with standard deviation 12.2. The value obtained for standard deviation shows the possibility of the scores to be widely spread from the mean score. A negligible positive value of skewness (0.20) indicates the symmetry of the distribution. The value of kurtosis (-0.43) is negative but a small value indicates the distribution is almost mesokurtic. Hence the distribution of post-test scores on the variable Attitude towards Mathematics can be considered as not deviating from normality.

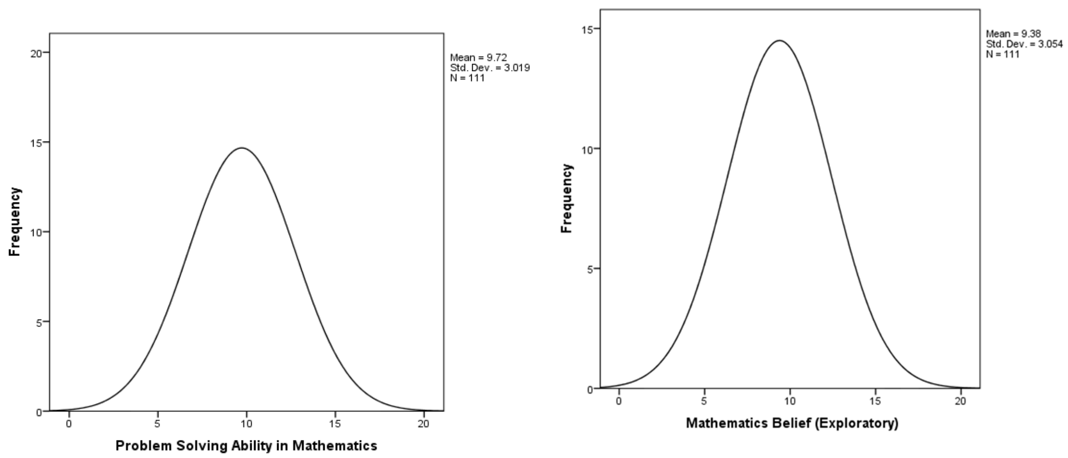
The measures of central tendency of post-test scores on Mathematics Anxiety are Mean=78.8, Median=81 and Mode=90. The standard deviation of the variable (14) shows that the scores are widely spread from the mean. The value of skewness is -0.36, a low value indicating symmetry of the distribution. Though the value of kurtosis is negative indicating a platykurtic distribution, a small value (-0.40) shows that the distribution can be considered as mesokurtic. Thus, the distribution of post-test scores on Mathematics anxiety can be considered as normal.

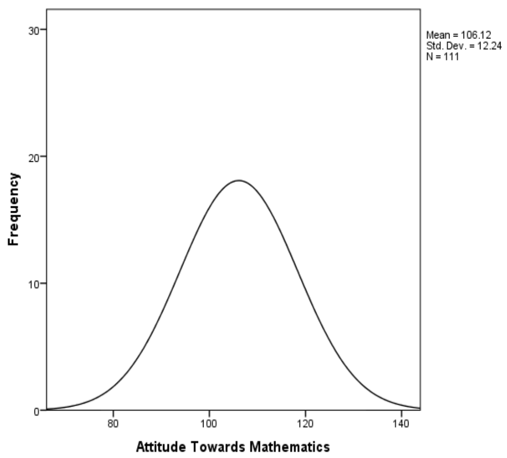
The measures of central tendency of post-test scores on Achievement in Mathematics (Mean=11.6, Median=11, Mode=10) are almost equal. Standard deviation of the variable (4.61), shows that the scores are not much dispersed from the central value. The value of skewness (0.25) and kurtosis (-0.53) are very small. These values show that the distribution is almost symmetric and mesokurtic. From the above discussion, the distribution of post-test scores on the variable Achievement in Mathematics can be considered as normal.

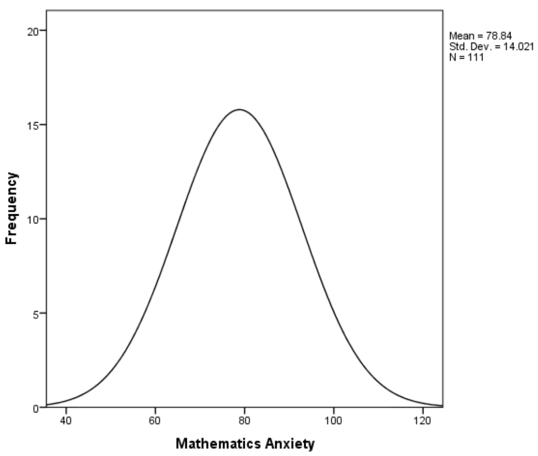
Smoothed frequency curves drawn to support the findings of descriptive analysis for post-test scores on select Mathematical Outcomes of eighth standard students are presented as figure 6.

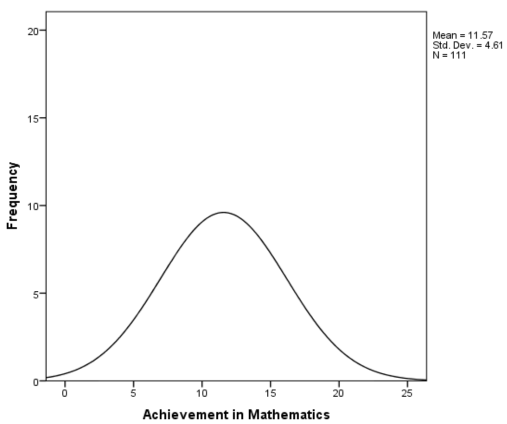
Figure 6

Smoothed Frequency Curves of the Distribution of Post-test Scores on Select Mathematical Outcomes of Eighth Standard Students









The smoothed frequency curves show that the post-test scores on the variables follow normal distribution.

Descriptive Statistics of Gain Scores on Select Mathematical Outcomes of Eighth Standard Students

The mean, median, mode, standard deviation, skewness and kurtosis of the gain scores on select Mathematical Outcomes were calculated and are presented in table 20.

Table 20

Statistical Constants of the Gain Scores on Select Mathematical Outcomes (Standard VIII)

Variable	Mean	Median	Mode	S D	Skewness	Kurtosis
Problem Solving Ability in Mathematics	2.61	3	3	2.36	0.29	0.59
Mathematics Belief (Exploratory)	2.13	2	0	2.17	0.51	0.52
Attitude Towards Mathematics	14.4	13	10	8.37	0.46	-0.7
Mathematics Anxiety	-12.4	-12	-16	8.94	-0.12	-0.43
Achievement in Mathematics	11.4	11	10	4.52	0.19	-0.47

From table 20, one can observe that the measures of central tendency of the gain scores on Problem-solving ability in Mathematics are almost equal (Mean= 2.61, Median=3, Mode=3). Standard deviation of the variable (2.36) shows that the scores are not much dispersed from the central value. The distribution is slightly positively skewed with a value of 0.29, low value of skewness indicates the distribution is almost symmetric. The positive value of kurtosis (0.59) indicates a slightly leptokurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of gain scores on Problem Solving Ability in Mathematics can be considered as normal.

For Mathematics belief (Exploratory), the obtained values of mean, median and mode are 2.13, 2 and 0 respectively. Standard deviation of the variable (2.17) shows that the scores are not much dispersed from the central value. The value of skewness is positive (0.51), but a low value of skewness indicates the distribution of

Mathematics belief (Exploratory) gain scores is approximately symmetric. A positive value of kurtosis (0.52) indicates a slightly leptokurtic distribution, but the value is less than one, so the distribution can be considered as mesokurtic. Thus, the distribution of gain Scores on Mathematics belief (Exploratory) is approximately normal.

The mean, median and mode of gain scores on Attitude towards Mathematics are 14.4, 13 and 10 respectively with standard deviation 8.37. The value obtained for standard deviation shows the possibility of the scores to be slightly spread from the mean score. A negligible positive value of skewness (0.46) indicates the symmetry of the distribution. The value of kurtosis (-0.7) is negative but a small value shows the possibility of the distribution to be mesokurtic. Hence the distribution of the gain scores on Attitude towards Mathematics can be considered as not deviating from normality.

The measures of central tendency of gain scores on Mathematics Anxiety are Mean= -12.4, Median= -12, and Mode= -16. The standard deviation of the variable (8.94) shows that the scores are slightly dispersed from the central value. Very small value of skewness (-0.12) indicates symmetry of the distribution. The negative value of kurtosis (-0.43) indicates a slightly platykurtic distribution, but the value is very small, hence the distribution can be considered as mesokurtic. Thus, the distribution of gain scores on Mathematics anxiety can be considered as normal.

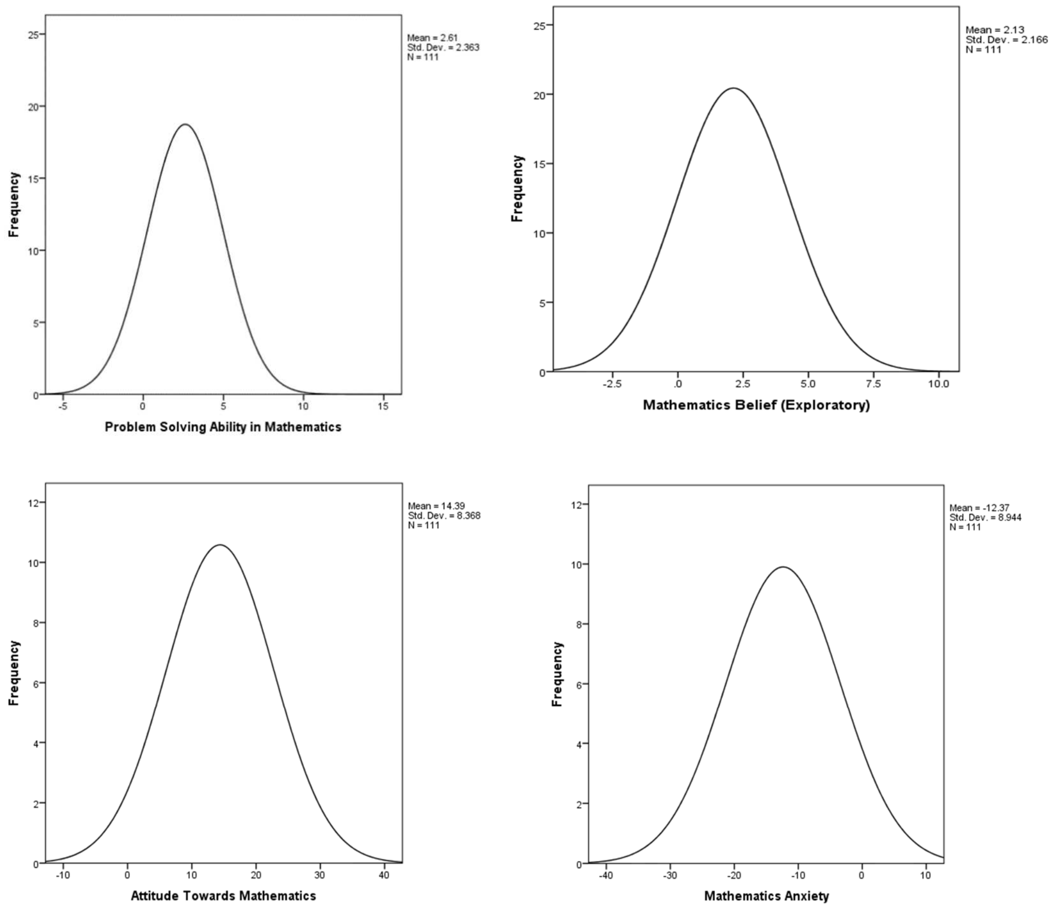
The measures of central tendency of the gain scores on Achievement in Mathematics (Mean=11.4, Median=11, Mode=10) are almost equal. The standard deviation of the variable (4.52), shows that the scores are not much dispersed from the central value. The value of skewness (0.19) and kurtosis (-0.47) are very small.

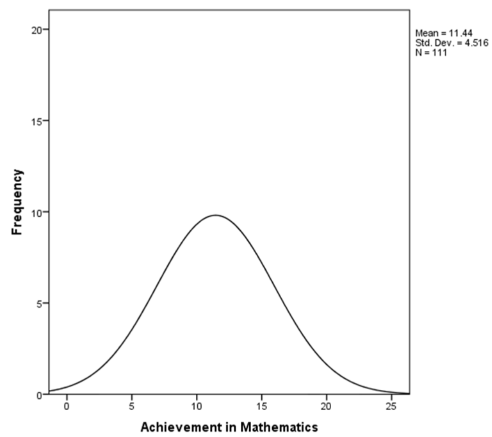
The values show that the distribution is almost symmetric and mesokurtic. From the above discussion, the distribution of gain scores on Achievement in Mathematics can be considered as normal.

Findings of the descriptive analysis for gain scores on select Mathematical Outcomes of eighth standard students are supported by the smoothed frequency curves drawn for the data which are presented as figure 7.

Figure 7

Smoothed Frequency Curves of the Distribution of Gain Scores on Select Mathematical Outcomes (Standard VIII)





Normality of the distribution of the gain scores on select Mathematical outcomes are clear from these smoothed frequency curves.

Discussion of Results

The above discussion shows that the pre-test, post-tests scores and gain scores on select Mathematical Outcomes viz., Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety are normally distributed but the distribution of Pre-test scores on Achievement in Mathematics cannot be considered as normal. The post-test and gain scores on Achievement in Mathematics are normally distributed. This finding is logically correct as per the operational definition of Achievement in Mathematics. In the present study, Achievement in Mathematics stands for the scores obtained by the respondents in an Achievement test, the learning outcomes measured being purely based on the content taught as part of the experiment.

Comparison of Mean Pre-test Scores on Select Mathematical Outcomes among the Three Groups of Eighth Standard Students

Arithmetic mean of the pre-test scores on select Mathematical Outcomes of the three groups (Eighth standard) were compared using one-way ANOVA and Kruskal-Wallis Test.

Comparison of Mean Pre-test scores on Select Mathematical Outcomes (Except Achievement in Mathematics) among the Three Groups of Eighth Standard Students

To know whether the three comparison groups viz., Art Integrated Information Processing Model group (AIIPM group), Information Processing Model group (IPM group) and the group taught with the Present method of teaching (Group 3) are equal in their entry level behaviour with respect to select Mathematical Outcomes, one-way ANOVA was executed except for pre-test scores on Achievement in Mathematics, the distribution of which is found to be deviating from normality.

Details of the analysis done are given in table 21.

Table 21

Details of ANOVA on Pre-test Scores on select Mathematical Outcomes (Except Achievement in Mathematics) of Comparison Groups (Standard VIII)

Variable	Group	N	Mean	SD	df 1	df 2	F	Level of Significance
Problem Solving Ability in Mathematics	AIIPM	36	6.03	2.83	2	71.5	4.09	.05
	IPM	36	7.81	2.73				
	Group 3	39	7.46	2.65				
Mathematics Belief (Exploratory)	AIIPM	36	8.03	2.92	2	71.4	3.07	NS
	IPM	36	6.47	2.35				
	Group 3	39	7.08	2.90				
Attitude Towards Mathematics	AIIPM	36	93.14	9.01	2	71.3	1.20	NS
	IPM	36	92.39	11.2				
	Group 3	39	89.82	9.98				
Mathematics Anxiety	AIIPM	36	87.42	14.41	2	71.1	4.00	.05
	IPM	36	97.36	16.78				
	Group 3	39	89.03	14.18				

From table 21, one can see that the F value obtained for pre-test scores on Problem solving ability in Mathematics is 4.09 with (2, 71.5) degrees of freedom. This value indicates that the mean difference in Problem solving ability in Mathematics (Pre-test) is significant at .05 level.

The F value obtained for pre-test scores on Mathematics belief (Exploratory) is 3.07 with (2,71.4) degrees of freedom. This value indicates that the mean difference in entry level of Mathematics belief (Exploratory) is not significant at .05 level.

The F value obtained for pre-test scores on Attitude towards Mathematics is 1.20 with (2,71.3) degrees of freedom. This value indicates that the three groups do not differ significantly in their entry level of Attitude towards Mathematics ($p > .05$).

The F value obtained for pre-test scores on Mathematics anxiety is 4 with (2,71.1) degrees of freedom. This value indicates that the mean difference in entry level Mathematics anxiety of the three groups is significant at .05 level.

To determine which groups do differ in their entry level with regard to Problem solving ability in Mathematics and Mathematics anxiety, Post-hoc comparison (Tukey method) was done. All pairwise comparisons among the three groups were examined and the results of the same are given in table 22.

Table 22

Mean Difference and Level of Significance as per Tukey Post-hoc Test (Standard VIII)

Variable	Group	AIIPM	IPM	Group 3
Problem Solving Ability in Mathematics	AIIPM		-1.78 (.05)	-1.434 (NS)
	IPM			0.344 (NS)
Mathematics Anxiety	AIIPM		-9.94 (.05)	-1.61 (NS)
	IPM			8.34 (.05)

Results of Post-hoc analysis using Tukey method (Table 22) shows that the AIIPM and IPM groups differ in their mean pre-test score in Problem solving ability in Mathematics ($p \leq .05$), but the two groups do not differ significantly from the group 3 in their mean pre-test score in Problem solving ability in Mathematics. A close observation of the mean values revealed that the group selected for Art Integrated Information Processing Model is slightly lower in their entry-level on problem-solving ability.

Also, the group 2 (IPM) differ in their mean pre-test score in Mathematics anxiety ($p \leq .05$) from the other two groups and is slightly higher in their Mathematics anxiety compared to other groups.

Comparison of Mean Pre-test Scores on Achievement in Mathematics among the Three Groups of Eighth Standard Students

The descriptive statistics of pre-test scores on Achievement in Mathematics and the smoothed frequency curve reveal that the assumption of normality of pre-test scores on Achievement in Mathematics is violated. Hence Kruskal-Wallis test, the non- parametric test parallel to ANOVA, was executed to know whether the groups differ in their initial level of Achievement in Mathematics. The details are given in table 23.

Table 23

Details of Kruskal-Wallis Test for Pre-test Scores on Achievement in Mathematics (Standard VIII)

Variable	χ^2	df	Significance level
Achievement in Mathematics	2.63	2	NS

The χ^2 value (2df) obtained is 2.63, which is less than the tabled value of χ^2_{2df} (5.991). Hence the null hypothesis, the three groups are selected from the same population with respect to Achievement in Mathematics (Pre-test) was accepted. That is, the three groups do not differ in the pre-test scores on Achievement in Mathematics. The initial level of Achievement in Mathematics can be considered as equal in the three groups.

Discussion of Results

The above analyses of mean scores revealed that the three groups are almost the same in the mean scores on Pre-tests of Mathematics belief (Exploratory), Attitude towards Mathematics, and Achievement in Mathematics, but AIIPM group has a lower mean score in Problem solving ability in Mathematics, and the IPM group has a higher mean score in Mathematics anxiety. But the difference is not very high and therefore it will not be affecting the experiment. Also, the initial status of comparison groups 1 and 2 are lower in Problem solving ability in Mathematics and high in Mathematics anxiety compared to group 3. This ensures the internal validity of the experiment conducted on eighth standard students.

Pairwise Comparison of Average Pre-test and Post-test Scores on Select Mathematical Outcomes for the Three Groups of Eighth Standard Students

To know the effectiveness of the models to improve Mathematical outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety of eighth standard students, paired t-test was used. The details are given below under separate headings.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Problem Solving Ability in Mathematics for the Three Groups of Eighth Standard Students

The mean of the pre-test and post-test scores for the variable Problem solving ability in Mathematics of the three groups were compared. For this the mean of pre-test scores on the variable was compared with that of post-test scores for the three groups using paired-test of mean comparison for large samples. The null hypotheses tested are

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of AIIPM group.'

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of IPM group.'

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of group taught with Present method of teaching.'

The details of the tests are given in table 24.

Table 24

Details of Paired t-test for Problem Solving Ability in Mathematics for the Three Groups (Standard VIII)

Variable	Group	Test	Mean	S D	N	t	Effect size
Problem solving ability in Mathematics	AIIPM	Pre	6.03	2.83	36	10.69	1.782
		Post	9.89	2.94	36		
	IPM	Pre	7.81	2.73	36	7.92	1.32
		Post	10.69	2.77	36		
	Group 3	Pre	7.46	2.65	39	3.83	0.614
		Post	8.67	3.05	39		

Table 24, shows that the t-value obtained for Problem solving ability in Mathematics when the pre-test and post-test mean scores are compared for the first comparison group (AIIPM) is 10.69. A score greater than 2.58 indicates that the pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of AIIPM group' is rejected.

A higher mean score for post-test indicates that teaching with Art Integrated Information Processing Model increases Problem solving ability in Mathematics of eighth standard students. The effect size obtained is 1.782, meaning that the mean difference of the two mean scores is 1.782 times the standard deviation. A value greater than 1.3 indicates that the effect size is very large. That is, teaching with Art Integrated Information Processing Model has a very large effect on Problem solving ability in Mathematics among eighth standard students.

For the second group (IPM), t-value obtained for Problem solving ability in Mathematics when the pre-test and post-test mean scores are compared is 7.92, which is greater than 2.58. This implies that the two mean scores differ significantly. That is, the pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of IPM group' is rejected.

A higher mean score for post-test indicates that the Information Processing Model improves Problem solving ability in Mathematics of eighth standard students. The effect size obtained is 1.32, meaning that the mean difference of the two mean scores is 1.32 times the standard deviation. An effect size of 1.32 indicates a very large effect. That is, Information Processing Model has a very large effect on Problem solving ability in Mathematics.

For group 3, t-value obtained for Problem solving ability in Mathematics when the pre-test and post-test mean scores are compared is 3.83, which is greater than 2.58. This reveals that the difference in pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Present method of teaching is not due to chance ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of group taught with Present method of teaching' is rejected.

A higher mean score for post-test indicates that the Present method of teaching increases Problem solving ability in Mathematics of eighth standard students. The effect size obtained is 0.614, meaning that the difference of the two mean scores is 0.614 times the standard deviation. An effect size of 0.614 indicates a moderate effect. That is, the Present method of teaching has a moderate effect on Problem solving ability in Mathematics.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective to develop Problem solving ability in Mathematics among eighth standard students. But Art Integrated Information Processing Model and Information Processing Model have a very large effect and the Present method of teaching has only a moderate effect on Problem solving ability in Mathematics among eighth standard students. The reason may be the systematic way of dealing with problems and the reflection of the process in Information Processing Model. Art integration may help the students to understand the problem more clearly.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Mathematics Belief (Exploratory) for the Three Groups of Eighth Standard Students

Arithmetic mean of the variable Mathematics belief (Exploratory) of three groups of eighth standard students were compared for the pre-test and post-test scores. For this the mean of pre-test scores on the variable was compared with that of post-test scores for the three groups using paired-test of mean comparison for large samples. The null hypotheses tested are

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of AIIPM group.'

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of IPM group.'

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of group taught with Present method of teaching.'

The details of testing these hypotheses are given in table 25.

Table 25

Details of Paired t-test for Mathematics Belief (Exploratory) for the Three Comparison Groups (Standard VIII)

Variable	Group	Test	Mean	S D	N	t	Effect size
Mathematics Belief (Exploratory)	AIIPM	Pre	8.03	2.92	36	5.52	0.92
		Post	9.86	2.61	36		
	IPM	Pre	6.47	2.35	36	6.13	1.02
		Post	8.67	2.93	36		
	Group 3	Pre	7.08	2.90	39	6.05	0.969
		Post	9.59	3.48	39		

Table 25, shows that the t-value obtained for Mathematics belief (Exploratory) when the pre-test and post-test mean scores are compared for the first comparison group (AIIPM) is 5.52. A value greater than 2.58 indicates that the pre- and post-test mean scores on Mathematics belief (Exploratory) of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of AIIPM group' is rejected.

A higher mean score for post-test indicates that Art Integrated Information Processing Model is effective in bringing out Mathematics belief (Exploratory) among eighth standard students. The effect size obtained is 0.92, meaning that the difference of the two mean scores is 0.92 times the standard deviation. A value greater than 0.8 indicates a large effect size. That is, Art Integrated Information Processing Model has a large effect on Mathematics belief (Exploratory).

When the pre-test and post-test mean scores of the second comparison group (IPM) in Mathematics belief (Exploratory) are compared, the t-value obtained is 6.13, a value greater than 2.58 indicating that the pre- and post-test mean scores in Mathematics belief (Exploratory) of students taught with Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of IPM group' is rejected.

A higher mean score for post-test indicates that Information Processing Model improves Mathematics belief (Exploratory) among eighth standard students. The effect size obtained is 1.02, meaning that the difference of the two mean scores is 1.02 times the standard deviation. An effect size of 1.02 indicates a large effect. That is, Information Processing Model has a large effect on Mathematics belief (Exploratory).

For the Comparison Group 3, t-value obtained for Mathematics belief (Exploratory) when the pre-test and post-test mean scores are compared is 6.05, which is greater than 2.58. The value indicates that the pre- and post-test mean scores in Mathematics belief (Exploratory) of students taught with Present method of teaching differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of group taught with Present method of teaching' is rejected. A higher mean score for post-test indicates that Present method of teaching is effective in developing Mathematics belief (Exploratory) among eighth standard students. The effect size obtained is 0.969, meaning that the difference of the two mean scores is 0.969 times the standard deviation. An effect size of 0.969 indicates a large effect. That is, the Present method of teaching has a large effect Mathematics belief (Exploratory).

A cross examination of numbers of students having the systematic, exploratory and utilitarian belief about Mathematics before and after experiment was done. The details are given in table 26.

Table 26

Number of Students having the Systematic, Exploratory and Utilitarian Belief about Mathematics Before and After Experiment (Standard VIII)

Group	Belief System					
	Systematic		Exploratory		Utilitarian	
	Pre	Post	Pre	Post	Pre	Post
AIIPM	8	6	16	22	12	8
IPM	12	7	7	18	17	11
Group 3	9	8	14	21	16	10

Number of students who have Exploratory belief has increased in all the three groups. Information Processing Model is more effective compared to Art Integrated Information Processing Model and Present method of teaching in bringing exploratory belief in Mathematics among eighth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective in developing Exploratory Mathematics belief among eighth standard students. But the Information Processing Model has a greater effect compared to Art Integrated Information Processing Model and Present method of teaching. Also, the Present method of teaching is more effective than AIIPM for developing Mathematics belief (Exploratory) among eighth standard students. Information Processing Model is effective in developing exploratory belief in Mathematics, but when Art is integrated with the model, it becomes less effective, may be because integration of art in the Information processing reduces the chance to know the real nature of Mathematics.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Attitude Towards Mathematics for the Three Groups of Eighth Standard Students

A comparison of the pre- and post-test mean scores on Attitude towards Mathematics was done for the three groups using paired-test of mean comparison for large samples. The null hypotheses tested are

'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of AIIPM group.'

'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of IPM group.'

'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of the group taught with Present method of teaching.'

Details of the paired t-test is given in table 27.

Table 27

Details of Paired t-test for Attitude towards Mathematics of the Three Groups (Standard VIII)

Variable	Group	Test	Mean	S D	N	t	Effect size
Attitude Towards Mathematics	AIIPM	Pre	93.1	9.01	36	8.44	1.406
		Post	108.2	10.30	36		
	IPM	Pre	92.39	11.20	36	14.98	2.50
		Post	109.03	11.94	36		
	Group 3	Pre	89.52	9.98	39	11.07	1.773
		Post	101.51	13.06	39		

Table 27, shows that the t-value obtained for Attitude towards Mathematics when the pre-test and post-test mean scores are compared for the first group (AIIPM) is 8.44, which is greater than 2.58, indicating a significant difference between the two mean scores ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of AIIPM group' is rejected.

A higher mean score for post-test indicates that the Art Integrated Information Processing Model improves Attitude towards Mathematics among eighth standard students. At the initial level the mean score was 93.1 (< 96) but after learning through Art Integrated Information Processing Model, it has increased to 108.2 (>96) indicating that Art Integrated Information Processing Model is efficient in changing negative Attitude towards Mathematics to positive attitude among eighth standard students.

The effect size calculated suggests that the difference of the two mean scores is 1.406 times the standard deviation. The effect size is greater than 1.3 and so the effect is very large. That is, Art Integrated Information Processing Model has a very large effect on Attitude towards Mathematics among eighth standard students.

In the case of students taught with Information Processing Model, t-value obtained is 14.98, indicating that the difference in pre- and post-test mean scores in Attitude towards Mathematics of students taught with Information Processing Model is significant ($p \leq .01$). This leads to rejection of the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of IPM group'.

Thus, Information Processing Model is effective in developing Attitude towards Mathematics among eighth standard students as the post-test mean score is higher than that of pre-test. At the initial level the mean score was 92.39 (<96) but after learning through Information Processing Model, it has increased to 109.03 (>96) indicating that the Information Processing Model is efficient in changing negative Attitude towards Mathematics to positive attitude among eighth standard students. The effect size (2.5), shows that the difference of the two mean scores is 2.5 times the standard deviation. Also, the Information Processing Model has a very large effect on Attitude towards Mathematics.

For the group taught with Present method of teaching, t-value obtained is 11.07, indicating that the pre- and post-test mean scores in Attitude towards Mathematics of students taught with existing method differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of the group taught with Present method of teaching' is rejected.

A higher mean score for post-test indicates that the existing method of teaching improves Attitude towards Mathematics of eighth standard students. At the initial level the mean score was 89.52 (<96) but after learning through the Present method of teaching, it has increased to 101.51 (>96) indicating that Present method of teaching is efficient in changing negative Attitude towards Mathematics to positive attitude among eighth standard students.

As the effect size obtained is 1.773, the difference of the two mean scores is 1.773 times the standard deviation and the existing method of teaching has a very large effect on Attitude towards Mathematics among eighth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective to improve Attitude towards Mathematics among eighth standard students, Information Processing Model being the most effective one. Also, the finding indicates that when art is integrated with Information Processing Model, its effectiveness in developing attitude towards Mathematics is reduced and Present method of teaching is found to be better than Art Integrated Information Processing Model in developing attitude towards the subject. This again may be due to integration of art to the model reduces the chance to reveal the nature of Mathematics for eighth standard students.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Mathematics Anxiety for the Three Groups of Eighth Standard Students

*C*omparison of mean scores obtained for the pre- and post-test of Mathematics anxiety of the three comparison groups were done using paired t-test of mean comparison for large samples. The null hypotheses tested are

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of AIIPM group.'

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of IPM group.'

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of the group taught with Present method of teaching.'

The details of analysis of data to test these hypotheses are given in table 28.

Table 28

Details of Paired t-test for Mathematics Anxiety for the Three Groups (*Standard VIII)*

Variable	Group	Test	Mean	S D	N	t	Effect size
Mathematics Anxiety	AIIPM	Pre	87.4	14.4	36	9.75	1.626
		Post	72.7	13.9	36		
	IPM	Pre	97.36	16.78	36	11.52	1.92
		Post	81.33	13.29	36		
	Group 3	Pre	89.03	14.18	39	6.58	1.054
		Post	82.23	13.21	39		

Table 28, shows that the t-value obtained for Mathematics anxiety when the pre-test and post-test mean scores are compared for the first comparison group (AIIPM) is 9.75. A score greater than 2.58 indicates that the pre- and post-test mean scores in Mathematics anxiety of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence, the null hypothesis ‘There is no significant mean difference in pre-test and post-test scores on Mathematics anxiety of AIIPM group’ is rejected.

A low mean score for post-test indicates that Art Integrated Information Processing Model decreases Mathematics anxiety of eighth standard students. The effect size obtained is 1.626, so the mean difference of the two sets of scores is 1.626 times the standard deviation. A value greater than 1.3 indicates a very large effect. That is, Art Integrated Information Processing Model has a very large effect in reducing Mathematics anxiety.

The t-value obtained for IPM group is 11.52, which is greater than 2.58. The value indicates that the pre- and post-test mean scores in Mathematics anxiety of students taught with Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis ‘There is no significant mean difference in pre-test and post-test scores on Mathematics anxiety of IPM group’ is rejected.

A low mean score for post-test indicates that teaching with Information Processing Model decreases Mathematics anxiety of eighth standard students. The effect size obtained is 1.92, meaning that the mean difference is 1.92 times the standard deviation. An effect size of 1.92 indicates a very large effect. That is, teaching with IPM has a very large effect on Mathematics anxiety.

In Group 3, t-value obtained for Mathematics anxiety when the pre-test and post-test mean scores are compared is 6.58, which is greater than 2.58, indicating a significant mean difference in the pre-test and post-test scores in Mathematics anxiety of students taught with present method ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of the group taught with Present method of teaching' is rejected.

A low mean score for post-test indicates that the Present method of teaching decreases Mathematics anxiety among eighth standard students. The effect size obtained is 1.054, meaning that the mean difference is 1.054 times the standard deviation. An effect size of 1.054 indicates a large effect. That is, Present method of teaching has a large effect on Mathematics anxiety among eighth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective in reducing Mathematics anxiety among eighth standard students. But Art Integrated Information Processing Model and Information Processing Model have very large effect and the Present method of teaching has large effect on Mathematics Anxiety among eighth standard students. Information Processing Model is found to be better than the other two treatments for reducing Mathematics anxiety among eighth standard students. The reason may be the same as that of belief and attitude.

Pairwise Comparison of Average Scores of Pre-test and Post-test on Achievement in Mathematics for the Three Groups of Eighth Standard Students

The average scores on pre- and post-tests on Achievement in Mathematics of each of the three groups were compared using Wilcoxon signed- rank test, the non-parametric test alternative to paired t -test. The null hypothesis tested is

'The median of differences between the pre-test and post-test scores on Achievement in Mathematics is zero in the three Comparison groups.'

The details of the test are given in table 29.

Table 29

Details of Wilcoxon Signed - Rank Test for Achievement in Mathematics for the Three Comparison Groups (Standard VIII)

Variable	Group	Test	Median	N	z	p	Effect size
Achievement in Mathematics	AIIPM	Pre	0	36	5.24	.01	.873
		Post	12	36			
	IPM	Pre	0	36	5.24	.01	.873
		Post	7.50	36			
	Group 3	Pre	0	39	5.46	.01	.874
		Post	6.50	39			

Table 29, shows that the z-value obtained for Achievement in Mathematics when the pre-test and post-test scores are compared for the first comparison group (AIIPM) is 5.24. The result shows that the median of difference between pre-test and post-test scores in Achievement in Mathematics of students taught with Art Integrated Information Processing Model is non-zero ($p \leq .01$).

For the second group (IPM), z-value obtained is 5.24 which shows that the median of difference between pre-test and post-test scores in Achievement in

Mathematics of students taught with Information Processing Model is non-zero ($p \leq .01$).

In group 3, z-value obtained is 5.46 which shows that the median of difference between pre-test and post-test scores in Achievement in Mathematics of students taught with the Present method of teaching is non- zero ($p \leq .01$). Hence the null hypothesis 'The median of differences between the pre-test and post-test scores on Achievement in Mathematics is zero in the three Comparison groups' is rejected.

The effect size obtained for the AIIPM, IPM and group 3 are .873, .873 and .874 respectively. All the values are greater than .8, suggesting that the three treatments, AIIPM, IPM, and Present method of teaching have a large effect on Achievement in Mathematics.

Discussion of Results. The three treatments, Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are equally effective in improving Achievement in Mathematics among eighth standard students. The three teaching strategies have a large effect on Achievement in Mathematics, likely because all effectively address cognitive and procedural skills essential for improving Achievement in Mathematics, leading to similar learning outcomes.

Multiple Comparison of Average of Post-test Scores on Select Mathematical Outcomes among the Three Comparison Groups of Eighth Standard Students

As there are multiple variables MANOVA (Multivariate Analysis of Variance) was executed to find out whether the treatments have any effect on the post-test scores on select Mathematical outcomes. MANOVA being a parametric test, certain assumptions are to be met, which are discussed below.

Independence

To satisfy this assumption, each observation must be sampled from the population without any influence from other observations. The independence of observations was ensured by selecting the three comparison groups randomly. Care was taken while administering the instruments to ensure independence in responding.

Random Sampling

Probability sampling method was used in the study by selecting the three comparison groups randomly. No special criteria were employed while selecting individuals in each group. Also, the school selected is not adopting homogeneous grouping in allotting students to various divisions.

