

**A STUDY ON *IT MATHS LAB* FOR TEACHING
LEARNING PROCESS IN MATHEMATICS
AMONG HIGHER SECONDARY
SCHOOLS OF KERALA**

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*Thesis submitted to the
University of Calicut for the partial fulfillment of the
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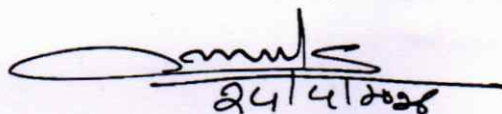
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LIST OF ABBREVIATIONS

ANOVA	: Analysis of Variance
BC	: Before Christ
CAS	: Computer Algebra Systems
CBSE	: Central Board of Secondary Education
DGS	: Dynamic Geometry Software
DMS	: Dynamic Mathematics Software
ICT	: Information and Communication Technology
IT	: Information Technology
KITE	: Kerala Infrastructure and Technology for Education
NCF	: National Curriculum Framework
OHP	: Overhead Projector
QR	: Quick Response
SCERT	: State Council of Educational Research and Training
SSLC	: Secondary School Leaving Certificate
URL	: Uniform Resource Locator

INTRODUCTION

- *Need and Significance*
- *Statement of the Problem*
- *Meaning and Definition of Key terms*
- *Variables of the Study*
- *Objectives of the Study*
- *Hypotheses of the Study*
- *Methodology in Brief*
- *Statistical Techniques*
- *Scope and Limitations of the Study*
- *Organization of the Report*

Introduction

The advancement in Information Technology has brought about revolutionary changes in all facets of education. The contemporary educational scenario of our country is transforming in tune with the scientific and technological advancement. The world is now transforming to a new era of learning environment.

Modern society places a high value on education in general and mathematics education in particular. With the explicit goal of promoting a scientific worldview among the populace, societies have developed institutions to integrate mathematics and science into society's culture over time. Society realize the necessity of implementing educational changes in the particular field of mathematics based on models that are more suited to school practices thanks to this rigorous societal process of scientific enlightenment. The methodical investigation of these processes' impacts is the focus of mathematics education.

Mathematics is an abstract science which deals with the quantitative aspects of the entire life as well as entire world. It is a systematized and organized science and a science of logical reasoning and abstract thinking. The study of Mathematics enhances students' logical, functional and aesthetic skills. It focuses on certain key concepts in Mathematics and the development of ability to solve problems and to reason in quantitative contexts. It has much influence on the analysis skills of the learners. Problems enable the learners to apply their skills to both familiar and unfamiliar situations and thereby giving them the ability to use the tested theories. It is essential for the learners to connect all of their mathematical knowledge of concepts, procedures, logical thinking, reasoning, and communication skills to solve

problems. The mathematical ability encompasses the Conceptual understanding, Procedural knowledge and Problem solving ability. It is not merely the numerical ability alone.

The dictionary meaning of Mathematics says ‘it is a science of number and space’ or ‘the science of measurement, quantity and magnitude’. Being an abstract subject, Mathematics is considered to be difficult by most of the pupils. Our National Curriculum Framework (National Council of Educational Research and Training, 2005) has rightly identified ‘a sense of fear and failure regarding mathematics among majority of children’ as a major problem in teaching and learning of Mathematics. A detailed analysis of teaching Mathematics revealed many reasons for such things to occur. Evidently it is a logical subject where knowledge and skill are built up systematically. It is a self contained mental discipline with its own language and structure. It is a mental tool for the training and exercise of intellectual functions. It is a sequential subject in the sense that the learning of any new topic in Mathematics depend on some previous related knowledge. To learn and perform in Mathematics requires a perfect understanding of the underlying principles. Hence the learners will be helped to have a carefully chosen set of mathematical experiences in order to help them to form a new concept in Mathematics. The National Policy on Education (Ministry of Human Resource Development, 1986) stressed “Mathematics should be visualized as the vehicle to train a child to think reason, analyze and to articulate logically. Apart from being a specific subject, it should be treated as concomitant to any subject involving analysis and reasoning.”

If the basic concepts in Mathematics are clear to the learners, interest in the subject will be developed in them automatically. The fundamental facts or even the concepts in Mathematics are so interrelated that the building of the larger concept is impossible without the knowledge of the previous concepts. Therefore proper understanding of the basic concepts and the ability to apply these concepts are extremely important. Consequently, a mathematics teacher should give special attention to the development of concepts through direct and concrete experiences in the learners. It is not easy to provide direct and concrete experiences in certain areas like Algebra. Hence a teacher should purposefully induce thinking in the learners for assimilating the concepts in their cognitive structure, which will result in meaningful learning. An attempt to impart instruction in such a way that the pupil acquires habit of curiosity, intelligent thinking and reasoning should be adopted. The intellectual process of the learners should be sharpened and challenged to argue and discover facts by them. Intellectual power and not simple knowledge should be the result of teaching Mathematics. The pupils have to be familiar with the basic concepts of Mathematics to think critically about the world and to take decisions about personal and social issues.

Evolution of Mathematics Teaching Tools

Although worries about teaching mathematics and its development are as old as education itself and as old as civilization, rigorous research aiming at identifying the phenomena that characterize it has only recently, possibly for a few decades, been conducted. Without doubt, the activity of professional mathematics education has been developed in an atmosphere favorable to serene research. Since its inception,

numerous generations of maths educators have emerged, and throughout that time, the field has developed into an independent area of study that has gained the authority of a collection of research questions. Perhaps in the beginning, a small group of disciplined young people would grasp every chance they could and build on one another's work, but today, in our little community, it is not hard to find a range of perspectives that strive to coexist in plurality.

In geometry, which Euclid developed in 300 B.C., has largely not altered in over 2000 years, and the algebra we teach now is essentially the same as that taught 200 years ago! Both of these topics are fascinating, essential to understanding both culture and science, difficult, and naturally fascinating. But in the present era, new mathematics themes have emerged that are suitable for classes at the secondary level. The secondary mathematics instructor could add further concepts, but only to broaden and strengthen the conventional core of mathematical learning rather than to undermine it. My argument is that some additional concepts can and should be taught in secondary algebra and geometry courses to make the whole learning experience more engaging, up to date, and intriguing.

The inference is that before electronic technology, there was no such thing as technology in education and that there were no huge expectations for changing teaching and learning. In truth, the use of tools to aid in the teaching and learning of mathematics has a long history stretching back before the invention of electronic technology, and some of these tools have even been dubbed revolutionary. With no predilection for electronic technology, we will try to examine the history of educational technology in this chapter in a more comprehensive way. Indeed, such a

strategy offers an insightful vantage point from which to examine the discussions around the contemporary electronic instruments.

It will restrict ourselves to physical devices in order to avoid going too far in the opposite direction and having technology include an unmanageably wide spectrum of human activities, possibly including mathematical notation and language in general. As a result, for instance, we will exclude logarithms from our definition of technology while including the slide rule, a physical object based on logarithms. It must also be emphasized that even within these restrictions, this chapter falls short of providing a comprehensive account of the history of technology in mathematics education globally. When we talk about general-purpose tools, we mean ones that have wide application outside of the classroom but are particularly useful in a learning environment.

Educational use of technology has been subject to overarching educational philosophies prevailing at any given time and place.

The Textbook

Technology has influenced mathematics and its teaching through developments in various points, like statistics, data science, computer education, science and commerce. One of the most widespread and enduring tools in mathematics education is the written form of book. Historically, the recitation method and the monitorial system supported a curriculum focused heavily on memorizing basic arithmetic and geometrical concepts. Before textbooks and blackboards became standard, it was common in many European and North

American schools for students to create their own books. They started with blank pages and copied down what the teacher dictated during lessons.

The Blackboard

Teachers could present problems from a book while students copied and solved them on their slates. This method enabled teachers to present complex verbal or visual information more clearly than by simply reading aloud. It also gave students the opportunity to solve problems on the blackboard, making their work visible to both the teacher and classmates for feedback and discussion. This interactive approach shifted the classroom dynamic and, in mathematics, the blackboard used, alongside the textbook played a key role in the growing emphasis on algebra and geometry in the curriculum.

Blackboards remain a principal component in mathematics classrooms even today also. A significant advancement came in the late 20th century with the introduction of interactive whiteboards, which can connect directly to computers to display content. Similarly, tablets and personal computers offer comparable features, including handwriting recognition, enabling the device to interpret handwritten input on the screen.

The Abacus

The abacus represents numbers using beads on wires and likely grown from early counting methods such as marks in sand or counters on boards. The Abacus appears to have originated somewhere in the eastern Mediterranean in ancient times, then spread eastward to Asia, and later traveled back west through Russia into

Europe and eventually the Americas. The route to Asia is uncertain, and it may have developed independently there. Abacus became a widely used calculating tool in China and Japan until recent times. In these regions, it was mostly used as a teaching aid for basic arithmetic to young children rather than as a practical calculation device.

The Slide Rule

“The slide rule incorporates in physical form the theory of logarithms pioneered by Scottish mathematician John Napier and English mathematician Henry Briggs in the early 1600s. By marking two straightedges with logarithmic scales and sliding one with respect to the other, it was possible to quickly calculate approximate answers to multiplication problems. Even more complicated problems could be handled with sufficient ingenuity, although the fact that the slide rule was an analog instrument meant that it always provided only approximate answers and thus was not appropriate for accounting or other commercial applications. Variations involving circular rules were also possible, and both possibilities had been explored by the middle of the seventeenth century in England. These slide rules were slowly improved over the next century and became a tool used by British engineers such as James Watt. By the early 1800s, they had spread to the European continent and to the United States” (von Jezierski 2000).

The Calculator

Unlike the slide rule, the calculator is fundamentally a digital instrument, which seems to have given it a decided advantage in achieving a place in mathematics instruction. Its place in the classroom is still in an experimental stage. European development of mechanical calculators dates from the seventeenth century, with such notable mathematicians as Pascal and Leibniz prominently involved (Goldstine, 1972). But it was not until the middle of the nineteenth century that industrial processes were sufficiently advanced to allow construction of calculating devices on a commercial basis, both in Europe and the United States. By the 1920s they had become a standard feature of many office settings. But it appears that it was not until after World War II that they received much consideration as educational assistants. In the 1950s there was some minor experimentation in classrooms with mechanical calculators, or mechanical calculators with electrical assistance, but the size and cost of these machines made them inconvenient as personal devices (Kidwell et al. 2008).

The Overhead Projector

A more recent classroom display technology is the overhead projector. Its earliest manifestations seem to have been related to education but not in school classrooms: public nineteenth-century science lecturers seeking added visual flair. Such use began to enter schools in the early twentieth century, as part of a wider movement for “visual education” that included photographic slides and filmstrips. About the same time, this technology also received a boost from a non-educational venue, the bowling alley, where it was used as a convenient way to project scores for

bowlers to view. Overhead projectors then received substantial use by the US military during World War II for training purposes, probably contributing to a major expansion of school use in the postwar years (Kidwell et al. 2008). Much more than the blackboard, this technology as used in schools has remained the exclusive domain of the teacher. It has two primary attractions. First, it allows the teacher to continue to face the students while displaying materials to them. Second, it allows the teacher to display elaborate transparencies created before class. For example, a teacher of solid geometry can prepare or purchase complicated diagrams of an exactitude that could never be hoped for in hand-drawn diagrams quickly improvised while watched by the students. There is however a drawback, in that reliance on prepared slides can encourage a too rapid succession of material that can overload the students' ability to assimilate the information presented.

The Computer

Enormous wider societal uses are seen in computer in education, like the book. Though their full potential in this area may still be uncertain, computers have now become a regular part of mathematics education around the world. Some argue that how computers are presently used in education often underutilizes their true capabilities. One of the most widespread applications in early education is using computers to give students instant feedback on problems in their learning area. While this is certainly more convenient, and might have astonished past generations, it's essentially similar to checking answers at the back of a textbook. Unlike books, however, the introduction of computers into education is a contemporary development, still within living memory.

Programmed learning experiments, much of which were inspired by the work of B. F. Skinner and other psychologists, featured ordered sets of problems which the student was asked to work through (Vargas and Vargas 1996). The student's passage through the problems depended on whether the student gave correct or incorrect answers at each step; a student might be asked to cycle back through some material or else move on briskly to new topics. This could be accomplished merely with a book, by covering up the answers. Computers allowed this to be done more easily and with more flexibility. As already noted, this basic functionality continues to be one of the most widely used applications of computers in mathematics education.

GeoGebra

GeoGebra an application software, was first developed in 2001 as part of Markus Hohenwarter's Master's thesis at the University of Salzburg in Austria. The background in both mathematics education and computer engineering, helped to set out to create a software which could be mix dynamic geometry with computer algebra. Two areas of mathematics i.e., geometry and computer that are typically handled separately by other programs. The objective of developing the software was to design user-friendly educational software that merged the simplicity of dynamic geometry tools with the unconventional capabilities of computer algebra systems, making it appropriate for use by teachers, students and researchers from secondary school to college.

GeoGebra is one of the Dynamic Mathematics Software (DMS) designed to support the teaching and learning of mathematics from lower primary school to

higher level in colleges. It combines the user-friendly interface of Dynamic Geometry Software (DGS) with indispensable features of Computer Algebra Systems (CAS), helping to join mathematical concepts from geometry, algebra, and calculus. As an open-source program licensed under the GNU General Public License, GeoGebra is freely accessible at www.geogebra.org. Users can either download it for various platforms or run it online via GeoGebra Web Start. The software was developed to help students deepen their understanding of mathematical concepts.

The importance of making mathematics education accessible to all students and increasing their mathematics proficiency so as to prepare them for life outside school. In order to provide a higher quality education for students, capable teachers who are willing to implement creative learning environments with technology for the purpose of maximizing their students' learning success are desperately needed.

IT Maths Lab

In Kerala public education system, the IT Maths Lab has been started at the higher secondary level to make learning more engaging and student-friendly. IT Maths Lab activities provides a hands-on teaching learning environment that inspires cognitive understanding, creativity and joyful exploration, helping to enhance the effective teaching learning process. Every children naturally possess various type of mathematical abilities, which can flourish through proper schooling in terms of providing effective learning environment. In early childhood, they develop comparison of size, counting the things, number sense and basic numerical skills through play and interactive activities. However, as students progress to upper

grades, mathematical concepts are often presented in more abstract ways, which can diminish their genuine interest in the subject.

In the education context, designing an appropriate classroom activity to teach concepts like finding the maximum surface area of a rectangular prism with a fixed volume can be reasonably challenging. When a concept involves a complex chain of logical reasoning, it's often more effective to turn it into a hands-on activity, allowing students to discover and understand the idea through experience. In the technological era, transforming abstract concepts into interactive activities has become much easier, and students are well-prepared to adapt to these technology based teaching learning methods. Tools like GeoGebra play a significant role in this transformation. In the IT Maths Lab, many activities are facilitated using GeoGebra, and a comprehensive Lab Manual is provided to guide students through the learning process.

Need and Significance of the Study

As the role of Mathematics in the modern world is significant, the teaching of Mathematics at the higher secondary school level is extremely imperative. It is a subject built on certain postulates, axioms and basic concepts. The fundamental facts or even concepts in Mathematics are so inter-related that the attainment of a larger concept is not viable without the knowledge of the basic concepts. Therefore, proper understanding of basic concepts and ability to apply these concepts in different situations, are significant for the realization of the objectives of teaching the subject. For attaining these objectives, a teacher of Mathematics should use appropriate

strategies, which provide direct and concrete sensory experiences and which stimulate thinking on the part of the learners.

A major cause for failure in Mathematics is the way in which the subject is being taught and learned rather than the difficulty of the subject itself as a discipline. However the ways in which children learn Mathematics depend on the ways in which they are being taught.

A new challenge in the present Mathematics class room is that “Knowledge is not attained, but constructed”. Constructivism in the pedagogical dimension gives importance to the construction and generation of new knowledge. The teacher has to encourage children to clarify and articulate their own understanding. Therefore its pedagogy highlights the need for a programme of activities from which knowledge can be generated or acquired. It is suggested in the State Curriculum Frame work of Kerala that the present secondary school curriculum should be based on Constructivist theories and hence the teachers follow the Activity Methods for teaching various subjects. Educational Technology offers many solutions to tackle the problems of modern educational system.

Statement of the Problem

Development of Educational Technology, and integration of technology in to the curricular activiites in all subjects especially in Mathematics provide concrete sensory experience in teaching learning process. In this context, Government of Kerala introduced the IT Maths Lab in order to give the mathematics education in constructive paradigm and enhance the critical and logical thinking among students.

But the effectiveness of the IT Maths Lab is not assessed critically. Hence the present study is entitled as “**A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA**”.

Meaning and Definition of Key Terms

Definition of the key terms is given below:

IT Maths Lab

IT Maths Lab is introduced by the Department of Higher Secondary Education among Higher Secondary School Students to make the learning process more creative and child friendly. The IT Maths Lab provides a hands-on learning environment that makes the process enjoyable and increases understanding among students. Mathematical abilities are naturally present in all the children and are nurtured through formal education in the context of formal learning. From an early age, children develop number sense and numerical skills through play and interactive activities in their living environment. However, as they progress to higher grades, the abstract nature of mathematical concepts can diminish their genuine interest in the subject. Fortunately, technology now allows these abstract ideas to be transformed into engaging activities. Tools like GeoGebra play a key role in this transformation. In IT Maths Labs, activities are guided and supported using GeoGebra software.

Teaching Learning Process

Teaching and learning are the backbone of the educational process. Teaching

at all levels must be innovative and contemporary to equip the learners to face the emerging challenges of the future. Teaching in its modern definition pertains to the way the learned and experienced enable the learners to take life in a more meaningful and positive way. Teaching of Mathematics is a challenge to teachers because of its wide utility in all developmental programmes of mankind.

Higher Secondary Schools

The students typically between ages 15 to 18 years, studying in Plus one and Plus two classes in higher secondary schools of Kerala.

The present study makes use of a representative group of standard XII students with Mathematics as optional subject in the higher secondary schools.

Variables of the Study

In the present study attitude of higher secondary school mathematics teachers and perceived effectiveness of IT Maths Lab among higher secondary school mathematics students is treated as the dependent variable.

Classificatory Variables

In the present study, the classificatory variables those considered were the following:

1. Gender
2. Type of management of the school
3. Locale of the school
4. Grade obtained for mathematics in the SSLC examination
5. Teaching experience of teachers

Objectives of the Study

The objectives set for the present study are the following:

1. To identify the technological elements of *IT Maths Lab* and its evolution.
2. To identify the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools.
3. To identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.
4. To compare the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools students of subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.
5. To identify the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary schools.
6. To compare the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.
7. To identify the challenges and problems in the implementation of the *IT Maths Lab* activities in Higher Secondary Schools of Kerala.

Hypotheses of The study

The hypotheses formulated for the present study are the following:

- 1) The Instructional method using *IT Maths* Lab is significantly effective for the transaction of the content among higher secondary school students.
- 2) The Instructional method using *IT Maths* Lab is significantly effective in enhancing abstract thinking among higher secondary school students.
- 3) There is no significant difference in the perceived effectiveness of *IT Maths* Lab for learning mathematics among higher secondary school students of subsamples based on Gender, Locality, Management of school and Grade in Mathematics of SSLC examination.
- 4) Attitude of higher secondary school teachers towards the *IT Maths* Lab for teaching learning process is significantly high.
- 5) There is no significant difference in the attitude towards the *IT Maths* Lab of higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.

Methodology in Brief

Survey method was adopted for the present study. In order to measure the attitude of higher secondary school mathematics teachers on the use of *IT Maths* Lab in teaching – learning, survey method was adopted. The opinionnaire consists of dimensions such as **Participation of Learners, Motivation, Resources, Concept Formation, Transaction, Evaluation and Training**

The effectiveness of IT Maths Lab was found out using perceived effectiveness scale. The scale consists of dimensions such as ***Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking, and Problem solving.***

Sample

The sample for the survey of attitude of teachers towards IT Maths Lab consists of 779 higher secondary school mathematics teachers covering all districts of Kerala selected on the basis of random sampling technique. The samples selected were from government and aided schools and it comprises both male and female teachers.

The sample for the Perceived effectiveness towards IT Maths Lab consists of 1631 higher secondary school students from various districts of Kerala State. The samples selected were from aided and government schools and it comprises both male and female students from rural and urban areas.

Method

After consulting experts in Mathematics, an attitude scale was prepared and administered among teachers. This contains questions related **Participation of Learners, Motivation, Resources, Concept Formation, Transaction, Evaluation and Training.**

Tools used for Data Collection

The following tools were used for collecting data in the present study:

1. **A Scale on Perceived Effectiveness of IT Maths Lab:** A perception scale for students to know their perception on the effectiveness of IT Maths Lab for learning Mathematics.
2. **A Scale on Attitude of Mathematics Teachers towards IT Maths Lab:** Attitude scale to collect attitude of teachers on the use of IT Maths Lab for teaching learning of mathematics among higher secondary schools.
3. **Interview Schedule on the Functioning of IT Maths Lab:** An interview schedule was developed to identify the functioning of IT Maths Lab in the higher secondary schools for teaching learning process.

The above mentioned tools were constructed and standardized by the investigator in consultation with the supervising teacher.

Statistical Techniques

1. Descriptive Statistics such as Mean and Standard Deviation.
2. The parametric t-test to compare the attitude of teachers towards IT Maths Lab and Perceived Effectiveness of IT Maths Lab for learning.
3. Analysis of Variance (ANOVA)
4. Post-hoc Scheffe Test

Scope and Limitations of the Study

It would be relevant to specify that this method can be utilized to improve upon the present teaching practices charted in the higher secondary schools among mathematics teachers and student to a great extent. Every children is born with a great potential especially to learn mathematics with the help of technologies. The surroundings providing chances to learn, play an important role in determining how the child's potential is achieved.

Mathematics teaching programmes requisite to be oriented towards providing to the requirements of the learners so that in a requisition-poor environment, the learning of Mathematics is facilitated by the intrinsic motivation and interest of the learners. The teacher needs to function as an organizer and a facilitator in the classroom and provide opportunities to the learners. The teacher should adopt various materials and organize the learning environment to fulfil the learners needs.

Teaching materials play an important role in taking the learners to the threshold of mastery learning. Incorporating authentic materials, creating realistic situations and encouraging learners to participate in activities which help develop skills and strategies should be a concern for teachers. By encouraging learner's interest, challenging their intellect, teachers can provide much of the stimulation, which will motivate them to become more independent.

The results may be useful to teachers as well as learners to a great extent and thus improving the quality of education.

Population of the study was limited to standard XII of higher secondary school mathematics students. Effectiveness of *IT Maths* lab for the transaction of the content in mathematics among higher secondary schools was assessed as the perception of the students and it is not assessed as the experimental method. Availability of computer infrastructure and its relation with implementation of the *IT Maths* lab is not set under the purview of this investigation.

Organization of the Report

The study has been reported in five various chapters. The details presented in these chapters are given below:

Chapter – I: Introduction, in this chapter describes need and significance of the study, statement of the problem, objectives of the study, hypotheses formulated for the study and scope and limitations of the study.

Chapter – II: Review of Related Studies presents the review of related studies and literature on the critical appraisal, effectiveness and attitude.

Chapter – III: Methodology chapter gives a description on the selection of sample and variables, the tools employed for the collection of data, the procedure followed and statistical techniques used in the study.

Chapter – IV: Analysis and Interpretation of Data chapter concerned with the analysis of data obtained for the study followed by interpretation of the obtained results.

Chapter – V: Findings, Conclusions and Suggestions chapter summarizes the study in retrospect. It presents the summary of the procedure, major findings, conclusions, implications of the study and suggestions for further research in this area.

The report is supported with lists of Tables and Figures and Appendices pertaining to the study.

Chapter – VI: Generalization and Recommendations chapter summarizes the tenability of the hypothesis. This chapter contains general findings of the study and its scholastic implications. It also consist of suggestions and recommendations for further research based on the present study.