Multivariate Normality

Multivariate normality was established using the Shapiro-Wilk Multivariate Normality test. The obtained Shapiro-Wilk statistics is .174 ($p > .05$), with a W statistic of 0.983, which shows that the multivariate distribution does not significantly deviate from normality.

Homogeneity of Covariance Matrices

To ensure the homogeneity of covariance matrices, Box's test of equality of covariance matrices was used. The obtained Box's M statistic, χ^2 value (20 df) is 23.29 ($p > .05$). Hence Problem solving ability in Mathematics, Mathematics belief

(Exploratory), Attitude towards Mathematics, and Mathematics anxiety satisfy homogeneity of covariance matrices.

Inclusion of Achievement in Mathematics leads to violation of the assumption of homogeneity of covariance matrices and hence Achievement in Mathematics was excluded from the list in the analysis by MANOVA.

After ensuring assumptions, MANOVA was executed to find out whether the three comparison groups differ significantly in their post-test scores on Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety. Post-test scores on these variables were considered to test the hypothesis ‘There is no significant difference in the post-test scores among the three groups on the Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.

Details of the Multivariate analysis for the model using post-test scores are given in table 30.

Table 30

Multivariate Test Result for the Model on Post-test Scores on Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard VIII)

	Value	F	Sig.	Partial Eta Squared
Pillai's trace	.286	4.42	.01	.143
Wilks' lambda	.734	4.40	.01	.143

From table 30, it can be observed that the multivariate test performed implies the model has significant effect on select Mathematical outcomes from both Pillai's trace (.286), $F_{(8, 212)} = 4.42$, and Wilk's lambda (.734), $F_{(8, 210)} = 4.4$, $p \leq .01$. The effect size represented by the partial eta squared (.143) indicates a high effect.

As the model is found to have significant effect on select Mathematical outcomes, univariate analysis was done. Details are presented in table 31.

Table 31

Univariate Test Values for Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Post-test) (Standard VIII)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Problem Solving ability in Mathematics	78.48	2	39.24	4.59	.05	.08
Mathematics Belief (Exploratory)	28.37	2	14.18	1.54	NS	.03
Attitude Towards Mathematics	1287.12	2	643.56	4.58	.05	.08
Mathematics Anxiety	2044.16	2	1011.08	5.64	.01	.095

The difference in the mean score on Problem solving ability in Mathematics (post-test) among the groups is significant at .05 level ($F_{(2,108)} = 4.59$, $p \leq .05$). The partial eta squared is .08 that shows that there is a moderate effect for the treatments on Problem solving ability in Mathematics.

In the case of Mathematics belief (Exploratory) (post-test), the difference in mean scores on Post-test on Mathematics Belief (Exploratory) among the three comparison groups is not significant ($F_{(2,108)} = 1.54$, $p > .05$).

There is significant mean difference in Attitude towards Mathematics (Post-test) among the groups under study ($F_{(2,108)} = 4.58$, $p \leq .05$). The partial eta squared is .08 that indicates moderate effect for the treatments on Attitude towards Mathematics.

In the case of post-test scores on Mathematics anxiety, the groups differ significantly ($F_{(2,108)} = 5.64$, $p \leq .01$). The value of partial eta squared shows (.095) a moderate effect for the treatments on Mathematics anxiety.

These results partially substantiate the null hypothesis ‘There is no significant mean difference in the post-test scores among the three groups on select Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.’ No significant difference is found in the case of Mathematics belief (Exploratory), but significant difference is reported in Problem solving ability in Mathematics, Attitude towards Mathematics and Mathematics anxiety.

As significant difference among the groups is reported for Problem solving ability in Mathematics, Attitude towards Mathematics and Mathematics anxiety, Post hoc analysis (Scheffe test) was done. The details of the follow up analysis is given in table 32.

Table 32

Mean Difference and Level of Significance as per Scheffe Post-hoc Test for Problem solving Ability in Mathematics, Attitude towards Mathematics and Mathematics Anxiety (*Standard VIII)*

Variable	Group	AIIPM	IPM	Present method of teaching
Problem Solving Ability in Mathematics	AIIPM		-.806 (NS)	1.22 (NS)
	IPM			2.03 (.05)
Attitude towards Mathematics	AIIPM		-.833 (NS)	6.682 (NS)
	IPM			7.515 (.05)
Mathematics Anxiety	AIIPM		-8.667 (.05)	-9.564 (.05)
	IPM			-.897 (NS)

In the case of Problem solving ability in Mathematics (post-test), AIIPM group does not differ significantly from the IPM group and Group 3, but significant difference exists between IPM group and group 3. Information Processing Model is more effective than the Present method of teaching for improving Problem solving ability in Mathematics (Mean score of IPM group=10.69, comparison group 3=8.67). Art Integrated Information Processing Model is equally effective as the Present method of teaching in developing Problem solving ability in Mathematics among eighth standard students.

In the case of Attitude towards Mathematics (post-test) there is no significant difference between the two comparison groups, AIIPM and IPM as well as AIIPM and comparison group 3, but significant difference exists between IPM group and comparison group 3. For improving Attitude towards Mathematics among eighth standard students, Information Processing Model is more effective than the Present method of teaching (Mean score of IPM group=109.03, comparison group 3=101.51). Art Integrated Information Processing Model is equally effective with Information Processing Model, but is not much effective than the Present method of teaching in developing Attitude towards Mathematics among eighth standard students.

In the case of Mathematics anxiety (post-test), the groups AIIPM and IPM as well as AIIPM and comparison group 3 differ significantly. But IPM and comparison group 3 do not differ significantly. For reducing Mathematics anxiety among eighth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=72.67, IPM group=81.33, Comparison group 3=82.23).

In the case of Achievement in Mathematics, Kruskal-Wallis test was executed to know whether the groups differ in the post-test scores on Achievement in Mathematics. The null hypothesis tested here is 'the three groups are selected from the same population with respect to Achievement in Mathematics (Post-test). The details are given in table 33.

Table 33

Details of Kruskal-Wallis Test for Post-test Scores on Achievement in Mathematics (Standard VIII)

Variable	χ^2	df
Achievement in Mathematics	4.34	2

The χ^2 value (2df) is 4.34, which is less than the tabled value of χ^2_{2df} (5.991). Hence the null hypothesis, 'the three groups are selected from the same population with respect to Achievement in Mathematics (Post- test)' is accepted. That is the three groups are equal in the post-test scores on Achievement in Mathematics. This shows that the three methods are equally effective in improving Achievement in Mathematics among eighth standard students.

Discussion of Results

Information Processing Model is more effective for improving Problem solving ability in Mathematics. Art Integration does not improve the efficiency of Information Processing Model in developing a positive Attitude towards Mathematics among eighth standard students. For reducing Mathematics anxiety among eighth standard students, Art Integrated Information Processing Model is more effective. The three teaching strategies are equally effective for developing exploratory belief and improving achievement in Mathematics among eighth standard students.

Multiple Comparison of Average Gain Scores on Select Mathematical Outcomes among the Three groups of Eighth Standard Students

MANOVA (Multivariate Analysis of Variance) was executed to find out whether the treatments have any effect on the gain scores on Mathematical Outcomes. Before performing MANOVA, the assumptions were tested for the gain scores of the variables, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety. Multivariate normality was tested using Shapiro-Wilk statistics (0.264, $p > .05$, with a W statistic of 0.985) and Homogeneity of covariance matrices was tested (Box's M statistic, χ^2_{2df} =26.73, p= .19). The results show no serious violations of the assumptions. When Achievement in Mathematics is included, the assumption of homogeneity of covariance matrices was violated and hence Achievement in Mathematics was excluded from the list for analysis by MANOVA.

After ensuring assumptions, MANOVA was executed to find out whether the three groups differ significantly in their gain scores on select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety. The hypothesis tested is 'There is no significant difference in the mean gain scores among the three comparison groups on Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.'

Details of the Multivariate analysis for the model using gain scores are given in table 34.

Table 34

Multivariate Test Result for the Model on Gain Scores on Select Mathematical Outcomes (Standard VIII)

	Value	F	Sig	Partial Eta Squared
Pillai's trace	.403	6.69	.01	.201
Wilks' lambda	.618	7.42	.01	.214

Table 34, shows that the model has significant effect on Mathematical Outcomes from both Pillai's trace (.403), $F_{(8, 212)} = 6.69$, and Wilk's lambda (.618), $F_{(8, 210)} = 7.42$, $p \leq .01$. The partial eta squared indicates a high effect.

As the model is found to have significant effect on select Mathematical Outcomes, univariate analysis was done, the details of which are presented in table 35.

Table 35

Univariate Test Values for Gain Scores on Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard VIII)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Problem Solving ability in Mathematics	136.12	2	68.06	15.37	.01	.22
Mathematics Belief (Exploratory)	10.41	2	5.21	1.11	NS	.02
Attitude Towards Mathematics	481.84	2	240.92	3.6	.05	.06
Mathematics Anxiety	1897.78	2	948.89	14.85	.01	.22

Table 35, shows that the difference in the mean gain scores on Problem solving ability in Mathematics among the groups is significant at .01 level ($F_{(2,108)} = 15.37$, $p \leq .01$). The partial eta squared is .22 indicating that there is high effect for the treatments on gain scores on Problem solving ability in Mathematics.

In the case of Exploratory beliefs about Mathematics there is no significant mean difference in gain score among the three comparison groups ($F_{(2,108)} = 1.11$, $p > .05$).

There is significant difference in the mean gain scores on Attitude towards Mathematics among the groups ($F_{(2,108)} = 3.6$, $p \leq .05$). The partial eta squared is .06 which indicates moderate effect for the treatments on gain scores on Attitude towards Mathematics.

In the case of gain scores on Mathematics anxiety, the groups differ significantly ($F_{(2,108)} = 14.85$, $p \leq .01$). The value of partial eta squared shows (.22) a high effect for the treatments on Mathematics anxiety.

These results partially substantiate the null hypothesis 'There is no significant difference in the mean gain scores among the three comparison groups on Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.' No significant difference in mean gain scores is found in the case of Mathematics belief (Exploratory), but significant difference is observed in Problem solving ability in Mathematics, Attitude towards Mathematics and Mathematics anxiety among the eighth standard students taught with Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.

Post hoc analysis (Scheffe test) was done to find out which groups differ in these variables. The details of the follow up analysis is given in table 36.

Table 36

Mean Difference and Level of Significance as per Scheffe Post-hoc Test for Gain Scores on Problem Solving Ability in Mathematics, Attitude towards Mathematics and Mathematics Anxiety of Comparison Groups (*Standard VIII)*

Variable	Group	AIIPM	IPM	Present method of teaching
Problem Solving Ability in Mathematics	AIIPM		.97 (NS)	2.66 (.01)
	IPM			1.68 (.01)
Attitude towards Mathematics	AIIPM		-1.58 (NS)	3.36 (NS)
	IPM			4.95 (.05)
Mathematics Anxiety	AIIPM		1.28 (NS)	-7.96 (.01)
	IPM			-9.23 (.01)

The groups, AIIPM and IPM do not differ significantly in the mean gain scores on Problem solving ability in Mathematics. But significant difference exists between Group 3 and AIIPM group as well as IPM group. A close observation of the mean gain scores on Problem solving ability in Mathematics of the three groups shows that, Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching for developing Problem solving ability in Mathematics among eighth standard students (Mean gain score of AIIPM group=3.86, IPM group = 2.89 and Group 3=1.21).

No significant difference exists in mean gain score for AIIPM group with IPM group and Group 3 on Attitude towards Mathematics, but significant difference exists between IPM group and Group 3. A higher mean gain score for IPM group indicates it is more effective than Present method of teaching for improving Attitude towards Mathematics among eighth standard students (Mean gain score of IPM group=16.64, Group 3=11.69). Art Integrated Information Processing Model is equally effective as Information Processing Model, but is not much effective than the Present method of teaching in developing Attitude towards Mathematics among eighth standard students.

In the case of Mathematics anxiety, Group 3 differ significantly from the groups AIIPM and IPM, but there is no significant mean difference in the gain scores on Mathematics anxiety between AIIPM and IPM groups. Low mean score for AIIPM and IPM groups compared to group 3 shows that Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching to reduce Mathematics anxiety. (Mean gain score of AIIPM group= -14.75, IPM group= -16.03, Group 3= -6.80).

Kruskal-Wallis test was executed to know whether the groups differ in the gain scores on Achievement in Mathematics. The null hypothesis tested here is 'the three groups are selected from the same population with respect to gain scores on Achievement in Mathematics' The details are given in table 37.

Table 37

Details of Kruskal-Wallis Test for Gain Scores on Achievement in Mathematics (Standard VIII)

Variable	χ^2	df
Achievement in Mathematics	4.24	2

The χ^2 value (2df) is 4.24, which is less than the tabled value of χ^2_{2df} (5.991) for significance at .05 level. Hence the null hypothesis, 'the three groups are selected from the same population with respect to gain scores on Achievement in Mathematics' is accepted. That is, the three groups are equal in the gain scores on Achievement in Mathematics. This shows that the three methods are equally effective in improving Achievement in Mathematics among eighth standard students.

Discussion of Results

Art Integrated Information Processing Model and Information Processing Model are effective for developing Problem solving ability, and reducing anxiety towards Mathematics among eighth standard students. IPM is effective for improving positive attitude towards Mathematics. The three teaching strategies are equally effective in improving exploratory belief and Achievement in Mathematics among eighth standard students.

Analysis of Data Based on Experimentation Conducted among Ninth Standard Students

As in the case of eighth standard students, data was collected from the three comparison groups of ninth standard before and after experimentation.

Description of analysis is given under the sections

- Descriptive statistics of pre-test, post-test and gain scores on select Mathematical outcomes of ninth standard students
- Comparison of mean of pre-test scores on select Mathematical outcomes among the three groups of ninth standard students
- Pairwise comparison of average pre-test, post-test scores on select Mathematical outcomes for the three groups of ninth standard students
- Multiple comparison of average post-test scores on select Mathematical outcomes among the three groups of ninth standard students
- Multiple comparison of average gain scores on select Mathematical outcomes among the three groups of ninth standard students

Descriptive Statistics of Pre-test, Post-test and Gain Scores on Select Mathematical Outcomes of Ninth Standard Students

The nature and characteristics of distributions of the variables, Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards

Mathematics, Mathematics anxiety and Achievement in Mathematics were analysed using descriptive statistics.

Descriptive Statistics of Pre-test Scores on Select Mathematical Outcomes of Ninth Standard Students

The mean, median, mode, standard deviation, skewness and kurtosis of the pre-test scores on Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics of ninth standard students are presented in table 38.

Table 38

Statistical Constants of the Pre-test Scores on Select Mathematical Outcomes (Standard IX)

Variable	Mean	Median	Mode	S D	Skewness	Kurtosis
Problem Solving Ability in Mathematics	6.35	6	10	2.97	0.42	-0.46
Mathematics Belief (Exploratory)	7.67	7	7	3.04	0.09	-0.30
Attitude Towards Mathematics	87.51	86	80	7.95	0.66	-0.35
Mathematics Anxiety	96.09	96	90	9.21	0.02	-0.19
Achievement in Mathematics	0.27	0	0	0.69	3.28	12.13

Table 38, shows that the mean, median and mode of Problem solving ability in Mathematics are 6.35, 6 and 10 respectively. The standard deviation of the variable shows that the scores are not much dispersed from the central value. The distribution is slightly positively skewed with a value of 0.42, which indicates that there is a tendency for the scores to accumulate at the lower end. But a low value of skewness indicates the distribution is almost symmetric. The negative value of kurtosis shows a chance for platykurtic distribution but a small value (-0.46) of kurtosis indicates almost mesokurtic distribution. Thus, the distribution of pre-test scores on Problem Solving Ability in Mathematics can be considered as not deviating from normality.

The measures of central tendency for Mathematics belief (Exploratory) are almost equal (Mean=7.67, Median=7, Mode=7). The standard deviation of the variable (3.04) shows that the scores are not much dispersed from the mean. The value of skewness is positive but a low value (0.09) indicates symmetry of the distribution of pre-test scores on Mathematics belief (Exploratory). A negative value of kurtosis (-0.30) indicates a platykurtic distribution, but a small value indicates mesokurtic distribution. Thus, the pre-test scores on Mathematics belief (Exploratory) can be considered as normally distributed.

For Attitude towards Mathematics, the mean, median and mode of pre-test scores are 87.51, 86 and 80 respectively with standard deviation 7.95. Mean and median of the scores are almost equal, but mode is lower than the other two values. The value obtained for standard deviation shows the possibility of the scores to be slightly spread from the mean score. A small value of skewness (0.66) suggests symmetry of the distribution. The value of kurtosis (-0.35) is negative but a small value indicates the distribution is mesokurtic. Hence the distribution of the pre-test scores on Attitude towards Mathematics can be considered as not highly deviating from normality.

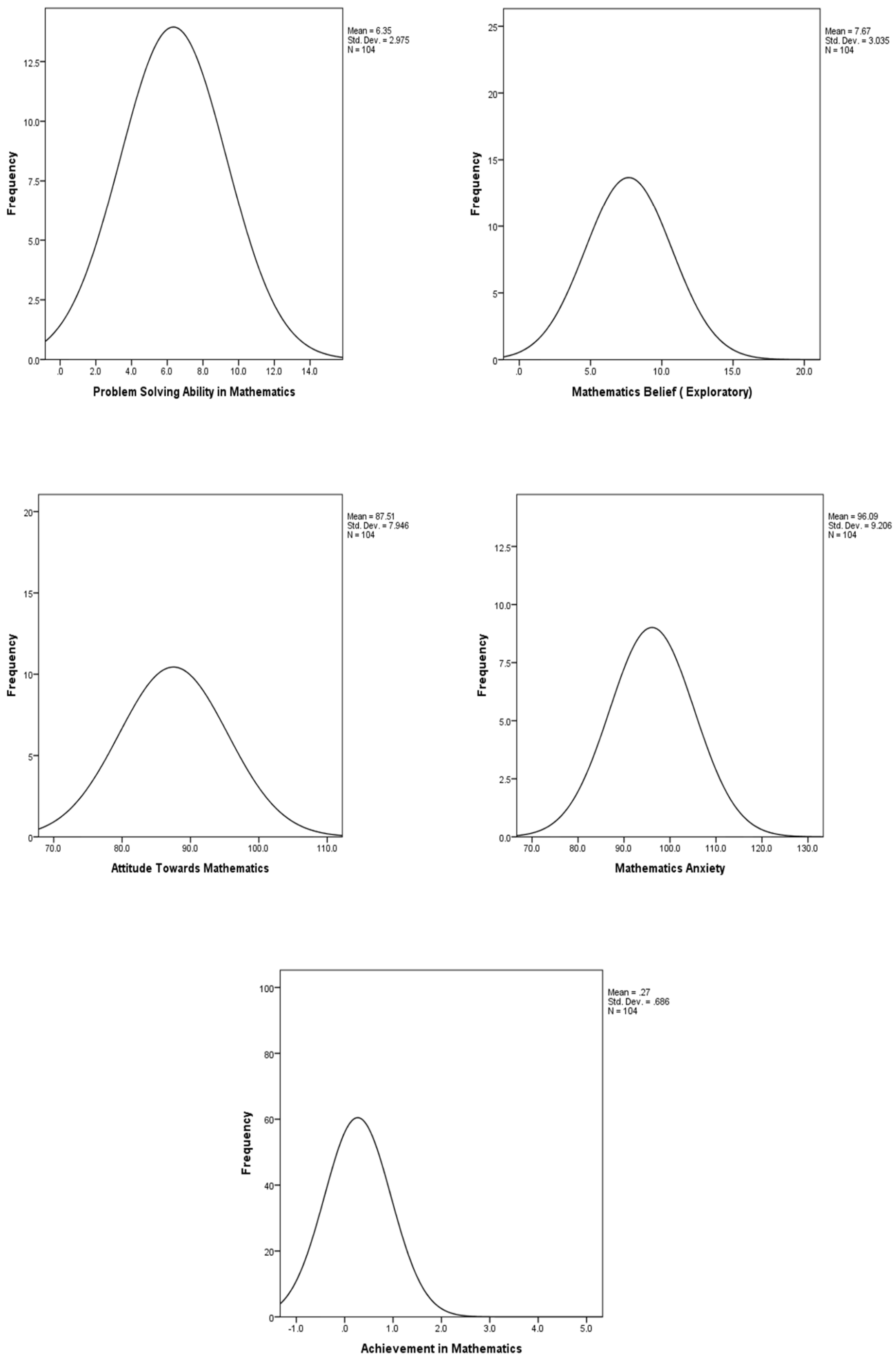
The mean, median and mode of pre-test scores on Mathematics Anxiety are 96.09, 96 and 90 respectively. The standard deviation (9.21) shows that the scores are dispersed to some extent from the central value. The value of skewness is 0.02, the low value indicates symmetry of the distribution. A very small value of kurtosis (-0.19) indicates mesokurtic nature of the distribution. Thus, the distribution of pre-test scores on Mathematics anxiety can be considered as normal.

Measures of central tendency of pre-test scores on Achievement in Mathematics (Mean=0.27, Median=0, Mode=0) are almost equal. The standard deviation of the variable (0.69), shows that the scores tend to be closer to the mean. The value of skewness (3.28) and kurtosis (12.13) are high. The distribution is positively skewed and leptokurtic. The pre-test scores on Achievement in Mathematics cluster at the lower end. Hence the distribution of pre-test scores on Achievement in Mathematics deviates from normality.

The descriptive analysis of pre-test scores on select Mathematical Outcomes of ninth standard students are supported by the smoothed frequency curves drawn for the data which is presented as figure 8.

Figure 8

Smoothed Frequency Curves of the Distribution of Pre-test Scores on Select Mathematical Outcomes (*Standard IX)*



The smoothed frequency curves of the distribution of pre-test scores show that distribution of pre-test scores on Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety are not deviating from normality but that of Achievement in Mathematics is deviating from normality.

Descriptive Statistics of Post-test Scores on Select Mathematical Outcomes of Ninth Standard Students

Mean, median, mode, standard deviation, skewness, and kurtosis of the post-test scores on select Mathematical outcomes were calculated and are presented in table 39.

Table 39

Statistical Constants of Post-test Scores on Select Mathematical Outcomes (*Standard IX)*

Variable	Mean	Median	Mode	S D	Skewness	Kurtosis
Problem Solving Ability in Mathematics	10.54	10	10	3.78	0.10	-0.81
Mathematics Belief (Exploratory)	10.47	10	10	3.11	0.41	-0.15
Attitude Towards Mathematics	98.64	98.5	90	10.32	-0.075	-0.71
Mathematics Anxiety	86.56	86	80	9.86	-0.04	-0.49
Achievement in Mathematics	9.9	9	10	5.19	0.71	-0.53

From table 39, the measures of central tendency of post-test scores on Problem-solving ability in Mathematics are almost equal (Mean=10.54, Median=10, Mode=10). The standard deviation of the variable (3.78) shows that the scores are not much deviated from the central value. The distribution is slightly positively skewed with a value of 0.10, low value of skewness indicates the distribution is almost symmetric. The negative value of kurtosis (-0.81) indicates a slight platykurtic distribution, but the value is small, hence the distribution can be considered as mesokurtic. Thus, the distribution of post-test scores on Problem Solving Ability in Mathematics can be considered as normal.

For Mathematics belief (Exploratory), the values of mean, median and mode are 10.47, 10 and 10 respectively which are almost equal. The standard deviation of the variable (3.11) indicates that the scores are not much varied from the central value. The value of skewness is positive (0.41), a low value of skewness indicates the distribution of Mathematics belief (Exploratory) is approximately symmetric. The value of kurtosis (-0.15) is very small indicating that the distribution is mesokurtic. Hence the distribution of post-test scores on Mathematics belief (Exploratory) is normal.

The mean, median and mode of post-test scores on Attitude towards Mathematics are 98.64, 98.5 and 90 respectively with standard deviation 10.32 indicating a possibility for the scores to be widely spread from the mean score. A negligible negative value of skewness (-0.075) indicates the symmetry of the distribution. The value of kurtosis (-0.71) is negative but a small value indicates the distribution is mesokurtic. Hence the distribution of the post-test scores on Attitude towards Mathematics can be considered as not deviating from normality.

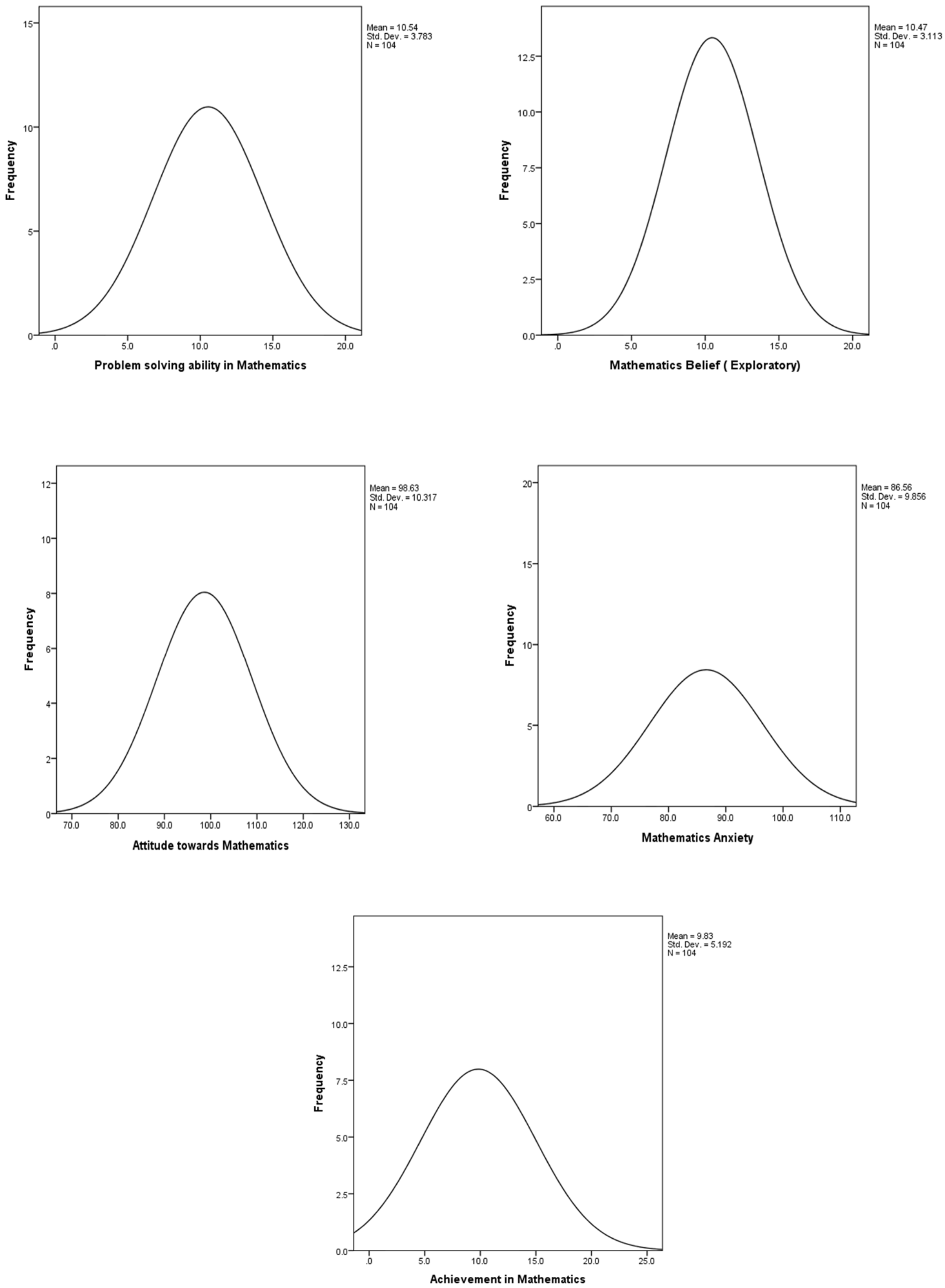
The mean, median and mode of post-test scores on Mathematics Anxiety are 86.56, 86 and 80. The standard deviation of the variable (9.86) shows that the scores are widely spread around the mean. The distribution is symmetric as the value of skewness is very low (-0.04). Again, a small value of kurtosis (-0.49) indicates mesokurtic distribution. Thus, the distribution of post-test scores on Mathematics anxiety can be considered as normal.

The measures of central tendency of post-test scores on Achievement in Mathematics (Mean=9.9, Median=9, Mode=10) are almost equal. The standard deviation (5.19), shows that the scores are not much dispersed from the mean score. The value of skewness (0.71) and kurtosis (-0.53) are very small. These values show that the distribution is almost symmetric and mesokurtic. From the above discussion, the distribution of post-test scores on the variable Achievement in Mathematics can be considered as normal.

Smoothed frequency curves are drawn to support the findings of descriptive analysis for post-test scores on select Mathematical outcomes of ninth standard students and are presented as figure 9.

Figure 9

Smoothed Frequency Curves of the Distribution of Post-test Scores on Select Mathematical Outcomes (Standard IX)



The smoothed frequency curves of the post-test scores on select Mathematical outcomes suggest the normality of the distribution.

Descriptive Statistics of Gain Scores on Select Mathematical Outcomes of Ninth Standard Students

The mean, median, mode, standard deviation, skewness and kurtosis of the gain scores on select Mathematical Outcomes were calculated and are presented in table 40.

Table 40

Statistical Constants of Gain Scores on Select Mathematical Outcomes (*Standard IX)*

Variable	Mean	Median	Mode	S D	Skewness	Kurtosis
Problem Solving Ability in Mathematics	4.19	4	5	2.59	0.65	-0.21
Mathematics Belief (Exploratory)	2.80	3	3	2.59	0.41	1.56
Attitude Towards Mathematics	11.13	10	8	6.72	0.58	-0.43
Mathematics Anxiety	-9.53	-9	-5	6.60	-0.30	-0.72
Achievement in Mathematics	9.56	9	6	5.06	0.75	-0.35

From table 40, one can observe that the measures of central tendency of the gain scores on Problem solving ability in Mathematics are almost equal (Mean=4.19, Median=4, Mode=5). The standard deviation of the variable (2.59) shows that the scores are not much dispersed from the central value. A small value of (0.65), low value of skewness indicates the distribution is almost symmetric. The value of kurtosis

(-0.21) is negative, but a small value shows the possibility of the distribution to be mesokurtic. Thus, the distribution of gain scores on Problem Solving Ability in Mathematics can be considered as normal.

For Mathematics belief (Exploratory), the obtained values of mean, median and mode are 2.80, 3 and 3 respectively. The standard deviation of the variable (2.59) shows that the scores are not much dispersed from the central value. The value of skewness is positive (0.41), but a low value of skewness indicates the distribution of gain scores on Mathematics belief (Exploratory) is approximately symmetric. A positive value of kurtosis (1.56) indicates a slightly leptokurtic distribution, but the value is not high, hence the distribution can be considered as mesokurtic. Hence the distribution of gain Scores on Mathematics belief (Exploratory) is approximately normal.

The mean, median and mode of gain scores on Attitude towards Mathematics are 11.13, 10 and 8 respectively with standard deviation 6.72 indicating a possibility of the scores to be slightly spread from the mean score. A low positive value of skewness (0.58) indicates the symmetry of the distribution. The value of kurtosis (-0.43) is negative but a small value shows the possibility of the distribution to be mesokurtic. Hence the distribution of the gain scores on Attitude towards Mathematics can be considered as not deviating from normality.

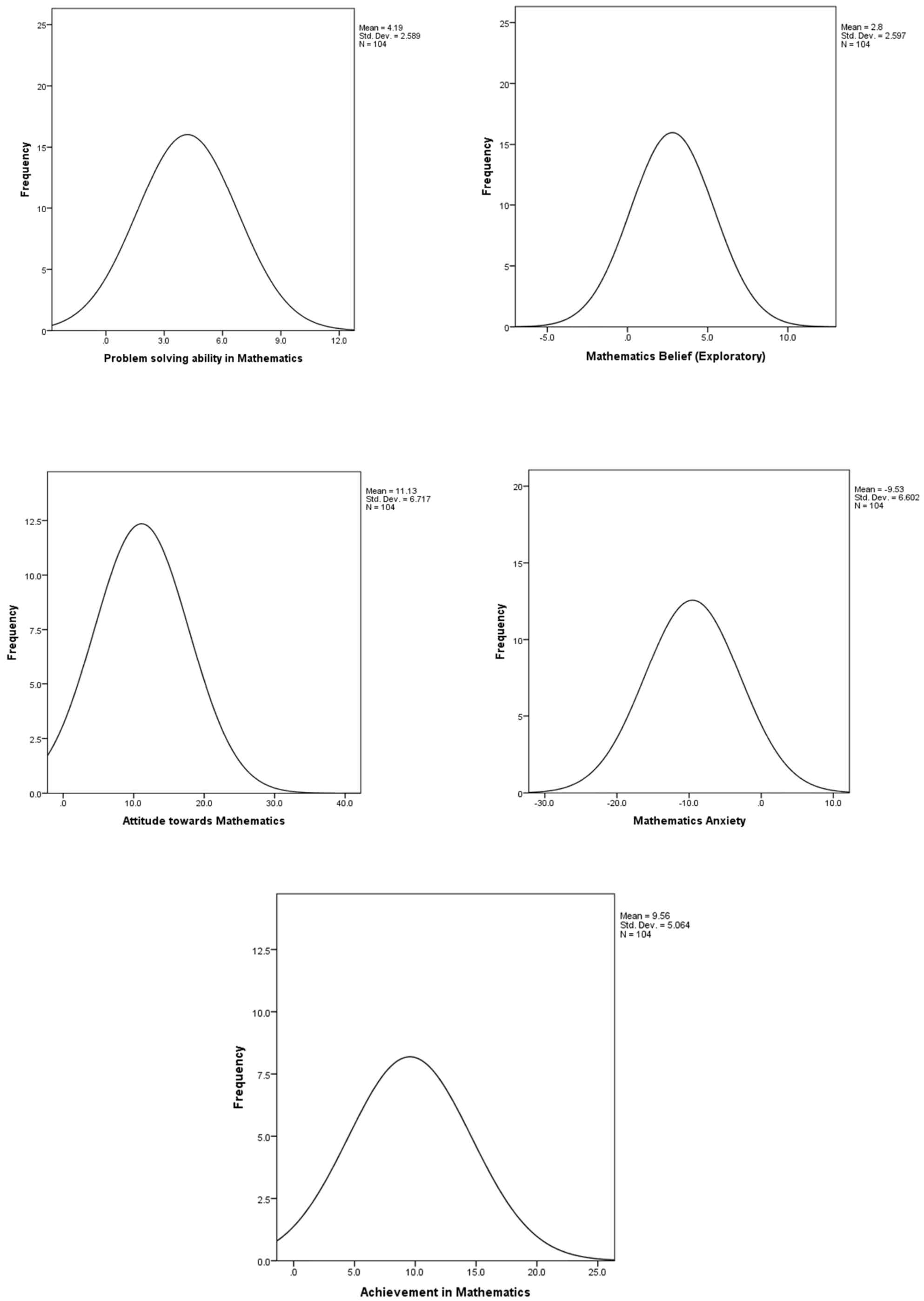
The measures of central tendency (mean, median and mode) of gain scores on Mathematics Anxiety are -9.53, -9 and -5. The standard deviation (6.60) shows that the scores are slightly dispersed from the central value. The value of skewness (-0.30), indicates the distribution is not much deviating from symmetry. The value of kurtosis (-0.72) indicates almost mesokurtic distribution. Thus, the distribution of gain scores on Mathematics anxiety can be considered as normal.

The mean, median and mode of the gain scores on Achievement in Mathematics are 9.56, 9, and 6 respectively. The standard deviation of the variable (5.06), shows that the scores are not much dispersed from the central value. The value of skewness (0.75) and kurtosis (-0.35) are very small. The values show that the distribution is almost symmetric and mesokurtic. From the above discussion, the distribution of gain scores on the variable Achievement in Mathematics can be considered as normal.

Findings of the descriptive analysis for gain scores on select Mathematical Outcomes of ninth standard students are supported by the smoothed frequency curves drawn for the data which are presented as figure 10.

Figure 10

Smoothed Frequency Curves of the Distribution of Gain Scores on Select Mathematical Outcomes (Standard IX)



The smoothed frequency curves of the gain scores on select Mathematical outcomes show that the distributions are almost normal.

Discussion of Results

The above discussion indicates that the pre-test, post-test scores, and gain scores for select Mathematical outcomes viz., Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics, and Mathematics Anxiety are normally distributed. The distribution of pre-test scores on Achievement in Mathematics cannot be considered as normal.

Comparison of Mean Pre-test Scores on Select Mathematical Outcomes among the Three Groups of Ninth Standard Students

Arithmetic mean of the pre-test scores on select Mathematical outcomes of the three groups (Ninth standard) were compared using one way ANOVA and Kruskal-Wallis Test.

Comparison of Mean Pre-test Scores on Select Mathematical Outcomes (Except Achievement in Mathematics) among the Three Groups of Ninth Standard Students

To know whether the three comparison groups viz., Art Integrated Information Processing Model group (AIIPM group), Information Processing Model group (IPM group) and the group taught with the Present method of teaching are equal in their entry level behaviour with respect to the select Mathematical outcomes, one-way ANOVA was executed except for pre-test scores on Achievement in Mathematics, the distribution of which is found to be deviating from normality.

The details of analysis done are given in table 41.

Table 41

Details of ANOVA on Pre-test Scores on Select Mathematical Outcomes (Except Achievement in Mathematics) of Comparison Groups (Standard IX)

Variable	Group	N	Mean	SD	df1	df2	F	Level of Significance
Problem Solving Ability in Mathematics	AIIPM	34	7.29	2.47	2	66.5	7.09	.01
	IPM	34	6.82	3.21				
	Group 3	36	5	2.76				
Mathematics Belief (Exploratory)	AIIPM	34	6.65	3.56	2	64	4.46	.05
	IPM	34	8.88	2.87				
	Group 3	36	7.50	2.22				
Attitude Towards Mathematics	AIIPM	34	87.88	7.34	2	66	22.78	.01
	IPM	34	92.68	7.01				
	Group 3	36	82.28	5.86				
Mathematics Anxiety	AIIPM	34	93.79	8.48	2	64.4	7.02	.01
	IPM	34	99.94	6.14				
	Group 3	36	94.61	11.15				

From table 41, one can see that the F value obtained for pre-test scores on Problem solving ability in Mathematics is 7.09 with (2, 66.5) degrees of freedom. This value indicates that the difference in the mean scores on Problem solving ability in Mathematics (Pre-test) is significant at .01 level.

The F value obtained for pre-test scores on Mathematics belief (Exploratory) is 4.46 with (2, 64) degrees of freedom. This value indicates that the difference in the mean scores on entry level of Mathematics belief as Exploratory is significant at .05 level.

The F value obtained for pre-test scores on Attitude towards Mathematics is 22.78 with (2,66) degrees of freedom. This value indicates that the three groups differ significantly in their entry level of Attitude towards Mathematics at .01 level.

The F value obtained for pre-test scores on Mathematics anxiety is 7.02 with (2,64.4) degrees of freedom. This value indicates that the difference in the mean scores on entry level Mathematics anxiety of the three groups is significant at .01 level.

To determine which of the groups have statistically significant difference in their entry level with regard to Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety, post-hoc comparison (Tukey method) was done. All pairwise comparisons among three groups were examined and the results of the same are given in table 42.

Table 42

Mean Difference and Level of Significance as per Tukey Post-hoc Test on Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard IX)

Variable	Group	AIIPM	IPM	Group 3
Problem Solving Ability in Mathematics	AIIPM		0.47 (NS)	2.29 (.01)
	IPM			1.82 (.05)
Mathematics Belief (Exploratory)	AIIPM		-2.24 (.01)	-0.853 (NS)
	IPM			1.38 (NS)
Attitude Towards Mathematics	AIIPM		-4.79 (.05)	5.6 (.01)
	IPM			10.4 (.01)
Mathematics Anxiety	AIIPM		-6.15 (.01)	-0.82 (NS)
	IPM			5.33 (.05)

Results of Post-hoc analysis using Tukey method (Table 42) show that both AIIPM and IPM groups differ from the group taught with Present method of teaching in their mean pre-test score on Problem solving ability in Mathematics, but the difference between AIIPM and IPM groups is not significant. A close observation of the mean values revealed that IPM group is slightly higher in their entry-level Problem-solving ability.

Post- hoc analysis using Tukey method shows that the AIIPM and IPM groups differ in their mean pre-test score in Mathematics belief (Exploratory) ($p \leq .01$). But the AIIPM, IPM groups do not differ from the group taught with Present method of teaching in their mean pre-test score in Mathematics belief (Exploratory). Group 2, selected for Information Processing Model, is slightly higher in their Exploratory belief in Mathematics compared to AIIPM group.

AIIPM and IPM groups differ in their mean pre-test score in Attitude towards Mathematics ($p \leq .05$), also the two groups differ from the group taught with Present method of teaching ($p \leq .01$). The comparison group 2, selected for Information Processing Model, is slightly higher in their Attitude towards Mathematics compared to other groups. But the mean scores, being less than 96 (32×3), indicate that the three groups do not have a positive attitude towards Mathematics at the initial level.

The first two comparison groups differ in their mean pre-test score in Mathematics anxiety ($p \leq .01$), also the IPM group differ from group 3 in their mean pre-test score in Mathematics anxiety ($p \leq .05$). The Group taught with Information Processing Model, is slightly higher in their Mathematics anxiety compared to other groups.

Comparison of Mean Pre-test Scores on Achievement in Mathematics among the Three Groups of Ninth Standard Students

Kruskal-Wallis test was executed to know whether the groups differ in their initial level of Achievement in Mathematics. The details are given in table 43.

Table 43

Details of Kruskal-Wallis Test for Pre-test Scores on Achievement in Mathematics (Standard IX)

Variable	χ^2	df
Achievement in Mathematics	7.26	2

The χ^2 value (2df) is 7.26, which is greater than the tabled value of χ^2_{2df} 5.991. Hence the null hypothesis, 'the three groups are selected from the same population with respect to Achievement in Mathematics (Pre-test)' is rejected. That is the three groups differ in the pre-test scores on Achievement in Mathematics.

Post-hoc comparison (Dwass-Steel-Critchlow-Fligner pairwise comparison) was done to know which groups differ in Achievement in Mathematics (pre-test). The results of the test are given in table 44.

Table 44

Details of Dwass-Steel-Critchlow-Fligner Pairwise Comparison Test (Post-hoc Test) for Pre-test Scores on Achievement in Mathematics (Standard IX)

Variable	Group	AIIPM	IPM	Group 3
Achievement in Mathematics	AIIPM		1.41 (NS)	-2.66 (NS)
	IPM			-3.80 (.05)

Post-hoc analysis using Dwass-Steel-Critchlow-Fligner (Table 44) shows that the first two comparison groups do not differ in their median pre-test score of Achievement in Mathematics, but the IPM group and the group taught with Present method of teaching differ in their median pre-test score of Achievement in Mathematics ($p \leq .05$).

Discussion of Results

The groups taught with Art Integrated Information Processing Model and Information Processing Model are equal in their Problem solving ability in Mathematics and Achievement in Mathematics; AIIPM group is equal in Mathematics belief, Mathematics anxiety and Achievement in Mathematics with Group 3. The maximum score obtainable for Problem solving ability in Mathematics is 25, the mean scores obtained by the three groups in pre-test are 7.29, 6.82 and 5 which are far below the middle score (12.5) in the test. Hence the slight difference observed between Group 3 and AIIPM group as well as IPM group will not much influence the experiment. The difference in pre-test scores on Mathematics belief between AIIPM group and IPM group can be neglected as the both groups have score less than the middle score in the inventory (11) with almost equal variance. Though the three groups differ in Attitude towards Mathematics, the three groups have negative Attitude towards Mathematics and hence this difference in attitude will not influence the result remarkably. IPM group is found to have higher Mathematics anxiety compared to AIIPM group and Group 3. The level of anxiety in the groups are the same as the mean scores are greater than 85, the scale value indicating moderate level of anxiety, and less than 115, the scale value indicating high level of anxiety. The median scores on Achievement in Mathematics (pre-test) of IPM group and Group 3 are found to be different, a higher value for IPM group. The first and third comparison groups do not differ in their median pre-test achievement score.

Pairwise Comparison of Average of Pre-test and Post-test Scores on Select Mathematical Outcomes for the Three Groups of Ninth Standard Students

To know the effectiveness of models to improve Mathematical outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety of ninth standard students, paired t-test was used. The details are given below under separate headings.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Problem Solving Ability in Mathematics for the Three groups of Ninth Standard Students

The mean of pre-test scores on Problem solving ability in Mathematics was compared with that of post-test scores for each of the three groups of ninth standard students using paired-test of mean comparison for large groups. The null hypotheses tested are

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of AIIPM group.'

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of IPM group.'

'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of Group taught with Present method of teaching.'

The details of the test are given in table 45.

Table 45

Details of Paired t-test for Problem Solving Ability in Mathematics for the Three groups (Standard IX)

Variable	Group	Test	Mean	S D	N	t	Effect size
Problem solving ability in Mathematics	AIIPM	Pre	7.29	2.47	34	14.6	2.5
		Post	13.56	2.84	34		
	IPM	Pre	6.82	3.21	34	9.31	1.6
		Post	10.32	3.02	34		
	Group 3	Pre	5	2.76	36	10.18	1.70
		Post	7.89	3.12	36		

Table 45, shows that the t-value obtained for Problem solving ability in Mathematics when the pre- and post-test mean scores are compared for the first comparison group (AIIPM) is 14.6. A score greater than 2.58 indicates that the pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of AIIPM group' is rejected.

A higher mean score for post-test indicates that teaching with Art Integrated Information Processing Model increases Problem solving ability in Mathematics of ninth standard students. The effect size obtained is 2.5, meaning that the difference of the two mean scores is 2.5 times the standard deviation. A value greater than 1.3 indicates that the effect size is very large. That is, teaching with Art Integrated Information Processing Model has a very large effect on Problem solving ability in Mathematics among ninth standard students.

For the second group (IPM), t-value obtained for Problem solving ability in Mathematics when the pre-test and post-test mean scores are compared is 9.31, which is greater than 2.58. This implies that the two mean scores differ significantly. That is, the pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of IPM group' is rejected.

A higher mean score for post-test indicates that the Information Processing Model improves Problem solving ability in Mathematics of ninth standard students. The effect size obtained is 1.6, meaning that the difference of the two mean scores is 1.6 times the standard deviation. An effect size of 1.6 indicates a very large effect. That is, Information Processing Model has a very large effect on Problem solving ability in Mathematics.

For the group taught with Present method of teaching (Group 3), t-value obtained for Problem solving ability in Mathematics when the pre- and post-test mean scores are compared is 10.18, which is greater than 2.58. This reveals that the difference in pre- and post-test mean scores in Problem solving ability in Mathematics of students taught with Present method of teaching is not due to chance ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Problem solving ability in Mathematics of group taught with Present method of teaching (Group 3)' is rejected.

A higher mean score for post-test indicates that teaching with Present method of teaching increases Problem solving ability in Mathematics of ninth standard students. The effect size obtained is 1.7, meaning that the difference of the two mean scores is 1.7 times the standard deviation. An effect size of 1.7 indicates a very large effect. That is, Present method of teaching has a very large effect on Problem solving ability in Mathematics.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective to improve Problem solving ability in Mathematics among ninth standard students, Art Integrated Information Processing Model being the most effective one. Though the effect size of Information Processing Model and Present method of teaching are almost equal, the standard deviation of the group taught with Present method of teaching has been increased compared to the AIIPM and IPM groups indicating a wide spread of values from the central value. AIIPM is a better choice than the IPM and Present method of teaching to develop Problem solving ability in Mathematics among ninth standard students.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Mathematics Belief (Exploratory) for the Three Groups of Ninth Standard Students

Comparison of the mean scores on pre-test on Mathematics belief (Exploratory) was done for each group using paired-test of mean comparison for large groups. The null hypotheses tested are

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of AIIPM group.'

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of IPM group.'

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of the Group taught with Present method of teaching.'

The details of testing these hypotheses are given in table 46.

Table 46

Details of Paired t-test for Mathematics Belief (Exploratory) for the Three Comparison Groups (Standard IX)

Variable	Group	Test	Mean	S D	N	t	Effect size
Mathematics belief (Exploratory)	AIIPM	Pre	6.65	3.56	34	12.6	2.16
		Post	11.62	3.65	34		
	IPM	Pre	8.88	2.87	34	3.89	0.67
		Post	10.44	3.04	34		
	Group 3	Pre	7.5	2.22	36	6.85	1.14
		Post	9.42	2.2	36		

Table 46, shows that the t-value obtained for Mathematics belief (Exploratory) when the pre- and post-test mean scores are compared for the first comparison group (AIIPM) is 12.6. A value greater than 2.58 indicates that the pre- and post-test mean scores in Mathematics belief (Exploratory) of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis

'There is no significant mean difference in pre-test and post-test scores on Mathematics belief (Exploratory) of AIIPM group' is rejected.

A higher mean score for post-test indicates that the Art Integrated Information Processing Model is effective in bringing out Exploratory beliefs about Mathematics among ninth standard students. The effect size obtained is 2.16, meaning that the difference of the two mean scores is 2.16 times the standard deviation. A value greater than 1.3 indicates a very large effect size. That is, Art Integrated Information Processing Model has a very large effect on Mathematics belief (Exploratory).

For the second comparison group (IPM), t-value obtained for Mathematics belief (Exploratory) when the pre-test and post-test mean scores are compared is 3.89, which is greater than 2.58. The value shows that the pre- and post-test mean scores in Mathematics belief (Exploratory) of students taught with Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in Pre-test and Post-test Scores on Mathematics belief (Exploratory) of IPM group' is rejected.

A higher mean score for post-test indicates that the Information Processing Model improves Mathematics belief (Exploratory) among ninth standard students. The effect size obtained is 0.67, meaning that the difference of the two mean scores is 0.67 times the standard deviation. An effect size of 0.67 indicates a moderate effect. That is, Information Processing Model has a moderate effect on Mathematics belief (Exploratory).

For the group taught with Present method of teaching, t-value obtained for Mathematics belief (Exploratory) when the pre-test and post-test mean scores are compared is 6.85, which is greater than 2.58. The value indicates that the pre- and post-test mean scores in Mathematics belief (Exploratory) of students taught with Present method of teaching differ significantly ($p \leq .01$).

A higher mean score for post-test indicates that teaching with the Present method of teaching is effective in developing Mathematics belief (Exploratory) among ninth standard students. The effect size obtained is 1.14, meaning that the mean difference of the two mean scores is 1.14 times the standard deviation. An effect size of 1.14 indicates a large effect. That is, teaching with the Present method of teaching has a large effect on Mathematics belief (Exploratory).

A cross examination of numbers of students having the systematic, exploratory, and utilitarian belief about Mathematics before and after experiment was done. The details are given in table 47.

Table 47

Number of Students having the Systematic, Exploratory and Utilitarian Belief about Mathematics Before and After Experiment (Standard IX)

Group	Belief System					
	Systematic		Exploratory		Utilitarian	
	Pre	Post	Pre	Post	Pre	Post
AIIPM	12	2	13	28	9	4
IPM	6	3	19	26	9	5
Group 3	8	6	11	25	17	5

Number of students who have Exploratory belief has increased for all the three teaching strategies. Art Integrated Information Processing Model (AIIPM) is more effective compared to Information Processing Model and Present method of teaching in bringing exploratory belief in Mathematics among ninth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective in developing Mathematics belief (Exploratory) among ninth standard students. But Art Integrated Information Processing Model has a greater effect compared to the other two teaching strategies for developing Mathematics belief (Exploratory) among ninth standard students. Also, the Present method of teaching is more effective than IPM for developing Mathematics belief (Exploratory) among ninth standard students.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Attitude Towards Mathematics for the Three Groups of Ninth Standard Students

A comparison of the pre- and post-test mean scores on Attitude towards Mathematics was done for the three groups using paired-test of mean comparison for large samples. The null hypotheses tested are

‘There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of AIIPM group.’

‘There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of IPM group.’

‘There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of group taught with Present method of teaching.’

These hypotheses were tested using paired test of mean comparison for large samples. The details of testing the hypotheses are given in table 48.

Table 48

Details of Paired t-test for Attitude towards Mathematics for the Comparison Groups (Standard IX)

Variable	Group	Test	Mean	S D	N	t	Effect size
Attitude Towards Mathematics	AIIPM	Pre	87.88	7.34	34	16.3	2.79
		Post	104.29	6.93	34		
	IPM	Pre	92.68	7.01	34	11.7	2.01
		Post	104.06	6.85	34		
	Group 3	Pre	82.28	5.86	36	9.32	1.55
		Post	88.17	7.17	36		

Table 48, shows that the t-value obtained for Attitude towards Mathematics when the pre-test and post-test mean scores are compared for AIIPM group is 16.3, which is greater than 2.58, indicating a significant difference between the two mean scores ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of AIIPM group' is rejected.

A higher mean score for post-test indicates that Art Integrated Information Processing Model improves Attitude towards Mathematics among ninth standard students. At the initial level the mean score was 87.88 (< 96) but after learning through Art Integrated Information Processing Model, it has increased to 104.29 (>96) indicating that Art Integrated Information Processing Model is efficient in changing negative Attitude towards Mathematics to positive attitude among ninth standard students.

The effect size calculated suggests that the difference of the two mean scores is 2.79 times the standard deviation. The effect size is greater than 1.3 and so the effect is very large. That is, Art Integrated Information Processing Model has a very large effect on Attitude towards Mathematics among ninth standard students.

In the case of IPM group, t-value obtained is 11.7, indicating that the difference in pre- and post-test mean scores in Attitude towards Mathematics of students taught with Information Processing Model is significant ($p \leq .01$). This leads to rejection of the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of IPM group.

At the initial level the mean score was 92.68 (< 96) but after learning through Information Processing Model, it has increased to 104.06 (>96) indicating that Information Processing Model is efficient in changing negative Attitude towards Mathematics to positive attitude among ninth standard students. It can be concluded that the Information Processing Model is effective in developing Attitude towards Mathematics among ninth standard students as the post-test mean score is higher than that of pre-test. The effect size (2.01), shows that the difference of the two mean scores is 2.01 times the standard deviation. Also, the Information Processing Model has a very large effect on Attitude towards Mathematics.

For the group taught with Present method of teaching, t-value obtained is 9.32, indicating that the pre- and post-test mean scores in Attitude towards Mathematics of students taught with existing method differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Attitude towards Mathematics of group taught with Present method of teaching' is rejected.

At the initial level the mean score was 82.28 (< 96) but after learning through Present method of teaching it has increased to 88.17 (< 96) but is negative among the group taught with Present method of teaching.

A higher mean score for post-test indicates that the Present method of teaching improves Attitude towards Mathematics of ninth standard students. As the effect size obtained is 1.55, the difference of the two mean scores is 1.55 times the standard deviation and the Present method of teaching has a very large effect on Attitude towards Mathematics among ninth standard students. But the finding shows that the Present method of teaching does not change the negative Attitude towards Mathematics to positive among ninth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective to improve Attitude towards Mathematics among ninth standard students, Art Integrated Information Processing Model being the most effective one for developing positive Attitude towards Mathematics. But students taught with Present method of teaching is found to have a mean score indicating negative attitude. The initial mean score of the third comparison group was significantly less than the other two groups and this may be the reason for getting a mean score indicating negative attitude towards Mathematics. As the post-test mean score indicates negative attitude towards

Mathematics, Present method of teaching is not much effective for developing positive Attitude towards Mathematics among ninth standard students.

Pairwise Comparison of Mean of Pre-test and Post-test Scores on Mathematics Anxiety for the Three Groups of Ninth Standard Students

Comparison of mean scores obtained for the pre-test and post-test on Mathematics anxiety of the three comparison groups were done using paired-test of mean comparison for large samples. The null hypotheses tested are

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of AIIPM group.'

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of IPM group.'

'There is no significant mean difference in the pre-test and post-test scores on Mathematics anxiety of the group taught with Present method of teaching.'

The details of testing these hypotheses are given in table 49.

Table 49

Details of Paired t-test for Mathematics Anxiety for the Three Groups (Standard IX)

Variable	Group	Test	Mean	S D	N	t	Effect size
Mathematics Anxiety	AIIPM	Pre	93.79	8.48	34	13.5	2.32
		Post	79.79	7.92	34		
	IPM	Pre	99.94	6.14	34	8.26	1.42
		Post	91.44	6.79	34		
	Group 3	Pre	94.61	11.15	36	7.04	1.17
		Post	88.33	10.61	36		

Table 49, shows that the t-value obtained for Mathematics anxiety when the pre-test and post-test mean scores are compared for the first comparison group (AIIPM) is 13.5. A score greater than 2.58 indicates that the pre- and post-test mean scores in Mathematics anxiety of students taught with Art Integrated Information Processing Model differ significantly ($p \leq .01$). Hence, the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics anxiety of AIIPM group' is rejected.

A low mean score for post-test indicates that the Art Integrated Information Processing Model decreases Mathematics anxiety of ninth standard students. The effect size obtained is 2.32, so the mean difference of the two sets of scores is 2.32 times the standard deviation. A value greater than 1.3 reveals that the effect is very large. That is, Art Integrated Information Processing Model has a very large effect on Mathematics anxiety.

For the second comparison group (IPM), t-value obtained is 8.26, which is greater than 2.58. The value indicates that the pre- and post-test mean scores in Mathematics anxiety of students taught with the Information Processing Model differ significantly ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics anxiety of IPM group' is rejected.

A low mean score for post-test indicates that teaching with Information Processing Model decreases Mathematics anxiety of ninth standard students. The effect size obtained is 1.42, meaning that the mean difference is 1.42 times the standard deviation. It also indicates a very large effect. That is, teaching with IPM has a very large effect on Mathematics anxiety.

For the group taught with Present method of teaching (Group 3), t-value obtained for Mathematics anxiety when the pre-test and post-test mean scores are compared is 7.04, which is greater than 2.58, indicating a significant difference in the pre-test and post-test scores in Mathematics anxiety of students taught with present method ($p \leq .01$). Hence the null hypothesis 'There is no significant mean difference in pre-test and post-test scores on Mathematics anxiety of group taught with Present method of teaching' is rejected.

A low mean score for post-test indicates that the Present method of teaching decreases Mathematics anxiety among ninth standard students. The effect size obtained is 1.17, meaning that the mean difference is 1.17 times the standard deviation. An effect size of 1.17 indicates a large effect. That is, the Present method of teaching has a large effect on Mathematics anxiety among ninth standard students.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective in reducing Mathematics Anxiety among ninth standard students. Art Integrated Information Processing Model and Information Processing Model have very large effect and the Present method of teaching has large effect on Mathematics Anxiety among ninth standard students. Also, the results indicate that Art Integrated Information Processing Model is better than the other two teaching strategies for reducing Mathematics anxiety among ninth standard students.

Pairwise Comparison of Average Scores of Pre-test and Post-test on Achievement in Mathematics for the Three Groups of Ninth Standard Students

The average (Median) scores of pre- and post-tests on Achievement in Mathematics were compared for each group using Wilcoxon signed- rank test. The null hypothesis tested is

'Median of the differences between the pre- and post-tests scores on Achievement in Mathematics is zero in the three Comparison groups.'

The details of the test are given in table 50.

Table 50

Details of Wilcoxon Signed - Rank Test for Achievement in Mathematics for the Three Comparison Groups (Standard IX)

Variable	Group	Test	Median	N	z	p	Effect size
Achievement in Mathematics	AIIPM	Pre	0	34	5.09	.01	0.873
		Post	12	34			
	IPM	Pre	0	34	5.10	.01	0.875
		Post	7.5	34			
	Group 3	Pre	0	36	5.24	.01	0.873
		Post	6.5	36			

Table 50, shows that the z-value obtained for Achievement in Mathematics when the pre-test and post-test scores are compared for the first comparison group (AIIPM) is 5.09. The result shows that the median difference between pre-test and post-test scores on Achievement in Mathematics of students taught with Art Integrated Information Processing Model is non-zero ($p \leq .01$).

For the second comparison group (IPM), z-value obtained is 5.10. The result shows that the median of difference between pre-test and post-test scores on Achievement in Mathematics of students taught with Information Processing Model is non-zero ($p \leq .01$).

For the third comparison group, z-value obtained is 5.24 which shows that the median of difference between pre-test and post-test scores on Achievement in Mathematics of students taught with the Present method of teaching is non- zero ($p \leq .01$). Hence the null hypothesis 'Median of the differences between the pre- and post-tests scores on Achievement in Mathematics is zero in three Comparison groups' is rejected.

The effect size obtained in three groups are .873,.875 and .873 for the AIIPM, IPM and group taught with Present method of teaching respectively. All these values are greater than .8, suggesting that AIIPM, IPM, and Present method of teaching have a large effect on Achievement in Mathematics. Almost equal values show that the three treatments are equally effective in improving Achievement in Mathematics.

Discussion of Results. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching have a large effect on Achievement in Mathematics among ninth standard students. Hence the three treatments are equally effective in improving Achievement in Mathematics.

Multiple Comparison of Average Post-test Scores on Select Mathematical Outcomes among the Three Groups of Ninth Standard Students

The effect of the treatments on post-test scores on select Mathematical outcomes was tested using MANCOVA with scores on Achievement in Mathematics (pre-test) as covariate.

The assumptions of independence and random sampling are satisfied as the sample is selected using probability sampling and the instruments are administered ensuring independence in responding.

Multivariate Normality

Multivariate normality was established using the Shapiro-Wilk Multivariate Normality test. The obtained Shapiro-Wilk statistics is .08 ($p > .05$), with a W statistic of 0.978, which shows that the multivariate distribution does not significantly deviate from normality.

Homogeneity of Covariance Matrices

To ensure the homogeneity of covariance matrices, Box's test of equality of covariance matrices was used. The obtained Box's M statistic, χ^2 value (20 df) is 36.2 ($p \leq .05$). Hence the select Mathematical outcomes, Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety exhibit homogeneity of covariance matrices.

When Achievement in Mathematics is included, the assumption of homogeneity of covariance matrices was violated and hence this variable was excluded from the list in executing MANCOVA

After ensuring assumptions, MANCOVA was executed to find out whether the two comparison groups and the group taught with Present method of teaching differ significantly in their Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety. Post-test scores on these variables were considered to test the hypothesis ‘There is no significant difference among the three comparison groups on the Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.’

Details of the Multivariate analysis for the model using post-test scores are given in table 51.

Table 51

Multivariate Test Result for the Model on Post-test Scores on Select Mathematical Outcomes (Standard IX)

	Value	F	Sig.	Partial Eta Squared
Pillai's trace	.90	20.09	.01	.451
Wilks' lambda	.29	20.99	.01	.464

From table 51, it can be seen that the multivariate test performed implies the model has significant effect on select Mathematical outcomes from both Pillai’s trace

(.90), $F_{(8, 198)} = 20.09$, and Wilk's lambda (.29), $F_{(8, 196)} =20.99$, $p \leq .01$. The effect size represented by the partial eta squared indicates a large effect.

As the model is found to have significant effect on select Mathematical outcomes, univariate analysis was done. The details are presented in table 52.

Table 52

Univariate Test Values for Post-test Scores on Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard IX)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Problem Solving ability in Mathematics	570.25	2	285.13	31.56	.01	.387
Mathematics Belief (Exploratory)	83.8	2	41.9	4.59	.05	.084
Attitude Towards Mathematics	5680.74	2	2840.37	57.64	.01	.535
Mathematics Anxiety	2546.48	2	1273.24	17.09	.01	.255

The difference in the mean score on Problem solving ability in Mathematics (post-test) among the groups is significant at .01 level ($F_{(2,101)} = 31.56$, $p \leq .01$). The partial eta squared is .387 which shows there is a high effect for the treatments on Problem solving ability in Mathematics.

In the case of Mathematics belief (Exploratory) among the three groups the difference is significant ($F_{(2,101)} = 4.59$, $p \leq .05$). The partial eta squared is .084 which shows there is a moderate effect for the treatments on post - test scores on Mathematics belief (Exploratory).

There is significant difference in the mean scores on Attitude towards Mathematics (Post-test) among the groups under study ($F_{(2,101)} = 57.64$, $p \leq .01$). The partial eta squared is .535 which indicates a high effect for the treatments on Attitude towards Mathematics.

In the case of post-test scores on Mathematics anxiety, the groups differ significantly ($F_{(2,101)} = 17.09$, $p \leq .01$). The value of partial eta squared shows (.255) a high effect for the treatments on Mathematics anxiety.

These results reject the null hypothesis that 'There is no significant difference in the mean post-test scores among the three comparison groups on select Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety'. Significant mean differences for post- test scores are found in Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.

As significant difference among the groups is reported for the variables Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety, Post-hoc analysis (Scheffe test) was done. The details of the follow up analysis is given in table 53.

Table 53

Mean Difference and Level of Significance as per Scheffe Post-hoc Test for Post-test Scores on Problem solving ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard IX)

Variable	Group	AIIPM	IPM	Present method of teaching
Problem Solving Ability in Mathematics	AIIPM		3.24 (.01)	5.67 (.01)
	IPM			2.44 (.01)
Mathematics Belief (Exploratory)	AIIPM		1.18 (NS)	2.20 (.05)
	IPM			1.03 (NS)
Attitude towards Mathematics	AIIPM		.235 (NS)	16.13 (.01)
	IPM			15.89 (.01)
Mathematics Anxiety	AIIPM		-11.65 (.01)	-8.54 (.01)
	IPM			3.11 (NS)

In the case of Problem solving ability in Mathematics (post-test), the AIIPM group differ significantly from IPM and group 3, IPM group differ significantly from group 3 in their mean score. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective for improving Problem solving ability in Mathematics among ninth standard students, but Art Integrated Information Processing Model is more effective than the other two methods for improving Problem solving ability in Mathematics (Mean score of AIIPM group=13.56, IPM group=10.32, group taught with Present method of teaching =7.89).

In the case of Mathematics belief (Exploratory) there is no significant difference between the comparison groups, AIIPM and IPM as well as IPM and group 3, but significant difference exists between AIIPM group and group 3. Hence, for developing Mathematics belief (Exploratory) among ninth standard students, Art Integrated Information Processing Model is more effective than the Present method of teaching (Mean score of AIIPM group=11.62, group taught with Present method of teaching=9.42).

In the case of Attitude towards Mathematics (post-test) there is no significant difference between the two comparison groups, AIIPM and IPM but significant difference exists for AIIPM group and IPM group with group 3. Hence, for improving Attitude towards Mathematics among ninth standard students, Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching (Mean score of AIIPM group=104.29, IPM group=104.06, group taught with Present method of teaching= 88.17).

In the case of Mathematics anxiety (post-test), the groups AIIPM group differ significantly from IPM group and group taught with Present method of teaching. But IPM and group taught with Present method of teaching do not differ significantly. Hence, for reducing Mathematics anxiety among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=79.79, IPM group=91.44, Group taught with Present method of teaching =88.33).

In the case of Achievement in Mathematics, Kruskal-Wallis test was executed to know whether the groups differ in the post-test scores on Achievement in Mathematics. The null hypothesis tested here is 'the three groups are selected from the same population with respect to Achievement in Mathematics (Post-test).' The details are given in table 54.

Table 54

Details of Kruskal-Wallis Test for Post-test Scores on Achievement in Mathematics (Standard IX)

Variable	χ^2	df
Achievement in Mathematics	26.68	2

The χ^2 value (2df) is 26.68, which is greater than the tabled value of χ^2_{2df} 5.991. Hence the null hypothesis, 'the three groups are selected from the same population with respect to Achievement in Mathematics (Post-test)' is rejected. That is the three groups differ in the post-test scores on Achievement in Mathematics.

To determine which comparison groups, have statistically significant difference in their post-test scores on Achievement in Mathematics, Post-hoc comparison (Dwass-Steel-Critchlow-Fligner pairwise comparison) was done. The results of the same are shown in table 55.

Table 55

Details of Dwass-Steel-Critchlow-Fligner Pairwise Comparison Test (Post-hoc Test) for Post-test Scores on Achievement in Mathematics (Standard IX)

Variable	Group	AIIPM	IPM	Group 3
Achievement in Mathematics	AIIPM		5.35 (.01)	6.80 (.01)
	IPM			2.28 (NS)

Post-hoc analysis using Dwass-Steel-Critchlow-Fligner (Table 55) shows that in the case of Achievement in Mathematics (post-test), AIIPM group differ significantly from IPM group and the group taught with Present method of teaching. But IPM group and group 3 do not differ significantly. Hence, for improving Achievement in Mathematics among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Median score of AIIPM group=12, IPM group=7.5, Group taught with Present method of teaching=6.5).

Discussion of Results

Art Integrated Information Processing Model is more effective than the other two methods for improving Problem solving ability in Mathematics, for developing Mathematics belief (Exploratory), reducing Mathematics anxiety, and improving achievement in Mathematics among ninth standard students. Also, for improving Attitude towards Mathematics among ninth standard students Art Integrated

Information Processing Model and Information Processing Model are equally effective.

Multiple Comparison of Average Gain Scores on Select Mathematical Outcomes among the Three Groups of Ninth Standard Students

As there are multiple select Mathematical outcomes MANOVA (Multivariate Analysis of Variance) was executed to test whether the treatments have any effect on select Mathematical outcomes using gain scores. Before performing MANOVA, preliminary assumption testing was conducted for the variables, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, and Mathematics anxiety to check for Independence, Random sampling, Multivariate normality (Shapiro-Wilk statistics is .011 ($p >.05$), with a W statistic of 0.967) and Homogeneity of covariance matrices (Box's M statistic, χ^2 value (20 df) is 34.55 ($p \leq .05$) with no serious violations noted. When Achievement in Mathematics is included, the assumption of homogeneity of covariance matrices was violated and hence this variable was excluded from the list in the analysis by MANOVA.

After ensuring assumptions, MANOVA was executed to find out whether the three comparison groups differ significantly in their gain scores on select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety. Gain scores on these variables were considered to test the hypothesis 'There is no significant difference in the mean gain scores among the three groups on select

Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.

Details of the Multivariate analysis for the model using gain scores are given in table 56.

Table 56

Multivariate Test Result for the Model on Gain Scores on Select Mathematical Outcomes (Standard IX)

	Value	F	Sig.	Partial Eta Squared
Pillai's trace	.84	17.92	.01	.420
Wilks' lambda	.25	24.09	.01	.496

Table 56, shows that the multivariate test performed implies the model has significant effect on select Mathematical outcomes from both Pillai's trace (.84), $F_{(8,198)} = 17.92$, and Wilk's lambda (.25), $F_{(8,\ 196)} = 24.09$, $p \leq .01$. The effect size represented by the partial eta squared indicates a high effect.

As the model is found to have significant effect on select Mathematical outcomes (gain Scores), univariate analysis was done. The details are presented in table 57.

Table 57

Univariate Test Values for Gain Scores on Select Mathematical Outcomes, Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard IX)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Problem Solving ability in Mathematics	223.48	2	111.74	24.18	.01	.32
Mathematics Belief (Exploratory)	240.66	2	120.33	26.76	.01	.35
Attitude Towards Mathematics	1939.56	2	969.78	36.17	.01	.42
Mathematics Anxiety	1096.19	2	548.10	16.31	.01	.24

Table 57, shows that the difference in the mean gain scores on Problem solving ability in Mathematics among the groups is significant at .01 level ($F_{(2,101)} = 24.18$, $p \leq .01$). The partial eta squared is .32 which shows there is a high effect for the treatments on gain scores on Problem solving ability in Mathematics among ninth standard students.

In the case of Exploratory beliefs about Mathematics (gain score) the three groups differ significantly ($F_{(2,101)} = 26.76$, $p \leq .01$) at .01 level. The partial eta squared is .35 which shows a high effect for the treatments on Mathematics belief (Exploratory) among ninth standard students.