Chapter 2

REVIEW OF RELATED LITERATURE

- *Theoretical Overview of the Study*
- *Studies related to ICT for teaching learning process in Mathematics*
- *Studies related to Attitude of teachers towards ICT for teaching Maths*
- *Studies related to Effectiveness perception of ICT enabled activities*
- *Summary of the studies*
- *Research gap and conclusion*

In this chapter, the researcher has arranged the overview of some relevant studies connected to the problem under study “**A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA**”. It is the attempt to review of similar studies to find out the development of IT Maths lab and its impact on the teaching learning process of Mathematics. The review has also helped in understanding the research gap, to choose the title, its methodology, and the suitable statistical techniques to analyses of the data.

The literature so collected and reviewed is logically graded and presented under specific themes for quick and better understanding. The overview of the studies is organized under different categories as follows:

- Studies related to ICT for teaching learning process in Mathematics
- Studies related to Attitude of teachers towards ICT for teaching Maths
- Studies related to Effectiveness of lab activities
- Summary of the studies
- Research gap and conclusion

Theoretical Overview of the Study

The area of the present investigation is the application of technology based lab activities for **Mathematics Education**. It is the practice of teaching and learning Mathematics with the help of IT Maths lab introduced by the Government of Kerala in Higher secondary level. The essence of teaching and learning Mathematics at the higher secondary school level lies in the using of the subject. It is an abstract science

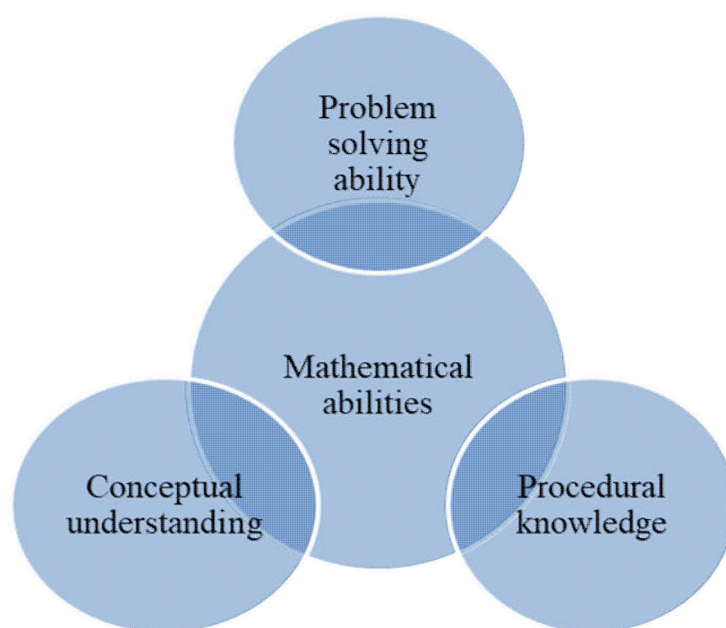
which deals with the quantitative aspects of our life in the concrete as well as abstract form. It is a systematized and organized science and a science of abstract thinking logical reasoning. It is also a language of nature and mankind. The dictionary meaning of mathematics says 'it is a science of number and space' it also explains as 'the science of measurement, quantity and magnitude'. The ability to calculate more accurately is not sufficient to enable a child to use the subject. It is more than just a science of numbers. It is an essential discipline recognized world-wide and it needs to be augmented in education to equip students with skills necessary for achieving higher education, career ambitions and for attaining personal accomplishment. While studying mathematics one must also have the power to decide what type of calculation is needed, which method is to be used etc., and it is in this respect that much of the efforts to teach Mathematics fail. The child must be faced with situations which demand decisions from him and, which need a critical judgment and an intelligent appraisal. Mathematics is then fulfilling a major educational aim, reaching far beyond the subject itself.

The education that many students receive in Mathematics is not adequate for a world that is being transformed by scientific and technological advances. The very nature of learning Mathematics is relatively different from other subjects because it needs numbers sense, abstract reasoning, logical thinking, reasoning power and mental efforts to ascertain the knowledge in the subject of Mathematics. In the modern world, Mathematics is being increasingly used in all subjects like science, technology, industry, education, economics, commerce, statistics, actuarial science, artificial intelligence (AI), etc. There is more prominence on Mathematics while use

of computers and other devices in the modern daily life activities. It is the subject which forms the very basis of the entire world commercial system. Hence Mathematics Education occupies a prominent position in the field of education.

Mathematical Abilities

The abilities to be developed through the learning of Mathematics i.e., the mathematical abilities, are not merely for doing measurement and computations alone. The teaching and learning of the Mathematics should equip the learners with skills necessary for achieving higher education, career determinations and for achieving personal accomplishment. The study of Mathematics enhances students' logical, functional and aesthetic skills. It focuses on certain key concepts in Mathematics and the development of ability to rational thinking, solve problems and to reason in quantitative contexts. Problems enable the learners to apply their skills to both familiar and unfamiliar as well as specific and general situations and thereby giving them the ability to apply the established theories. By developing the problem solving strategies, students learn to understand problems, devise plans, carry out plans, analyze and review the accuracy of their solutions. The methods used in problem solving enables the learners to use their reasoning power and through careful and reasonable arguments they got situations for decision making as well. The mathematical ability encompasses the Conceptual understanding, Procedural knowledge and Problem solving ability and it is representation with the help of picture is given below:



Components of Mathematical Abilities

Conceptual Understanding

Students show they understand mathematical concepts when they can identify, describe, and create examples of those concepts. This kind of understanding reveals their capacity to think logically in situations that necessitate precise use of representations of the concepts, definitions, and relationships.

Procedural Knowledge

Students show procedural knowledge in mathematics when they appropriately choose and use proper methods or steps. This type of knowledge involves skills such as analyzing, interpreting and creating graphs and tables, carrying out geometric constructions, and performing non-computational tasks. It is often shown through a student's ability to link an algorithm to a specific problem, apply it exactly, and explain the outcome within the context of that problem.

Problem Solving Ability

Students show mathematical problem-solving skills when they identify and define problems, judge the trustworthiness of data, apply strategies, use data and models, and develop or adapt methods. They also apply cognitive reasoning in unaccustomed situations and evaluate whether their answers make sense and are accurate. Solving problems requires students to draw on their full range of mathematical understanding which includes concepts, procedures, reasoning, and communication skills.

IT Maths lab

In order to make the learning process more imaginative and kid-friendly, IT Maths Labs are introduced at the higher secondary level in Kerala State. By making studying enjoyable, Maths Lab speeds up learning and provides a platform for learning by doing. A learner's aptitude for mathematics is innate and develops with education. Through games and activities, children learn about numbers and develop numerical skills during their early years. In higher grades, the way mathematical ideas are presented becomes somewhat abstract, which stifles learners sincere enthusiasm in the subject. For instance, with suitable exercises, learners are able to grasp the idea of the area of a rectangle or the volume of a rectangular prism.

Finding a classroom-appropriate exercise that teaches the concept of the maximum surface area of a rectangular prism with a fixed volume, however, becomes an enormous undertaking. It would be preferable to turn a learning process that requires a laborious series of logical arguments into an activity that students

may complete to gain an understanding of the subject. Technology has made it simple to turn an idea into an activity these days, and children are well suited to keep up with it. This transformation is greatly aided by software such as GeoGebra. GeoGebra is used to regulate activities in the IT Maths Lab. Additionally, a comprehensive lab manual is available to assist the students.

Eight of the 16 labs from the class 11 textbook must be completed within the first year. All of the labs are open to those who are interested. There are two or three exercises in each lab, along with a few extras. Extra activities are not required. Nearly every lab has extra activities available, but they are just for those who are interested.

The purpose of lab 0 in the handbook is to acquaint the learner with the Geogebra tools. It provides a concise overview of GeoGebra's fundamental tools. It covers GeoGebra Interface, Graph of a Function, Standard Functions, and Domain and Range

The manual is so well-organized that students can use it to complete lab work on their own. A detailed description is provided for every activity. For those steps that need to be recorded in the observation book, distinct markings are provided. Every student is required to maintain an observation book, which the teacher will review and correct.

Additionally, an online platform is prepared to record the student's conclusions and discoveries. The environment of mathematics classes in higher secondary schools restricts the potential for creative learning. The department

therefore hopes that the IT Maths lab will successfully navigate the introduction of these environments.

The main content of the IT Maths lab activities are Value of functions, Shifting of Graphs, Domain and Range, Trigonometric Functions, Trigonometric Identities, Solutions of trigonometric equations, Shifting and scaling of graphs of trigonometric functions, Straight lines, Conic Sections, Circle and Parabola, Ellipse and Hyperbola, Basics of 3D, Limits, Derivative at a point, Derivative of a function and Miscellaneous.

Studies Related to ICT for Teaching Learning Process in Mathematics

Colley and Comber (2003) accompanied a study on ‘Age and gender differences in computer use and attitudes among secondary school students: What has changed?’ The investigation examined the possible changes in the computer experience and attitudes of primary school and secondary school students in use of ICT in the school curriculum. The result of the study was compared with the similar previous investigation. It is seen that, there was difference of reduced gender gap, predominantly in the use of computers for applications softwares like computerised word-processing, application of graphics, programming as well as maths. Similarly, applications of communication such as e-mail; accessing the internet showed no markable gender difference in regularity of use. But, some gender differences particularly in attitudes can be seen. Generwise analysis shows that Boys liked computers more with more self-confidence in their use than girls. Age wise difference is seen in the attitude of the students with regard to ICT use in the

curriculum of schools. Similarly age differences in use of ICT were also found in the study.

Pinta Romaito (2008) conducted a study on the topic ‘The Mathematics Learning using Geogebra Software to Improve Students’ Creative Thinking Ability’. This study employs quantitative data collection methods through Quasi-Experimental Design. The sample of the study were the students studying in eight standard consisting of 184 students classified in to experimental and control groups. This primary aim of the study is to determine students' creative thinking skills through learning mathematics with the help of Geogebra software. Creative thinking can be developed by building specific changes to the way mathematics is taught in an effective way by incorporating softwares like GeoGebra in the mathematics learning process. Normality of the data was ensured by conducting the Shapiro-Wilk test and followed the independent sample t-test to test the hypothesis. Study discloses that markable difference is seen between the students who taught conventional learning method and who taught mathematics with the help of Geogebra software. Students with mathematics learning with the help of geogebra software seen higher creative thinking skill than conventional learning students.

Saha (2010) conducted a study on the ‘effects of GeoGebra on mathematics achievement: Enlightening Coordinate Geometry learning’. The aim of the study was to find out the effectiveness of Geogebra software in the achievement of mathematical concepts among school students. Many investigation point out that the use of Information and Communication Technology (ICT) has useful as a tool in in achieving mathematical concepts and it is supporting teaching and learning. This

investigation is a quasi-experimental study with non-equivalent control group post-test only. This experimental design was done to identify the effectiveness of using a GeoGebra in the teaching learning process of Coordinate Geometry among students classified as high visual-spatial ability students and low visual-spatial ability students. In this experiment a total of 53 students from secondary school in Wilayah Persekutuan Kuala Lumpur was selected as the sample. The sample students were assigned into two different groups and one group was given the lesson of Coordinate Geometry with the help of GeoGebra. And the other group was given the lesson of Coordinate Geometry using the traditional method of teaching without using GeoGebra. An achievement test was conducted after the treatment both group of the students as post test at the end of the intervention. To compare the achievement scores, the independent samples t-test was done and the results showed that there was a significant difference in mean score of mathematical achievement between the experimental group (Mean=65.23; SD=19.20) and the control group (Mean=54.7, SD=15.66) and the difference is statistically significant, since the p-value [$t(51) = 2.25$, $p = .028 < .05$] is less than 0.05. The findings of the study showed that the use of GeoGebra software along with the traditional method enhanced the students' achievement in learning mathematical concepts especially Coordinate Geometry.

In the study conducted by Zerrin (2010), **Computer supported mathematics with Geogebra**. The aim of the present study is to find out the easiest method to teach integers among students of 6th standard. The concept of integers has been taught two classes with homogeneous groups using different methods. One of the classes was given traditional teaching method, whereas the other was taught with

the help of Geogebra software. A test was applied to know the level of understanding among two groups and after two weeks, a new test was conducted to know how much of the subject they achieved. After conducting the statistical test the result seen that, the contributions and benefits of Geogebra software in achieving the concepts among experimental groups.

Alexandre (2011), conducted a study on ‘Information technology in university-level mathematics teaching and learning: a mathematician’s point of view’. This study is an attempt to explain mathematicians’ discrimination in use of information and communications technology (ICT) and its supervisory principles. The paper is addressed to the non-mathematician generations and is not planned to be a survey of the current software and courseware for mathematics teaching – the body of existing solutions is enormous and its debate inevitably involves hardcore mathematics.

Omoniyi and Eunice (2012), conducted a study on ‘ICT skills activation for secondary school students and its implication on mathematics proficiency’. The study explored an assessment of ICT skills needed among secondary school students for mathematical proficiency. In the study procedural fluency, conceptual understanding, strategic competence, adaptive reasoning and productive disposition of Mathematics proficiency were examined. The descriptive survey research design was employed, as it enables the researcher pronounce the current situation regarding participants’ opinion in the direction of the integration of Information Communication Technology (ICT) into teaching and learning of mathematics. The population of the present study consists of students and mathematics teachers of

senior secondary schools in Ado-Ekiti Local Government of Ekiti State. A total of 1000 students from 189 public and private secondary schools in Ado-Ekiti were selected as sample for the study. The tool used in carrying out this research was a questionnaire on the level of students' use of Information Communication Technology (ICT) and mathematics proficiency. The reliability of the instrument was ensured by administering it on 20 students outside the sample used in this study. Content validity and face validity of the instrument was ascertained. Descriptive statistics of frequency, percentage, and inferential statistics such as t-test, regression and analysis of variance were used to analyse the collected data. The findings of the investigation revealed that the procedural fluency in ICT makes students more effective in learning mathematics. Conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, productive disposition has significant positive correlations with performance in mathematics. Based on these results, the study recommended that conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, productive disposition should be applied in order to achieve mathematics proficiency among teachers and students.

Kamel (2013) delve a study on 'Integration of Information and Communication Technologies (ICT) in Mathematical Understanding Using Modeling'. In mathematical education, Information and Communication Technologies (ICT) is a very active field of research and innovation. Students experience difficulties in learning concepts relevant to understanding mathematics can reduce with the utilization of new learning approaches with ICT. This paper highlight the interest of the integration of information and communication

technologies (ICT) into the teaching and learning of mathematics especially in quadratic functions. It aims to investigate the effect of four instructional methods on students' mathematical understanding and problem solving. The methods adopted in the investigation were Quantitative as well as qualitative to report by selecting about 43 students in middle school. According the investigataion results, it is showed that mathematical thinking and problem solving evolves as students engage with ICT activities and learn cooperatively.

Ambika (2014) steered a study on 'Role of ICT in Mathematics Teaching and Learning'. The objective of this research is to explore the advantages and disadvantages of using Information and Communication Technology (ICT) in Teaching Mathematics. As Mathematics is a complex and challenging subject among students of all levels. The researcher believes that use of Information and Communication Technology (ICT) can make Mathematics teaching more interactive, interesting, and motivating. The research explained the impact of Information Communication Technology in Mathematics teaching and learning and Challenges faced by the teachers while using Information and Communication Technology (ICT) in the classroom context.

Nazihatulhasanah and Nurbiha (2014) conducted a study on '**The effects of GeoGebra** on students achievement'. The fast and ennumerous growth of technology for learning includes the introduction of educational information technology and related software. This study investigates the effectiveness of using GeoGebra software on learning Mathematics among selected 62 students in Malaysia. Analysis and results of the study shows that students have positive perception towards

learning (Mean=4.26) and have better and positive learning achievement is seen using the software GeoGebra ($p < 0.05$). GeoGebra - available free online software, can advantage students for learning Mathematics and diversifying learning in classrooms. The overflown of resources triggered students' interest to learn Mathematics however, the selection of software has to be properly planned.

Tatar (2016) conducted a study on 'Conceptual Understanding of Definite Integral with GeoGebra'. The study mainly aimed to find out the effect of a computer-assisted instruction method using GeoGebra on achievement of mathematics. The study is on prospective secondary mathematics teachers in the definite integral topic and the study also intended to determine the teachers opinions about this method. The sample group consisted of 35 prospective secondary mathematics teachers at a state university in Turkey who studying in the mathematics education program. An embedded design was used for the study. For data collection Definite Integral Knowledge Test and an opinion form were used. Based on the analyses of the data, it is seen that the computer-assisted instruction method using GeoGebra was effective to the success of teaching the definite integral topic. As per the opinion of prospective teachers, this method creates a fun and interesting environment, it provides visualization and opportunities to learn mathematics through practice and exercises, it enables thorough understanding and explication of skills, and makes way for conceptual learning instead of memorizing. Hence they opined that this method should be used in maths courses.

Kostić (2016) conducted a study on 'Visualization of problem solving related to the quantitative composition of solutions in the dynamic GeoGebra environment'.

Create dynamic worksheets, applying software GeoGebra, which makes a strong link between real life problems from the field of Quality Control and Assurance is the foremost objective of this study. Based on the results of the initial test, the students were classified into two groups as experimental and control groups. Both groups were trained in the same pool of problems from the QCS field. Traditional approach based on algebraic methods was applied in the control group. For the experimental group, graphical method based on the dynamic properties of GeoGebra was presented. Final testing of all students was conducted after two months. The results were analysed and it is shown that the results of the experimental group were significantly better than control group. The findings of these research confirmed that the students' learning achievement in solving QCS problems is better when they are familiar with the GeoGebra environment.

İbrahim (2016) delve a study on 'The Effect of GeoGebra on Achievement of Pre-service Mathematics Teachers about Concepts of Limit and Continuity'. In this research, the primary aim was to examine the effect of using GeoGebra, for teaching the limit and continuity concepts among pre-service mathematics teachers. Considering this aim, an experimental design research was applied among 40 second grade pre-service elementary mathematics teachers from a state university. These second grade pre-service elementary mathematics teachers were divided into two equal groups considering their scores on a test conducted based on limit and continuity concepts. The test was prepared by the researcher himself and this test was used as pre and post-test. After six hours of lecture in both groups, the post-test of the research is applied among second grade pre-service elementary mathematics

teachers. The gathered data was analyzed by using appropriate parametric statistical tests. The result, of the findings shows that the post-test scores of the participants in the experimental group is significantly higher than the control group. Hence, the experiment is effective among second grade pre-service elementary mathematics teachers to teach limit and continuity concept.

Dance (2017) conducted a study on 'ICT - The Educational Programs in Teaching Mathematics'. This investigation comes to knowledge that will be applicable to the educational practice. The findings gives that frequent use of the ICT in teaching mathematics from first to fifth grade as a mean for improving of the educational process. The possibilities of the application of the ICT in the educational programs in maths from first to fifth grade is the biggest challenge. The presentation of the Information and Communication Technology in the educational plans of mathematics touches the training of the pupils for easier acceptance of the mathematical concepts.

Zulnaidi (2017) conducted a study on 'The effectiveness of the geogebra software: The intermediary role of procedural knowledge on students' conceptual knowledge and their achievement in mathematics'. The primary objective of this study was to identify the effects of GeoGebra software among form two students on conceptual and procedural knowledge and the achievement. The topic considered for the present investigation is Function. This investigataion engaged a quasi-experiment approach and a sample of 345 students selected were divided into two groups. First group with 169 students wre adopted the GeoGebra software, and it is treated as experimental group. The second group consisted of 176 students, who

taught using the conventional method and treated as the control group. The conceptual and procedural tests were used to collect data to know the achievement in the topic Function of the Mathematic syllabus. From the analysis, it is seen that the students who used GeoGebra to learn Mathematics have higher mathematical conceptual and procedural knowledge compared to control group (those who learnt Mathematics through the conventional methods). It can be concluded that, GeoGebra software is capable for enhancing conceptual and procedural knowledge, among students.

Urgena (2017) delve a study to examined 'the use of GeoGebra applets: Students' attitudes and achievement in learning quadratic functions, equations and inequalities'. In the K-12 mathematics curriculum in the Philippines, incorporation of technology adopted has been a challenge to many teachers. In this context, this study sought to examine the effects of dynamic graphing software - GeoGebra on students' attitudes and achievement in learning mathematics in the topic of quadratic functions, equations and inequalities. The study used a quasi-experimental design. A total of 75 students of Grade 9 from a technical institute underwent GeoGebra activities as an experimental group. And 142 students comprised the control group. Results of the analysis showed that the experiential (GeoGebra) group significantly outperformed the control group in achievement. Analysis of covariance (ANCOVA) indicated that space relation abilities as a covariate did not affect students' posttest scores on items that are abstract. Perceived ease of use, perceived usefulness, attitude towards usage and behavioral intention to use the system are the reasons to acceptance of GeoGebra among students.

Suweken (2018) conducted a study on 'the implementation of e-learning with mathlet GeoGebra in Analytic Geometry course to improve students' engagement and achievement'. The present investigation aimed at to investigate the effect of the e-learning with GeoGebra mathlet followed by its assessments to enhance students' achievement in mathematics. The researcher felt from their experience that students' engagement during the course of Analytic Geometry course was very low. After setting up a classroom action research with the e-learning, to investigate whether or not the implementation of this kind of e-learning was capable in improving students' participation and achievement. After completing the investigation the results showed that the execution of this kind of e-learning was capable of improving students engagements and achievement.

Semenikhina (2018) conducted as study on 'GeoGebra as means of improving the quality of education'. The article point outs that the use of GeoGebra a dynamic mathematics software is an effective means of creation of the functional thinking of students, which unswervingly influence on the quality of education especially in mathematical education. GeoGebra lessen the weight of analytical computations in the constructive approaches of learning in solving mathematical problems. The researcher use GeoGebra in solving extreme problems using method based on creating an empirical graph of the relations between the values and defining of extremum. The second method is visualisation of spreadsheets of the values of the empirical function and their analysis. The effectiveness of the two methods was tested experimentally confirmed in the work on the research topic "The use of information technology in education". The overall level of academic

achievement and its dynamics was recorded and used the sign test. The statistical test reveals the positive impact of the group works on the quality of mathematical preparation of students and impact is significant at the significance level of 0.05.

Simon (2018) studied on ‘Effects Of The Use Of Computer Animated Technique On Loci During Instruction On Secondary School Students’ Mathematics Misconceptions In Kitui County, Kenya’. Kenyan secondary school students have continued to perform poorly in mathematics in Kenya Certificate of Secondary Education (KCSE) examinations. The reason for the poor performance in mathematics has been attributed to several factors, which include: poor teaching methods, lack of teaching and learning resources, and abstract nature of mathematics. Some mathematics topics have been labeled hard to teach and learn by the teachers and the students respectively. Loci is a topic in the form four syllabus that is labeled hard or difficulty to teach and learn. The students’ performance in the topics has consistently been poor. This study sought to investigate effects of using Computer Animated technique on Loci during instruction on students’ misconception made in the mathematics topic. It was hoped that the use of ICT would improve the sorry state of mathematics misconceptions. ICT has been used in teaching and learning of chemistry with remarkable improvement. The theoretical frame work to guide the study was based on constructionist theory of learning where the students constructed new knowledge from real life experiences. The researcher constructed Computer Animations on Loci concepts to augment the teaching of loci. Solomon Four, Non-Equivalent Control Group Research Design was used. To ensure that there was no interactions between groups a Simple random sampling was used

to assign each group to a specific sub-county out of sixteen Sub-Counties in Kitui County. A purposive random sampling was used to choose a school for each group that had graduate teachers teaching form four and had a computer laboratory. The study was carried out in a mathematics classroom setting. The two experimental groups were exposed to Computer Animated Loci technique as the treatment while the two control groups were taught using the conventional teaching/learning methods. The sample size was 207 students consisting of 95 girls and 112 boys. A Mathematics Achievement Tests (MAT), adopted from KCSE past Examinations on Loci was used. Misconception that a student made on Loci concepts in MAT were noted and awarded one mark. The instruments were pilot tested to estimate their reliability. The instrument was validated by experts from the Department of Curriculum, Instruction and Educational Management of Egerton University and mathematics examiners. The reliability coefficient of the instrument was computed to be 0.8157 using K-R 20 formula. A Pre-test was administered to the two groups, one experimental and one control before intervention and then the same MAT was administered to all the four groups after intervention as a Post-test. The Statistical Package for Social Sciences (SPSS) version 21.0 was used to analyse the collected data. The t-test and ANOVA were used to test hypotheses at Coefficient alpha (α) level of 0.05. The findings are expected to be useful to students, teachers, Policy makers, teacher training colleges and curriculum developers in secondary schools because they may be able to identify a teaching/learning technique which may improve the quality of education in the country.