There is a significant difference in the mean gain scores on Attitude towards Mathematics among the groups under study ($F_{(2,101)} = 36.17$, $p \leq .01$). The partial eta squared is .42 which indicates a high effect for the treatments on Attitude towards Mathematics among ninth standard students.

In the case of gain scores on Mathematics anxiety, the groups differ significantly ($F_{(2,101)} = 16.31$, $p \leq .01$). The value of partial eta squared shows (.24) a high effect for the treatments on Mathematics anxiety.

These results reject the null hypothesis 'There is no significant difference in the mean gain scores among the three groups on select Mathematical Outcomes, Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety.' Significant differences in mean scores of gain scores are found in the case of Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety among ninth standard students.

As significant difference among the groups is reported for the variables Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics and Mathematics anxiety, Post-hoc analysis (Scheffe test) was done. The details of the follow up analysis is given in table 58.

Table 58

Mean Difference and Level of Significance as per Scheffe Post-hoc Test for Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics and Mathematics Anxiety (Standard IX)

Variable	Group	AIIPM	IPM	Present method of teaching
Problem Solving Ability in Mathematics	AIIPM		2.77 (.01)	3.38 (.01)
	IPM			.61 (NS)
Mathematics Belief (Exploratory)	AIIPM		3.41 (.01)	3.05 (.01)
	IPM			-.36 (NS)
Attitude towards Mathematics	AIIPM		5.03 (.01)	10.52 (.01)
	IPM			5.49 (.01)
Mathematics Anxiety	AIIPM		-5.50 (.01)	-7.72 (.01)
	IPM			-2.22 (NS)

In the case of Problem solving ability in Mathematics, the group, AIIPM differ significantly from IPM group and group 3 in their mean gain score. But significant difference does not exist between the IPM group and the group taught with Present method of teaching (Group 3). Hence, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching for improving Problem solving ability in Mathematics (Mean score of AIIPM group=6.26, IPM group=3.5 and Group 3=2.89).

In the case of Mathematics belief (Exploratory) there is a significant difference in mean gain score of AIIPM group from that of IPM group and group 3, but the difference is not significant for IPM group and group taught with Present method of teaching. Hence, for developing Mathematics belief (Exploratory) among ninth standard students Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=4.97, IPM group=1.56, Group 3=1.92).

In the case of Attitude towards Mathematics, there is significant difference in mean gain scores of the AIIPM group with that of IPM group and the group taught with Present method of teaching, also IPM group and group taught with Present method of teaching differ significantly in their mean gain scores on Attitude towards Mathematics. Hence, for improving Attitude towards Mathematics among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=16.4, IPM group=11.4, Group 3=5.89)

In the case of Mathematics anxiety, the groups AIIPM and IPM as well as AIIPM group and group taught with Present method of teaching differ significantly in the mean gain scores. But IPM group and group taught with Present method of teaching do not differ significantly in their mean gain scores on Mathematics Anxiety. Hence, for reducing Mathematics anxiety among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group= -14, IPM group= -8.5, Group 3= -6.28).

In the case of Achievement in Mathematics, Kruskal-Wallis test was executed to know whether the groups differ in the gain scores on Achievement in Mathematics. The null hypothesis tested here is 'The three groups are selected from the same population with respect to Achievement in Mathematics (gain scores).' The details are given in table 59.

Table 59

Details of Kruskal-Wallis Test for Gain Scores on Achievement in Mathematics (Standard IX)

Variable	χ^2	df
Achievement in Mathematics	26.1	2

The χ^2 value (2df) is 26.1, which is greater than the tabled value of χ^2_{2df}5.991. Hence the null hypothesis, 'the three groups are selected from the same population with respect to Achievement in Mathematics (gain scores)' is rejected. That is, the three groups are different in the median gain scores on Achievement in Mathematics.

To determine which of the comparison groups differ significantly in their median gain scores on Achievement in Mathematics, Post-hoc comparison (Dwass-Steel-Critchlow-Fligner pairwise comparison) was done. The results of the same are shown in table 60.

Table 60

Details of Dwass-Steel-Critchlow-Fligner Pairwise Comparison Test(Post-hoc Test) for Gain Scores on Achievement in Mathematics (Standard IX)

Variable	Group	AIIPM	IPM	Group 3
Achievement in Mathematics	AIIPM		5.53 (.01)	6.64 (.01)
	IPM			1.90 (NS)

Post-hoc analysis using Dwass-Steel-Critchlow-Fligner (Table 60) shows that in the case of Achievement in Mathematics (gain score), AIIPM group differ significantly from IPM group and the group taught with Present method of teaching in the median gain scores. But IPM and group taught with Present method of teaching do not differ significantly. Hence, for improving Achievement in Mathematics among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Median score of AIIPM group=12, IPM group=7, Group 3=6).

Discussion of Results

Art Integrated Information Processing Model is more effective than the other two methods for improving Problem solving ability in Mathematics, for developing Mathematics belief (Exploratory), reducing Mathematics anxiety, developing a positive Attitude towards Mathematics and improving achievement in Mathematics among ninth standard students.

Analysis of Standard Scores of Both Eighth and Ninth Standard Students

To get an overall result of the treatments on select Mathematical outcomes among secondary school students, MANOVA was executed on standard scores. Standard scores were calculated as both eighth and ninth standard students were included for the study. Here the comparison groups are constituted as AIIPM group (group taught with Art Integrated Information Processing Model including both eighth and ninth standard students), IPM group (group taught with Information Processing Model including both eighth and ninth standard students) and Group 3, the group thought with the Present method of teaching Mathematics, both of eighth and ninth standard students.

Multiple Comparison of Average Standard Scores on Select Mathematical Outcomes among the Three Groups of Secondary School Students (Total Sample)

As there are multiple select Mathematical outcomes MANOVA (Multivariate Analysis of Variance) was executed to establish the effects of the treatments have any effect on select Mathematical outcomes using standard scores.

Assumptions for MANOVA viz., Independence, Random sampling, Multivariate normality (Shapiro-Wilk statistics is .03 ($p > .01$), with a W statistic of 0.986) and Homogeneity of covariance matrices (Box's M statistic, χ^2 value (20 df) is 17.49 ($p > .05$) were ensured. When Attitude towards Mathematics and Achievement in Mathematics are included, the assumption of homogeneity of covariance matrices was violated and hence these variables were excluded from the list in the analysis by MANOVA.

After ensuring assumptions, MANOVA was executed to find out whether the three groups differ significantly in their Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory) and Mathematics anxiety. The hypothesis tested is 'There is no significant difference in the mean standard scores among the three groups on select Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory) and Mathematics anxiety.'

Details of the Multivariate analysis for the model using standard scores are given in table 61.

Table 61

Multivariate Test Result for the Model on Standard Scores on Select Mathematical Outcomes

	Value	F	Sig.	Partial Eta Squared
Pillai's trace	.29	11.74	.01	.143
Wilks' lambda	.73	12.00	.01	.146

Table 61, shows that the multivariate model has significant effect on select Mathematical outcomes by both Pillai's trace (.29), $F_{(6,422)}$= 11.74, and Wilk's lambda (.73), $F_{(6, 420)}$ =12.00, $p \leq .01$. The effect size represented by the partial eta squared indicates a high effect.

As the model is found to have significant effect on select Mathematical outcomes, univariate analysis was done. The details are presented in table 62.

Table 62

Univariate Test Values for Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory) and Mathematics Anxiety (Standard Score)

Dependent Variable	Sum of Squares	df	Mean Square	F	Sig	Partial Eta Squared
Problem Solving ability in Mathematics	36.31	2	18.15	21.87	.01	.17
Mathematics Belief (Exploratory)	6.86	2	3.43	3.55	.05	.032
Mathematics Anxiety	23.53	2	11.76	15.14	.01	.13

The difference in the mean standard scores on Problem solving ability in Mathematics among the groups is significant at .01 level ($F_{(2,212)} = 21.87$, $p \leq .01$). The partial eta squared is .17 which shows a high effect for the treatments on Problem solving ability in Mathematics among secondary school students.

In the case of Exploratory belief about Mathematics the three comparison groups differ significantly ($F_{(2,212)} = 3.55$, $p \leq .05$) in the mean standard score. The partial eta squared is .032 which means there is only a low effect for the treatments on Mathematics belief (Exploratory).

In the case of standard scores on Mathematics anxiety, the groups differ significantly ($F_{(2,212)} = 15.14$, $p \leq .01$). The value of partial eta squared shows (.13) a moderate effect for the treatments on Mathematics anxiety.

These results reject the null hypothesis ‘There is no significant difference in the standard scores among the three groups on select Mathematical Outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), and

Mathematics anxiety.' Significant differences are found in the case of Problem solving ability in Mathematics, Mathematics belief (Exploratory), and Mathematics anxiety among secondary school students.

As significant differences among the groups are reported for the variables Problem solving ability in Mathematics, Mathematics belief (Exploratory), and Mathematics anxiety, Post-hoc analysis (Scheffe test) was done, the details of which is given in table 63.

Table 63

Mean Difference and Level of Significance as per Scheffe Post-hoc Test for Standard Scores on Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), and Mathematics Anxiety

Variable	Group	AIIPM	IPM	Present method of teaching
Problem Solving Ability in Mathematics	AIIPM		.34 (NS)	.98 (.01)
	IPM			.65 (.01)
Mean Score		0.45	0.12	-0.53
Mathematics Belief (Exploratory)	AIIPM		.38 (NS)	.39 (NS)
	IPM			.007 (NS)
Mean Score		0.266	-0.112	-0.119
Mathematics Anxiety	AIIPM		-.74 (.01)	-.66 (.01)
	IPM			.08 (NS)
Mean Score		-0.454	0.29	0.203

In the case of Problem solving ability in Mathematics (standard scores), both AIIPM and IPM groups differ significantly from Group 3. The difference in mean standard scores on Problem solving ability in Mathematics is not significant between the groups AIIPM and IPM. Hence, Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching for improving Problem solving ability in Mathematics (Mean score of AIIPM group=0.45, IPM group=0.12 and Group 3= -0.53) among secondary school students.

In the case of Mathematics belief (Exploratory) there is no significant difference in the standard scores among the comparison groups, AIIPM, IPM and group taught with Present method of teaching. Hence, for developing Mathematics belief (Exploratory) among secondary students the three methods are equally effective.

AIIPM group differ significantly from IPM group and Group 3 in the mean standard score on Mathematics anxiety. But IPM group do not differ significantly from group 3in the mean standard score on Mathematics anxiety. Hence, for reducing Mathematics anxiety among secondary school students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group= -.0.454, IPM group=0.29, Group 3=0.203).

In the case of Attitude towards Mathematics and Achievement in Mathematics, Kruskal-Wallis test was executed to know whether the groups differ in the standard scores on Attitude towards Mathematics and Achievement in Mathematics. The null hypothesis tested here are

'The three groups are selected from the same population with respect to Attitude towards Mathematics (standard scores).'

'The three groups are selected from the same population with respect to Achievement in Mathematics (standard scores).'

The details are given in table 64.

Table 64

Details of Kruskal-Wallis Test for Standard Scores on Attitude towards Mathematics and Achievement in Mathematics

Variable	χ^2	df	p
Attitude towards Mathematics	43.6	2	.01
Achievement in Mathematics	23.6	2	.01

For Attitude towards Mathematics, the χ^2 value (2df) is 43.6, which is greater than the tabled value of χ^2_{2df} 5.991. Hence the null hypothesis, 'the three groups are selected from the same population with respect to Attitude towards Mathematics (standard scores)' is rejected. i.e., the three groups are different in the standard scores on Attitude towards Mathematics.

In the case of Achievement in Mathematics, the obtained χ^2 value (2df) is 23.6, which is greater than the tabled value of χ^2_{2df} 5.991. Hence the null hypothesis, 'the three groups are selected from the same population with respect to Achievement in

Mathematics (standard score)' is rejected. i.e., the three groups are different in the standard scores on Achievement in Mathematics.

To determine which of the comparison groups showed statistically significant difference in their standard scores with regard to Attitude towards Mathematics and Achievement in Mathematics, Post-hoc comparison (Dwass-Steel-Critchlow-Fligner pairwise comparison) were done. The results of the same are shown in table 65.

Table 65

Details of Dwass-Steel-Critchlow-Fligner Pairwise Comparison Test (Post-hoc Test) for Standard Scores on Attitude towards Mathematics and Achievement in Mathematics

Variable	Group	AIIPM	IPM	Group 3
Attitude towards Mathematics	AIIPM		-0.230 (NS)	-8.09 (.01)
	IPM			-7.97 (.01)
Achievement in Mathematics	AIIPM		-5.78 (.01)	-6.14 (.01)
	IPM			0.20 (NS)

Post-hoc analysis using Dwass-Steel-Critchlow-Fligner (Table 65) shows that in the case of Attitude towards Mathematics (standard scores), AIIPM and IPM groups differ significantly from group 3 in their Attitude towards Mathematics but AIIPM group does not differ significantly from IPM group in median standard scores on Attitude towards Mathematics. Hence, for improving Attitude towards Mathematics among secondary school students, Art Integrated Information Processing Model and

Information Processing Model are more effective than the Present method of teaching (Median score of AIIPM group =0.22, IPM group =0.15, Group 3 = -0.89).

In the case of Achievement in Mathematics (standard scores), post-hoc analysis using Dwass-Steel-Critchlow-Fligner (Table 65) shows that AIIPM group differ significantly from IPM group and the group taught with Present method of teaching in their median standard score. But IPM and group taught with Present method of teaching do not differ significantly in the median standard score on Achievement in Mathematics. Hence, for improving Achievement in Mathematics among secondary school students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Median score of AIIPM group=0.26, IPM group = -0.34, Group taught with Present method of teaching=-0.14).

Discussion of Results

Art Integrated Information Processing Model and Information Processing Model are effective for improving Problem solving ability in Mathematics and developing a positive Attitude towards Mathematics among secondary school students. Art Integrated Information Processing Model is effective for reducing Mathematics anxiety, and improving Achievement in Mathematics among secondary school students. Also, for developing Mathematics belief (Exploratory) among secondary school students the three teaching strategies are equally effective.

Conclusion

Art Integrated Information Processing Model is effective to bring out Problem solving ability in Mathematics (very large effect), Exploratory Mathematics belief (large effect) Attitude towards Mathematics (very large effect), reducing Mathematics anxiety (very large) and to enhance Achievement in Mathematics (large effect) among eighth standard students. It is equally effective to bring out these outcomes among ninth standard too, the effectiveness being very large for Problem solving ability in Mathematics, Exploratory Mathematics belief, Attitude towards Mathematics, reducing Mathematics anxiety and large effect for enhancing Achievement in Mathematics.

Information Processing Model has a very large effect on Problem solving ability in Mathematics, Attitude towards Mathematics and reducing Mathematics anxiety whereas the effect is large in the case of Achievement in Mathematics among eighth and ninth standard students. For developing exploratory Mathematics belief, it has a large effect for eighth standard students, but only a moderate effect for ninth standard students.

Present method of teaching has large effect on exploratory Mathematics belief, reducing Mathematics anxiety and improving Achievement in Mathematics as well as a very large effect on Attitude towards Mathematics among eighth and ninth standard students. For developing Problem solving ability in Mathematics, it has very large effect for ninth standard students, but only a moderate effect for eighth standard students.

The findings shows that the Art-Integrated Information Processing Model is effective in enhancing select Mathematical outcomes, viz., Problem Solving Ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics, and reduced Mathematics Anxiety among secondary school students.

Chapter 5

SUMMARY, FINDINGS AND CONCLUSION

SUMMARY, FINDINGS AND CONCLUSION

This chapter provides an overview of the research, under the headings Study in Retrospect, Major Findings of the Study, Tenability of Hypotheses and Conclusion of the Study.

Study in Retrospect

It outlines various stages and facets of the current study, encompassing the Title, Variables, Objectives, Hypotheses, and Methodology used.

Restatement of the Problem

The study was an attempt to find out the effectiveness of Art Integrated Information Processing Model in enhancing select Mathematical outcomes, viz., Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and in reducing Mathematics Anxiety among secondary school students.

The study was titled as "EFFECTIVENESS OF ART INTEGRATED INFORMATION PROCESSING MODEL IN ATTAINING MATHEMATICAL OUTCOMES AMONG SECONDARY SCHOOL STUDENTS."

Variables of the Study

The treatment variable of the study was method of teaching with three levels viz., Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics. The dependent variable was select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics.

Objectives of the Study

The following were the objectives of the study

1. To find out the effectiveness of Art Integrated Information Processing Model on select Mathematical outcomes among secondary school students.
2. To find out the effectiveness of Information Processing Model on select Mathematical outcomes among secondary school students.
3. To find out the effectiveness of Present method of teaching Mathematics on select Mathematical outcomes among secondary school students.

Hypotheses of the Study

Following hypotheses were formulated for the study

1. There will be significant difference in the average pre-test and post-test scores on select Mathematical outcomes for the three comparison groups.

2. There will be significant difference in the average post-test scores on select Mathematical outcomes among the three comparison groups.

3. There will be significant difference in the average gain scores on select Mathematical outcomes among the three comparison groups.

4. There will be significant difference in the average standard scores on select Mathematical outcomes among secondary school students taught through Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.

The first hypothesis was tested for each Mathematical outcome separately for the three comparison groups both for eighth and ninth standard students, the second and third hypotheses were tested for each Mathematical outcome separately for eighth and ninth standard students, and the fourth hypothesis was tested for each Mathematical outcome for the total group.

Methodology

Design of the Study

The present study followed quasi-experimental pre-test-post-test comparison group design with three unequal groups. To find out the effectiveness of Art Integrated Information Processing Model (AIIPM), effectiveness of Information Processing Model and Present method of teaching Mathematics in enhancing select Mathematical outcomes were compared with that of Art Integrated Information Processing Model. Hence the three comparison groups were the groups taught with AIIPM, IPM and Present method of teaching Mathematics. The three comparison groups were selected from eighth and ninth standard students separately and the study was conducted both for eighth and ninth standards.

Internal and External Validity of the Experimental Design

To ensure internal validity of the experiment conducted among eighth standard students the mean pre-test score on each Mathematical outcomes was compared among the three groups.

Though significant difference ($p \leq .05$) was observed among the groups in Problem solving ability in Mathematics and Mathematics anxiety, the post-hoc analysis showed that the difference in Problem solving ability in Mathematics is between AIIPM and IPM groups with a higher score for IPM group, which will not affect the findings of the study. No significant difference was observed for AIIPM and IPM groups with the group taught with the Present method of teaching in Problem solving ability in Mathematics. In the case of Mathematics anxiety, higher score on anxiety was observed for IPM group. The other Mathematical outcomes, Mathematics belief, Attitude towards Mathematics and Achievement in Mathematics are found to be not significantly differing among the three comparison groups.

The groups for the experiment were selected randomly and the three groups were of the same nature with regard to gender, socio-economic status, aptitude and size of the group. This was ensured as the school has no practice of homogeneous grouping with regard to any of the factors that may affect the experiment. The time of intervention for the three groups were same as the classes were arranged based on the regular time table followed in the school.

The problem of statistical regression was resolved as any of the comparison groups do not have a very high or low values in the pre-test scores.

Also, the experiment was replicated with another set of comparison groups of ninth standard students. No remarkable difference in the entry behaviour (Pre- test score on Problem Solving Ability in Mathematics, Mathematics Belief, Attitude towards Mathematics and Mathematics Anxiety) of the comparison groups of ninth standard was identified that may affect the results of the study, but significant difference in entry level Achievement in Mathematics was reported influence of which was controlled statistically using MANCOVA.

The external validity of the experiment was ensured to some extent by selecting the groups randomly for the interventions. The results are generalizable as the groups are true representation of a typical secondary school students studying in Government/ Aided schools in Kerala. It is expected that interaction among students will not affect the treatment as the interventions are made as part of regular classroom teaching without highlighting the difference in approach. Also, as the interventions are made as part of regular classroom activities, the results will not be context based, increasing the generalizability of the results.

The experiment has construct validity as the variables measured and the interventions adopted have enough theoretical background. The dependent variable Mathematical outcomes was clearly defined as cognitive and affective learning outcomes of Mathematics and important learning outcomes like Problem solving Ability in Mathematics, Mathematics belief, Attitude Towards Mathematics, Mathematics Anxiety and Achievement in Mathematics were selected as

Mathematical outcomes. These variables were measured using separate instruments with sufficient validity and reliability.

Participants of the Study

The population under study was secondary school students of Kerala. The sampling frame included students studying in standard VIII and IX. The experiment was conducted separately for students of standard VIII and IX. For the conduct of the study, AIIPM, IPM groups and group to be taught with Present method of teaching as three comparison groups for each level (8^{th} and 9^{th} standard) were needed. The participants of the study were 215 students, 111 from 8^{th} standard and 104 from 9^{th} standard of HSS Arimpur, Thrissur.

Instruments Used for the Study

Following tools and materials were used for collecting data for the study.

a) Mathematics Belief inventory (Saritha & Vijayakumari, 2019)

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

c) Scale of Attitude towards Mathematics (Saheedali & Vijayakumari, 2013)

d) Mathematics Anxiety Scale (Malini & Sumangala, 1996; Re-standardized by Midhundas & Vijayakumari,2017)

e) Achievement tests in Mathematics (Saritha & Vijayakumari, 2019)

f) Teaching Manual based on Art Integrated Information Processing Model (Saritha & Vijayakumari, 2019)

g) Teaching Manual based on Information Processing Model (Saritha & Vijayakumari, 2019)

h) Teaching Manual based on Present method of teaching (Saritha & Vijayakumari, 2019)

Statistical Techniques Used

Following statistical techniques were used for analysing the data.

- Preliminary Analysis
- One way ANOVA
- Kruskal-Wallis Test
- Paired t-test
- Multivariate Analysis
- Post-hoc Test (Tukey Method, Dwass-steel-Critchlow-Fliger pairwise comparison test)

Major Findings of the Study

The major findings of the study are given below.

Pairwise Comparison of Average Pre-test and Post-test Scores on Select Mathematical outcomes among the Three Groups of Eighth Standard Students

1. The pre-test and post-test mean scores on Problem solving ability in Mathematics of

   i. Students taught with Art Integrated Information Processing Model differ significantly ($t=10.69$, $p \leq .01$) with a very large effect ($d=1.782$)

   ii. Students taught with Information Processing Model differ significantly ($t= 7.92$, $p \leq .01$) with a very large effect ($d=1.32$).

iii. Students taught with Present method of teaching differ significantly (t=3.83, p≤ .01) with a moderate effect (d=0.614).

2. The pre-test and post-test mean scores on Mathematics belief (Exploratory) of

   i. Students taught with Art Integrated Information Processing Model differ significantly (t=5.52, p≤ .01) with a large effect (d=0.92).

   ii. Students taught with Information Processing Model differ significantly (t= 6.13, p≤ .01) with a large effect (d=1.02).

   iii. Students taught with Present method of teaching differ significantly (t=6.05, p≤ .01) with large effect (d=0.969).

3. The pre-test and post-test mean scores on Attitude towards Mathematics of

   i. Students taught with Art Integrated Information Processing Model differ significantly (t=8.44, p≤ .01) with a very large effect (d=1.406).

   ii. Students taught with Information Processing Model differ significantly (t= 14.98, p≤ .01) with a very large effect (d=2.50).

   iii. Students taught with Present method of teaching differ significantly (t=11.07, p≤ .01) with a very large effect (d=1.773).

4. The pre-test and post-test mean scores on Mathematics anxiety of

   i. Students taught with Art Integrated Information Processing Model differ significantly (t=9.75, p≤ .01) with a very large effect (d=1.626).

   ii. Students taught with Information Processing Model differ significantly (t= 11.52, p≤ .01) with a very large effect (d=1.92).

iii. Students taught with Present method of teaching differ significantly ($t=6.58$, $p\leq .01$) with a large effect ($d=1.054$).

5. The pre-test and post-test median scores on Achievement in Mathematics of

i. Students taught with Art Integrated Information Processing Model differ significantly ($z=5.24$, $p\leq .01$) with a large effect ($d=.873$).

ii. Students taught with Information Processing Model differ significantly ($z=5.24$, $p\leq .01$) with a large effect ($d=.873$).

iii. Students taught with Present method of teaching differ significantly ($z=5.46$, $p\leq .01$) with a large effect ($d=.874$).

Multiple Comparison of Average of Post-test Scores on Select Mathematical outcomes among the Three Comparison Groups of Eighth Standard Students

1. There exists significant difference in the mean score on Problem solving ability in Mathematics (post-test) among the groups ($F_{(2,108)} = 4.59$, $p \leq .05$) with moderate effect (partial eta squared .08). Significant difference exists between IPM group and group 3. Information Processing Model being more effective than the Present method of teaching (Mean score of IPM group=10.69, group taught with Present method of teaching=8.67) in developing Problem solving ability in Mathematics among eighth standard students.

2. There exists no significant difference in the post-test mean scores on Mathematics belief (Exploratory) among groups AIIPM, IPM and group taught with Present method of teaching ($F_{(2,108)} = 1.54$, $p > .05$).

3. There exists significant difference in the mean scores on Attitude towards Mathematics (Post-test) among the groups ($F_{(2,108)} = 4.58$, $p \leq .05$) with moderate effect (partial eta squared .08). Significant difference exists only between IPM group and group taught with Present method of teaching. Information Processing Model is more effective than the Present method of teaching (Mean score of IPM group=109.03, group taught with Present method of teaching=101.51) in developing Attitude towards Mathematics among eighth standard students.

4. In the case of post-test scores on Mathematics anxiety, the groups differ significantly ($F_{(2,108)} = 5.64$, $p \leq .01$) with moderate effect (partial eta squared .095). The AIIPM group differ significantly with IPM group and group taught with Present method of teaching. Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=72.67, IPM group=81.33, Group taught with Present method of teaching=82.23) in reducing Mathematics anxiety among eighth standard students.

5. There exists no significant difference in the post-test median scores on Achievement in Mathematics among groups AIIPM, IPM and group taught with Present method of teaching ($\chi^2_{2df} = 4.34$, $p > .01$).

Multiple Comparison of Average Gain Scores on Select Mathematical Outcomes among the Three Comparison Groups of Eighth Standard Students

1. The difference in the mean gain scores on Problem solving ability in Mathematics among the groups is significant ($F_{(2,108)}$ = 15.37, $p \leq .01$) with high effect (partial eta squared .22). Significant difference exists between Group 3 and AIIPM group as well as IPM group. Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching (Mean score of AIIPM group=3.86, IPM group = 2.89 and group taught with Present method of teaching=1.21) for developing Problem solving ability in Mathematics among eighth standard students.

2. There is no significant difference in the mean gain scores on Mathematics belief (exploratory) among AIIPM, IPM groups and group taught with Present method of teaching ($F_{(2,108)}$ = 1.11, $p > .05$) of eighth standard students.

3. There is significant difference in the mean gain scores on Attitude towards Mathematics among three comparison groups ($F_{(2,108)}$ = 3.6, $p \leq .05$) with a moderate effect (partial eta squared .06). Significant difference exists only between IPM group and group taught with Present method of teaching. Information Processing Model is more effective than the Present method of teaching in developing Attitude towards Mathematics among eighth standard students (Mean score of IPM group=16.64, group taught with Present method of teaching=11.69).

4. In the case of Mathematics anxiety, there exists significant difference among the groups on mean gain scores ($F_{(2,108)}$ = 14.85, $p \leq .01$) with moderate effect (partial eta squared .22). Group 3 differ significantly from the groups AIIPM and IPM. Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching (Mean score of AIIPM group= -14.75, IPM group= -16.03, Group taught with Present method of teaching= -6.80) to reduce Mathematics anxiety among eighth standard students.

5. The groups do not differ significantly in the median gain score on Achievement in Mathematics (χ^2_{2df} = 4.24, $p > .01$) among eighth standard students.

Pairwise Comparison of Average of Pre-test and Post-test on Select Mathematical Outcomes among the Three Groups of Ninth Standard Students

1. The pre-test and post-test mean scores on Problem solving ability in Mathematics of students taught with

   i. Art Integrated Information Processing Model differ significantly (t=14.6, $p \leq .01$) with a very large effect (d=2.5).

   ii. Information Processing Model differ significantly (t= 9.31, $p \leq .01$) with a very large effect (d=1.6).

   iii. Present method of teaching differ significantly (t=10.18, $p \leq .01$) with a very large effect (d=1.70).

2. The pre-test and post-test mean scores on Mathematics belief (Exploratory) of students taught with

   i. Art Integrated Information Processing Model differ significantly ($t=12.6$, $p \leq .01$) with a very large effect ($d=2.16$).

   ii. Information Processing Model differ significantly ($t=3.89$, $p \leq .01$) with a moderate effect ($d=0.67$).

   iii. Present method of teaching differ significantly ($t=6.85$, $p \leq .01$) with large effect ($d=1.14$).

3. The pre-test and post-test mean scores on Attitude towards Mathematics of students taught with

   i. Art Integrated Information Processing Model differ significantly ($t=16.3$, $p \leq .01$) with a very large effect ($d=2.79$).

   ii. Information Processing Model differ significantly ($t=11.7$, $p \leq .01$) with a very large effect ($d=2.01$).

   iii. Present method of teaching differ significantly ($t=9.32$, $p \leq .01$) with a very large effect ($d=1.55$).

4. The pre-test and post-test mean scores on Mathematics anxiety of students taught with

   i. Art Integrated Information Processing Model differ significantly ($t=13.5$, $p \leq .01$) with a very large effect ($d=2.32$).

ii. Information Processing Model differ significantly ($t=8.26$, $p\leq .01$) with a very large effect ($d=1.42$).

iii. Present method of teaching differ significantly ($t=7.04$, $p\leq .01$) with a large effect ($d=1.17$).

5. The pre-test and post-test median scores on Achievement in Mathematics of students taught with

   i. Art Integrated Information Processing Model differ significantly ($z=5.09$, $p\leq .01$) with a large effect ($d=.873$).

   ii. Information Processing Model differ significantly ($z=5.10$, $p\leq .01$) with a large effect ($d=.875$).

   iii. Present method of teaching differ significantly ($z=5.24$, $p\leq .01$) with a large effect ($d=.873$).

Multiple Comparison of Average Post-test Scores on Select Mathematical Outcomes among the Three Groups of Ninth Standard Students

1. The difference in the mean score on Problem solving ability in Mathematics (post-test) among the groups is significant ($F_{(2,101)} = 31.56$, $p \leq .01$), with high effect (partial eta squared .387). Significant difference exists between all three groups. Art Integrated Information Processing Model is more effective than the other two methods of teaching for improving Problem solving ability in Mathematics among ninth standard students (Mean score of AIIPM=13.56, IPM group=10.32, group taught with Present method of teaching=7.89).

2. There exists significant difference in the mean post-test scores on Mathematics belief (Exploratory) among the groups is significant ($F_{(2,101)} = 4.59$, $p \leq .05$) with a moderate effect (partial eta squared .084). Significant difference exists between the AIIPM group and the group taught with Present method of teaching. Art Integrated Information Processing Model is more effective than the Present method of teaching (Mean score of AIIPM group=11.62, group taught with Present method of teaching=9.42) for developing Mathematics belief (Exploratory) among ninth standard students.

3. There is significant difference in the mean scores of Attitude towards Mathematics (Post-test) among the three groups ($F_{(2,101)} = 57.64$, $p \leq .01$) with high effect (partial eta squared = .535). Significant difference exists between AIIPM group and IPM group with group 3. Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching (Mean score of AIIPM group = 104.29, IPM group=104.06, group taught with Present method of teaching=88.17) for improving attitude towards Mathematics among ninth standard students.

4. In the case of post-test scores on Mathematics anxiety, the groups differ significantly ($F_{(2,101)} = 17.09$, $p \leq .01$) with high effect (partial eta squared = .255). AIIPM group differ significantly from IPM group and group 3. Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching for reducing Mathematics anxiety among ninth standard students (Mean score of AIIPM

group=79.79, IPM group=91.44, Group taught with Present method of teaching=88.33).

5. The group taught with AIIPM differ significantly in the median of post-test scores on Achievement in Mathematics from the groups taught with IPM and the Present method of teaching (χ^2_{2df}= 26.68, p $\leq$ .01). The median score of post-test in Achievement in Mathematics is higher for AIIPM group compared to IPM and group taught with Present method of teaching (Median score of AIIPM group=12, IPM group=7.5, Group taught with Present method of teaching=6.5).

Multiple Comparison of Average Gain Scores on Select Mathematical outcomes among the Three groups of Ninth Standard Students

1. The difference in the mean gain score on Problem solving ability in Mathematics among the groups is significant ($F_{(2,101)}$ = 24.18, p $\leq$.01) with high effect (partial eta square .32). Significant difference exists for AIIPM group with IPM group and group 3. Art Integrated Information Processing Model is more effective than the IPM and Present method of teaching (Mean score of AIIPM group=6.26, IPM group = 3.5 and group taught with Present method of teaching=2.89) for improving Problem solving ability in Mathematics among ninth standard students.

2. There exists significant difference in the mean gain score on Mathematics belief (Exploratory) among students taught with AIIPM and IPM as well as Group 3 ($F_{(2,101)}$ = 26.76, p $\leq$.01) with high effect (partial eta square = .35).

Art integrated, Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean gain score of AIIPM group=4.97, IPM group=1.56, group taught with Present method of teaching=1.92) for developing Mathematics belief (Exploratory) among ninth standard students.

3. There is significant difference in the mean gain scores of Attitude towards Mathematics among three comparison groups ($F_{(2,101)} = 36.17$, $p \leq .01$) with a high effect (partial eta squared .42). Significant difference exists for AIIPM group with IPM group, and group taught with Present method of teaching, and IPM and group taught with Present method of teaching. For developing Attitude towards Mathematics among ninth standard students, Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Mean score of AIIPM group=16.4, IPM group=11.4, group taught with Present method of teaching=5.89)

4. There exists significant difference in the mean gain scores on Mathematics anxiety, for AIIPM group with IPM group and group taught with Present method of teaching ($F_{(2,101)} = 16.31$, $p \leq .01$) with a high effect (partial eta squared .24). For reducing Mathematics anxiety among ninth standard students Art Integrated Information Processing Model is more effective than and Information Processing Model and the Present method of teaching (Mean score of AIIPM group= -14, IPM group= -8.5, Group taught with Present method of teaching= -6.28).

5. There exists significant difference in the median gain scores on Achievement in Mathematics for AIIPM group with IPM group and group taught with Present method of teaching (χ^2_{2df} = 26.1, p≤ .01). Art Integrated Information Processing Model is more effective than the Information Processing Model and Present method of teaching (Median score of AIIPM group=12, IPM group=7, Group taught with Present method of teaching=6) for improving Achievement in Mathematics among ninth standard students.

Multiple Comparison of Average Standard Scores on Select Mathematical Outcomes among the Three groups of Secondary School Students (Total Sample)

1. The difference in the mean standard score on Problem solving ability in Mathematics among the groups is significant ($F_{(2,212)}$ = 21.87, p ≤.01) with high effect (partial eta squared .17). Significant difference exists for the group taught with Present method of teaching with AIIPM and IPM groups. Art Integrated Information Processing Model and Information Processing Model are more effective than the Present method of teaching for improving Problem solving ability in Mathematics among Secondary school students (Mean score of AIIPM group=0.45, IPM group = 0.12 and group taught with Present method of teaching=-0.53).

2. There exists significant difference in the mean standard scores on Mathematics belief (Exploratory) among AIIPM, IPM groups and group taught with Present method of teaching ($F_{(2,212)}$ = 3.55, p ≤.05) with low effect (partial eta square .032), but the difference is not significant in post hoc analysis. Hence, for

developing Mathematics belief (Exploratory) among secondary students the three methods are equally effective.

3. There is significant difference in the median standard scores of Attitude towards Mathematics among three groups (χ^2_{2df}=43.6, p≤ .01). Significant difference exists for Group 3 with AIIPM group and IPM group. Art Integrated Information Processing Model and Information Processing Model are effective than the Present method of teaching (Median score of AIIPM group=0.22, IPM group=0.15, group taught with Present method of teaching = -0.89) for devolving positive attitude towards Mathematics among Secondary school students.

4. There exists significant difference in the mean standard scores on Mathematics anxiety among AIIPM group with IPM and group taught with Present method of teaching ($F_{(2,212)}$ = 15.14, p ≤ .01) with a moderate effect (partial eta squared .13). Art Integrated Information Processing Model is more effective than Information Processing Model and the Present method of teaching (Mean score of AIIPM group= -.454, IPM group=0.29, Group taught with Present method of teaching=0.203) in reducing Mathematics anxiety among Secondary school students.

5. There exists significant difference in the median standard scores on Achievement in Mathematics for the AIIPM group with IPM group and group taught with Present method of teaching (χ^2_{2df} =23.6, p≤ .01). Art Integrated Information Processing Model is more effective than the Information

Processing Model and Present method of teaching (Median score of AIIPM group=0.26, IPM group= -0.34, Group taught with Present method of teaching= -0.14) for improving Achievement in Mathematics among Secondary school students.

These major findings are summarized in table 66.

Table 66

Results of Statistical Analysis of the Data Collected from Eighth and Ninth Standard Students, and Total Sample about the Effectiveness of AIIPM, IPM and Present Method of Teaching

	Problem Solving Ability in Mathematics		Mathematics Belief (Exploratory)		Attitude towards Mathematics		Mathematics Anxiety		Achievement in Mathematics	
	Standard VIII	Standard IX	Standard VIII	Standard IX	Standard VIII	Standard IX	Standard VIII	Standard IX	Standard VIII	Standard IX
Pre-test and Post-test scores	AIIPM (1.782) IPM (1.32) Very large	AIIPM (2.5) Present method (1.7) IPM (1.6) Very large	IPM (1.02) Present method (0.969) AIIPM (0.92) Large	AIIPM (2.16) Very large	IPM (2.50) Present method (1.773) AIIPM (1.406) Very large	AIIPM (2.79) IPM (2.01) Present method (1.55) Very large	IPM (1.92) AIIPM (1.626) Very large	AIIPM (2.32) IPM (1.42) Very large	AIIPM (0.875) IPM (0.873) Present method (0.874) Large and equal	AIIPM (0.873) IPM (0.875) Present method (0.873) Large and equal
Average Post-test scores	IPM	AIIPM	AIIPM IPM Present method	AIIPM	IPM	AIIPM IPM	AIIPM	AIIPM	AIIPM IPM Present method	AIIPM
Average Gain scores	AIIPM IPM	AIIPM	AIIPM IPM Present method	AIIPM	IPM	AIIPM	AIIPM IPM	AIIPM	AIIPM IPM Present method	AIIPM
Standard score (Total Sample)	AIIPM IPM		AIIPM IPM Present method		AIIPM IPM		AIIPM		AIIPM	

Tenability of Hypotheses

The tenability of the hypotheses was examined in accordance with the analysis results.

1. The first hypothesis is **'There will be significant difference in the average pre-test and post-test scores on select Mathematical outcomes for the three comparison groups.**

   The study found that the pre-and post-test mean scores on the select Mathematical outcomes viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics Anxiety and Achievement in Mathematics differ significantly for the three comparison groups of eighth and ninth standard students. Hence the hypothesis is substantiated.

2. The second hypothesis states that '**There will be significant difference in the average post-test scores on select Mathematical outcomes among the three comparison groups.'**

   The study found that no significant difference is found in the case of Mathematics belief (Exploratory) and Achievement in Mathematics, but significant difference is reported in the other dependent variables, viz., Problem solving ability in Mathematics, Attitude towards Mathematics and Mathematics anxiety among the three comparison groups of eighth standard students. These results partially substantiate the hypothesis for eighth standard students.

A significant difference among the groups is reported for all the select Mathematical outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics of ninth standard students. These results substantiate the hypothesis for ninth standard students.

As per these findings the second hypothesis is not fully substantiated.

3. The third hypothesis states that '**There will be significant difference in the average gain scores on select Mathematical outcomes among the three comparison groups.'**

The study found that no significant difference in the mean gain score is found in the case of Mathematics belief (Exploratory) and Achievement in Mathematics, but significant difference is reported in the other dependent variables, viz., Problem solving ability in Mathematics, Attitude towards Mathematics and Mathematics anxiety among the three comparison groups of eighth standard students. These results partially substantiate the hypothesis for eighth standard students.

A significant difference in the mean gain score among the groups is reported for all select Mathematical outcomes, viz., Problem solving ability in Mathematics, Mathematics belief (Exploratory), Attitude towards

Mathematics, Mathematics anxiety and Achievement in Mathematics of ninth standard students. These results substantiate the hypothesis for ninth standard students.

Hence the third hypothesis is partially substantiated.

4. Fourth hypothesis states that **'There will be significant difference in the average standard scores on select Mathematical outcomes among secondary school students taught through Art Integrated Information Processing Model, Information Processing Model and Present method of teaching Mathematics.'**

   The study found that no significant difference is found in the case of Mathematics belief (Exploratory) but significant difference is reported in other select Mathematical outcomes, viz., Problem solving ability in Mathematics, Attitude towards Mathematics, Mathematics anxiety and Achievement in Mathematics, among the three comparison groups of secondary school students. These results partially substantiate the fourth hypothesis.

Conclusion

Present study attempted to find out whether Art Integrated Information Processing Model, Information Processing Model or Present method of teaching Mathematics is the most effective in bringing out Mathematical outcomes, viz., Problem Solving Ability in Mathematics, Mathematics belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and reduced Mathematics Anxiety among secondary school students.

Art Integrated Information Processing Model and Information Processing Model have very large effect on Problem solving ability in Mathematics among eighth standard students but Present method of teaching Mathematics has a moderate effect. Art Integrated Information Processing Model, Information Processing Model and Present method of teaching have very large effect on Problem solving ability in Mathematics among ninth standard students. Hence Art Integrated Information Processing Model and Information Processing Model are more effective to improve Problem solving ability in Mathematics of both eighth and ninth standard students compared to the Present method of teaching. Art Integrated Information Processing Model and Information Processing Model are more effective teaching strategies to improve Problem solving ability in Mathematics among secondary school students.

Information Processing Model is more effective in developing exploratory belief in Mathematics among eighth standard students compared to other two teaching methods. Art Integrated Information Processing Model and Present method of teaching have large effect and both are effective in developing exploratory belief in Mathematics among eighth standard students. Art Integrated Information Processing Model has a very large effect in developing exploratory belief in Mathematics among ninth standard students compared to the other two teaching methods. Information Processing Model has only a moderate effect in developing exploratory belief in Mathematics whereas the Present method of teaching has a large effect. The three teaching strategies can be used for developing exploratory Mathematics belief among secondary school students.

All the three treatments have very large effect on Attitude towards Mathematics for both eighth and ninth standard students. For eighth standard students Information Processing Model has a higher effect size whereas for ninth standard students Art Integrated Information Processing Model has the higher value. Art Integrated Information Processing Model and Information Processing Model are effective to develop positive attitude towards Mathematics among Secondary school students.

Art Integrated Information Processing Model and Information Processing Model have very large effect in reducing Mathematics anxiety among eighth and ninth standard students. A higher effect size for Art Integrated Information Processing Model suggest that it is more effective to reduce Mathematics anxiety among ninth standard students but Information Processing Model is more effective for eighth standard students. A lower mean standard score in Mathematics anxiety for the group taught with Art Integrated Information Processing Model shows that Art Integrated Information Processing Model is more effective to reduce Mathematics anxiety among secondary school students.

Art Integrated Information Processing Model, Information Processing Model and Present method of teaching have a large effect on Achievement in Mathematics among eighth and ninth standard students. This shows that the three methods are equally effective in improving Achievement in Mathematics among both eighth and ninth standard students. This finding agrees with that of Arjun and Niranjana (2017). But analysis of standard scores for the total group reveals that Art Integrated Information Processing Model is more effective for improving Achievement in Mathematics among secondary school students which is concomitant with that of (Egna-delsol, 2023; Yildizhan & Cezikturk, 2022; Heiman, 2020; Joseph, 2019; An et al., 2013; Baird, 2015; De Leo, 2003) which advocates for Art integration in teaching.

From the above results, it can be concluded that Art Integrated Information Processing Model is more effective in enhancing select Mathematical outcomes viz., Problem Solving Ability in Mathematics, Mathematics Belief (Exploratory), Attitude towards Mathematics, Achievement in Mathematics and in reducing Mathematics Anxiety among secondary school students, with slight variations for different grades. These findings align with those of Mishra (2024); Willis (2024); Melnick et al. (2011). But Art integrated / not integrated Information Processing Model is found to be a better choice to attain select Mathematical outcomes among secondary school students.

Chapter 6

RECOMMENDATIONS

- Educational Implications
- Recommendations
- Suggestions for Further Research

RECOMMENDATIONS

This chapter reflects on the broader significance of major findings of the study. By synthesizing the results, this chapter seeks to clarify how the research contributes to both theoretical insights and practical applications in the field. The discussion highlights the study's implications, shedding light on potential advancements or changes that can be made to improve current practices. Furthermore, this chapter identifies areas where gaps remain and offers targeted recommendations for future research, encouraging further exploration and development.

Educational Implications

The findings of this study offer important educational implications, particularly for improving Mathematics education at the secondary school level. By exploring the impact of the Art-integrated Information Processing Model, this research underscores the potential for innovative teaching approaches to foster key Mathematical outcomes such as problem-solving ability, positive attitude, exploratory belief, achievement, and reduced anxiety. The following implications highlight practical strategies for educators and curriculum designers to effectively incorporate these methods, ultimately fostering a more engaging and effective Mathematics learning environment.

Art integration explores affective and cognitive outcomes in Mathematics. By demonstrating the imaginative and useful aspects of math, art integration may stimulate students' positive attitude and reduce anxiety in Mathematics that leads to improvement in learning. By presenting real or visual representations, art integration can help students in understanding abstract Mathematical concepts.

Integration of arts promotes creativity, which can develop analytical and problem-solving abilities. Combining Mathematical ideas with artistic techniques will demand critical thinking from the students. Art Integrated Information Processing Model will help to mathematize the thinking process as suggested in various national policies.

Art integration to Information processing approach model is found to be a more effective strategy to develop Problem solving ability among secondary school students. Integrating art to systematic processing of information helps students to engage with Mathematics in a multi-sensory way. Incorporating a variety of art form including auditory, visual and kinesthetics elements makes the abstract Mathematical concepts more concrete and meaningful. This will help students who do not excel in logical mathematical intelligence. Art forms help the students to internalize the problems or sense the problem more realistically. The use of art in different stages of Information processing approach model helps students to visualize relationships and patterns more easily.

Art Integrated Information Processing Model and Information Processing Model are effective to develop affective Mathematical outcomes like positive attitude towards Mathematics, exploratory belief and reduced debilitating anxiety. These strategies help students to connect Mathematics to their personal interests and real-world applications by engaging them in Mathematics learning through the type of intelligence they excel, music/drawing/acting/dancing etc. This develops a sense of purpose and relevance of Mathematics learning.

In regular classroom a most neglected part is student's belief about Mathematics. Teachers must adopt strategies that give importance to the learners at the same time it must help students to develop appropriate belief about Mathematics so that they can walk independently towards the world of wonderful mathematical knowledge in future.

Art Integrated Information Processing Model, Information Processing Model and Present method of teaching are effective in content-based learning outcomes. Achievement with affective changes through learning is prudent and hence Art integration and information processing model are more useful in classroom practices to develop a Mathematics community who enjoy Mathematics learning and work for its development.

Students with varying skills could find it difficult to participate in inclusive regular secondary math classroom. Art makes Mathematics more inclusive and accessible by allowing students who may struggle with verbal or numerical reasoning to explore the subject through different audio-visual forms. While selecting teaching strategies care is to be given to conserve and transfer the real nature of Mathematics as in Information processing model. The findings emphasize the effectiveness of combining different models and methods, suggesting that an integrated approach could offer benefits to Mathematics education, creating inclusive and enjoyable learning environment.

Curriculum designers and teachers must keep an open-mindedness towards innovative strategies and try to implement diverse approaches effectively, integrating creativity, systematic thinking, and exploratory practices into their teaching.

Education policymakers should consider incorporating art-integrated and information-processing strategies into Mathematics curriculum at secondary level. This includes developing teaching aids, resources, and lesson plans that align with these approaches, ensuring standardization of effective practices across schools and fostering consistency in their implementation.

Recommendations

Based on the results of the study, the following recommendations can be made to enhance Mathematical outcomes among secondary school students,

- Schools should incorporate Art Integrated Information Processing Model in Mathematics teaching, as it has been shown to have a very large effect on problem-solving abilities, exploratory Mathematics beliefs, attitude towards Mathematics, and reducing Mathematics anxiety. This model enhances cognitive and affective outcomes deepening students' understanding of Mathematical concepts.

- Art integration offers students the opportunity to see the connections between disciplines. By exploring how math is used in other disciplines, students can understand the real-world applications of Mathematical concepts. This can provide a more holistic education and enhance a positive attitude towards the subject, which can lead to better career development in the future.

- Implement more scaffolding and interactive teaching methods like Art integration for secondary school students to enhance their perceptions of Mathematics as enjoyable, practical, and relevant to real life. Develop novel instructional approaches that integrate creativity, exploration, and structured learning to promote holistic student development and foster both cognitive and affective growth in Mathematics.
- Teachers may require assistance and training to successfully incorporate art into math lessons. Education department could spend money on materials like workshops, interdisciplinary teaching guidelines, or partnerships with art educators to make sure that art is connected to the Mathematical material in a meaningful way. To assess students' creative Mathematical work, teachers will also need to modify current evaluation procedures and create new tactics.
- To ensure the successful implementation of innovative instructional models, continuous professional development should be offered to teachers. This training will equip educators with the tools and strategies needed to effectively integrate new models into their teaching practice and improve students' outcomes in Mathematics. For this, refresher courses and training programs can equip teachers with the expertise to design lesson transcripts using the Art-Integrated Information Processing Model and other innovative teaching methods, linking them to real-life contexts and follow-up activities.

Additionally, in-service training, courses, and hands-on workshops can demonstrate the effective integration of arts and other innovative methods into classroom teaching. Furthermore, these training programs can support teachers in incorporating arts and other innovative methods into their teaching, improving the overall educational experience for students.

- It is important to create a supportive and encouraging classroom atmosphere that reduces math anxiety and builds positive classroom culture. This positive classroom culture enhances over all development in the learner.

Suggestions for Further Research

Findings of this study explore several avenues for future research, particularly in the area of Art Integrated and Information Processing Model on Mathematical outcomes. The effectiveness of Art Integrated Information Processing Model enhancing various Mathematical outcomes suggests that there are still many unexplored areas that could benefit from further investigation. The following are some key research questions and areas that warrant further exploration to deepen our understanding of the impact of art integration and information processing models on educational process.

- The study was to find out the effectiveness of Art Integrated Information Processing Model, Information Processing Model and Present method of teaching in the enhancement of Mathematical outcomes viz., Problem solving ability in Mathematics, Achievement in Mathematics, Mathematics belief, Attitude towards

Mathematics, and reducing Mathematics anxiety in Secondary School students. Further research can be conducted with other variables to test the effectiveness of these teaching strategies (like student engagement, motivation, self-efficacy in Mathematics, critical thinking etc.).

- Further research can be carried out to investigate whether the effectiveness of these models extends to other subjects especially science subjects, to determine their interdisciplinary applicability. It is also relevant to conduct the study among secondary school students studying in schools under various boards of education in India.
- Examining the impact of these models on diverse groups of learners, such as students with special educational needs, varying socioeconomic backgrounds, or different cultural contexts will be beneficial.
- The study can be carried out in other levels like Upper primary and Higher secondary to find out the effectiveness of Art Integrated Information Processing Model and Information Processing Model in different levels.
- The same experiment using different research designs can be carried out to test the effectiveness of teaching strategies.
- Effect of incorporating art on different successful strategies can be examined in different subjects and among different groups of students.
- Further research can be carried out to teachers' experiences and challenges in implementing these models to identify areas for professional development and practical support.

- Conduct long-term studies to assess the sustained impact of the Art-Integrated Information Processing Model, Information Processing Model, and traditional methods on students' Mathematical outcomes across multiple grades. The study can be replicated by increasing the duration of experimentation as well as ensuring the rotation of groups for the treatments.

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APPENDICES

Appendix I

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

LIST OF SCHOOL IN THRISSUR EAST AND WEST EDUCATIONAL SUB DISTRICTS

	School Name	Type of School
1	St.Josephs C. G. H. S. S. Thrissur	Aided
2	Chaldean Syrian H. S. S. Thrissur	Aided
3	Marthoma Girls H. S. Thrissur	Aided
4	M. T. H. S. Chelakkottukara	Aided
5	V. V. S. H. S. Mannuthy	Aided
6	St Sebastian's C G H S Nellikkunnu	Aided
7	A. K. M. H. S. S. Poochatty	Aided
8	ST. Augustine H. S. S. Kuttanellur	Aided
9	St Clare`s C. G. H. S. S Thrissur	Aided
10	St Thomas College H. S. S. Thrissur	Aided
11	St Thomas H. S. S. Thope	Aided
12	S. H. C. G. H. S. S. Thrissur	Aided
13	H. F. C. G. H. S. Thrissur	Aided
14	B C H S Mukkattukara	Aided
15	G. V. H. S. S. For Girls Thrissur	Government
16	G. M. B. H. S. S. Thrissur	Government
17	G. H. S. S. Pattikkad	Government
18	G. H. S. S. Peechi	Government
19	VYLOPPILLY S M GOVT.V H S S OLLUR	Government
20	St. Raphel C. G. H. S. Ollur	Aided
21	G. H. S. S. Anchery	Government
22	St.Sebasian`s H. S. Mannamangalam	Aided
23	G. V. H. S. S. Puthur	Government
24	G. H. S. S. Kattilapoovam	Government
25	G. V. H. S. S. Ramavarmapuram	Government

	School Name	Type of School
26	G. H. S. S. Villadam	Government
27	TECHNICAL HS THRISSUR	Government
28	J. P. E. H. S. KOORKANCHERY	Aided
29	S. N. B. H. S. KANIMANGALAM	Aided
30	S. N. G. H. S. KANIMANGALAM	Aided
31	H. S. ANTHIKAD	Aided
32	G. H. S. S. MANALUR	Government
33	P. J. M. S. G. H. S. S. KANDASSANKADAU	Government
34	S. H. OF MARY'S C. G. H. S. KANDASSANKADAVU	Aided
35	S. N. G. S. H. S. KARAMUCK	Aided
36	C. M. G. H. S. S. KUTTUR	Government
37	T. H. S. ARANATTUKARA	Aided
38	I. J. G. H. S. ARANATTUKARA	Aided
39	ST. ANNE`S C. G. H. S. WEST FORT THRISSUR	Aided
40	G. V. H. S. S. AYYANTHOLE	Government
41	H. S. S. ARIMPUR	Aided
42	ST .ANTONY`S H. S. PUTHENPEEDIKA	Aided
43	ST. ALOYSIUS H. S. ELTHURUTH	Aided
44	L. F. C. G. H. S. OLARIKKARA	Aided
45	C. M. S. H. S. S. THRISSUR	Aided
46	V. B. H. S. S. THRISSUR	Aided
47	V. G. H. S. S. THRISSUR	Aided
48	G. H. S. S. POONKUNNAM	Government
49	ST. JOHN`S H. S. PARAPPUR	Aided
50	S. S. G. H. S. S. PURANATTUKARA	Aided
51	S. R. K. G. V. M. H. S. S. PURANATTUKARA	Aided
52	ST. GEORGE`S H. S. PUTTEKKARA	Aided
53	SANTHA H. S. S. AVANUR	Aided
54	S. D. V. H. S. PERAMANGALAM	Aided

Appendix II

CERTIFICATE

This is to certify that Smt. Saritha A S, Senior research scholar, Farook Training College, Kozhikode has consulted me in the process of construction and standardization of the tool ***Mathematics Belief Inventory.***

I have gone through the Mathematics Belief Inventory and have suggested appropriate modifications wherever necessary. helping to betterment of the inventory.

Signature

Name & Designation
Dr. V. Sumangala
Former Professor and H/D of Education, University of Calicut.

Place

Date 17.04.2019

Appendix III.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

MATHEMATICS BELIEF INVENTORY (DRAFT)
MALAYALAM VERSION

Saritha A S
Research Scholar

Prof. (Dr.) Vijayakumari K
Professor

Personal Information

Name of the student

Name of the School

Class

Gender : Male/ Female

Type of School : Govt / Aided / Unaided

Locality : Rural / Urban

നിർദ്ദേശങ്ങൾ

ഗണിതശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില പ്രസ്താവനകൾ ആണ് താഴെക്കൊടുത്തിരിക്കുന്നത്. ഓരോ പ്രസ്താവനയും വായിച്ചശേഷം തന്നിരിക്കുന്ന മൂന്ന് വിഭാഗങ്ങളിൽ നിന്നും, നിങ്ങൾക്ക് അനുയോജ്യമായ പ്രസ്താവനയ്ക്ക് പ്രതികരണ ഷീറ്റിൽ tick (✓) അടയാളപ്പെടുത്തുക. നിങ്ങളുടെ പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ എന്ന് ഉറപ്പ നൽകുന്നു. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്തേണ്ടതാണ്.

1. ഗണിതശാസ്ത്രം എന്നത്
   a. കൃത്യമായ ഒരു രീതി പിന്തുടരലാണ്.
   b. പ്രശ്നങ്ങൾക്ക് നിർധാരണം കണ്ടെത്തലാണ്.
   c. നിത്യജീവിത പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിനുള്ള ഒരു ഉപകരണമാണ്.
2. ഗണിതശാസ്ത്രത്തിന്റെ അടിസ്ഥാനം പ്രധാനമായും
   a. യുക്തിയാണ്.
   b. പരസ്പരം ബന്ധപ്പെട്ട വിവരങ്ങൾ ചേർത്തിണക്കി പ്രശ്ന നിർദ്ധാരണത്തിന് ഉപയോഗിക്കലാണ്.
   c. മറ്റ് വിഷയങ്ങളുടെ പഠനത്തെ സഹായിക്കലാണ്.
3. ഗണിതശാസ്ത്ര പഠനത്തിലൂടെ പ്രധാനമായും
   a. ജീവിതരീതി ക്രമപ്പെടുത്തുന്നു

b. ജീവിത പ്രശ്നങ്ങളെ അവലോകനം ചെയ്ത് അനുയോജ്യമായ തീരുമാനങ്ങൾ എടുക്കുന്നു.

c. ജീവിതം മാർഗത്തിനുള്ള വഴി കണ്ടെത്തുന്നു.

4. മറ്റ് വിഷയങ്ങളിൽ നിന്നും ഗണിതശാസ്ത്രത്തെ വ്യത്യസ്തമാക്കുന്നത്

a. ഉത്തരത്തിലെ കൃത്യത.

b. വ്യത്യസ്തവും വെല്ലുവിളി ഉയർത്തുന്നതുമായ പ്രശ്നങ്ങളിൽ നിന്നും കണ്ടെത്തുന്ന പുതിയ ബന്ധങ്ങൾ.

c. പ്രശ്നപരിഹാരം മനഃപാഠമാക്കാവുന്ന വിധത്തിലുള്ള അഭ്യാസങ്ങൾ.

5. ഗണിതശാസ്ത്ര പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിലൂടെ നേടിയെടുക്കുന്ന കഴിവ്

a. പ്രവർത്തനങ്ങളെ ചിട്ടയായി പൂർത്തീകരിക്കുന്നു.

b. പ്രശ്നപരിഹാരത്തിന് വ്യത്യസ്തമായ വഴികൾ പരീക്ഷിക്കുന്നു.

c. പരിശീലിച്ച രീതിയിലൂടെ പുതിയ പ്രശ്നങ്ങൾക്ക് പരിഹാരം കാണുന്നു.

6. ഗണിതശാസ്ത്ര പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിൽ പ്രധാനപ്പെട്ടത്

a. പൊതുവായ ഒരു രീതി പിന്തുടരുന്നതാണ്.

b. വിവരങ്ങളെ പരസ്പരം ബന്ധപ്പെടുത്തുന്നതാണ്.

c. ഉചിതമായ സൂത്രവാക്യം ഉപയോഗിക്കുന്നതാണ്.

7. ഗണിത പ്രശ്നങ്ങളിൽ സാമാന്യവൽക്കരണം നടത്തുന്നത്

a. സാമാന്യവൽക്കരണത്തിന് ആവശ്യമായ സൂചനകൾ ലഭിച്ചാൽ മാത്രം.

b. പുതിയ ബന്ധങ്ങൾ കണ്ടെത്തുന്നതിന് വേണ്ടി.

c. തന്നിരിക്കുന്ന ഗണിത പ്രശ്നത്തിൽ സാമാന്യവൽക്കരണം ആവശ്യപ്പെടുന്നുണ്ടെങ്കിൽ മാത്രം.

8. ഗണിതശാസ്ത്ര അഭ്യാസങ്ങൾ പ്രധാനമായും

a. ഒരേ രീതി (സമാന സ്വഭാവം) പിന്തുടരുന്നവയാകണം.

b. വ്യത്യസ്ത ചിന്താരീതികളെ പ്രചോദിപ്പിക്കുന്നവയാകണം.

c. പരീക്ഷയ്ക്ക് ചോദിക്കാൻ സാധ്യതയുള്ളത് ആകണം.

9. ഗണിതശാസ്ത്ര അഭ്യാസങ്ങൾ ചെയ്യുന്നതിലൂടെ

a. പ്രശ്നനിർധാരണ ഘട്ടങ്ങൾ മന:പ്പാഠമാകുന്നു.

b. പ്രശ്നനിർധാരണത്തിന് വ്യത്യസ്ത രീതികൾ ഉണ്ടെന്ന് മനസ്സിലാക്കുന്നു.

c. പരീക്ഷയ്ക്ക് ഉയർന്ന മാർക്ക് ലഭിക്കുന്നു

10. ഒരു നല്ല ഗണിതശാസ്ത്ര പ്രശ്നം എന്നാൽ

a. ഒരു നിശ്ചിത ഉത്തരത്തിന് പ്രാധാന്യം നൽകുന്നത്.

b. വ്യത്യസ്തനിർധാരണ രീതികൾ പ്രോത്സാഹിപ്പിക്കുന്നത്.

c. സൂത്രവാക്യം ഉപയോഗിക്കേണ്ടത്.

11. ഗണിതശാസ്ത്ര പ്രശ്നനിർധാരണം ലക്ഷ്യമാക്കുന്നത്
    a. എളുപ്പമുള്ള പ്രശ്നങ്ങൾക്ക് നിശ്ചിത ഉത്തരം കണ്ടെത്തൽ.
    b. വെല്ലുവിളി ഉയർത്തുന്ന പ്രശ്നങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ.
    c. എളുപ്പ മാർഗത്തിലൂടെ (സൂത്രവഴികൾ /സൂത്രവാക്യങ്ങൾ) ഉപയോഗിച്ച് നിശ്ചിത ഉത്തരത്തിലേക്ക് എത്തിച്ചേരൽ.
12. ഗണിതശാസ്ത്ര പഠനത്തിന് ഏറ്റവും കൂടുതൽ സഹായിക്കുന്നത്
    a. അധ്യാപിക /അധ്യാപകൻ
    b. സ്വന്തം കഴിവുകൾ
    c. മന:പ്പാഠമാക്കിയ തന്ത്രങ്ങൾ/ സൂത്രവാക്യങ്ങൾ
13. ഗണിതശാസ്ത്ര പഠനത്തിൽ കേന്ദ്രീകരിക്കേണ്ടത്
    a. ക്ലാസ് നോട്സ്
    b. സ്വയം പരിശീലനം
    c. എളുപ്പവഴികൾ/സൂത്രവാക്യങ്ങൾ
14. ഗണിതശാസ്ത്ര പഠനം എന്നതുകൊണ്ട് ഉദ്ദേശിക്കുന്നത്
    a. അധ്യാപിക/അധ്യാപകൻ അവതരിപ്പിക്കുന്ന രീതി പിന്തുടരൽ.
    b. സ്വന്തമായ ശൈലി കണ്ടെത്തൽ.
    c. എളുപ്പവഴികൾ/സൂത്രവാക്യങ്ങൾ മന:പ്പാഠമാക്കൽ
15. പുതിയ ഗണിത പ്രശ്നത്തെ നിർധാരണം ചെയ്യുമ്പോൾ
    a. മുൻപ് ചെയ്ത രീതി പ്രയോഗിക്കും.
    b. സൂക്ഷ്മമായി അപഗ്രഥനം ചെയ്ത് അനുയോജ്യമായ രീതി കണ്ടെത്തും.
    c. മനഃപാഠമാക്കിയ എളുപ്പമാർഗങ്ങൾ ഉപയോഗിക്കും.
16. ഗണിതശാസ്ത്ര പഠനത്തിൽ പ്രാധാന്യം നൽകേണ്ടത്
    a. കൃത്യമായ വഴി ഉപയോഗിച്ച് ശരിയുത്തരത്തിൽ എത്തിച്ചേരൽ
    b. പ്രശ്നനിർധാരണ പ്രക്രിയ സ്വായത്തമാക്കൽ
    c. ഉത്തരത്തിൽ എത്താനുള്ള സൂത്രവാക്യങ്ങൾ/ മാർഗങ്ങൾ മന:പ്പാഠമാക്കൽ
17. ഗണിതശാസ്ത്രത്തിന്റെ അടിത്തറ എന്നത്
    a. യുക്തിചിന്ത
    b. പരസ്പരം ബന്ധപ്പെട്ട ആശയങ്ങൾ
    c. കണക്കുകൂട്ടൽ
18. ഗണിതശാസ്ത്ര ശാഖ
    a. നിശ്ചിതമാണ്.
    b. ചലനാത്മകമാണ്.
    c. പ്രായോഗികമാണ്.

19. ഗണിതശാസ്ത്ര ബോധന രീതിയിൽ പ്രാധാന്യം അർഹിക്കുന്നത്

    a. അധ്യാപക കേന്ദ്രീകൃത പ്രവർത്തനങ്ങൾ

    b. ഗവേഷണ ചിന്തയെ പ്രചോദിപ്പിക്കുന്ന പ്രവർത്തനങ്ങൾ

    c. സൂത്രവാക്യങ്ങൾ/ തന്ത്രങ്ങൾ മന:പ്പാഠമാക്കാൻ ഉള്ള പ്രവർത്തനങ്ങൾ

20. ഗണിത പ്രശ്നപരിഹാരത്തിന്റെ പ്രത്യേകത

    a. ഒരേ ഒരു രീതിയിലൂടെ മാത്രമാണ് ഉത്തരത്തിൽ എത്തിച്ചേരാൻ സാധിക്കുക.

    b. വ്യത്യസ്ത രീതിയിൽ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ സാധിക്കും.

    c. ഉത്തരത്തിൽ എത്തിച്ചേരുക എന്നതിനാണ് പ്രാധാന്യം.

21. ഗണിതശാസ്ത്ര അധ്യാപിക/അധ്യാപകൻ ശ്രദ്ധിക്കേണ്ടത്

    a. ചിട്ടയോടും കൃത്യതയോടും കൂടി പാഠഭാഗം അവതരിപ്പിക്കണം.

    b. ചിന്തകളെ പ്രചോദിപ്പിക്കുന്ന രീതിയിൽ പാഠഭാഗം അവതരിപ്പിക്കണം.

    c. പരീക്ഷയെ കേന്ദ്രീകരിച്ച് പാഠഭാഗം അവതരിപ്പിക്കണം.

22. ഗണിത പ്രശ്നങ്ങൾക്ക് പരിഹാരം കണ്ടെത്താൻ

    a. അധ്യാപിക/അധ്യാപകൻ അവതരിപ്പിക്കുന്ന രീതി പിന്തുടരും.

    b. സ്വന്തമായ രീതിയിൽ പ്രശ്നത്തെ പരിഹരിക്കും.

    c. കൃത്യമായി ഉത്തരത്തിൽ എത്തിച്ചേർന്നവരോട് ചോദിച്ച് മനസ്സിലാക്കും.

23. ഗണിത പ്രശ്നങ്ങൾ പൊതുവെ

    a. കൃത്യമായ ഘട്ടങ്ങളിലൂടെ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ കഴിയുന്നവ ആകണം.

    b. ഗണിത ചിന്തകളെ ഉത്തേജിപ്പിക്കുന്നവ ആകണം.

    c. നേരിട്ട് സൂത്രവാക്യം ഉപയോഗിക്കാൻ പറ്റുന്ന രീതിയിൽ ആകണം.

24. ഗണിത പ്രശ്നപരിഹാരം എന്നത്

    a. ശരിയുത്തരത്തിൽ എത്തുക എന്നതാണ്.

    b. കൃത്യമായ പ്രശ്നം നിർധാരണ രീതി കണ്ടെത്തുക എന്നതാണ്.

    c. സൂത്രവാക്യം ഉപയോഗിക്കുക എന്നതാണ്.

25. ഗണിത പ്രശ്നങ്ങൾ

    a. ടെക്സ്റ്റ് ബുക്ക് കേന്ദ്രീകൃതമായിരിക്കണം

    b. താത്പര്യമുണർത്തുന്നതും ചിന്തിപ്പിക്കുന്നവയും ആയിരിക്കണം

    c. എളുപ്പത്തിൽ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ കഴിയുന്നവ ആയിരിക്കണം

26. ഗണിത പ്രശ്നപരിഹാരത്തിൽ അധ്യാപിക/അധ്യാപകൻ വിദ്യാർത്ഥികൾക്ക്

    a. കൃത്യമായ സൂചകങ്ങൾ നൽകി പ്രശ്നപരിഹാരത്തിൽ എത്തിക്കണം.

    b. ചിന്തയെ പ്രചോദിപ്പിക്കുന്ന ചോദ്യങ്ങളിലൂടെ പ്രശ്നനിർധാരണ ഘട്ടത്തിലേക്ക് നയിക്കണം.

    c. നേരിട്ട് ഉത്തരത്തിൽ എത്തിക്കണം.

Appendix III.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

MATHEMATICS BELIEF INVENTORY (DRAFT)
ENGLISH VERSION

Saritha A S
Research Scholar

Prof. (Dr.) Vijayakumari K
Professor

Personal Information

Name of the student

Name of the School

Class

Gender	:	Male/ Female
Type of School	:	Govt / Aided / Unaided
Locality	:	Rural / Urban

INSTRUCTIONS

Some statement related to Mathematics are given below. Each statement have three responses. After reading each statement, put a tick mark (✓) for more suitable response in the response sheet. Your responses will be used for research purpose only. Response to all statements must be recorded.

1. Mathematics is
   a. Following a definite method
   b. Finding solutions to problems
   c. A tool for solving daily life problems
2. The basis of Mathematics is
   a. Logic
   b. Combining related information to solve problems.
   c. Helpful for learning other subjects
3. Through the study of Mathematics, mainly
   a. Organize life systematically
   b. Analyzes life problems and makes appropriate decisions
   c. Finding a way for livelihood

4. Mathematics is different from other subjects for
   a. The precision of answers.
   b. Discovering new relationships through unique and challenging problems.
   c. Exercises that are memorized for problem-solving.
5. The ability acquired through solving mathematical problems is
   a. Completing tasks systematically.
   b. Exploring different ways to solve problems.
   c. Using learned methods to solve new problems.
6. The most important aspect of solving mathematical problems is
   a. Following a common method
   b. Connecting information logically
   c. Using appropriate formulas
7. Generalization in Mathematical problems is done
   a. Only when necessary hints are provided.
   b. To discover new relationships.
   c. Only if the given problem demands it.
8. Mathematics exercises are
   a. Follow the same pattern
   b. Inspire different way of thinking
   c. Examination based
9. By practicing mathematical exercises
   a. Memorizes the steps of problem solving
   b. Understands that different ways exist for problem solving
   c. Scores high marks in examination
10. A good Mathematical problem is
    a. Prioritizes a specific answer.
    b. Encourages various solving methods.
    c. Requires using formulas.
11. The goal of mathematical problem solving is
    a. Finding definite answers for simple problems.
    b. Finding answers to challenging problems.
    c. Reaching a specific answer using formulas or shortcuts.