Ján et al. (2018) **Mathematics with Using Information and Communication** Technology. Mathematics has an irreplaceable function in human life. Pupils and students at primary, secondary schools and universities have a non-adequate attitude to mathematics. Their imaginations and attitudes are on the scale from high admiration to rejection of mathematics as such. We suppose that the problem is not in mathematics itself but in the way and art of its teaching. In spite of many doubts about its usefulness, many application tasks indicate the fact that without mathematics we would not be able to solve many simple life situations. Using ICT in mathematics education can help by the solving of these topics.

Septian (2020) studied Somatic, auditory, visualization, intellectually learning assisted by GeoGebra to improve student's mathematical representation skills. The purpose of this research was to determine the improvement of student's mathematical representation skills and student's attitudes towards learning using SAVI learning assisted by GeoGebra. This research is a quasi-experimental research with the object of research of students of SMP Negeri 3 Cianjur. Students in class VIII-5 will be the experimental class and students in class VIII-7 will be the control class. The method used in this study is quasi-experimental research methods with non-randomized control group pretest - post-test design. Data processing will be executed with the normality test, Mann Whitney test, and the percentage of achievement indicators. Based on the results of data processing and interpretation, it is shown that SAVI learning assisted by GeoGebra better than ordinary learning in improving student's mathematical representation skills. Then the attitude of students towards SAVI learning assisted by GeoGebra is generally positive.

Ogbonnaya (2020) studied ‘The efficacy of geogebra-assisted instruction on students’ drawing and interpretations of linear functions’. The purpose of this study was to explore the effectiveness of GeoGebra assisted instruction on students’ achievement in drawing graphs of linear functions and interpretation of the representations of linear functions. These aspects of linear functions tend to pose a challenge to many students. The non-equivalent control group pre-testpost-test quasi-experimental research design was used in the study. The sample was 94 Grade 9 students from three secondary schools in a province in South Africa. Two schools formed the control groups and one school was the experimental group. Data were collected using achievement tests. The tests results were analysed using inferential statistics (Kruskal-Wallis and Mann-Whitney U comparison tests) at 0.05 level of significance. Statistically significant differences were found between the groups with respect to drawing and interpretation of linear functions graphs with the experimental group obtaining the highest mean scores. The findings suggest that GeoGebra assisted instruction might be a way of enhancing students’ ability to draw the graphs of linear functions and analyse and interpret the representations of linear functions.

Zetriuslita (2020) conducted a study on “The Effect of Geogebra-Assisted Direct Instruction on Students’ Self-Efficacy and Self-Regulation”. The aim of the study is to find out the effectiveness of Geogebra Assisted Direct Instruction on self-efficacy and self-regulation among students. Mixed method approach with a sequential explanatory strategy was applied. Research design is a pretest and posttest unequivalent group design. The Geogebra Assisted Direct Instruction was applied

among experimental group and conventional learning method was applied among control group. The third semester students who have studied Field and Space Analytic Geometry consists the population in this study. The cluster random sampling technique was adopted to select research sample. The self-efficacy and self-regulation questionnaires was the research instruments for quantitative data. Interview sheets were used to get qualitative data. Inferential statistical analysis was applied for quantitative data. The results reveals that achievement of students' self-efficacy and self-regulation has significant effect while using geogebra-assisted direct instruction.

Radović (2020) delve a study on “Examining the effects of Geogebra applets on mathematics learning using interactive mathematics textbook”. This investigation emphases on the design and testing of an eBook (interactive learning textbook), created with Geogebra applets. The eBook is designed to meet the pedagogical and didactic needs of learners. Tests of knowledge and tests of retention were used in order to determine the effect of the created materials on students’ achievements. Study discloses that students who have used the eBook show increased knowledge and knowledge retention compared to others and it is statistically significant. Both in schools and at home, interactive applets inspired the students.

Birgin (2020) conducted a study on “The effect of computer-supported collaborative learning using GeoGebra software on 11th grade students’ mathematics achievement in exponential and logarithmic functions”. The study aims to determine the effect of Computer-Supported Collaborative Learning – CSCL – using GeoGebra software on 11th grade students’ achievement in “exponential and

logarithmic functions”. Quasi-experimental design consisting of a pre-test and a post-test was applied among experimental group and the control group. Sample of study consists of 35 eleventh grade students of 18 experimental and 17 control groups in Istanbul, Turkey. The the control group was taught through textbook-based direct instruction while experimental group was taught through CSCL activities using GeoGebra software. Mathematics achievement test developed by researcher were used to collect data. The tool consisted of 20 multiple-choice items. Data were analysed with using independent sample t-test and Analysis of Covariance. Results disclosed that Computer-Supported Collaborative Learning using GeoGebra software had significant effects on students’ achievement in exponential and logarithmic functions.

Evans et al. (2020) conducted a study on “The Use of **Technology among School Mathematics** Teachers and Students: The New Wave of Recommended Instructions”. Integration of ICT in mathematics is using Information Communication Technology in teaching various topics in mathematics. Integration of ICT in mathematics education has a positive influence on mathematics teaching and learning. Use of technology in teaching is necessary for teachers in mathematics, and also to encourage students to use technology in mathematics learning. Today’s younger generations, the teaching and learning of mathematics becoming more and more technology base. It is, therefore, crucial to throw more light on the use of technology among students and school mathematics teachers which is the novel wave of recommended instructions.

Ahmad (2021) conducted a study on “Development of student **worksheets assisted by GeoGebra** application in improving higher-order thinking ability in mathematics learning”. This research was motivated by the low thinking level of students in solving higher-order thinking problems and inadequate maths teachers using mathematics applications in the learning process. The aim of this study was to develop student worksheets assisted by the GeoGebra application for developing higher-order thinking skills. The participants were 27 eleventh-grade students. Tests, student activity observation sheets, teacher implementation sheets, and questionnaires were the instruments. The results shows that the student worksheets were in the valid category. The findings implied that the development of student worksheets assisted by the GeoGebra application met the valid, practical, and effective criteria.

Dadang (2021) delve a study on “A meta-analysis of **Geogebra software decade of assisted mathematics learning**: what to learn and where to go? Today, hundreds of studies on mathematics learning have been found in various literature, supported by the use of GeoGebra software”. The aim of this meta-analysis is to determine the effect of using GeoGebra software. The study alos analysing the extent to which study characteristics moderate the study effect sizes. The investigation analyzed thirty six effect sizes from twenty nine primary studies known from Google Scholar, ERIC documents, Sage Publishing, and repositories. Hedges equation was used to determine the effect size, with an acceptable confidence level of 0.05. It is seen that the overall effect size of using GeoGebra software is 0.96 on the mathematical abilities of students based on the estimation of

the random-effect model. The study reveals that, on average, students learned using GeoGebra-based activities outperformed in maths abilities. When the treatment duration is set to less than or equal to four weeks, GeoGebra software is more effective.

Dragan (2021) conducted a study on “Application of Geogebra in Mathematics Teaching”. Geogebra is designed for innovative, interactive and dynamic teaching in numerous ranges of mathematics. Software application and integration with the Moodle platform was explained in the study. Visual mastering of mathematical material among students is the great advantage of using software application. The paper was created with the aim of promoting the free GeoGebra software and the remote learning platform Moodle.

Rybak (2021) conducted a study on “Effectiveness of teaching and learning in technology-supported mathematics education”. Information and Communication Technologies (ICT) is the significant teaching resource in present school. The paper concerns in the investigation on the efficiency of using Information and Communication Technologies in mathematics education. The research on effectiveness of using Information and Communication Technologies in average secondary school in Bialystok conducted at the University of Bialystok. Action research method was used and it described in this paper. It was a initial study of what was happening in the classroom at various schools in the everyday didactic work with using Information and Communication Technologies in appropriate didactic situations and in everyday school circumstances. Study highlights that some students observed better results of their class tests. Connection between using

computers in mathematics education and the individual development of the student and his progress in learning mathematics will be investigated in the next stages of research.

Tamam (2021) conducted a study on “The use of Geogebra software in teaching mathematics”. This article is library research and here, the researcher uses the method of documentation to gather data. The collected data then analysed using content analysis. Analysis shows that, twelve related articles which revealed the benefits of using Geogebra in teaching learning process especially in learning mathematics. It is found that there are several significant results obtained regarding the advantages of using Geogebra. The findings include, a) to comprehend mathematical concepts in geometry, Geogebra make ease among students; b) create interest among students; c) students also tend to be happier in learning geometry.

Latifi (2021) conducted a study on “The effect of dynamic mathematics software geogebra on student' achievement: The case of differential equations”. The main objectives of the study are i) to examine the impact of the use of Geogebra on the students' understanding of differential equations and ii) to see how the students interact with a Geogebra environment according to their styles of mathematical thinking. The sample of this research were 35 students for the experimental group and 32 students of control group from 12th grade at a government schools. The results derives that teaching differential equations with GeoGebra is more effective than the conventional method in terms of conceptual knowledge. While considering the procedural knowledge, students from experimental group and control group were in similar achievement levels. It can be concluded that Geogebra was more

beneficial to integrated thinking, especially for conceptual knowledge among students.

Maryono (2021) delve a study on “Mathematical communication skills of students through GeoGebra-assisted ELPSA approach”. The aim of this study was to find out the development of students' mathematical communication skills among those who obtained the conventional learning model and who obtained the ELPSA learning model supported by GeoGebra. Quasi-experimental method was adopted by this study. The findings revealed that the group obtained ELPSA learning model assisted by GeoGebra has gained more achievement and improvement of mathematical communication skills than conventional instruction model. The GeoGebra supported ELPSA learning model has the ability to develop mathematical communication skills in secondary schools.

Öndeş (2021) conducted a study on “Research trends in dynamic geometry software: A content analysis from 2005 to 2021”. The aim of this study was to give a broad picture about researches connected to dynamic geometry software. For this purpose, a total of 210 articles accessed from the Web of Science database and it was analysed in terms of their objectives, research methodology, population, size of sample, tools of data collection and analysis of data techniques by adopting the method of content analysis. Findings of the study discloses that, an uniform pattern of sample size, research methodology, and data analysis is seen in all the works. These results will helpful to the researchers to identify the past trends in dynamic geometry software and to derive new area of studies.

Smirnov (2021) conducted a study on “Technological stages of Schwartz Cylinder's computer and mathematics design using intelligent system support”. In this research article, one of the “problem zones in mathematics concerned with the surface area of three-dimensional bodies” is presented by computer and mathematical modeling with synergetic effects using intelligent system support. Findings shows that the methods of intelligent management of student's research activity and thinking development by means of neural networks support was carried out based on lateral surface triangulations of the Schwartz' cylinder. Computer and mathematical modeling tools as one of the educational trajectories of student's research activity.

Nthabiseng (2021) conducted a study on “**GeoGebra and students' learning achievement** in trigonometric functions graphs representations and interpretations”. This research activity explores the effectiveness of the GeoGebra on twelveth standard students' success in creating relations between the representations of trigonometric functions and the interpretation of graphs. An experimental design was employed consisting of experimental and control groups. The sample of the study consisted of 61 number of 12th standard students of selected two schools. The results of the study reveals that there exist significant difference between the mean achievements of the control group and the experimental group on creating relations between representations of trigonometric functions and interpretations of graphs of trigonometric functions.

Jeevalata (2022) conducted a study on “Exploring Initial **Mathematical Modelling Process Using Geogebra** of Form Four Students”. This investigation

takes a closer look at fourth level students' initial mathematical modelling process while solving problems in mathematical using GeoGebra. Multiple case study method was employed as qualitative approach. Four students from fourth level were selected considering criteria that they have no prior experience in mathematical modelling. Findings of this study disclosed the importance of real model and situation model with additional mathematical knowledge in displaying their mathematical process and GeoGebra's usefulness was learned.

Nazarzoda (2022) delve an investigation on “**The Benefit of Teaching Mathematic Using Maple Software** at Public Secondary Schools in Dushanbe”. The use of information and technology nowadays has an important effect on the aspects of human societies, including tools and methods of teaching-learning. Maple is a piece of software that may be used to learn and teach maths to help students to grasp concepts more quickly. The main objective of this research were a) to examine and comprehend the actual implementation of Maple software in junior secondary schools; b) measure the level of comprehension of Maple software, and c) observe the challenges that teachers and students encounter. A mixed-method was applied and qualitative and quantitative approach was adopted using descriptive analysis to look at the information gathered through online surveys and interviews. The findings of the results of analysis revealed that the majority of teachers were in favor of adopting this software in their classrooms. In this study, 79 percent did not know about Maple software, indicating that the use of Maple software in high schools is relatively low; 50 percent did not know about using ICT tools. As a result, it can be

stated that more attention should be paid to the implementation of training for both teachers and pupils while using Maple software in junior high schools.

Al. Aktayeva1 et al. (2022) done an investigation on ‘**Digital transformation and innovation in the teaching of mathematics**’. This research work explores the fundamental components of the methodological system in mathematics education, comprising objectives, teaching methods, instructional forms, and learning tools. Integration of information and communication technologies (ICT) as an innovative element in the educational process is the key focus. It also examines the role of scientific principles in various aspects of maths instruction such as understanding the nature of mathematics, foundational knowledge, skills, and habits. This approach enhances material comprehension by clearly illustrating logical transitions and emphasizing key concepts in both lectures and practical sessions. In addition to that, the article discusses pedagogical resources, teaching methods and innovative strategies relate to the application of information and communication technologies in mathematics teaching learning process.

Supianto et al. (2022) conducted study on Development of Geogebra Assisted Problem-Based Learning Tools to Improve **Mathematical Critical Thinking Ability** and Self-Efficacy of Students at SMP Negeri. The aim of the study was to produce quality problem-based learning tools for grade VII students; to analyzing the improvement of mathematical critical thinking skills; to analyzing the increase in self-efficacy of students after using the Geogebra-assisted Problem-Based Learning tool. This research was conducted in the even semester of the

academic year students. The results reveals that Geogebra-assisted problem-based learning tools is helpful in improving students' critical thinking skills and self-efficacy. Students' mathematical self-efficacy was alos increased.

Gülay and Melike (2022) conducted a study on supporting prospective **mathematics teachers' planning and teaching technology-based tasks** in the context of a practicum course. Through this study, prospective secondary mathematics teachers' planning and teaching of technology-based mathematical tasks investigation was examined within a 14-week practicum course among four-year mathematics education programme in Türkiye. The conceptual basis of the study are Dynamic Geometry Task Analysis as well as Instrumental Orchestration frameworks. Using the technology specific frameworks in a practicum course was helpful to improve prospective teachers' designing and teaching technology-based tasks was the findings of the study.

Rohmad et al. (2022) conducted a study on '**Development of Learning Model Based on Discovery Learning Assisted by Geogebra Applet** to Improve Students' Creative Thinking Ability'. The aims of the study are a) To find out validity, practicality and effectiveness of the Geogebra Applet-Assisted Discovery Learning-Based Learning Model; and b) To find out the improvement of students' creative thinking skills by developing a Geogebra AppletAssisted Discovery Learning-Based Learning Model. In this research at first, the development of the Geogebra Applet-Assisted Discovery Learning-Based Learning Model was carried out. The sample of this study were 25 students of class VII. The results of the study shows Geogebra Applet-Assisted Discovery Learning-Based Learning Model is

valid, practical and effective. It also reveals that students' creative thinking skills was improved after using the Geogebra Applet-Assisted Discovery Learning-Based Learning Model.

Bekene and Machaba (2022) conducted a study on 'The effect of GeoGebra on STEM students learning trigonometric functions'. This investigation searches the effectiveness of the GeoGebra on Grade 12 students' success in achieving the concepts related to functions. It examine to making associations between the representations of trigonometric functions and the interpretation of graphs. A non-equivalent control-group pre-test and post-test quasi-experimental design was used. The study sample consisted of seventy-three Grade 12 students enrolled in Science, Technology, Engineering and Mathematics (STEM) from different schools of the Hadiya zone. The trigonometric representation ability test developed for research used as instrument. Independent sample t-test, ANOVA, and the mean of achievement indicators was used for data analysis. Statistically significant difference between the overall mean scores of achievements of experimental groups and the control group. Hence, the study strongly endorse that teachers add GeoGebra with the teaching of trigonometric functions and mathematics in general.

Polishchuk and Voznosyenko (2022) conducted a study on 'Digital technologies, in particular augmented reality (AR), are rapidly changing the field of education, especially in science, technology, art and mathematics'. The research paper analyzes usage of GeoGebra based augmented reality in solving problems on "Geometric and mechanical applications of integrals, Area of definition of the function of several variables, Mathematical Analysis" in training future teachers of

science, especially mathematics, physics and computer science. The study also highlights the advantages of the dynamic mathematical system GeoGebra based augmented reality.

Shyshenko et al. (2022) conducted a research on a topic ‘A Mathematics Teacher's Training to Create a Maker Space in Mathematics Lessons by Means of GeoGebra’. The research paper presents a description of the experience of training teachers of mathematics to create a maker space in mathematics lessons with the help of GeoGebra package based on the program and methods of advanced training courses. By conducting a survey of mathematics teachers, shows the need of refresher courses for the implementation geogebra based practices in the educational process. The statistical analysis of experimental results on the effectiveness of training mathematics teachers in advanced training courses using GeoGebra shows that teachers of mathematics a high level of motivation to device various ways to implement the concept of technology education.

Uwurukundo (2022) conducted a study on Effect of GeoGebra Software on Secondary School Students’ Achievement in 3-D Geometry. The researcher employed GeoGebra software to identify the in teaching learning geometrical concepts of Mathematics in Rwandan secondary schools. The design of the study was quasi-experimental, and altogether four schools were included in the study purposefully in which two schools were from Northern region and remaining two of them from Kigali city. Out of four schools two of them treated as experimental group and the the remaining two assigned as control group. Pre-test was conducted among the students of all the selected school using a tool containing 15 questions

based on the geometry part of Mathematics. Experimental group was given the support of Geogebra software for learning mathematical concepts related to geometry. The result was analyzed data using appropriate statistical software. It was found that learners who educated with GeoGebra outpaced those who learned without GeoGebra and the difference in the achievement is statistically significant since the p-value is less than the critical regions ($p < .001$). Result correspondingly found that the total of students able to perform in each of the 15 questions drastically increased after the implementation of GeoGebra software. Hence, this investigation recommends to make use of GeoGebra in teaching and learning activities of mathematics especially in geometrical part.

Azimi et al. (2023) conducted a study on 'Using a design-based research methodology to develop and study prompts integrated into GeoGebra to support mathematics learning of gifted students'. This study is in employment with the Design-Based Research methodology. It aims to explore how to design instructional prompts integrated into a computer-based cognitive tool for gifted mathematics education. The study divided into two iterative research phases in which differentiating the instructional prompts for gifted students was explored for lasting three semesters. To examine the effect of the designed prompts on gifted students' learning achievements, a combination of quantitative and qualitative data collection and analysis were used. Research conducted on 60 participants who were tenth-grade students and explored their feedback on the learning activities. The findings of the study led to a set of design propositions which contribute to the literature on both

gifted mathematics education and instructional prompts integrated into computer-based cognitive tools.

Wahyuni et al. (2024) piloted a study on 'Enhancing Creative Mathematical Thinking with GeoGebra: A Comparative Study of Secondary School Students. The study intended to analyze an overview of the improvement in students' creative mathematical thinking skills using GeoGebra software in schools with various characteristics. The study used a quasi-experimental method with a pre-test and post-test design without a control group. The sample consists of 90 plus one students from three high schools. Data were collected through tests of creative mathematical thinking skills as well as classroom observations. Wilcoxon and t-tests, were conducted to measure the significance of changes in students' creative thinking skills. The results reveals that most aspects of creative thinking skills showed significant improvement, mainly in originality and flexibility, while there was a decline in some features, namely fluency and elaboration, in these schools. The Wilcoxon and t-test analyses showed a significant difference ($p < 0.05$) between students' pre-test and post-test creative mathematical thinking scores. Therefore, there is an enhancement in students' creative mathematical thinking skills subsequently learning using GeoGebra.

Amantle (2024) conducted a study on 'Effectiveness of GeoGebra on Botswana TVET students' performance on linear equations'. This study was intended to examine the comparative effects of using GeoGebra software versus traditional teaching approaches on students' performance in solving linear equations. The method adopted for the study was quasi-experimental, utilizing non-equivalent

groups. The students from the southern region of Botswana consisted the population. The students from this group selected as sample using the convenience sampling method. For the experimental group, one institution were selected and which was taught using GeoGebra software. Other intitutions formed the control group, receiving instruction through traditional methods. Collected data were analyzed using independent sample t-test to know the significance of difference. The findings of the study revealed significant difference in post-test mean scores. The experimental group outperforming the control group in the test and the difference is statistically significant. Hence, the results suggest that the use of GeoGebra enhanced students' understanding and performance significantly in linear equations compared to conventional teaching methods.

Studies Rewalted to Attitude of teachers towards IT Maths lab/ ICT for teaching Maths

Afzal et al. (2011) conducted a study on 'Attitude of Mathematics Teachers Related to the Use of Computer Technology in the Classroom'. The principal purpose of this study was to assess attitude of mathematics teachers toward the use of computer technology in the classroom. The data wre collected from mathematics teachers of the Jhelum district, with a randomly selected sample drawn from those teaching in various government high schools. The researcher hypothesised that demographic variables such as gender, locality, and professional qualifications would have no impact on the attitudes of mathematics teachers. The tool used to collect data was questionnaire developed by the investigator which includes personal information and six questions related to computer access and training. Independent

Sample t-test was applied to analyze the data to driven conclusion. The results shows that positive attitude toward using technology is high among male teachers than female teachers. Moreover, professional qualifications were found to positively influence teachers' attitudes. It is also seen that locality had no significant effect on the attitude of teachers towards using technology.

Şandır and Aztekin (2016) delve a study, Pre-service maths teachers' opinions about dynamic geometry softwares and their expectations from them. This study was designed to determine the pre-service teachers' opinions about three dynamic geometry software (Cabri II Plus, the Geometer's Sketchpad, GeoGebra) and influences of gender and academic achievement to these opinions. By conducting this investigation, the researchers explored the key features that pre-service teachers look for in dynamic geometry software. The study conducted among the 64 prospective teachers who had completed a university course on mathematics education software during the 2011–2012 academic year. Findings showed that, as per the opinion of the pre-service teachers Geometer's Sketchpad to be the most effective tool for teaching advanced geometry concepts and to influence attitude of students positively towards mathematics learning. According to the participants, a) support for the native language, b) clear interface, c) comprehensive user documentation, and d) overall ease of use are the most valued features of dynamic geometry software.

Al-zboon et al. (2021) conducted a study on 'The Attitudes of Science and Mathematics Teachers toward the Integration of Information and Communication Technology (ICT) in their Educational Practice'. This study investigates the attitudes

of science and mathematics teachers toward integrating Information and Communication Technology (ICT) into their teaching. A structured questionnaire was developed by the investigator incorporating the constructs of performance expectancy, social influence, facilitating conditions, effort expectancy, and attitude scales. Randomly selected mathematics and science teachers were the sample included in the study. Analysis of data was done using appropriate statistical techniques such as descriptive statistics and regression analysis. The result of the findings discloses that mathematics and science teachers generally held strong and positive attitudes toward the use of Information and Communication Technology (ICT) in their educational practice.

Patar (2023) conducted a study on 'Pre-Service Mathematics Teachers' Engagement in Geogebra Applet-Based Task Design in Online Learning'. The objective of the present study is to examine the engagement of pre-service mathematics teachers in online lectures that utilize GeoGebra, specifically in analytic geometry and multivariable calculus courses. Data were gathered using a Likert scale to measure the Math Engagement Scales questionnaire, which measures cognitive, behavioral, emotional, and social engagement. The sample collection involved 72 pre-service teachers enrolled in these courses. The data were analyzed using descriptive as well as inferential quantitative methods. The findings of the investigation includes that pre-service teachers demonstrated a high level of engagement across cognitive, behavioral, emotional, and social engagement dimensions. These results suggest that a didactic design incorporating GeoGebra

applets can effectively promote engagement in online mathematics instruction for pre-service teachers.