12. The Most helpful aspect of learning Mathematics is
    a. The Teacher
    b. One's abilities
    c. Memorized techniques/ formulas
13. The focus in learning Mathematics should be on
    a. Class notes
    b. Self practice
    c. Shortcuts and formulas
14. Studying of Mathematics means
    a. Following the method presented by the teacher
    b. Finding your own way
    c. Memorizing shortcuts and formulas
15. When solving a new Mathematical problem, one should
    a. apply previously learned methods
    b. Analyze carefully and find a suitable method
    c. Use memorized shortcuts
16. The emphasis in learning Mathematics is
    a. Reaching the correct answer through precise methods.
    b. Mastering the problem-solving process.
    c. Memorizing formulas/methods for answers.
17. The foundation of Mathematics is
    a. Logical thinking
    b. Interrelated concepts
    c. Calculations
18. The branch of Mathematics is
    a. Static
    b. Dynamic
    c. Practical
19. The importance in Mathematics teaching is
    a. Teacher centered activities
    b. Activities that stimulate research thinking
    c. Activities for memorizing formulas

20. The uniqueness of solving mathematical problems is that
    a. Only single method for solving problems
    b. Different ways for solving problems
    c. The focus is on the final answer.
21. The Mathematics teacher should focus on
    a. Presenting lesson in a systematic way
    b. Presenting lessons in a way that inspires thinking.
    c. Presenting lessons with focus on exams.
22. To find solutions to mathematical problems, students should
    a. Follow the method presented by the teacher
    b. Solve the problems in your own way
    c. Ask and understand from those who got the correct answer.
23. Mathematical problems are generally
    a. Allow reaching answers through precise steps
    b. Stimulate mathematical thinking
    c. Use formulas directly
24. Mathematical problem solving means
    a. Getting the correct answer
    b. Identifying a systematic problem solving approach
    c. Using formulas
25. Mathematical problems should
    a. Be textbook-centered.
    b. Be thought-provoking and engaging.
    c. Be easy to solve.
26. In mathematical problem-solving, a teacher should
    a. Provide specific clues to help students reach a solution.
    b. Guide students to the problem-solving stage through thought-provoking questions.
    c. Directly provide the solution.

Appendix IV.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

MATHEMATICS BELIEF INVENTORY (FINAL)
MALAYALAM VERSION

Saritha A S
Research Scholar

Prof. (Dr.) Vijayakumari K
Professor

Personal Information

Name of the student

Name of the School

Class

Gender	:	Male/ Female
Type of School	:	Govt / Aided / Unaided
Locality	:	Rural / Urban

നിർദ്ദേശങ്ങൾ

ഗണിതശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില പ്രസ്താവനകൾ ആണ് താഴെക്കൊടുത്തിരിക്കുന്നത്. ഓരോ പ്രസ്താവനയും വായിച്ചശേഷം തന്നിരിക്കുന്ന മൂന്ന് വിഭാഗങ്ങളിൽ നിന്നും, നിങ്ങൾക്ക് അനുയോജ്യമായ പ്രസ്താവനയ്ക്ക് പ്രതികരണ ഷീറ്റിൽ tick (✓) അടയാളപ്പെടുത്തുക. നിങ്ങളുടെ പ്രതികരണങ്ങൾ ഗവേഷണ ആവശ്യങ്ങൾക്ക് മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ എന്ന് ഉറപ്പ് നൽകുന്നു. എല്ലാ പ്രസ്താവനകൾക്കും പ്രതികരണം രേഖപ്പെടുത്തേണ്ടതാണ്.

1. ഗണിതശാസ്ത്രം എന്നത്
   a. കൃത്യമായ ഒരു രീതി പിന്തുടരലാണ്.
   b. പ്രശ്നങ്ങൾക്ക് നിർധാരണം കണ്ടെത്തലാണ്.
   c. നിത്യജീവിത പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിനുള്ള ഒരു ഉപകരണമാണ്.
2. ഗണിതശാസ്ത്ര പഠനത്തിലൂടെ പ്രധാനമായും
   a. ജീവിതരീതി ക്രമപ്പെടുത്തുന്നു
   b. ജീവിത പ്രശ്നങ്ങളെ അവലോകനം ചെയ്ത് അനുയോജ്യമായ തീരുമാനങ്ങൾ എടുക്കുന്നു.
   c. ജീവിതം മാർഗത്തിനുള്ള വഴി കണ്ടെത്തുന്നു.
3. ഗണിതശാസ്ത്ര പ്രശ്നങ്ങൾ പരിഹരിക്കുന്നതിലൂടെ നേടിയെടുക്കുന്ന കഴിവ്
   a. പ്രവർത്തനങ്ങളെ ചിട്ടയായി പൂർത്തീകരിക്കുന്നു.
   b. പ്രശ്നപരിഹാരത്തിന് വ്യത്യസ്തമായ വഴികൾ പരീക്ഷിക്കുന്നു.
   c. പരിശീലിച്ച രീതിയിലൂടെ പുതിയ പ്രശ്നങ്ങൾക്ക് പരിഹാരം കാണുന്നു.

4. ഗണിത പ്രശ്നങ്ങളിൽ സാമാന്യവൽക്കരണം നടത്തുന്നത്
    a. സാമാന്യവൽക്കരണത്തിന് ആവശ്യമായ സൂചനകൾ ലഭിച്ചാൽ മാത്രം.
    b. പുതിയ ബന്ധങ്ങൾ കണ്ടെത്തുന്നതിന് വേണ്ടി.
    c. തന്നിരിക്കുന്ന ഗണിത പ്രശ്നത്തിൽ സാമാന്യവൽക്കരണം ആവശ്യപ്പെടുന്നുണ്ടെങ്കിൽ മാത്രം.
5. ഗണിതശാസ്ത്ര അഭ്യാസങ്ങൾ പ്രധാനമായും
    a. ഒരേ രീതി (സമാന സ്വഭാവം) പിന്തുടരുന്നവയാകണം.
    b. വ്യത്യസ്ത ചിന്താരീതികളെ പ്രചോദിപ്പിക്കുന്നവയാകണം.
    c. പരീക്ഷയ്ക്ക് ചോദിക്കാൻ സാധ്യതയുള്ളത് ആകണം.
6. ഗണിതശാസ്ത്ര അഭ്യാസങ്ങൾ ചെയ്യുന്നതിലൂടെ
    a. പ്രശ്നനിർധാരണ ഘട്ടങ്ങൾ മനഃപ്പാഠമാകുന്നു.
    b. പ്രശ്നനിർധാരണത്തിന് വ്യത്യസ്ത രീതികൾ ഉണ്ടെന്ന് മനസ്സിലാക്കുന്നു.
    c. പരീക്ഷയ്ക്ക് ഉയർന്ന മാർക്ക് ലഭിക്കുന്നു
7. ഗണിതശാസ്ത്ര പ്രശ്നനിർധാരണം ലക്ഷ്യമാക്കുന്നത്
    a. എളുപ്പമുള്ള പ്രശ്നങ്ങൾക്ക് നിശ്ചിത ഉത്തരം കണ്ടെത്തൽ.
    b. വെല്ലുവിളി ഉയർത്തുന്ന പ്രശ്നങ്ങൾക്ക് ഉത്തരം കണ്ടെത്താൻ.
    c. എളുപ്പ മാർഗത്തിലൂടെ (സൂത്രവഴികൾ /സൂത്രവാക്യങ്ങൾ) ഉപയോഗിച്ച് നിശ്ചിത ഉത്തരത്തിലേക്ക് എത്തിച്ചേരൽ.
8. ഗണിതശാസ്ത്ര പഠനത്തിന് ഏറ്റവും കൂടുതൽ സഹായിക്കുന്നത്
    a. അധ്യാപിക /അധ്യാപകൻ
    b. സ്വന്തം കഴിവുകൾ
    c. മനഃപ്പാഠമാക്കിയ തന്ത്രങ്ങൾ/ സൂത്രവാക്യങ്ങൾ
9. ഗണിതശാസ്ത്ര പഠനത്തിൽ കേന്ദ്രീകരിക്കേണ്ടത്
    a. ക്ലാസ് നോട്സ്
    b. സ്വയം പരിശീലനം
    c. എളുപ്പവഴികൾ/സൂത്രവാക്യങ്ങൾ
10. ഗണിതശാസ്ത്ര പഠനം എന്നതുകൊണ്ട് ഉദ്ദേശിക്കുന്നത്
    a. അധ്യാപിക/അധ്യാപകൻ അവതരിപ്പിക്കുന്ന രീതി പിന്തുടരൽ.
    b. സ്വന്തമായ ശൈലി കണ്ടെത്തൽ.
    c. എളുപ്പവഴികൾ/സൂത്രവാക്യങ്ങൾ മനഃപ്പാഠമാക്കൽ

11. പുതിയ ഗണിത പ്രശ്നത്തെ നിർധാരണം ചെയ്യുമ്പോൾ
    a. മുൻപ് ചെയ്ത രീതി പ്രയോഗിക്കും.
    b. സൂക്ഷ്മമായി അപഗ്രഥനം ചെയ്ത് അനുയോജ്യമായ രീതി കണ്ടെത്തും.
    c. മനഃപാഠമാക്കിയ എളുപ്പമാർഗങ്ങൾ ഉപയോഗിക്കും.
12. ഗണിതശാസ്ത്ര പഠനത്തിൽ പ്രാധാന്യം നൽകേണ്ടത്
    a. കൃത്യമായ വഴി ഉപയോഗിച്ച് ശരിയുത്തരത്തിൽ എത്തിച്ചേരൽ
    b. പ്രശ്നനിർധാരണ പ്രക്രിയ സ്വായത്തമാക്കൽ
    c. ഉത്തരത്തിൽ എത്താനുള്ള സൂത്രവാക്യങ്ങൾ/ മാർഗങ്ങൾ മന:പ്പാഠമാക്കൽ
13. ഗണിതശാസ്ത്രത്തിന്റെ അടിത്തറ എന്നത്
    a. യുക്തിചിന്ത
    b. പരസ്പരം ബന്ധപ്പെട്ട ആശയങ്ങൾ
    c. കണക്കുകൂട്ടൽ
14. ഗണിതശാസ്ത്ര ശാഖ
    a. നിശ്ചിതമാണ്.
    b. ചലനാത്മകമാണ്.
    c. പ്രായോഗികമാണ്.
15. ഗണിതശാസ്ത്ര ബോധന രീതിയിൽ പ്രാധാന്യം അർഹിക്കുന്നത്
    a. അധ്യാപക കേന്ദ്രീകൃത പ്രവർത്തനങ്ങൾ
    b. ഗവേഷണ ചിന്തയെ പ്രചോദിപ്പിക്കുന്ന പ്രവർത്തനങ്ങൾ
    c. സൂത്രവാക്യങ്ങൾ/ തന്ത്രങ്ങൾ മന:പ്പാഠമാക്കാൻ ഉള്ള പ്രവർത്തനങ്ങൾ
16. ഗണിത പ്രശ്നപരിഹാരത്തിന്റെ പ്രത്യേകത
    a. ഒരേ ഒരു രീതിയിലൂടെ മാത്രമാണ് ഉത്തരത്തിൽ എത്തിച്ചേരാൻ സാധിക്കുക.
    b. വ്യത്യസ്ത രീതിയിൽ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ സാധിക്കും.
    c. ഉത്തരത്തിൽ എത്തിച്ചേരുക എന്നതിനാണ് പ്രാധാന്യം.
17. ഗണിതശാസ്ത്ര അധ്യാപിക/അധ്യാപകൻ ശ്രദ്ധിക്കേണ്ടത്
    a. ചിട്ടയോടും കൃത്യതയോടും കൂടി പാഠഭാഗം അവതരിപ്പിക്കണം.
    b. ചിന്തകളെ പ്രചോദിപ്പിക്കുന്ന രീതിയിൽ പാഠഭാഗം അവതരിപ്പിക്കണം.
    c. പരീക്ഷയെ കേന്ദ്രീകരിച്ച് പാഠഭാഗം അവതരിപ്പിക്കണം.
18. ഗണിത പ്രശ്നങ്ങൾക്ക് പരിഹാരം കണ്ടെത്താൻ
    a. അധ്യാപിക/അധ്യാപകൻ അവതരിപ്പിക്കുന്ന രീതി പിന്തുടരും.
    b. സ്വന്തമായ രീതിയിൽ പ്രശ്നത്തെ പരിഹരിക്കും.
    c. കൃത്യമായി ഉത്തരത്തിൽ എത്തിച്ചേർന്നവരോട് ചോദിച്ചു മനസ്സിലാക്കും.

19. ഗണിത പ്രശ്നങ്ങൾ പൊതുവെ
    a. കൃത്യമായ ഘട്ടങ്ങളിലൂടെ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ കഴിയുന്നവ ആകണം.
    b. ഗണിത ചിന്തകളെ ഉത്തേജിപ്പിക്കുന്നവ ആകണം.
    c. നേരിട്ട് സൂത്രവാക്യം ഉപയോഗിക്കാൻ പറ്റുന്ന രീതിയിൽ ആകണം.
20. ഗണിത പ്രശ്നപരിഹാരം എന്നത്
    a. ശരിയുത്തരത്തിൽ എത്തുക എന്നതാണ്.
    b. കൃത്യമായ പ്രശ്നം നിർധാരണ രീതി കണ്ടെത്തുക എന്നതാണ്.
    c. സൂത്രവാക്യം ഉപയോഗിക്കുക എന്നതാണ്.
21. ഗണിത പ്രശ്നങ്ങൾ
    a. ടെക്സ്റ്റ് ബുക്ക് കേന്ദ്രീകൃതമായിരിക്കണം
    b. താത്പര്യമുണർത്തുന്നതും ചിന്തിപ്പിക്കുന്നവയും ആയിരിക്കണം
    c. എളുപ്പത്തിൽ ഉത്തരത്തിൽ എത്തിച്ചേരാൻ കഴിയുന്നവ ആയിരിക്കണം
22. ഗണിത പ്രശ്നപരിഹാരത്തിൽ അധ്യാപിക/അധ്യാപകൻ വിദ്യാർത്ഥികൾക്ക്
    a. കൃത്യമായ സൂചകങ്ങൾ നൽകി പ്രശ്നപരിഹാരത്തിൽ എത്തിക്കണം.
    b. ചിന്തയെ പ്രചോദിപ്പിക്കുന്ന ചോദ്യങ്ങളിലൂടെ പ്രശ്നനിർധാരണ ഘട്ടത്തിലേക്ക് നയിക്കണം.
    c. നേരിട്ട് ഉത്തരത്തിൽ എത്തിക്കണം.

Appendix IV.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

MATHEMATICS BELIEF INVENTORY (FINAL)
ENGLISH VERSION

Saritha A S
Research Scholar

Prof. (Dr.) Vijayakumari K
Professor

Personal Information

Name of the student

Name of the School

Class

Gender	:	Male/ Female
Type of School	:	Govt / Aided / Unaided
Locality	:	Rural / Urban

INSTRUCTIONS

Some statement related to Mathematics are given below. Each statement have three responses. After reading each statement, put a tick mark (✓) for more suitable response in the response sheet. Your responses will be used for research purpose only. Response to all statements must be recorded.

1. Mathematics is
   a. Following a definite method
   b. Finding solutions to problems
   c. A Tool for solving daily life problems
2. Through the study of Mathematics, mainly
   a. Organize life systematically
   b. Analyzes life problems and makes appropriate decisions
   c. Finding a way for livelihood
3. The ability acquired through solving mathematical problems is
   a. Completing tasks systematically.
   b. Exploring different ways to solve problems.
   c. Using learned methods to solve new problems.

4. Generalization in Mathematical problems is done
   a. Only when necessary hints are provided.
   b. To discover new relationships.
   c. Only if the given problem demands it.
5. Mathematics exercises are
   a. Follow the same pattern
   b. Inspire different way of thinking
   c. Examination based
6. By practicing mathematical exercises
   a. Memorizes the steps of problem solving
   b. Understands that different ways exist for problem solving
   c. Scores high marks in examination
7. The goal of mathematical problem solving is
   a. Finding definite answers for simple problems.
   b. Finding answers to challenging problems.
   c. Reaching a specific answer using formulas or shortcuts.
8. The Most helpful aspect of learning Mathematics is
   a. The Teacher
   b. One's abilities
   c. Memorized techniques/ formulas
9. The focus in learning Mathematics should be on
   a. Class notes
   b. Self practice
   c. Shortcuts and formulas
10. Studying of Mathematics means
    a. Following the method presented by the teacher
    b. Finding your own way
    c. Memorizing shortcuts and formulas
11. When solving a new Mathematical problem, one should
    a. Apply previously learned methods
    b. Analyze carefully and find a suitable method
    c. Use memorized shortcuts

12. The emphasis in learning Mathematics is
    a. Reaching the correct answer through precise methods.
    b. Mastering the problem-solving process.
    c. Memorizing formulas/methods for answers.
13. The foundation of Mathematics is
    a. Logical thinking
    b. Interrelated concepts
    c. Calculations
14. The branch of Mathematics is
    a. Static
    b. Dynamic
    c. Practical
15. The importance in Mathematics teaching is
    a. Teacher centered activities
    b. Activities that stimulate research thinking
    c. Activities for memorizing formulas
16. The uniqueness of solving mathematical problems is that
    a. Only single method for solving problems
    b. Different ways for solving problems
    c. The focus is on the final answer.
17. The Mathematics teacher should focus on
    a. Presenting lesson in a systematic way
    b. Presenting lessons in a way that inspires thinking.
    c. Presenting lessons with focus on exams.
18. To find solutions to mathematical problems, students should
    a. Follow the method presented by the teacher
    b. Solve the problems in your own way
    c. Ask and understand from those who got the correct answer.
19. Mathematical problems are generally
    a. Allow reaching answers through precise steps
    b. Stimulate mathematical thinking
    c. Use formulas directly

20. Mathematical problem solving means
    a. Getting the correct answer
    b. Identifying a systematic problem solving approach
    c. Using formulas
21. Mathematical problems should
    a. Be textbook-centered.
    b. Be thought-provoking and engaging.
    c. Be easy to solve.
22. In mathematical problem-solving, a teacher should
    a. Provide specific clues to help students reach a solution.
    b. Guide students to the problem-solving stage through thought-provoking questions.
    c. Directly provide the solution.

Appendix IV.c

FAROOK TRAINING COLLEGE
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MATHEMATICS BELIEF INVENTORY (FINAL)
RESPONSE SHEET

Items	A	B	C
1			
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Appendix V

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ITEM- TOTAL CORRELATION COEFFICIENT (STANDARD VIII)

Cronbach's Alpha	No. of Items
.845	11

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item1	.536	.834
Item2	.649	.827
Item3	.555	.832
Item4	.440	.838
Item5	.559	.829
Item6	.540	.831
Item7	.397	.838
Item8	.632	.822
Item9	.568	.828
Item10	.620	.824
Item11	.588	.833

Based on the corrected item-total correlations and internal consistency metrics (as indicated by Cronbach's Alpha if Item Deleted), all items were retained.

Appendix VI.a

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ACHIEVEMENT TEST IN MATHEMATICS
STANDARD VIII

സമയം : 1 മണിക്കൂർ **സ്കോർ : 25**

നിർദ്ദേശങ്ങൾ

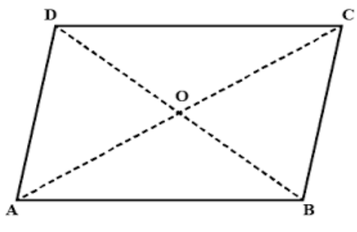
- എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതുക.
- ഉത്തരങ്ങളിൽ ആവശ്യമുള്ളിടത്ത് വിശദീകരണം നൽകേണ്ടതാണ്.
- ആദ്യത്തെ 10 മിനിറ്റ് സമാശ്വാസ സമയമാണ്. ഈ സമയം ചോദ്യങ്ങൾ പരിചയപ്പെടാനും, ഉത്തരങ്ങൾ ആസൂത്രണം ചെയ്യാനും ഉപയോഗിക്കുക.

1 മുതൽ 3 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 1 സ്കോർ വീതം. $(1 \times 3 = 3)$

1. താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് പ്രസ്താവനയാണ് സാമാന്തരികത്തിന് ശരിയാകാത്തത്?
   a) എതിർവശങ്ങൾ സമാന്തരം
   b) എതിർവശങ്ങൾ തുല്യം
   c) എതിർകോണുകൾ തുല്യം
   d) ഒരു കോണിന്റെ അളവ് 180°
2. ഒരു ജോടി എതിർവശങ്ങൾ മാത്രം സമാന്തരമായ രൂപമാണ് ________.
3. വാർഷിക പലിശ നിരക്ക് 8% ആയാൽ അർധവാർഷിക പലിശ നിരക്ക് ____ആണ്.

4 മുതൽ 7 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 2 സ്കോർ വീതം. $(2 \times 4 = 8)$

4. രവി 50000 രൂപ ബാങ്കിൽ നിന്ന് ഭവന വായ്പ എടുത്തു. ഒരു വർഷം കഴിഞ്ഞപ്പോൾ 55000 രൂപയാണ് തിരിച്ച് കൊടുക്കേണ്ടി വന്നത് . എത്രയാണ് പലിശ നിരക്ക് ?
5. ABCD എന്ന സാമാന്തരികത്തിൽ OA= 4cm, OB= 3cm. സാമാന്തരികത്തിന്റെ വികർണ്ണങ്ങളുടെ നീളം എന്താണ് ?



6. വശങ്ങൾ തുല്യമായതിനാൽ സമഭുജസാമാന്തരികം വരയ്ക്കുന്നതിന് ഒരളവ് മാത്രം മതി . ഈ പ്രസ്താവന ശരിയോ തെറ്റോ, എന്തുകൊണ്ട് ?

7. പത്മ 10% വാർഷിക നിരക്കിൽ സാധാരണ പലിശ കണക്കാക്കുന്ന ബാങ്കിൽ നിന്നും 25000 രൂപ രണ്ട് വർഷത്തേക്ക് ലോൺ എടുത്തു. 2 വർഷം കഴിഞ്ഞ് പത്മ ലോൺ അവസാനിപ്പിക്കാൻ 28500 രൂപയുമായി ബാങ്കിൽ എത്തി. പത്മയ്ക്ക് ബാങ്ക് ലോൺ അവസാനിപ്പിക്കാൻ 28500 രൂപ മതിയാകുമോ? എന്തുകൊണ്ട്?

8 മുതൽ 9 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 3 സ്കോർ വീതം. (3 × 2 = 6)

8. ഒരു മൊബൈൽ കമ്പനി അവരുടെ പ്രത്യേക ഇനം മൊബൈലിന്റെ വില വർഷം തോറും വിലയുടെ 4% വീതം കുറയ്ക്കുന്നു. മൊബൈലിന്റെ ഇപ്പോഴത്തെ വില 16000 രൂപയാണെങ്കിൽ 3 വർഷം കഴിയുമ്പോൾ വില എന്തായിരിക്കും ?

9. ഒരു ചതുർഭുജത്തിന്റെ പ്രത്യേകതകൾ താഴെ തന്നിരിക്കുന്നു

- വശങ്ങൾ തുല്യം
- എതിർവശങ്ങൾ സമാന്തരം
- എതിർ കോണുകൾ തുല്യം
- ഒരേ വശത്തിലെ കോണുകളുടെ തുക 180°.
- വികർണങ്ങൾ പരസ്പരം ലംബ സമഭാജികൾ.

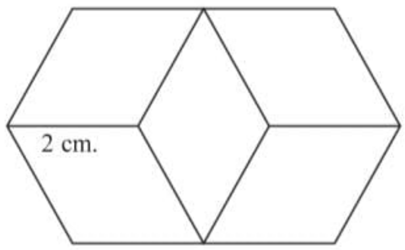
a) ഇത് ഏതിനം ചതുർഭുജം ആണ്?

b) ഇത്തരം ഒരു ചതുർഭുജം ഇഷ്ടമുള്ള അളവിൽ വരയ്ക്കുക .

10 മുതൽ 11 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 4 സ്കോർ വീതം. (4 × 2 = 8)

10. ബാബുവും ഹരിയും ഒരേ തുക 2 വർഷത്തേക്ക് ബാങ്കിൽ നിക്ഷേപിച്ചു . ബാബു 10% സാധാരണ പലിശയ്ക്കും ഹരി 10% വാർഷിക കൂട്ടുപലിശയ്ക്കും ആണ് നിക്ഷേപിച്ചത് . കാലാവധി പൂർത്തിയായപ്പോൾ ഹരിക്ക് ബാബുവിനെക്കാൾ 150 രൂപ കൂടുതൽ കിട്ടിയെങ്കിൽ എത്ര രൂപ വീതമാണ് അവർ നിക്ഷേപിച്ചത് ?

11. തുല്യമായ 5 സമഭുജ സാമാന്തരികങ്ങൾ ചേർത്തുവച്ച രൂപം തന്നിരിക്കുന്നു. തന്നിട്ടുള്ള അളവിൽ ചിത്രം വരയ്ക്കുക.



Appendix VI.b

FAROOK TRAINING COLLEGE
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ACHIEVEMENT TEST IN MATHEMATICS
STANDARD VIII

Time: 1 hour **Score : 25**

Instructions

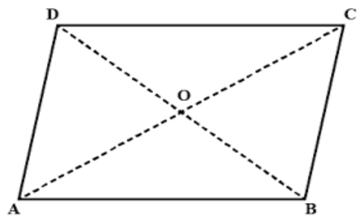
- Answer all questions.
- Give explanation wherever necessary.
- There is a cool of time of 10 minutes. Use this time to get familiar with questions and plan your answers.

Questions from 1 to 3 carry 1 score each. **($1 \times 3 = 3$)**

1. Which of the following statements is not true for a parallelogram?
   a) Opposite sides are parallel
   b) Opposite sides are equal
   c) Opposite angles are equal
   d) One angle is 180°
2. A shape with only one pair of opposite sides parallel is ________.
3. If the annual interest rate is 8%, what is the half-yearly interest rate?

Questions 4 to 7 carry 2 scores each. **($2 \times 4 = 8$)**

4. Ravi took out a housing loan of 50,000 rupees from a bank. After one year, he pay back 55,000 rupees. What is the interest rate?
5. In parallelogram ABCD, OA = 4 cm, OB = 3 cm. What is the length of the diagonals of the parallelogram?



6. The statement "It is enough to know one measurement to draw a rhombus since all the sides are equal" is true or false? Why?
7. Padma took out a loan of 25,000 rupees for two years from a bank at simple interest rate of 10% annually. After two years, Padma went to the bank with

28,500 rupees to close the loan. Will 28,500rupees be enough to close the loan? Why?

Questions 8 and 9 carry 3 scores each. **($3 \times 2 = 6$)**

8. A mobile company reduces the price of a particular model by 4% every year. If the current price of the mobile is 16,000 rupees, what will be the price after 3 years?

9. The properties of a quadrilateral are given below:
   - Opposite sides are equal
   - Opposite angles are equal
   - The sum of the angles on the same side is 180°
   - The diagonals are perpendicular to each other

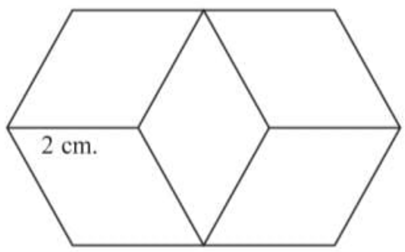
   a) What type of quadrilateral is this?

   b) Draw such a quadrilateral with any measurements of your choice.

Questions 10 and 11 carry 4 marks each. **($4 \times 2 = 8$)**

10. Babu and Hari both deposited the same amount for 2 years in a bank. Babu invested at 10% simple interest, and Hari invested at 10% annual compound interest. After the investment period, Hari received 150 rupees more than Babu. How much did each invest?

11. A figure is given with five equal rhombuses joined together. Draw the figure with the given measurements.



Appendix VII.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

SCORING KEY AND MARKING SCHEME
ACHIEVEMENT TEST – STANDARD VIII

SCORING KEY

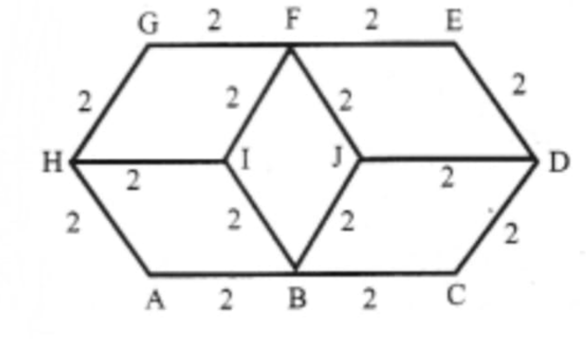
Qn No.	Answer key
1	ഒരു കോണിന്റെ അളവ് 180°
2	ലംബകം
3	4%

MARKING SCHEME

Qn No.	Key	score	
4	മുതൽ (P) = ₹50,000 മൊത്തം തിരിച്ചടവ്= ₹55,000 പലിശ= ₹55,000 - ₹50,000 = ₹5,000 സാധാരണ പലിശ, I=PNR 5000=50000×R×1 R=10%	1 1	 2
5	വികർണം AC = 4+4= 8 cm, വികർണം BD =3+3= 6 cm	1 1	 2
6	ഇല്ല രണ്ട് അളവുകൾ തന്നാൽ മാത്രം ആണ് വരയ്ക്കാൻ സാധിക്കുക.	1 1	 2
7	ഇല്ല മുതൽ (P) = ₹25,000 പലിശ നിരക്ക് = 10% , കാലയളവ് = 2 വർഷം സാധാരണ പലിശ: I=PNR=25000×2×$\frac{10}{100}$ =5000 മൊത്തം തുക തിരിച്ച നൽകേണ്ടത് = ₹25,000 + ₹5,000 = ₹30,000 പത്മയ്ക്ക് ₹28,500 മാത്രമാണ്, ₹1,500 കുറവാണ്	1 1	 2

8	പ്രാരംഭ വില = ₹16,000 വാർഷിക കുറവ് = 4% 3 വർഷങ്ങൾ കഴിഞ്ഞ്, വില= $P\left(1-\frac{r}{100}\right)^n$ = $16000\left(1-\frac{4}{100}\right)^3$ =$16000\times(1-0.04)^3$ =16000×0.884736 =₹14,156	 1 1 1	3
9	സമഭുജസാമാന്തരികം കൃത്യമായി സമഭുജ സാമാന്തരികം വരച്ചാൽ	1 2	3
10	ബാബുവിന് സാധാരണ പലിശ I=P×10%×2= $\frac{20P}{100}=\frac{P}{5}$ ബാബുവിന്റെ മൊത്തം തുക= $P+\frac{P}{5}=\frac{6P}{5}$ ഹരിക്ക് കൂട്ടുപലിശ = $P\left(1+\frac{r}{100}\right)^n$ $P\left(1+\frac{10}{100}\right)^2$ = $P(1+0.10)^2$ = 1.21P വ്യത്യാസം = ₹150: $1.21P-\frac{6P}{5}=150$ $\frac{P}{100}=150$ P= 150x100= 15000	 1 1 1 1	4
11	4cm നീളമുള്ള AC വരച്ച് അതിന്റെ മധ്യഭാഗം B അടയാളപ്പെടുത്തുക. എല്ലാം സമഭുജ സമാന്തരികമായതിനാൽ,Δ ABI ഒരു സമഭുജ ത്രികോണമാണ്. അതിന്റെ കോൺ 60° വീതം. BCDJ എന്ന സമഭുജസാമാന്തരികത്തിൽ, ∠ JBC = ∠JDC = 60°, ∠BCD = ∠BJD = 120° BJFI എന്ന സമഭുജസാമാന്തരികത്തിൽ, ∠IBJ =∠IFJ = 60°, ∠BJF = ∠FIB = 120°.	 1	 4

Appendix

	ഓരോ സമഭുജസാമാന്തരികവും വരച്ച് പാറ്റേൺ പൂർത്തിയാക്കുക. 	3	

Appendix VII.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

SCORING KEY AND MARKING SCHEME
ACHIEVEMENT TEST – STANDARD VIII

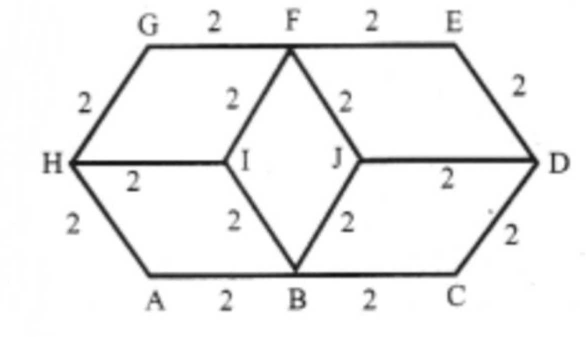
SCORING KEY

Qn No.	Answer key
1	One angle is 180°
2	Trapezium
3	4%

MARKING SCHEME

Qn no.	Key	score	
4	Principal (P) = ₹50,000 Total repayment = ₹55,000 Interest = ₹55,000 - ₹50,000 = ₹5,000 Simple Interest formula: I=PNR 5000=50000×R×1 R=10%	1 1	2
5	Diagonal AC = 4+4= 8 cm, Diagonal BD =3+3= 6 cm	1 1	2
6	No, we want two measurements to draw the Rhombus.	1 1	2
7	**No.** Principal (P) = ₹25,000 Interest rate = 10% per annum, Time = 2 years.	1	2

	Simple Interest: $I=PNR=25000\times2\times\frac{10}{100}$ =5000 Total amount to repay = ₹25,000 + ₹5,000 = ₹30,000 Padma has ₹28,500, which is ₹1,500 less than required.	1	
8	Initial price = ₹16,000 Annual decrease = 4% After 3 years, using compound decrease = $P\left(1-\frac{r}{100}\right)^n$ $= 16000\left(1-\frac{4}{100}\right)^3$ Price=$16000\times(1-0.04)^3$ =16000×0.884736 =₹14,156	1 1 1	3
9	Rhombus Draw the rhombus	1 2	3
10	Simple Interest for Babu is $I=P\times10\%\times2=\frac{20P}{100}=\frac{P}{5}$ Total amount for babu is $P+\frac{P}{5}=\frac{6P}{5}$ Compound interest for Hari is $P\left(1+\frac{r}{100}\right)^n$ $P\left(1+\frac{10}{100}\right)^2=$ $P(1+0.10)^2 = 1.21P$ Difference = ₹150: $1.21P-\frac{6P}{5}=150$ $\frac{P}{100} = 150$ P= 150x100= 15000	1 1 1 1	4
11	Draw AC, 4 cm long and mark its midpoint B. Since all are rhombuses, ABI is a equilateral triangle. Its angle are 60° each. In the rhombus BCDJ, ∠ JBC = ∠JDC = 60°, ∠BCD = ∠BJD = 120° In the rhombus BJFI, ∠IBJ =∠IFJ = 60°, ∠BJF = ∠FIB = 120°.	1	4

	Draw each rhombus and complete the pattern. 	3	

Appendix VIII

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

ITEM- TOTAL CORRELATION COEFFICIENT (STANDARD IX)

Cronbach's Alpha	No. of Items
.844	12

	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
Item1	.446	.837
Item2	.495	.835
Item3	.487	.835
Item4	.495	.835
Item5	.344	.843
Item6	.389	.841
Item7	.340	.843
Item8	.664	.819
Item9	.716	.814
Item10	.592	.826
Item11	.622	.823
Item12	.578	.830

Based on the corrected item-total correlations and internal consistency metrics (as indicated by Cronbach's Alpha if Item Deleted), all items were retained.