Studies Related to Effectiveness Perception of ICT Enabled Activities

Linda (2000) conducted a study on ‘Shift happens Online education as a new paradigm in learning’. The study is an attempt to analyse the history of online education in the context of education prevailed in the society. The study mainly focused in the use of computer and network technologies after the secondary education in the context of collaborative learning. The study also focuses on the application of Virtual-U, an environment in the Web-based technology to support advanced educational practices. This research paper completes by discoursing the indications to upcoming advances that suggest the data.

Lorraine and Calvin (2002) conducted a study on ‘Interactive Televised Courses: Student Perceptions of Teaching Effectiveness, with Recommendations’. The study on student satisfaction while using Interactive Televised Courses (ITV) shows that majority of students often confused to distinguish between their perception regarding the effectiveness and the influence of the technology based learning and conventional learning method. Students are marked higher rating for the factors of teaching learning processs, but lower rating to the the instructor’s teaching effectiveness when using ITV. Further, the study also sightsees the consequences of using Interactive Televised Courses for both educators and learners and offers recommendations for optimizing the use of ITV.

Rozalind (2003) conducted a study on 'Technology and its impact in the classroom'. The aim of this investigation is to examine level of attention and academic performance of students in the classroom while using computer technology in the mathematics classrooms. Data was collected from the teachers who are using computers in the classroom teaching process using the survey method. Participants included teachers from a high school in Northwest Ohio. The study assessed the technology integration i.e., how frequently both teachers and students use technology in classrooms, as well as the overall level of technology integration. The findings of the study reveals technology use among teachers in the sample was significantly low. These results suggest that for technology to positively influence the academic outcomes of at-risk students, schools must be adequately prepared. The research suggestions are incorporate technology into the curriculum, providing targeted and sufficient training for staff, and allowing time for collaboration among staff.

Baya'a and Daher (2009) conducted a study on Students' Perceptions of Mathematics Learning Using Mobile Phones. This study is experimental in nature which conducted at an Arab middle school in Israel, conducted by pre-service teachers as part of teaching project focused on using mobile phones using in mathematics instruction. To discover students' perceptions of learning mathematics using mobile phone, the researchers employed discourse analysis and grounded theory. The findings of the result reveals that the students responded positively to the potential and functionality of mobile phones in the context of learning mathematics. This suggests that incorporating such technological tools could enhance

mathematics education. Furthermore, a) Learning mathematics through equal and collaborative teamwork, b) Applying mathematical learning to real-world, authentic contexts, c) Utilizing advanced technologies to perform a variety of mathematical tasks, d) Engaging in independent exploration of mathematical concepts, e) Experiencing mathematics in a socially and humanistically rich environment, f) Visualizing and dynamically investigating mathematical ideas, and g) Achieving more accessible and efficient mathematics learning are the perceived qualities of the mathematics learning with the use of mobile phones.

Saras (2016) conducted a study on ‘Students’ Perceptions of Learning Mode in Mathematics’ Blended courses or hybrid courses have gained popularity over the years because of their flexibility and convenience. This study examines the perception of the students of both the off-line and online components in the hybrid mode of teaching learning in mathematics subject. The study bring out the result that face-to-face learning is the preference for the students. As per the opinion of the students, this method feels more at ease to understand, engaging with peers and instructors in person. The peer interaction and communication with instructors in person helps them to grasp mathematical concepts more clearly and effectively. The study concludes that the future research may focus on collecting qualitative as well as quantitiive feedback to study the students’ preferences regarding learning modes.

Nuril et al. (2020) conducted a study on Students' Perceptions of Online Mathematics Learning and Its Relationship Towards Their Achievement’. In the context of the spread of pandemic corona virus, the entire education system adopted the technology oriented teaching learning method. This study is aimed to learn the

perception of the students with regard to online learning. The main objective the study are a) to identify the students perception about the online learning of mathematics subject, and b) to assess the relationship between the perception of online learning and achievement in mathematics. The method of study is ex post-facto with a quantitative data approach. The sample selected for this study consists of 216 10th standard students. Sample were selected in a simple random sampling method at State Madrasah Aliyah. Tools used for data collection were questionnaires and achievement tests. Online learning the platforms used are google classroom, youtube and whatsapp group. Descriptive statistics and product moment correlation were employed fro data analysis. The result shows that perception of students with regard to online learning is significantly high. The study also discloses that there exist significant relationship between the perception of the students with regard to online learning and achievement in Mathematics. The study concludes that there is a positive relationship between perception of the students regarding online learning and achievement.

Summary of the Studies

Review of related studies conducted in various topics are summarised and presented in as given below.

Table 1

Summary of studies related to Functioning of IT Maths Lab

Year	Author	Finding
2002	Uwurukundo	This study discloses that students who used GeoGebra for learning process outperformed those who learned without GeoGebra.

Year	Author	Finding
2003	Azimi	Set of design propositions that contribute to the literature on both instructional prompts integrated into computer-based cognitive tools and gifted mathematics education.
2003	Colley and Comber	There is no gender gap, using technology in education, particularly in the use of computer applications such as word-processing.
2008	Pinta Romaito	Considering the creative thinking ability of students, group with learning process uses with Geogebra Software is higher than those using conventional learning models in mathematics learning.
2010	Saha	Low vision students in GeoGebra group significantly outperformed the low vision students in traditional group.
2010	Zerrin	In this study, contributions and benefits of Geogebra software in teaching Maths have been analyzed.
2011	Alexandre	Corpus of existing solutions is enormous and its discussion inevitably involves hardcore mathematics.
2012	Omoniyi and Eunice	In order to achieved mathematics proficiency and expectations i.e., procedural fluency, conceptual understanding, strategic competence, adaptive reasoning and productive disposition should be applied.
2013	Kamel	Mathematical thinking and problem solving evolves as students engagement with activities of ICT embedded and learn cooperatively.
2014	Nazihatulhasanah and Nurbiha	Results discloses that students have positive significant perception towards mathematics learning and have better learning achievement while using GeoGebra.

Year	Author	Finding
2014	Ambika	Study derives the result that mathematics teaching can make more interactive and interesting while using ICT.
2016	İbrahim	Findings of the research disclose that in the experimental group the post-test scores of the participants is greater than the score of the control group.
2016	Tatar	Study was found that technology to facilitate conceptual learning of the association between the lower sum, upper sum and Riemann sum.
2016	Kostić	Learning achievement of the students in solving QCS problems is better when they are familiar with the GeoGebra assisted environment.
2017	Dance	In the educational programs of mathematics, application of the ICT affects the training of the students for easier adoption of the mathematical concepts.
2017	Zulnaidi	Learners who used GeoGebra to study Mathematics have higher mathematical conceptual and procedural knowledge when compared to those who learnt Mathematics through the conventional methods.
2017	Urgena	Students' achievement of GeoGebra group significantly outperformed the control group with large effect size ($d = 0.92$).
2018	Suweken	Implementation of e-learning was capable of improving students' engagements and achievement in learning.
2018	Semenikhina	It is seen that the positive impact of the assemblage works on the quality of mathematical preparation among students.
2018	Ján et al.	Using ICT in mathematics education can help by the solving of these topics.

Year	Author	Finding
2018	Simon	ICT has been used in teaching and learning of chemistry with remarkable improvement
2020	Septian	Attitude of selected students towards learning assisted by GeoGebra is generally positive and significant.
2020	Ogbonnaya	Students' ability to draw the graphs of linear functions can be enhance by using GeoGebra assisted instruction.
2020	Zetriuslita	Achievement of students' self-efficacy and self-regulation can facilitate by the application of Geogebra-assisted Direct Instruction.
2020	Radović	Tasks with interactive applets and new kind of learning materials inspired the students to learn more.
2020	Birgin	Students' achievement in exponential and logarithmic functions had significant effects while using CSCL GeoGebra software.
2020	Evans et al.	Integration of ICT in mathematics enable the students to better understand the mathematics concept taught.
2021	Ahmad	Worksheets assisted by the GeoGebra application obtained a very positive response.
2021	Dadang	When the treatment duration is set to less than or equal to four weeks then GeoGebra is more effective.
2021	Dragan	Increasing the interactivity between teachers and students
2021	Rybak	Using computer for change of style of work during maths lesson reveals the progress.
2021	Tamam	Geogebra software expect that it can be a great media to help its users visualise abstract geometric objects quickly, accurately, and efficiently.

Year	Author	Finding
2021	Latifi	More efficiency in terms of conceptual knowledge using GeoGebra than the conventional method.
2021	Maryono	ELPSA learning model (assisted by GeoGebra) is better than those who obtained the direct-instruction model (without assisted by GeoGebra)
2021	Öndeş	Among high school students, ‘The effect of DGS on something’ as a purpose, qualitative method as a research design.
2021	Smirnov	Intelligent management of student's research activity and thinking development using neural networks support was carried out on the basis of lateral surface triangulations.
2021	Nthabiseng	Study approves the findings of previous studies on the effectiveness of dynamic mathematics software on students’ learning of representations and interpretation of graphs of trigonometric functions
2022	Jeevalata	Real model with extra-mathematical knowledge (EMK) has importance of situation model.
2022	Nazarzoda	While using Maple software in junior high schools, more attention should be paid to the implementation of training for both teachers and pupils.
2022	Al. Aktayeva1	To forming a system of basic mathematical knowledge, skills and habits of students in various segments of maths teaching, starting with the nature of maths to mathematical tasks as an important method.
2022	Supianto	Improving students' mathematical critical thinking skills and self-efficacy can be seen using Geogebra-assisted problem-based learning tools.
2022	Gülay	Using the technology specific frameworks in a practicum course was helpful to improve prospective teachers’ designing and teaching

Year	Author	Finding
		technology-based tasks
2022	Rohmad	The improvement of students' creative thinking skills after using the Geogebra Applet-Assisted Discovery Learning-Based Learning Model on the rectangular flat shape material is the average achievement of students' creative thinking abilities
2022	Bekene	Strongly recommend that teachers integrate GeoGebra with the teaching of trigonometric functions and mathematics in general
2022	Polishchuk	The advantages of the dynamic mathematical system GeoGebra AR highlighted
2022	Shyshenko	Mathematics lessons using GeoGebra shows that mathematics teachers have a high level of motivation to implement various ways
2023	Azimi	Design propositions which contribute to the literature on both gifted mathematics education and instructional prompts integrated into computer-based cognitive tools
2024	Wahyuni et al	Most aspects of creative thinking skills showed significant improvement, mainly in originality and flexibility. There is an enhancement in students' creative mathematical thinking skills subsequently learning using GeoGebra
2024	Amantle	Use of GeoGebra enhanced students' understanding and performance significantly in linear equations compared to conventional teaching methods

Table 2

Summary of studies related to Attitude of teachers towards IT Maths lab/ ICT for teaching Maths

Year	Author	Finding
2011	Afzal et al.	Positive attitude is high among male teachers as compared to female teachers. Also the respondents of Professional qualification had positive effect on the attitude of mathematics teachers, whereas locality had no effect on attitude of mathematics teachers.
2016	Şandır	According to Pre-service teachers Geometers' Sketchpad more effective than others in the positive attitude development among the students in teaching high level geometry.
2021	Al-zboon et al.	Attitudes towards integrating information and communication technology in the educational process were high and positive among science and mathematics teachers
2023	Patar	Pre-service mathematics teachers' engagement in online lectures can encourage using geogebra applet-based didactic design.

Table 3*Summary of studies related to Effectiveness perception of ICT enabled activities*

Year	Author	Finding
2000	Linda	Virtual-U is an environment customized to support advanced educational practices.
2002	Lorraine and Calvin	Students rated the effectiveness of the professor's teaching lower compared to others when ITV was involved.
2003	Rozalind	Technology use of teachers and students, and overall technology use have no significant effect on the grades and attendance.
2009	Baya'a and Daher	Findings shows that utilizing the new technological tools could benefit for Mathematics education.
2016	Saras	It is found out that face-to-face instruction enables the learners to learn and understand the mathematics concepts in better manner.
2020	Nuril et al.	The study discloses that the students have a good perception of online mathematics learning using youtube.