Appendix IX.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

ACHIEVEMENT TEST IN MATHEMATICS
STANDARD IX

സമയം : 1 മണിക്കൂർ **സ്കോർ : 25**

നിർദ്ദേശങ്ങൾ

- **എല്ലാ ചോദ്യങ്ങൾക്കും ഉത്തരം എഴുതുക.**
- **ഉത്തരങ്ങളിൽ ആവശ്യമുള്ളിടത്ത് വിശദീകരണം നൽകേണ്ടതാണ്.**
- **ആദ്യത്തെ 10 മിനിറ്റ് സമാശ്വാസ സമയമാണ്. ഈ സമയം ചോദ്യങ്ങൾ പരിചയപ്പെടാനും, ഉത്തരങ്ങൾ ആസൂത്രണം ചെയ്യാനും ഉപയോഗിക്കുക.**

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1 മുതൽ 5 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 1 സ്കോർ വീതം. **$(1 \times 5 = 5)$**

1. ഒരു സ്തംഭത്തിന്റെ വ്യാപ്തം അതിന്റെ _____ ന്റെയും ഉയരത്തിന്റെയും ഗുണനഫലമാണ്.
2. x ഒരു ന്യൂനസംഖ്യ ആയാൽ $|x|$ = ___ ആയിരിക്കും .
3. ഭിന്നകസംഖ്യകൾ അല്ലാത്ത സംഖ്യകളെ ____ എന്ന് പറയുന്നു.
4. വൃത്ത സ്തംഭത്തിന്റെ വക്രതല പരപ്പളവ് അതിന്റെ ____ ന്റെയും ഉയരത്തിന്റെയും ഗുണനഫലമാണ്.
5. $|5 - 8|$ = ____

6, 7 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 2 സ്കോർ വീതം. **$(2 \times 2 = 4)$**

6. $|x - 5| = 10$ ആയാൽ x ന്റെ വില എന്ത് ?
7. സംഖ്യാരേഖയിൽ 2, -6 എന്നിവ തമ്മിലുള്ള അകലവും അവയുടെ മധ്യബിന്ദുവും കണ്ടെത്തുക ?

8 മുതൽ 11 വരെയുള്ള ചോദ്യങ്ങൾക്ക് 3 സ്കോർ വീതം. **$(3 \times 4 = 12)$**

8. $|x - 2| = |x - 6|$ ആയാൽ × എന്താണ്?

   $|y - 3| = |y + 1|$ ആയാൽ y എന്താണ് ?

   $|x + y|$ എന്തായിരിക്കും ?
9. $\sqrt{2}$ ന്റെ സ്ഥാനം സംഖ്യാ രേഖയിൽ അടയാളപ്പെടുത്തുക ?
10. ഒരേ ഉയരമുള്ള രണ്ട് വൃത്തസ്തംഭങ്ങളുടെ വ്യാസങ്ങൾ തമ്മിലുള്ള അംശബന്ധം 1 : 3 ആണ്. അവയുടെ ആരങ്ങളുടെ അംശബന്ധവും വ്യാപ്തങ്ങളുടെ അംശബന്ധവും കണ്ടെത്തുക?

11. സമചതുരസ്തംഭാകൃതിയിലുള്ള ഒരു തടി കഷ്ണത്തിന്റെ പാദത്തിന്റെ വാക്കുകൾ 10 cm നീളവും 20 cm ഉയരവും ഉണ്ട്. ഇതിൽനിന്ന് ചെത്തിയെടുക്കാവുന്ന ഏറ്റവും വലിയ വൃത്തസ്തംഭത്തിന്റെ വ്യാപ്തം എത്ര ?

ചോദ്യം 12 ന് 4 സ്കോർ ആണ്. **($4 \times 1 = 4$)**

12. 2 മീറ്റർ ആരവും 11 മീറ്റർ ഉയരവും ഉള്ള വൃത്തസ്തംഭ കൃതിയിലുള്ള ഒരു ജലസംഭരണിയിൽ 1 മീറ്റർ ഉയരത്തിൽ വെള്ളം ഉണ്ട്. സംഭരണിയിലുള്ള വെള്ളത്തിന്റെ അളവ് എത്ര ലിറ്ററാണ് സംഭരണി നിറയാൻ ഇനി എത്ര ലിറ്റർ വെള്ളം കൂടി വേണം?

(π= 3.14, 1 ഘന. മീറ്റർ = 1000 ലിറ്റർ)

Appendix IX.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

ACHIEVEMENT TEST IN MATHEMATICS
STANDARD IX

Time: 1 hour **Score : 25**

<u>Instructions</u>

- Answer all questions.
- Give explanation wherever necessary.
- There is a cool of time of 10 minutes. Use this time to get familiar with questions and plan your answers.

Questions from 1 to 5 carry 1 score each. **(1 × 5 = 5)**

1. The volume of a prism is the product of its ____ and height.
2. If x is a negative number, then $|x| =$ ___
3. All numbers that are not rational numbers are called _____
4. The curved surface area of a cylinder is the product of the ____ and height.
5. $|5 - 8| =$ ____

Questions from 6 & 7 carry 2 scores each. **(2 × 2 = 4)**

6. If $|x - 5| = 10$, then find the value of x ?
7. Find the distance between points 2, - 6 on the number line then find the midpoint of these points

Questions from 8 to 11 carry 3 scores each. **(3 × 4 = 12)**

8. a. For what values of x, $|x - 2| = |x - 6|$?

   b. For what values of y, $|y - 3| = |y + 1|$

   c. Find $|x + y|$
9. Mark position $\sqrt{2}$ in the number line
10. The base diameters of two cylinders of the same height are in the ratio 1:3, what is the ratio of their radii and volumes?
11. The base of a rectangular block of wood is a square of side 10 cm and the height is 20 cm. What is the volume of the largest cylinder can be carved out of this?

Question 12 carries 4 scores. **($4 \times 1 = 4$)**

12. A water tank in the shape of a cylinder contains water to a depth of 1 metre. The radius of the cylinder is 2 metres and its height is 11 metres. How many litres of water is in the tank? How much more litres of water is required to fill the tank completely?

    ($\pi = 3.14$, 1 cubic metre = 1000 litres)

Appendix X.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

SCORING KEY AND MARKING SCHEME
ACHIEVEMENT TEST – STANDARD IX

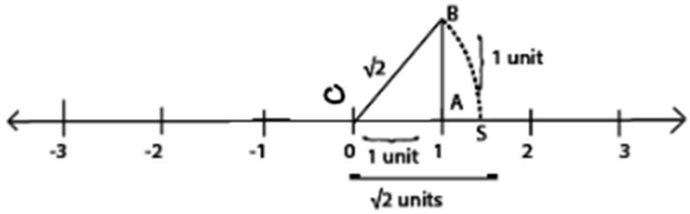
SCORING KEY

Qn No.	Answer key
1	പാദപരപ്പ്
2	-x
3	അഭിന്നക സംഖ്യ
4	പാദച്ചുറ്റളവ്
5	3

MARKING SCHEME

<table>
<tr><th>Qn no.</th><th>Key</th><th colspan="2">Score</th></tr>
<tr><td>6</td><td>$|x-5| = 10$
$x-5 = 10$ അല്ലെങ്കിൽ $x-5=-10$
$x= 10+5=15$ അല്ലെങ്കിൽ $x= -10+5= -5$
$x = 15,-5$</td><td>1
1</td><td>2</td></tr>
<tr><td>7</td><td>അകലം $= 2-(-6)$
$= 8$
മധ്യബിന്ദു$=\frac{2+(-6)}{2}$
$= -2$</td><td>1
1</td><td>2</td></tr>
<tr><td>8</td><td>$|x-2|= |x-6|$
$x=\frac{2+6}{2}$ $=4$
$|y-3|=|y+1|$
$y=\frac{3+(-1)}{2}$
$=1$
$|x+y|=|4+1|=5$</td><td>1
1
1</td><td>3</td></tr>
</table>

Appendix

9	 സംഖ്യ രേഖ വരയ്ക്കുന്നതിന് മട്ടത്രികോണം വരക്കുന്നു,പാദം=1cm, ഉയരം= 1cm. കർണം=$\sqrt{2}$ ആണെന്നും അതിന്റെ അളവ് സംഖ്യ രേഖയിൽ അടയാളപ്പെടുത്തുന്നതിന്	1 1 1	3
10	വ്യാസങ്ങൾ തമ്മിലുള്ള അംശബന്ധം = 1:3 a. ആരങ്ങൾ തമ്മിലുള്ള അംശബന്ധം =1:3 b. വ്യാപ്തം തമ്മിലുള്ള അംശബന്ധം= $\pi r_1^2 h : \pi r_2^2 h$ $=r_1^2:r_2^2=1:9$	1 2	3
11	വൃത്തത്തിന്റെ വ്യാസം= സമചതുരത്തിന്റെ ഒരു വശം= 10 സെ.മീ വൃത്ത സ്തംഭത്തിന്റെ വ്യാപ്തം= $\pi r^2 h$ വ്യാപ്തം= π×52×20 = 500π ഘന. സെ. മീ	1 1 1	3
12	വെള്ളത്തിന്റെ ഉയരം= 1 മീ വെള്ളത്തിന്റെ വ്യാപ്തം= $\pi r^2 h$ π×2×2×1= 4π 4×3.14= 12.56 cm^3 12.56×1000= 12560 ലിറ്റർ ഇനി 10 മീറ്റർ ഉയരം കൂടി വേണം ഇനി വേണ്ട വെള്ളത്തിന്റെ അളവ് = π×2×2×10 = 40π =40×3.14=125.6cm^3 = 125.6×1000= 125600 ലിറ്റർ	1 1 1 1	4

Appendix X.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

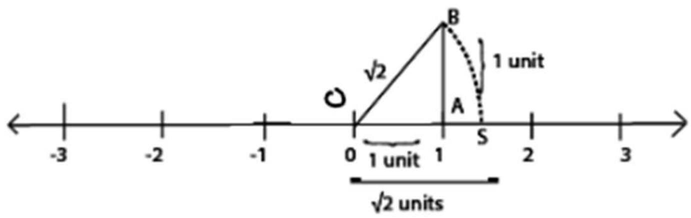
SCORING KEY AND MARKING SCHEME
ACHIEVEMENT TEST – STANDARD IX

SCORING KEY

Qn No.	Answer key
1	Base Area
2	-x
3	Irrational number
4	Base Perimeter
5	3

MARKING SCHEME

Qn No.	Key	Score	
6	$\lvert x-5\rvert = 10$ $x-5 = 10$ or $x-5=-10$ $x= 10+5=15$ or $x= -10+5= -5$ Values of x are 15,-5	1 1	2
7	Distance= 2-(-6) = 8 Mid point = $\frac{2+(-6)}{2}$ = -2	1 1	2
8	$\lvert x-2\rvert = \lvert x-6\rvert$ $x=\frac{2+6}{2}$ =4 $\lvert y-3\rvert=\lvert y+1\rvert$ $y=\frac{3+(-1)}{2}$ =1 $\lvert x+y\rvert=\lvert 4+1\rvert=5$	1 1 1	3

9	 Draw the number line Draw the right traingle,base=1cm, height= 1cm. Hypotenuse=$\sqrt{2}$ then mark $\sqrt{2}$ on the number line.	1 1 1	3
10	Ratio of the diameters = 1:3 c. Ratio of the radii =1:3 d. Ratio of their volumes= $\pi r_1^2h : \pi r_2^2h$ $=r_1^2:r_2^2=1:9$	1 2	3
11	Diameter of circle= side of the square= 10cm Volume of cylinder= πr^2h $= \pi\times52\times20$ $= 500\pi$ cm^3	1 1 1	3
12	Height of water= 1 m Volume of water= πr^2h $\pi\times2\times2\times1= 4\pi$ $4\times3.14= 12.56$ cm^3 $12.56\times1000= 12560$ ലിറ്റർ The water level is to be increased by 10m. Volume of water required $= \pi\times2\times2\times10$ $= 40\pi$ $=40\times3.14=125.6$cm^3 $= 125.6\times1000= 125600$ litres.	1 1 1 1	4

Appendix XI.a

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

TEACHING MANUAL ON

INFORMATION PROCESSING MODEL (IPM) (Malayalam)

Name of the teacher	:	Class	: VIII
Name of the school	:	Division	:
Subject	: **ഗണിതശാസ്ത്രം**	Strength	:
Unit	: **പണവിനിമയം**	Date	:
Topic	: **കൂട്ടുപലിശ**	Duration	: 45 **മിനിറ്റ്**

Effect

Instructional Effect

- **വ്യത്യസ്ത പലിശാസമ്പ്രദായങ്ങൾ ഉണ്ടെന്ന് കണ്ടെത്തുന്നു**
- **പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കി കാണുന്നതാണ് കൂട്ടുപലിശ എന്ന് തിരിച്ചറിയുന്നു**

Nurturant Effect

- അന്വേഷണാത്മക പഠനത്തിന് താല്പര്യമുണ്ടാകുന്നു
- സന്ദർഭങ്ങളെ അപഗ്രഥനം ചെയ്യാനുള്ള ശേഷി നേടുന്നു
- നിത്യജീവിതത്തിൽ പലിശയുമായി ബന്ധപ്പെട്ട പ്രശ്നങ്ങൾക്ക് പരിഹാരം കണ്ടെത്താനുള്ള മനോഭാവം
- പണമിടപാടുകളിലെ ചതികൾ തിരിച്ചറിഞ്ഞ് ഉചിതമായി പ്രതികരിക്കാനുള്ള മനോഭാവം

Principle of Reaction

പ്രശ്നത്തിലെ വേരിയബിളുകൾ തിരിച്ചറിയാൻ അധ്യാപകൻ വിദ്യാർത്ഥികളെ പിന്തുണയ്ക്കുന്നു. സിദ്ധാന്തവും അതിന്റെ സ്ഥിരീകരണവും രൂപീകരിക്കാൻ അധ്യാപകൻ വിദ്യാർത്ഥികളെ പ്രോത്സാഹിപ്പിക്കുന്നു.

Social System

ക്ലാസ് റൂം മിതമായ ഘടനയുള്ളതാണ്.

Support system

ബ്ലാക്ക്ബോർഡ്, പവർപോയിന്റ്

Appendix

<table>
<tr><th>Process</th><th>Response</th></tr>
<tr><td>

Phase 1: Teacher Initiates

ടിവിയിൽ കാണുന്ന വിവിധതരം പരസ്യങ്ങൾ ഏതൊക്കെയാണെന്ന് ചോദിച്ചുകൊണ്ട് അധ്യാപിക ക്ലാസ് ആരംഭിക്കുന്നു. പരസ്യങ്ങളിലെ ആകർഷണങ്ങൾ, തന്ത്രങ്ങൾ എന്നിവയിലൂടെ വിവിധതരം പരസ്യങ്ങളിലേക്ക് കടക്കുന്നു. തുടർന്ന് ബാങ്ക് പരസ്യങ്ങളിലേക്കും കുട്ടികളുടെ ശ്രദ്ധ കൊണ്ടു വരുന്നു.

Phase 2 : Presents the Problem

രണ്ടു സുഹൃത്തുക്കൾ ബാങ്കിൽ പോയി ലോൺ എടുത്ത സന്ദർഭം അധ്യാപിക പറയുന്നു.

സുഹൃത്തുക്കളായ മാധവും സൂരജും രണ്ട് വ്യത്യസ്ത ബാങ്കിൽ നിന്നും പതിനായിരം രൂപ രണ്ടു വർഷത്തേക്ക് 10% പലിശ നിരക്കിൽ ലോൺ എടുക്കുന്നു. രണ്ടുവർഷം കഴിഞ്ഞ് തിരിച്ചടയ്ക്കാൻ ചെന്നപ്പോൾ മാധവ് 12000 രൂപയും സൂരജിന് 12100 രൂപയും അടയ്ക്കേണ്ടി വന്നു. ഒരേ തുക, ഒരേ പലിശ നിരക്ക്, ഒരേ കാലയളവ് എന്തുകൊണ്ടാണ് അടയ്ക്കേണ്ട തുകയിൽ വ്യത്യാസം വന്നത്?

Phase 3 : Explore relationship among variables

രണ്ട് സന്ദർഭവും പരസ്പരം അവലോകനം ചെയ്ത ശേഷം അവതരിപ്പിക്കാൻ (ഗ്രൂപ്പ് പ്രവർത്തനം) നിർദ്ദേശം നൽകുന്നു.

<table>
<tr><th></th><th>മാധവ്</th><th>സൂരജ്</th></tr>
<tr><td>തുക</td><td>10,000</td><td>10,000</td></tr>
<tr><td>വർഷം</td><td>2</td><td>2</td></tr>
<tr><td>പലിശ നിരക്ക്</td><td>10%</td><td>10%</td></tr>
<tr><td>അടച്ച തുക</td><td>12,000</td><td>12,100</td></tr>
</table>

</td><td></td></tr>
</table>

Phase 4: Formulate Hypothesis

രണ്ട് സന്ദർഭത്തിനെയും അവലോകനം ചെയ്തതിനുശേഷം എന്തുകൊണ്ടാണ് തുകയിൽ വ്യത്യാസം വന്നത് എന്ന് ഗ്രൂപ്പിൽ ചർച്ച ചെയ്യാൻ ആവശ്യപ്പെടുന്നു. തുടർന്ന് അധ്യാപികയോട് ചോദ്യങ്ങൾ ചോദിക്കാമെന്നും ചോദ്യങ്ങൾക്ക് അധ്യാപിക 'yes' അല്ലെങ്കിൽ 'no' എന്ന് മാത്രമായിരിക്കും ഉത്തരം നൽകുക. അതിനാൽ ചോദ്യങ്ങൾ അതിന് അനുയോജ്യമായി ചോദിക്കാൻ പറയുന്നു.

വിദ്യാർത്ഥി : മാധവിന് I = PNR എന്ന രീതിയിൽ പലിശ കണക്കാക്കുമ്പോൾ പലിശ 2000 കിട്ടും. സാധാരണ പലിശയാണ് മാധവിന് ലഭിച്ചത്.

അധ്യാപിക : yes

വിദ്യാർത്ഥി : സൂരജിന് 100 രൂപ കൂടുതൽ അടയ്ക്കേണ്ടി വന്നു?

അധ്യാപിക : yes

വിദ്യാർത്ഥി : ആദ്യ വർഷത്തെ പലിശ രണ്ട് പേർക്കും 1000 ആണോ?

അധ്യാപിക : yes

വിദ്യാർത്ഥി : സൂരജിന് രണ്ടാം വർഷത്തെ പലിശയിൽ ആണോ വ്യത്യാസം വന്നത്?

അധ്യാപിക : yes

വിദ്യാർത്ഥി : രണ്ടാം വർഷത്തെ പലിശ സൂരജിന് 1100 ആണ്?

അധ്യാപിക : yes

വിദ്യാർത്ഥി : അപ്പോൾ സൂരജിന് 100 രൂപ കൂടുതൽ വന്നത് ആദ്യവർഷപലിശയുടെ 10% ആയ 100 രൂപയും കൂടി കൂട്ടിയതാണ്.

അധ്യാപിക : yes

<table>
<tr>
<td>
തുടർന്ന് ചർച്ചയിൽ നിന്നും എത്തിച്ചേർന്ന നിഗമനങ്ങളെ ക്രോഡീകരിക്കാൻ അധ്യാപിക പറയുന്നു.

ആദ്യവർഷ പലിശ രണ്ട് പേർക്കും തുല്യമാണ്. സൂരജിന് രണ്ടാം വർഷത്തെ പലിശ കണക്കാക്കിയപ്പോൾ ആദ്യവർഷ പലിശയും കൂടി പലിശ കണക്കാക്കിയാണ് കൂട്ടിയത്.

Phase 5 : Test hypothesis and Possible solution

സാധാരണ പലിശ കണക്കാക്കുന്ന രീതിയുമായി ബന്ധപ്പെടുത്തി നിർധാരണം ചെയ്യാൻ അധ്യാപിക പറയുന്നു.

<table>
<tr><td></td><td></td><td>ഒന്നാം വർഷം</td><td>രണ്ടാം വർഷം</td><td>തുക</td></tr>
<tr><td rowspan="2">മാധവ്</td><td>മുതൽ</td><td>10,000</td><td>10,000</td><td rowspan="2">12,000</td></tr>
<tr><td>പലിശ</td><td>1000</td><td>1000</td></tr>
<tr><td rowspan="2">സൂരജ്</td><td>മുതൽ</td><td>10,000</td><td>11,000</td><td rowspan="2">12,100</td></tr>
<tr><td>പലിശ</td><td>1000</td><td>1100</td></tr>
</table>
ആശയങ്ങൾ അവതരിപ്പിച്ചതിന് ശേഷം ആദ്യവർഷത്തെ പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കുന്ന പലിശ രീതി ഉണ്ടെന്നും അത്തരം പലിശ സമ്പ്രദായത്തെ കൂട്ടുപലിശ എന്നാണ് പറയുന്നതെന്നും അധ്യാപിക വിശദീകരിക്കുന്നു.

ആശയം power point ൽ കാണിക്കുന്നു.

Phase 6 : Helps to verify the accepted conclusion

കൂട്ടുപലിശ എന്ന ആശയത്തെ ഉറപ്പിക്കുന്നതിനായി മറ്റൊരു പ്രശ്നം പരിഹരിക്കാൻ നൽകുന്നു.

സുമയും രാധികയും 20,000 രൂപ ഒരു ബാങ്കിൽ നിക്ഷേപിച്ചു. സുമ സാധാരണ പലിശ
</td>
<td></td>
</tr>
</table>

നിരക്കിലും രാധിക കൂട്ടുപലിശ നിരക്കിലും ആണ് നിക്ഷേപിച്ചത്. 8% പലിശ നിരക്കിൽ രണ്ടുവർഷം കഴിഞ്ഞ് രണ്ടുപേർക്കും ലഭിക്കുന്ന തുക എത്രയാകും? വിദ്യാർത്ഥികൾ സാധാരണ പലിശ, പലിശയ്ക്ക് പലിശ എന്ന ആശയങ്ങൾ ഉപയോഗിച്ച് പ്രശ്നപരിഹാരം നടത്തുന്നു. **Phase 7 : Analysis of thinking Process** കൂട്ടുപലിശ എന്ന ആശയത്തിൽ എത്തിച്ചേർന്ന പ്രവർത്തനങ്ങളെ വിശകലനം ചെയ്യുകയും വിദ്യാർത്ഥികളുടെ ഗ്രൂപ്പ് ചർച്ചയിൽ ഉണ്ടായ വ്യത്യസ്ത ചിന്തകളെക്കുറിച്ചും വിശദീകരിക്കുന്നു. പണമിടപാടിൽ വ്യത്യസ്ത പലിശരീതികൾ ഉണ്ടെന്നും കൃത്യമായി പരിശോധിച്ച ശേഷം പണമിടപാടുകൾ നടത്തണം എന്ന ചിന്ത കുട്ടികളിൽ എത്തിക്കുന്നു.	
Follow up Activity അഞ്ച് ശതമാനം വാർഷിക നിരക്കിൽ ഒരു തുകയ്ക്ക് രണ്ടു വർഷത്തേക്ക് സാധാരണ പലിശയായി 200 രൂപ ലഭിച്ചു. അതേ തുകയ്ക്ക് അതേ നിരക്കിൽ രണ്ടു വർഷത്തേക്ക് ലഭിക്കുന്ന കൂട്ടുപലിശ എത്രയാണ്?	

Appendix XI.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

TEACHING MANUAL ON
INFORMATION PROCESSING MODEL (IPM)
(English)

Name of the teacher	:	....	Class	:	VIII
Name of the school	:	....	Division	:	
Subject	:	MATHEMATICS	Strength	:	
Unit	:	Money Maths	Date	:	
Topic	:	Compound Interest	Duration	:	45 minutes

Effect

Instructional Effect:

- Identifies that different types of interest calculation methods.
- Understands that compound interest is calculated by adding the interest to the principal for further interest calculation.

Nurturant Effect:

- Develops an interest in investigative learning.
- Gains the ability to analyze situations critically.
- Cultivates an attitude to solve real-life problems related to interest.
- Builds awareness to recognize and respond appropriately to fraud in financial transactions.

Principle of Reaction

The teacher supports the students in identifying the variables in the problem and encourages them to form hypotheses and verify them.

Social System

The classroom environment is moderately structured.

Support System

- Blackboard, PowerPoint

<table>
<tr><th>Process</th><th>Response</th></tr>
<tr><td>
Phase 1: Teacher Initiates

The teacher begins the class by asking students about the types of advertisements they see on TV. Through discussions about the attractions and strategies in advertisements, the focus shifts to different types of advertisements and eventually to banking advertisements.

Phase 2: Presents the Problem

The teacher narrates an incident where two friends went to a bank to take a loan.

Madhav and Suraj, two friends, took a loan of ₹10,000 for two years at an interest rate of 10% from two different banks. After two years, when they went to repay the loan, Madhav had to pay ₹12,000, while Suraj had to pay ₹12,100. The teacher poses the question: Why is there a difference in the repayment amounts despite the same principal, interest rate, and time?

Phase 3: Explore Relationship Among Variables

The teacher assigns the students to compare and analyze both scenarios in groups and present their findings.

<table>
<tr><th>Details</th><th>Madhav</th><th>Suraj</th></tr>
<tr><td>Principal</td><td>₹10,000</td><td>₹10,000</td></tr>
<tr><td>Time (years)</td><td>2</td><td>2</td></tr>
<tr><td>Interest Rate</td><td>10%</td><td>10%</td></tr>
<tr><td>Total Amount</td><td>₹12,000</td><td>₹12,100</td></tr>
</table>
Phase 4: Formulate Hypothesis

After analyzing both scenarios, the teacher encourages group discussions to determine why there is a difference in the total amount. The teacher also allows students to ask questions but will only respond with “yes” or “no.”
</td><td></td></tr>
</table>

Student Questions: *When Madhav calculates interest using I=PNR, is the interest ₹2,000?* Teacher: **Yes** *Did Suraj have to pay ₹100 more?* Teacher: **Yes** *Was the first-year interest the same for both, ₹1,000?* Teacher: **Yes** *Was the difference in the second-year interest for Suraj?* Teacher: **Yes** *Is Suraj's second-year interest ₹1,100?* Teacher: **Yes** *So, the extra ₹100 comes from adding 10% of the first year's interest ₹1,000?* Teacher: **Yes** The teacher consolidates the conclusions from the discussion. **Conclusion:** In the first year, the interest is the same for both. However, Suraj's second-year interest was calculated by adding the first year's interest to the principal. **Phase 5: Test Hypothesis and Possible Solution** The teacher asks the students to relate their findings to the method of calculating simple and compound interest.	

Year	Principal	Madhav	Suraj
First Year	₹10,000	₹1,000	₹1,000
Second Year	₹10,000	₹1,000	₹1,100
Total Amount	₹12,000	₹12,000	₹12,100

After presenting the findings, the teacher explains that compound interest involves calculating interest on the accumulated interest from the previous year. This method is shown using a PowerPoint presentation. **Phase 6: Verifies the Conclusion** To reinforce the concept of compound interest, the teacher provides another problem: **Problem:** Suma and Radhika deposit ₹20,000 in a bank. Suma earns simple interest, while Radhika earns compound interest at an 8% interest rate for two years. How much will they each receive? Students solve this problem using the concepts of simple and compound interest. **Phase 7: Analysis of Thinking Process** The teacher analyzes the activities that led to understanding compound interest. The teacher also discusses the different perspectives observed during group discussions. The teacher emphasizes the importance of understanding different interest calculation methods in financial transactions and urges students to carefully evaluate such aspects before making decisions.	
Follow-Up Activity: At an annual rate of 5%, a sum earned ₹200 as simple interest for two years. What would be the compound interest for the same sum, rate, and duration?	

Appendix XII

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LIST OF ART FORMS USED IN AIIPM (STANDARD VIII AND STANDARD IX)

	Unit	Learning Outcomes	Art forms used
Standard VIII	Money Maths	• Explains the method of computing interest by simple interest and compounding interest for interest.	Drama, pictures (comic, trolls, etc.), Music
		• Explains the method of computing amounts under interest compounded, half yearly, quarterly or in any frequencies.	Skit, Drawings Role play, pictures (comic, trolls, etc.)
		• Solves other practical problems, using the method of compound interest.	Role play Tableau Drawings dance
	Construction of Quadrilaterals	9. Finds the measurements needed to specify a parallelogram.	Drawing and colouring Role play
		10. Draws parallelogram according to specifications.	Drawing and colouring
		11. Finds the measurements needed to specific trapezium.	Role play puppet
		12. Explains the methods of drawing trapezium according to specification.	Dance (Movement)
		13. Draws quadrilateral according to specifications	Craft (Card making) Role play Puppet

			Skit Content writing (Reporting a news)
Standard IX	Real Numbers	14. Draws a number line and explains its properties.	Craft (thread) Drawings Music
		15. Describes the method to find distance between two points.	Role play
		16. Computes the midpoints of two points.	Craft (thread)
		17. Identifies absolute value of numbers.	Drama drawings
	Prisms	• Describes the method of finding volume of prisms.	Craft (clay)
		• Explains the method to find the area of prisms.	Origami Drawing and colouring
		• Describes the method to calculate the volume and area of a cylinder.	Puppet Origami
		• Solves practical problems related to prisms.	Role play Script writing

Appendix XIII.a

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TEACHING MANUAL ON

ART INTEGRATED INFORMATION PROCESSING MODEL (AIIPM) (Malayalam)

Name of the teacher	:	Class	:	VIII
Name of the school	:	Division	:	
Subject	: ഗണിതശാസ്ത്രം	Strength	:	
Unit	: പണവിനിമയം	Date	:	
Topic	: കൂട്ടുപലിശ	Duration	:	45 മിനിറ്റ്

Effect

Instructional Effect

- വ്യത്യസ്ത പലിശാസമ്പ്രദായങ്ങൾ ഉണ്ടെന്ന് കണ്ടെത്തുന്നു
- പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കി കാണുന്നതാണ് കൂട്ടുപലിശ എന്ന് തിരിച്ചറിയുന്നു

Nurturant Effect

- അന്വേഷണാത്മക പഠനത്തിന് താല്പര്യമുണ്ടാകുന്നു
- സന്ദർഭങ്ങളെ അപഗ്രഥനം ചെയ്യാനുള്ള ശേഷി നേടുന്നു
- നിത്യജീവിതത്തിൽ പലിശയുമായി ബന്ധപ്പെട്ട പ്രശ്നങ്ങൾക്ക് പരിഹാരം കണ്ടെത്താനുള്ള മനോഭാവം
- പണമിടപാടുകളിലെ ചതികൾ തിരിച്ചറിഞ്ഞ് ഉചിതമായി പ്രതികരിക്കാനുള്ള മനോഭാവം
- സന്ദർഭങ്ങളെ വ്യത്യസ്ത രീതിയിൽ അവതരിപ്പിക്കാനും അപഗ്രഥിക്കാനും ശേഷി നേടുന്നു.

Principle of Reaction

എല്ലാ പഠന ഘട്ടങ്ങളിലും അധ്യാപകർ വിദ്യാർത്ഥികളെ പിന്തുണയ്ക്കുന്നു. ആർട്ട് ഇന്റഗ്രേഷൻ ഘട്ടങ്ങളിലേക്ക് വിദ്യാർത്ഥികളെ പ്രോത്സാഹിപ്പിക്കുന്നു.

Social System

അധ്യാപകനാണ് ആർട്ട് ഇന്റഗ്രേഷൻ ഘട്ടങ്ങൾ നിയന്ത്രിക്കുന്നത്. ക്ലാസ് റൂം മിതമായ ഘടനയുള്ളതാണ്.

Support system

ആർട്ട് ഇന്റഗ്രേഷൻ - സ്ക്രിപ്റ്റ്, ട്രോൾ ചിത്രം ബ്ലാക്ക്ബോർഡ്, പവർപോയിന്റ്

Pre planning of Art integration

Art integration phases - phase 2 , phase 5 and phase 6

- നാടകത്തിനുള്ള തിരക്കഥ
- നാടകത്തിനായി വിദ്യാർത്ഥികളെ തയ്യാറാക്കുക

Phase 1: Teacher Initiates

ടിവിയിൽ കാണുന്ന വിവിധതരം പരസ്യങ്ങൾ ഏതൊക്കെയാണെന്ന് ചോദിച്ചുകൊണ്ട് അധ്യാപിക ക്ലാസ് ആരംഭിക്കുന്നു. പരസ്യങ്ങളിലെ ആകർഷണങ്ങൾ തന്ത്രങ്ങൾ എന്നിവയിലൂടെ വിവിധതരം പരസ്യങ്ങളിലേക്ക് കടക്കുന്നു. തുടർന്ന് ബാങ്ക് പരസ്യങ്ങളിലേക്കും കുട്ടികളുടെ ശ്രദ്ധ കൊണ്ടു വരുന്നു.

Phase 2 : Presents the Problem

രണ്ടു സുഹൃത്തുക്കൾ ബാങ്കിൽ പോയി ലോൺ എടുത്ത സന്ദർഭം ക്ലാസിൽ വിദ്യാർത്ഥികൾ അവതരിപ്പിക്കുന്നു (drama).

അവതരണം ശ്രദ്ധിച്ചു കണ്ടതിനുശേഷം എന്തുകൊണ്ടാണ് രണ്ടുപേർക്കും വ്യത്യസ്ത തുക ലോൺ അടയ്ക്കാൻ വേണ്ടി വന്നത്? എന്ന് അധ്യാപിക ചോദിക്കുന്നു.

Phase 3 : Explore relationship among variables

രണ്ട് സന്ദർഭവും പരസ്പരം അവലോകനം ചെയ്ത ശേഷം അവതരിപ്പിക്കാൻ (ഗ്രൂപ്പ് പ്രവർത്തനം) നിർദ്ദേശം നൽകുന്നു.

	ഹരി	ജിതിൻ
തുക	10,000	10,000
വർഷം	2	2
പലിശ നിരക്ക്	10%	10%
അടച്ച തുക	12,000	12,100

Phase 4: Formulate Hypothesis

രണ്ട് സന്ദർഭത്തിനെയും അവലോകനം ചെയ്തതിനുശേഷം എന്തുകൊണ്ടാണ് തുകയിൽ വ്യത്യാസം വന്നത് എന്ന് ഗ്രൂപ്പിൽ ചർച്ച ചെയ്യാൻ ആവശ്യപ്പെടുന്നു. തുടർന്ന് അധ്യാപികയോട് ചോദ്യങ്ങൾ ചോദിക്കാമെന്നും ചോദ്യങ്ങൾക്ക് അധ്യാപിക YES അല്ലെങ്കിൽ NO എന്ന് മാത്രമായിരിക്കും ഉത്തരം നൽകുക. അതിനാൽ ചോദ്യങ്ങൾ അതിന് അനുയോജ്യമായ ചോദിക്കാൻ പറയുന്നു.

വിദ്യാർത്ഥി	:	ഹരിക്ക് I = pnr എന്ന രീതിയിൽ പലിശ കണക്കാക്കുമ്പോൾ പലിശ 2000 കിട്ടും. സാധാരണ പലിശയാണ് ഹരിക്ക് ലഭിച്ചത്.
അധ്യാപിക	:	yes
വിദ്യാർത്ഥി	:	ജിതിന് 100 രൂപ കൂടുതൽ അടക്കേണ്ടി വന്നു?
അധ്യാപിക	:	yes
വിദ്യാർത്ഥി	:	ആദ്യ വർഷത്തെ പലിശ രണ്ട് പേർക്കും 1000 ആണോ?
അധ്യാപിക	:	yes
വിദ്യാർത്ഥി	:	ജിതിന് രണ്ടാം വർഷത്തെ പലിശയിൽ ആണോ വ്യത്യാസം വന്നത്?
അധ്യാപിക	:	yes
വിദ്യാർത്ഥി	:	രണ്ടാം വർഷത്തെ പലിശ ജിതിന് 1100 ആണ്?
അധ്യാപിക	:	yes
വിദ്യാർത്ഥി	:	അപ്പോൾ ജിതിന് 100 രൂപ കൂടുതൽ വന്നത് ആദ്യവർഷപലിശയുടെ 10% ആയ 100 രൂപയും കൂടി കൂട്ടിയതാണ്.
അധ്യാപിക	:	yes

തുടർന്ന് ചർച്ചയിൽ നിന്നും എത്തിച്ചേർന്ന നിഗമനങ്ങളെ ക്രോഡീകരിക്കാൻ അധ്യാപിക പറയുന്നു.

Phase 5 : Test hypothesis and Possible solution

Drama (scene 2) അവതരിപ്പിക്കുന്നു.

തുടർന്ന് വിദ്യാർത്ഥികളുടെ നിഗമനം അവതരിപ്പിക്കുന്നു.

ആദ്യവർഷ പലിശ രണ്ട് പേർക്കും തുല്യമാണ് ജിതിന് രണ്ടാം വർഷത്തെ പലിശ കണക്കാക്കിയപ്പോൾ ആദ്യവർഷ പലിശക്കും കൂടി പലിശ കണക്കാക്കിയാണ് കൂട്ടിയത്.
സാധാരണ പലിശ കണക്കാക്കുന്ന രീതിയുമായി ബന്ധപ്പെടുത്തി നിർധാരണം ചെയ്യാൻ അധ്യാപിക പറയുന്നു.

Phase 6 : Helps to verify the accepted conclusion

		ഒന്നാം വർഷം	രണ്ടാം വർഷം
ഹരി	മുതൽ	10,000	10,000
	പലിശ	1000	1000
ജിതിൻ	മുതൽ	10,000	11,000
	പലിശ	1000	1100

വിദ്യാർത്ഥികളുടെ ആശയങ്ങൾ അവതരിപ്പിച്ചതിന് ശേഷം പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കുന്ന പലിശ രീതി ഉണ്ടെന്നും അത്തരം പലിശ സമ്പ്രദായത്തെ കൂട്ടുപലിശ എന്നാണ് പറയുന്നതെന്നും അധ്യാപിക വിശദീകരിക്കുന്നു.
ആശയം power point ൽ കാണിക്കുന്നു.

സാധാരണ പലിശ, കൂട്ടുപലിശ എന്നിവയുടെ ഒരു troll picture കാണിക്കുന്നു.

Phase 7 : Analysis of thinking Process

കൂട്ടുപലിശ എന്ന ആശയത്തിൽ എത്തിച്ചേർന്ന പ്രവർത്തനങ്ങളെ വിശകലനം ചെയ്യുകയും വിദ്യാർത്ഥികളുടെ ഗ്രൂപ്പ് ചർച്ചയിൽ ഉണ്ടായ വ്യത്യസ്ത ചിന്തകളെക്കുറിച്ചും വിശദീകരിക്കുന്നു.

പണമിടപാടിൽ വ്യത്യസ്ത പലിശാരീതികൾ ഉണ്ടെന്നും കൃത്യമായി പരിശോധിച്ച ശേഷം പണമിടപാടുകൾ നടത്തണം, എന്ന ചിന്ത കുട്ടികളിൽ എത്തിക്കുന്നു.

Followup Activity

- അഞ്ച് ശതമാനം വാർഷിക നിരക്കിൽ ഒരു തുകയ്ക്ക് രണ്ടു വർഷത്തേക്ക് സാധാരണ പലിശയായി 200 രൂപ ലഭിച്ചു. അതേ തുകയ്ക്ക് അതേ നിരക്കിൽ രണ്ടു വർഷത്തേക്ക് ലഭിക്കുന്ന കൂട്ടുപലിശ എത്രയാണ്?
- സുമയും രാധികയും 20,000 രൂപ ഒരു ബാങ്കിൽ നിക്ഷേപിച്ചു. സുമ സാധാരണ പലിശ നിരക്കിലും രാധിക കൂട്ടുപലിശ നിരക്കിലും ആണ് നിക്ഷേപിച്ചത്. 8% പലിശ നിരക്കിൽ രണ്ടുവർഷം കഴിഞ്ഞ് രണ്ടുപേർക്കും ലഭിക്കുന്ന തുക എത്രയാകും?

DRAMA SCRIPT

(രണ്ട് സുഹൃത്തുക്കളുടെ സംഭാഷണത്തോടെയാണ് scene 1 ആരംഭിക്കുന്നത്.)

ഹരി	:	Degree കഴിഞ്ഞല്ലോ! ഇനി എന്തെങ്കിലും pocket money കിട്ടുന്ന ഒരു side job ചെയ്യണം. തുടർ പഠനത്തിനോടൊപ്പം ഒരു ജോലി.
ജിതിൻ	:	ഞാനും അതിനെക്കുറിച്ച് തന്നെയാണ് ആലോചിക്കുന്നത്. എന്ത് ജോലി?
ഹരി	:	ഇപ്പോ online marketing trend ആണല്ലോ? അതിനാണെങ്കിൽ അധികം investment ഉം വേണ്ട. നമുക്ക് സമയനിയന്ത്രണങ്ങളും ഇല്ല.
ജിതിൻ	:	Online marketing! ഹും... Business. അതെനിക്ക് ശരിയാകില്ല.
ഹരി	:	ജിതിനെ, നീ ഇപ്പോൾ ഹോം ട്യൂഷൻ എടുക്കുന്നില്ല? ആ ഹോം ട്യൂഷൻ തന്നെ ഓൺലൈൻ ചെയ്താൽ മതി. ഓൺലൈൻ ട്യൂഷൻ.
ജിതിൻ	:	ആ അത് ശരിയാണല്ലോ... ഇപ്പോ എല്ലാം ഓൺലൈൻ ആപ്പ് വഴിയാണ്. ബൈജൂസ് ആപ്പ് അങ്ങനെ നിരവധി ആപ്പ് ഉണ്ടല്ലോ. നമ്മൾ ആത്മാർത്ഥമായി വർക്ക് ചെയ്താൽ നമുക്കും സക്സസ് ആകാം. അല്ലേ, നീ എന്താണ് ഓൺലൈൻ ബിസിനസ് ചെയ്യാൻ പോകുന്നത്?
ഹരി	:	എനിക്ക് ഫാഷൻ എന്നും ഒരു ഹരമാണ്. ഓൺലൈൻ cloth ഷോപ്പ് തുടങ്ങാം.
ജിതിൻ	:	ആദ്യം തന്നെ ഒരുപാട് ഇൻവെസ്റ്റ്മെന്റ് വേണ്ട. ഒന്ന ട്രാക്കിൽ ആയിട്ട് കൂടുതൽ ഇൻവെസ്റ്റ്മെന്റ് ആലോചിക്കാം.

രണ്ടുപേരും തുടർന്ന് ഇൻവെസ്റ്റ്മെന്റിനെ പറ്റി ആലോചിക്കുന്നു. ബാങ്കിൽ നിന്ന് പണം വായ്പ എടുക്കാൻ തീരുമാനിക്കുന്നു. തുടർന്ന് ബാങ്കിൽ പോയി വിവരങ്ങൾ ശേഖരിക്കാൻ തീരുമാനിക്കുന്നു.

Scene 2

('ബാങ്ക് പരിസരം' രണ്ടുപേരും വ്യത്യസ്ത ബാങ്കിൽ നിന്ന് മൊബൈൽ ഫോണിൽ...)

ഹരി	:	ഡാ, ഞാൻ ബാങ്കിലാണ്. ഇവിടെ 10% പലിശയ്ക്ക് തരാമെന്ന് പറഞ്ഞു. നീ അവിടെ അന്വേഷിച്ചോ?
ജിതിൻ	:	ആ ഇവിടെയും അങ്ങനെയാണ് പറഞ്ഞത്. എങ്കിൽ നീ ആ ബാങ്കിൽ loan അപ്ലിക്കേഷൻ കൊടുത്തോളൂ ഞാൻ ഇവിടെയും കൊടുക്കാം.

(രണ്ടുപേരും ബാങ്കിൽ ലോൺ അപ്ലിക്കേഷൻ കൊടുക്കുന്നു! കുറേ ഡോക്യുമെന്റ് സൈൻ ചെയ്യുന്നു! ബിസിനസ് തുടങ്ങുന്നു... രണ്ടുവർഷത്തിനുശേഷം ലോൺ ക്ലോസ് ചെയ്യാൻ തീരുമാനിക്കുന്നു. രണ്ടുപേരും ബാങ്കിൽ പോയി ലോൺ ക്ലോസ് ചെയ്യുന്നു.)

Scene 3

ഹരി	:	അങ്ങനെ ലോൺ അവസാനിപ്പിച്ചു. സമാധാനമായി. അത്യാവശ്യം പോക്കറ്റ് മണി കിട്ടുന്നുണ്ട്. ബിസിനസ്സിൽ നിന്ന് 12000 രൂപ ബാങ്കിൽ അടച്ചു. ഇനി,
ജിതിൻ	:	എന്ത് 12,000 മോ? എനിക്ക് 12100 ആയല്ലോ?
ഹരി	:	100 രൂപ ബാങ്കിന്റെ എന്തെങ്കിലും സർവീസു ചാർജ് ആയിരിക്കും...
ജിതിൻ	:	ഏയ്, സർവീസ് ചാർജ് ഒന്നുമില്ല എന്ന് അവർ നേരത്തെ പറഞ്ഞതാണ്.
ഹരി	:	അങ്ങനെയെങ്കിൽ ഇതേതാ 100? ഈ നിലയ്ക്ക് 100000 എടുത്തിരുന്നെങ്കിൽ നീ 10000 കൂടുതൽ അടക്കേണ്ടി വരുമായിരുന്നു.
ജിതിൻ	:	ഇനി അവർക്ക് (ബാങ്കിന്) തെറ്റി കാണുമോ?
ഹരി	:	നമുക്ക് വീട്ടിൽ പോയി ആദ്യം പാസ് ബുക്ക് നോക്കാം.

Part II

ഹരി	:	ജിതിനെ, നിനക്ക് രണ്ടാം വർഷം 1100 ആണ് പലിശ. എനിക്ക് 1000. നിന്റെ ബാങ്കിൽ കൂട്ടുപലിശരീതിയാണ്.
ജിതിൻ	:	എന്ത് പലിശയ്ക്ക് പലിശ രീതിയോ!
ഹരി	:	അതെ...
ജിതിൻ	:	ബാങ്കിൽ ലോണിന് ചെന്നപ്പോൾ അതിനെ പറ്റി ഒന്നും കൂടുതൽ ചോദിച്ചില്ല! അതെന്റെ തെറ്റാണ്. അവർ പറഞ്ഞ ഡോക്കുമെന്റ്സിൽ എല്ലാം സൈൻ ചെയ്തു. എന്തായാലും ഇതൊരു പാഠമാണ് എനിക്ക്. ഇനി ബിസിനസിന്റെ പടികൾ ചവിട്ടി കയറാൻ ഈ ഒരു അനുഭവം സഹായിക്കും.
ഹരി	:	എനിക്കും.

Appendix XIII.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

TEACHING MANUAL ON ART INTEGRATED INFORMATION PROCESSING MODEL(AIIPM)
(English)

Name of the teacher	:	....	Class	:	VIII
Name of the school	:	....	Division	:	
Subject	:	MATHEMATICS	Strength	:	
Unit	:	Money Maths	Date	:	
Topic	:	Compound Interest	Duration	:	45 minutes

Effect

Instructional Effect:

- Identifies that different types of interest calculation methods.
- Understands that compound interest is calculated by adding the interest to the principal for further interest calculation.

Nurturant Effect:

- Develops an interest in investigative learning.
- Gains the ability to analyze situations critically.
- Cultivates an attitude to solve real-life problems related to interest.
- Builds awareness to recognize and respond appropriately to fraud in financial transactions.

Principle of Reaction

Teacher support the students in all learning phases. Encourages the students to the art integration phases.

Social System

Art integration phases are controlled by the teacher. The classroom environment is moderately structured.

Support system

Art integration - script, troll picture

Blackboard, PowerPoint

Appendix

Pre planning of Art integration

Art integration phases - phase 2 , phase 5 and phase 6

- Script for drama
- Prepare the students for Drama

Phase 1: Teacher Initiates

The teacher begins the class by asking students about the various types of advertisements they see on TV. Through discussions about the attractions and strategies in advertisements, the conversation transitions to different types of advertisements and then focuses on banking advertisements.

Phase 2: Presents the Problem

Two friends go to a bank to take a loan, and the situation is presented by the students through a drama.

After watching the presentation, the teacher asks, *"Why did the two friends have to repay different amounts despite taking the same loan?"*

Phase 3: Explore Relationship Among Variables

The teacher instructs students to analyze and compare both scenarios through group activities.

Details	HARI	JITHIN
Principal	₹10,000	₹10,000
Time (years)	2	2
Interest Rate	10%	10%
Total Amount	₹12,000	₹12,100

<table>
<tr><td>

Phase 4: Formulate Hypothesis

After analyzing both scenarios, students are asked to discuss in groups why there is a difference in the amounts. The teacher allows students to ask questions but will only respond with *'yes'* or *'no.'* The teacher encourages students to frame questions appropriately.

Student Questions:

When Hari calculates interest using I=PNR, is the interest ₹2,000?

Teacher: **Yes**

Did Jithin have to pay ₹100 more?

Teacher: **Yes**

Was the first-year interest the same for both, ₹1,000?

Teacher: **Yes**

Was the difference in the second-year interest for Jithin?

Teacher: **Yes**

Is Jithin's second-year interest ₹1,100?

Teacher: **Yes**

So, the extra ₹100 comes from adding 10% of the first year's interest ₹1,000?

Teacher: **Yes**

The teacher then guides students to consolidate their findings.

Conclusion:
In the first year, the interest is the same for both Hari and Jithin. However, in the second year, Jithin's interest was calculated by adding the first year's interest to the principal.

Phase 5: Test Hypothesis and Possible Solution

The students present their conclusions through another drama (Scene 2).

</td><td></td></tr>
</table>

Key Findings: In the first year, the interest for both Hari and Jithin was ₹1,000. For the second year, Jithin's interest was calculated by adding the first year's interest to the principal. The teacher explains how this is related to the method of calculating simple and compound interest.	

Year	Principal	Hari	Jithin
First Year	₹10,000	₹1,000	₹1,000
Second Year	₹10,000	₹1,000	₹1,100
Total Amount	₹12,000	₹12,000	₹12,100

The teacher explains that compound interest involves adding the first year's interest to the principal for subsequent calculations. This is illustrated using a PowerPoint presentation.

Phase 6: Verifies the Accepted Conclusion

After presenting their ideas, the students are introduced to the concept of compound interest. The teacher explains that calculating interest on accumulated interest is known as compound interest.

A troll picture related with simple and compound interest is shown.

Phase 7: Analysis of Thinking Process

The teacher analyzes the steps taken to understand the concept of compound

interest and discusses the different perspectives observed during group discussions. The teacher emphasizes the importance of understanding the different methods of interest calculation in financial transactions and encourages students to verify such aspects carefully before making any financial decisions.	
Follow-Up Activity: 1. At an annual rate of 5%, a sum earned ₹200 as simple interest for two years. What would be the compound interest for the same sum, rate, and duration? 2. Suma and Radhika deposit ₹20,000 in a bank. Suma earns simple interest, while Radhika earns compound interest at an 8% interest rate for two years. How much will each receive?	

Appendix

DRAMA SCRIPT

Scene 1

The first scene begins with a conversation between two friends.

Hari	:	We have finished our degree right now! Now I wish I could do a side job along with my studies to get some pocket money.
Jithin	:	I am also thinking about it. What job can we do?
Hari	:	Nowadays, online marketing is trending and not much investment is needed for it. We also wouldn't have any time schedule.
Jithin	:	Online marketing? Huh! Business won't suit me.
Hari	:	Hey! You have been taking home tuition, right? Just take the same as online, like and online tuition.
Jithin	:	That's a great idea! Lately, everyone is using online apps and platforms. For example Bijus, ig app. If you honestly and sincerely work we can succeed in our life! Amn't I right? What are you gonna do?
Hari	:	I am obsessed with fashion, so I'm planning to start an online cloth shop.
Jithin	:	First of all, not much investment is needed for it. If we have come to the track everything is gonna be a cake walk!

Both of them are thinking about the investment. They have decided to take a loan from the bank and for further enquiries they approached the bank.

Scene 2

At the bank….

They're at different banks and they both are having a conversation on their mobile phones.

Hari	:	Hey! I am in the bank now! Here they said that they would give me a 10% interest. What about yours?
Jithin	:	Yeah! It's the same scenery here. Then you can give the loan application to the bank.

(They both have given the loan application. They have signed numerous documents. They started the business…. 2 years passed! They decided to close the loan.)

Scene 3

Hari	:	Finally that's over! It's a relief now! I am able to meet the growing expenses for myself with the business. I have paid 12000 rupees at the bank. Now…
Jithin	:	12000? My amount to be paid was 12100.
Hari	:	The 100 rupees might be some service charges.
Jithin	:	No! They have already mentioned that there are no additional service charges.
Hari	:	Then, what's that ₹100? If this situation was like this and you took Rs 100000 as loan, you would have to pay rupees 10000 more in addition.
Jithin	:	Ehmm.. what if the bank officials had made some mistakes?
Hari	:	Let's go home and check the passbook.

Scene 2

Hari	:	For you the interest is ₹1100 for 2 years. For me it's ₹1000. In your bank it's compound interest!
Jithin	:	How come? Compound interest?
Hari	:	Yeah! Exactly.
Jithin	:	When I had approached the bank for the loan, I didn't ask anything much. I regret it right now! You know what, I signed a bunch of documents given by them without asking a single word about it! Anyway, this must be a lesson for me. Later, I wouldn't make this same mistake again!
Hari	:	Same

Appendix XIV.a

FARROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

TEACHING MANUAL ON PRESENT METHOD OF TEACHING (Malayalam)

Name of the teacher	:	Class	: VIII
Name of the school	:	Division	:
Subject	: **ഗണിതശാസ്ത്രം**	Strength	:
Unit	: **പണവിനിമയം**	Date	:
Topic	: **കൂട്ടുപലിശ**	Duration	: 45 **മിനിറ്റ്**

Learning Outcome	• പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കി കൂട്ടുപലിശ കാണുന്ന രീതി വിശദീകരിക്കുന്നു. • സാധാരണ പലിശയും കൂട്ടുപലിശയും തമ്മിൽ താരതമ്യം ചെയ്യാൻ കഴിയുന്നു.
Concept	ഓരോ കാലയളവിലും മുതൽ മാറിക്കൊണ്ടിരിക്കുകയും ലഭിക്കുന്ന പലിശയും മാറുന്ന രീതിയാണ് കൂട്ടുപലിശ.
Pre-requisites	സാധാരണ പലിശ കാണാനുള്ള അറിവ്
Attitude and Values	**പണവിനിമയം** നടത്തുമ്പോൾ ജാഗ്രത പാലിക്കാനും ചതിക്കുഴികൾ തിരിച്ചറിയാനും കഴിയുന്നു. സഹകരണ മനോഭാവം, പ്രശ്ന പരിഹാരശേഷി, പ്രായോഗിക പ്രശ്നങ്ങൾ ഗണിതപരമായ രീതിയിൽ നിർദ്ധാരണം ചെയ്യാനുള്ള കഴിവ്, വിമർശനാത്മക ചിന്ത.
Learning Resources	**പ്രവർത്തന കാർഡ്, ബ്ലാക്ക് ബോർഡ്,** **പവർ പോയിൻറ്**

പഠനപ്രക്രിയ	പ്രതികരണങ്ങൾ
ടിവിയിൽ കാണുന്ന വിവിധതരം പരസ്യങ്ങൾ ഏതൊക്കെയാണെന്ന് ചോദിച്ചുകൊണ്ട് അധ്യാപിക ക്ലാസ് ആരംഭിക്കുന്നു. പരസ്യങ്ങളിലെ ആകർഷണങ്ങൾ, തന്ത്രങ്ങൾ എന്നിവയിലൂടെ വിവിധതരം പരസ്യങ്ങളിലേക്കും അതിൽ നിന്ന് ബാങ്ക് പരസ്യങ്ങളിലേക്കും ശ്രദ്ധ കൊണ്ടുവരുന്നു. പണം അത്യാവശ്യമായി വരുമ്പോൾ ബാങ്കിൽ നിന്ന് ലോൺ എടുക്കാറുണ്ട്. രണ്ടു പരസ്യ ബോർഡുകൾ കാണിച്ചുകൊണ്ട് ഇതിൽ ഏത് ബാങ്കിൽ നിന്നാണ് പണം ആവശ്യമായി വരുമ്പോൾ ലോൺ എടുക്കുക എന്ന് അധ്യാപിക ചോദിക്കുന്നു. 10% പലിശ 24 മാസംകൊണ്ട് 1 ലക്ഷം രൂപ 1.20 ലക്ഷം രൂപയാകും. 10% പലിശ 24 മാസം കൊണ്ട് 1 ലക്ഷംരൂപ 1.21 ലക്ഷം രൂപയാകും. **പ്രവർത്തനം:1** രണ്ട് ബാങ്കിലെയും പലിശ നിരക്ക്, വർഷം എന്നിവ എല്ലാം ഒരുപോലെ ആയിരുന്നു. രണ്ടുവർഷം കഴിഞ്ഞ് അടയ്ക്കേണ്ട തുകയിൽ വ്യത്യാസം വന്നു. എന്തുകൊണ്ടാണ് വ്യത്യാസം വന്നത്? എന്നത് ഗ്രൂപ്പിൽ ചർച്ച ചെയ്ത് കണ്ടെത്താൻ പറയുന്നു. ഗ്രൂപ്പ് പ്രവർത്തനത്തിന് ആവശ്യമായ നിർദ്ദേശങ്ങൾ അധ്യാപിക നൽകുന്നു. സാധാരണ പലിശ കണക്കാക്കുന്ന രീതിയുമായി ബന്ധപ്പെടുത്തി നിർധാരണം ചെയ്തതിനുശേഷം, ഓരോ ഗ്രൂപ്പും അവരുടെ ആശയങ്ങൾ അവതരിപ്പിക്കുന്നു. ഗ്രൂപ്പ് പ്രവർത്തനത്തിലെ ആശയങ്ങൾ ബ്ലാക്ക് ബോർഡിൽ എഴുതിയതിനുശേഷം ആശയം അധ്യാപിക ക്രോഡീകരിക്കുന്നു.	

		ഒന്നാം വർഷം	രണ്ടാം വർഷം	തുക
ബാങ്ക് 1	മുതൽ	10,000	10,000	12,000
	പലിശ	1000	1000	
ബാങ്ക് 2	മുതൽ	10,000	11,000	12,100
	പലിശ	1000	1100	

ആദ്യവർഷ പലിശയായ 1000 രൂപയ്ക്ക് കൂടി, രണ്ടാം വർഷം പലിശ കണക്കാക്കി. അതായത് രണ്ടാം വർഷത്തെ മുതലിനോട് ആദ്യവർഷ പലിശ കൂട്ടിയാണ് പലിശ കണക്കാക്കിയത്. അതുകൊണ്ടാണ് രണ്ടാമത്തെ ബാങ്കിൽ തുക കൂടിയത്. ആദ്യവർഷ പലിശയുടെ (1000 ന്റെ 10%) ആയ 100 രൂപയാണ് രണ്ടാംവർഷാവസാനം കൂടുതലായി വന്നത്. ഇത്തരം പലിശ സമ്പ്രദായത്തെ കൂട്ടുപലിശ എന്നാണ് പറയുന്നതെന്നും അധ്യാപിക വിശദീകരിക്കുന്നു.

സാധാരണ പലിശയിൽ നിന്നും വ്യത്യസ്തമായി പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കുന്ന പലിശ രീതിയാണ് കൂട്ടുപലിശ.

പ്രവർത്തനം:2

കൂട്ടുപലിശ ഉൾപ്പെടുന്ന മറ്റൊരു പ്രവർത്തനം നൽകുന്നു. പ്രവർത്തന കാർഡിലുള്ള പ്രശ്നം ഗ്രൂപ്പായി ചർച്ച ചെയ്ത് പരിഹരിക്കാൻ അധ്യാപിക പറയുന്നു.

സുമയും രാധികയും 20,000 രൂപ ഒരു ബാങ്കിൽ നിക്ഷേപിച്ചു. സുമ സാധാരണ പലിശ നിരക്കിലും രാധിക കൂട്ടുപലിശ നിരക്കിലും ആണ് നിക്ഷേപിച്ചത്. 8% പലിശ നിരക്കിൽ രണ്ടുവർഷം കഴിഞ്ഞ് രണ്ടുപേർക്കും ലഭിക്കുന്ന തുക എത്രയാകും?

ഗ്രൂപ്പ് പ്രവർത്തനത്തിന് ശേഷം പരിഹരിച്ച രീതി ബ്ലാക്ക് ബോർഡിൽ അധ്യാപിക എഴുതുന്നു. പലിശയ്ക്ക് കൂടി പലിശ കണക്കാക്കുമ്പോൾ കൂട്ടുപലിശ രീതി സാധാരണ പലിശയിൽ നിന്നും വ്യത്യാസം എന്ന ആശയം ഉറപ്പിക്കുന്നു.

തുടർപ്രവർത്തനം

അഞ്ച് ശതമാനം വാർഷിക നിരക്കിൽ ഒരു തുകയ്ക്ക് രണ്ടു വർഷത്തേക്ക് സാധാരണ പലിശയായി 200 രൂപ ലഭിച്ചു. അതേ തുകയ്ക്ക് അതേ നിരക്കിൽ രണ്ടു വർഷത്തേക്ക് ലഭിക്കുന്ന കൂട്ടുപലിശ എത്രയാണ്?

Appendix XIV.b

FAROOK TRAINING COLLEGE
Research Centre in Education
University of Calicut

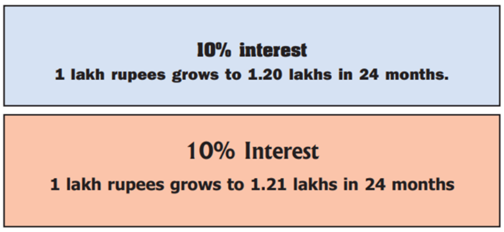
TEACHING MANUAL ON PRESENT METHOD OF TEACHING
(English)

Name of the teacher	:	Class: VIII	
Name of the school	:	Division:	
Subject	: MATHEMATICS	Strength	:
Unit	: Money Maths	Date	:
Topic	: Compound Interest	Duration	: 45 minutes

Learning Outcomes	• Explains the method of calculating compound interest by adding interest to the principal. • Compares simple interest and compound interest.
Concept	Compound interest is the method where the principal changes over each time period, and the interest is calculated on the new principal.
Pre-requisites	Knowledge of calculating simple interest.
Attitude and Values	While engaging in financial transactions, one develops the ability to remain vigilant and identify potential pitfalls. Encouraging cooperation, problem-solving ability, practical problem analysis using mathematics, and critical thinking.
Learning Resources	Activity cards Blackboard PowerPoint

<table>
<tr><th>Learning process</th><th>Responses</th></tr>
<tr><td>
The teacher starts the class by asking students about various types of advertisements they have seen on TV. By discussing the attractions and strategies in advertisements, the focus shifts to banking advertisements.

The teacher then shows two advertisement boards and asks, "From which bank would you take a loan if needed?"



Activity 1

The interest rate, period, and other conditions are identical for two banks. However, the repayment amounts after two years differ. The teacher asks, "Why is there a difference in the amounts?" Students discuss this question in groups, guided by the teacher's instructions.

Each group presents their ideas after determining the difference in terms of the method of calculation. The teacher consolidates the students' ideas on the blackboard and explains further.

<table>
<tr><th></th><th></th><th>First year</th><th>Second year</th><th>Amount</th></tr>
<tr><td rowspan="2">Bank 1</td><td>Principal</td><td>10,000</td><td>10,000</td><td rowspan="2">12,000</td></tr>
<tr><td>Interest</td><td>1000</td><td>1000</td></tr>
<tr><td rowspan="2">Bank 2</td><td>Principal</td><td>10,000</td><td>11,000</td><td rowspan="2">12,100</td></tr>
<tr><td>Interest</td><td>1000</td><td>1100</td></tr>
</table>
At the end of the second year, Bank 2's total amount is higher because the second year's interest was calculated on
</td><td></td></tr>
</table>

the updated principal, which included the first year's interest. An additional ₹100 (10% of ₹1,000) resulted from this calculation. This method is known as *compound interest*. The teacher explains that, unlike simple interest, compound interest involves calculating interest on the accumulated interest as well. **Activity 2** Another example involving compound interest is provided. Suma and Radhika each deposited ₹20,000 in a bank. Suma earned interest at a simple interest rate, while Radhika earned interest at a compound interest rate. After two years, how much will each of them receive at an 8% rate of interest? The groups discuss and solve the problem. The teacher then writes the solution on the blackboard and confirms the understanding of how compound interest differs from simple interest.	
Follow-Up Activity At an annual rate of 5%, a sum earned ₹200 as simple interest for two years. Calculate the compound interest for the same amount, rate, and duration.	

Appendix XV

Certificates from Experts

CERTIFICATE

This is to Certify that Smt. Saritha A S, Senior research scholar, Farook Training College, Kozhikode has consulted me in the process of construction and standardization of the lesson plans in Mathematics as part of her research work among students of standard VIII and standard IX.

I have gone through the lesson plans and have suggested appropriate modifications wherever necessary.

DISTRICT INSTITUTE OF EDUCATION AND TRAINING PALAKKAD

Name & Designation

Signature

Dr. M. SAHEEDALI
PEN : 479644
Senior Lecturer, DIET Palakkad
Department of General Education

Place

Date 09.08.2019

CERTIFICATE

This is to Certify that Smt. Saritha A S, Senior research scholar, Farook Training College, Kozhikode has consulted me in the process of construction and standardization of the lesson plans in Mathematics as part of her research work among students of standard VIII and standard IX.

I have gone through the lesson plans and have suggested appropriate modifications wherever necessary.

RAJASREE T.K.
HST MATHEMATICS
GHSS VARAVOOR
Name & Designation

Signature

GOVERNMENT HIGHER SECONDARY SCHOOL
THRISSUR-DIST
VARAVOOR

Place

Date 5.08.2019

CERTIFICATE

This is to Certify that Smt. Saritha A S, Senior research scholar, Farook Training College, Kozhikode has consulted me in the process of construction and standardization of the lesson plans in Mathematics as part of her research work among students of standard VIII and standard IX.

I have gone through the lesson plans and have suggested appropriate modifications wherever necessary.

BASTIAN GEORGE V
HST- MATHS
Name & Designation

Signature

Place

Date 6.8.2019

H.S.S. ARIMPUR
School Code: 722021
UDISE Code: 32071402703
P.O. ARIMPUR

Appendix XVI

Certificate from School

CERTIFICATE

This is to Certify that Smt. Saritha A S, Senior research scholar, Farook Training College, Kozhikode has handled classes and administered tools as part of her research work among students of standard VIII and standard IX (three classes each) in this institution from 09.10.2019 to 31.01.2020.

Arimpur

Date
3.02.2020

H. S. S. ARIMPUR
School Code: 722021
UDISE Code: 32071402703
P. O. ARIMPUR

Headmistress
BEETTA VARGHESE N.
Headmistress
H.S. Arimpur

Appendix XVII

Sample Student Artifiacts

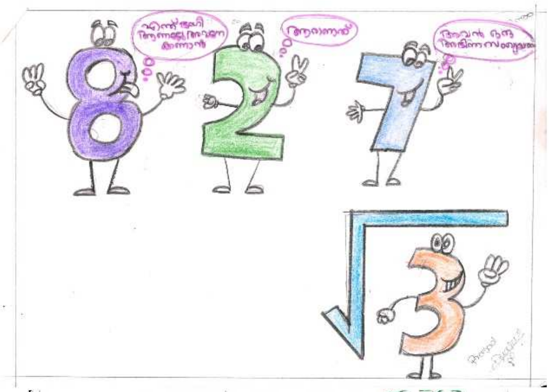
Appendix









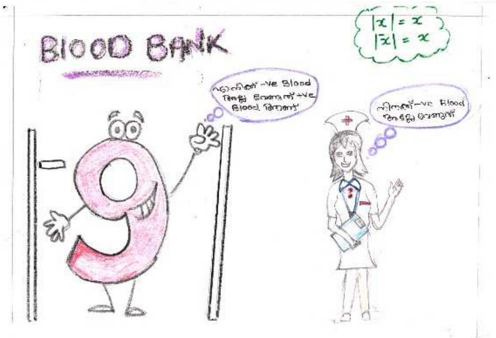
News Report

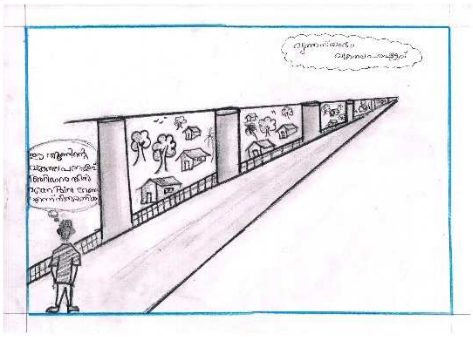
H.S.S. അരിമ്പൂരിന്റെ

ഒരു മഴവെള്ള സംഭരണി

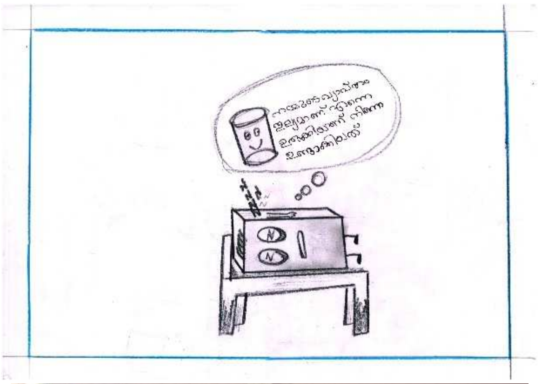
എച്ച്. എസ്. എസ്. അരിമ്പൂരിന്റെ അങ്കണത്തിൽ ഒരു മഴവെള്ള സംഭരണി നിർമ്മാണം.

അരിമ്പൂർ:- അരിമ്പൂർ ഹൈസ്കൂൾ മഴവെള്ളം ശേഖരിക്കാനായി സ്കൂൾ മുറ്റത്ത് ഒരു വിദ്യാർത്ഥികളുടെയും അധ്യാപകരുടെയും സഹകരണത്തോടെ ഒരു മഴവെള്ള സംഭരണി നിർമ്മിച്ചു. ~~മ~~ മഴവെള്ളം ശേഖരിക്കാനായി സ്കൂൾ മുറ്റത്ത് നിർമ്മിച്ച ഈ കുഴി സമചതുരാകൃതിയിലാണ്. സമചതുരാകൃതിയിലുള്ള കുഴിയുടെ ഒരു വശം 2m-ഉം കുഴിയുടെ ആഴം 3 മീറ്ററുമാണ്. ഇപ്പോൾ ഏകദേശം 1 ലിറ്ററോളം വെള്ളം ഈ ജലസംഭരണിയിലുണ്ട്. ഈ സമചതുരാകൃതിയിലുള്ള മഴവെള്ള സംഭരണിയിൽ ഏകദേശം 10380 L വെള്ളം കൊള്ളും. പരിസ്ഥിതി ദിനത്തിൽ ഉദ്ഘാടനം ചെയ്ത ഈ ജലസംഭരണിയിലെ ജലം വിദ്യാർത്ഥികൾക്ക് വേനൽക്കാലത്ത് നല്ലൊരു മുതൽക്കൂട്ടായിരിക്കും. നല്ലൊരു മുന്നേറ്റമാണ് ഈ ജലസംഭരണിയിലൂടെ അധ്യാപകർക്കും വിദ്യാർത്ഥികൾക്കും കൈവരിക്കാൻ കഴിഞ്ഞത്. സ്കൂളിൽ നിന്നും പിരിച്ചെടുത്ത ഒരു ചെറിയ തുകകൊണ്ടാണ് ഈ സംഭരണി നിർമ്മിച്ചത്.





Appendix




ഒരേ തുക,ഒരേ നിരക്കിൽ,ഒരേ കാലയളവിൽ
പാദവാർഷികമായും അർധവാർഷികമായും
വാർഷിക മായും നിക്ഷേപിച്ചാൽ കൂടുതൽ തുക
ലഭിക്കുന്നത്
2
1
3
അർധവാർഷികം
പാദവാർഷികം
വാർഷികം


നമ്മൾ രണ്ടാളും
വാങ്ങുന്നത്
തന്നെയാ
പാദവാർഷികം
അർധവാർഷികം
ഞാൻ 6
മാസംതോറും
വാങ്ങുന്നു
പാദവാർഷികം
അർധവാർഷികം
നീ 3 മാസംതോറും
പാദവാർഷികം
അർധവാർഷികം