Research Gap and Conclusion

The significant and relevant reviews related to the present research work are graded and lucidly presented under appropriate heads. The review helped to finalise the methodology and to find out the important variables required for the study. Review of related literature makes it evident that many studies are conducted in the field of application of some selected software (Geogebra) and its effectiveness mathematics teaching learning process.

The comprehensive literature review shows that there are a good number of studies in the area of ICT for teaching learning process in Mathematics and Attitude of teachers towards IT Maths lab/ ICT for teaching Maths in the national and international level. In Kerala also specific and unique studies have been conducted touching almost all areas of ICT for teaching learning process in Mathematics and Attitude of teachers towards IT Maths lab/ ICT for teaching Maths. A few studies are conducted regarding the Functioning of IT Maths Lab and Effectiveness of lab activities in Kerala as well. However it is observed that no researcher has made an attempt to study the functioning of IT Maths lab for teaching learning process in Mathematics among higher secondary school students in Kerala. Accordingly the research gap for the study is identified and hence the present study is relevant. So, the researcher initiated and completed a study on these variables to fill the research gap and entitled '**a study on *IT Maths lab* for teaching learning process in Mathematics among Higher Secondary Schools of Kerala**'.

METHODOLOGY

- *Objectives of the Study*
- *Hypotheses of the Study*
- *Method Adopted for the Study*
- *Variables Selected*
- *Sample Selected for the Study*
- *Tools Used for Data Collection*
- *Procedure for Data Collection*
- *Statistical Techniques Used for Analyzing the Data*

Methodology has a pivotal role in all type of scientific research. The methodology should describe the details such as objectives, hypothesis, procedure adopted for the study, description of the development of tools used, the sources of data and the statistical and mathematical techniques used for the analysis of data. These considerations are carefully taken and discussed in this chapter under the following heads:

Objectives of the Study

The objectives set for the present study are the following:

1. To identify the technological elements of *IT Maths Lab* and its evolution.
2. To identify the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools.
3. To identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.
4. To compare the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools students of subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.
5. To identify the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary schools.

6. To compare the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.
7. To identify the challenges and problems in the implementation of the *IT Maths Lab* activities in Higher Secondary Schools of Kerala.

Hypotheses of the Study

The hypotheses formulated for the present study are the following:

- 1) The Instructional method using *IT Maths Lab* is significantly effective for the transaction of the content among higher secondary school students.
- 2) The Instructional method using *IT Maths Lab* is significantly effective in enhancing abstract thinking among higher secondary school students.
- 3) There is no significant difference in the perceived effectiveness of *IT Maths Lab* for learning mathematics among higher secondary school students of subsamples based on Gender, Locality, Management of school and Grade in Mathematics of SSLC examination.
- 4) Attitude of higher secondary school teachers towards the *IT Maths Lab* for teaching learning process is significantly high.
- 5) There is no significant difference in the attitude towards the *IT Maths Lab* of higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.

Method Adopted for the Study

The purpose of the present study is assess the functioning of IT Maths lab implemented in the higher secondary curriculum along with the mathematics education to concretize the mathematical concepts as well as to enhance the interest of learning among mathematics students. For the purpose of the present study the researcher assessed the perceived effectiveness of IT Maths Lab from the students and Attitude of the teachers towards IT Maths Lab. Considering the nature of data required for the study Normative Survey methods were considered suitable for the present investigation. So the investigator decided to adopt **Survey** methods for the present study.

Variables Selected for the Study

The present study is mainly survey in nature. Here the investigator intends to determine the perceived effectiveness of IT Maths Lab among higher secondary school students and attitude of Maths teachers towards IT Maths Lab. The **gender, locality, management of school, and grade obtained for Mathematics in 10 standard** are considered as the independent variables in the case of perceived effectiveness. Similarly, **gender, locality, management of school, teaching experience, and age** are considered as the independent variables in the case of attitude towards IT Maths Lab. The dependent variable are perceived effectiveness and attitude towards IT Maths Lab.

Population

At the Higher Secondary level, at present, there are 2166 higher secondary schools of which 852 are government schools, 846 private aided schools and 379 unaided schools (<https://education.kerala.gov.in/schools/> accessed on 20/01/2022; Data Taken from *Sametham* on 18.11.2019). The total number of Plus One seats in the State is 378580 (Order No 86/2024GEDN dated 16-07-2024) of which the science batch is 2523. Total number of plus one batch with mathematics as option is 2523 in which biological science is 1985 and Computer science batch is 538.

Sample Selected for the Study

Considering the topic of the present study and the objective set for the investigation the researcher considered students, teachers and principals of higher secondary schools as the sample. For assessing the perceived effectiveness of the IT Maths Lab, the data gathered from the students. To know the attitude towards IT Maths Lab, data was elicited from the mathematics teachers of higher secondary schools in Kerala. In order to identify the practical difficulties for the implementation of the IT Maths Lab information were gathered from the selected principals of the higher secondary schools in Kerala.

Students

The sample selected for the study consists of 1631 students from higher secondary schools in Kerala. Distribution of the sample students selected for the study based on gender, locale and type of management of school are presented in Table 4.

Table 4*Details of the sample of students selected for the study*

Variable	Group	Number	Percentage
Gender	Male	470	28.82
	Female	1161	71.18
Locale	Rural	920	56.41
	Urban	711	43.59
Management	Government	905	55.49
	Aided	726	44.51
Total		1631	100.00

Table 4 shows that the sample consists of 1631 second year Higher Secondary Science Students with one of the subject is Mathematics. Out of the total sample of students, 470 (28.82%) are males and 1161 (71.18%) are females. Considering the locality of the school, 920 (56.41%) are from rural area and 711 (43.59%) are from urban areas. In the case of management of the schools, 905 (55.49%) are from government schools and 726 (44.51%) are from aided schools.

Mathematics Teachers

The sample selected for the study consists of 779 mathematics teacher from higher secondary schools in Kerala. Distribution of the sample teachers selected for the study based on gender, locale and type of management of school are presented in Table 5.

Table 5*Details of the sample of mathematics teachers selected for the study*

Variable	Group	Number	Percentage
Gender	Male	187	24.01
	Female	592	75.99
Locale	Rural	572	73.43
	Urban	207	26.57
Management	Government	370	47.50
	Aided	409	52.50
Total		779	100.00

Table 5 reveals that the sample consists of 779 Higher Secondary School Mathematics Teachers. Out of the total sample of teachers, 187 (24.01%) are male and 592 (75.99%) are female. Considering the locality of the school, 572 (73.43%) are from rural area and 207 (26.57%) are from urban areas. In the case of management of the schools, 370 (47.50%) are from government schools and 409 (52.50%) are from aided schools.

Principals

To identify the challenges and problems in the implementation of the IT Maths Lab activities in Higher Secondary Schools of Kerala, responses was collected from the selected principals of higher secondary schools. Details of schools selected for the present investigation is given in Table 6.

Table 6*Profile of the respondents of principals of higher secondary schools*

Variable		Number	Percentage
Locale of the school	Rural	30	85.71
	Urban	5	14.29
Management of school	Government	12	34.29
	Aided	23	65.71
Total		35	100.00

Table 6 shows the total number of 35 Higher Secondary School Principals were included in the study. Out of the total sample of principals, 30 are from rural area and five are from urban area. In the case of management of the schools, 12 are from government schools and 13 are from aided schools.

Tools Used for Data Collection

The following tools were used to collect the data relevant for the study:

1. A Scale on Perceived Effectiveness of IT Maths Lab
2. A Scale on Attitude of Mathematics Teachers towards IT Maths Lab
3. Interview Schedule on the Functioning of IT Maths Lab

All the above items (numbered 1 to 3) were prepared by the investigator along with supervising teacher. The details regarding the tools used for the study are outlined below:

Perceived Effectiveness of IT Maths Lab

An appropriate tool for measuring the Perceived Effectiveness of IT Maths Lab for learning Mathematics among Higher Secondary School Students was not available. Hence, the investigator decided to prepare an instrument for measuring the Perceived Effectiveness of IT Maths Lab for learning Mathematics. The tool was constructed and standardised by the researcher which consists of 36 statements. The researcher included seven areas to measure the effectiveness namely **Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking and Problem solving**. The dimensions considered for study and their related aspects are described below.

Participation

Participation in maths lab activities refers to the active involvement of students in hands-on, practical tasks and experiments within a laboratory setting. Participation includes performing maths lab activities according to specified procedures, collaborating with classmates to complete tasks, using computers and geogebra package, documenting observations as well as results, analyzing results, and participating in discussions.

Practicability

Practicability refers to the quality of being practical and feasible in terms of implementation and effectiveness. In the context of IT Maths lab assesses whether the activities can be realistically executed and function successfully in along with the normal learning process.

Understanding

Understanding refers to the cognitive process of comprehending or grasping the meaning, significance, or nature of something. In the context of IT Maths lab activities, it involves the ability to correlate the theoretical concept and concretize the concept with the help of IT Maths lab activities.

Self-assessment

Self-assessment is the process of evaluating one's own abilities, performance, and progress. This introspective practice involves reflecting on personal strengths and weaknesses, setting goals, and identifying areas for improvement. In the context of an IT Maths lab, self-assessment refers to the students' ability to evaluate their understanding and progress in learning mathematical concepts, as well as their engagement in IT Maths lab activities.

Concept Formation

Concept formation refers to the cognitive process through which individuals develop and refine their understanding of categories, ideas, or principles by recognizing patterns, distinguishing relevant from irrelevant information, and organizing knowledge.

Concept formation is essential for mathematics learning and problem-solving as it enables students to organize and structure their knowledge, making it easier to retrieve and apply various situations.

Reasoning /logical Thinking

Reasoning, also known as logical thinking, is the cognitive process of drawing conclusions, making decisions, and solving problems based on sound principles of logic and evidence. Reasoning and logical thinking in mathematics involve the use of structured, methodical approaches to understand concepts, solve problems, and derive conclusions.

Problem Solving

Problem solving is the process of finding solutions to difficult or complex issues. In mathematics, problem solving refers to the process of applying mathematical concepts, skills, and techniques to solve complex or challenging problems. In an IT Maths lab context, problem solving involves applying mathematical concepts and IT tools to solve real-world problems or simulate scenarios.

The Table 7 shows the details of the main categories of perceived effectiveness scale and its components.

Table 7

Categories of perceived effectiveness scale and its components

No.	Categories	Related aspects
1	Participation	Opportunity to study Mathematics with the help of IT Maths Lab Learning maths using the IT Maths lab has made learning more enjoyable All units of Mathematics can be studied in conjunction with the IT Maths Lab

No.	Categories	Related aspects
		It is possible to do the work in the IT Maths lab by yourself There has been an increased interest in learning through mathematics learning using the IT Maths Lab Maths learning with the help of maths lab inculcates interest in maths in us Difficulty using IT Maths lab for maths learning
2	Practicability	Software used to understand mathematics with the help of IT Maths lab is difficult to manage The time allotted is sufficient for the acquisition of mathematics subjects with the help of IT Maths Lab The work book/manual provided in the IT Maths lab can be used to master the math concepts IT Maths lab activities are easy to understand
3.	Understanding	Mathematics study using IT Maths lab helps to clear existing doubts I have a clear understanding of the workings of the IT Maths lab. With the help of activities in the IT Maths Lab, mathematics concepts can be covered in depth All units of mathematics can be understood through the activities of the IT Maths Lab Activities in the IT Maths lab help in understanding the basic concept of math
4	Self-assessment	With the help of the IT Maths lab, math concepts can be explained to the classmates Math learning activities discussed in the classroom can be done independently in the IT Maths lab Math Lab activities are designed to be self-paced The activities of the IT Maths lab enable self-assessment of the achievement achieved in the Math class Activities in the IT Maths lab are helpful in assessing whether each concept in math has been mastered
5	Concept formation	The activities included in the IT Maths lab are helpful in achieving learning outcomes Mathematics can be easily understood when presented with the help of IT Maths lab

No.	Categories	Related aspects
		A mathematical concept can be fully grasped when it is presented through visualization Understanding is possible by relating classroom activities to maths lab activities Existing IT Maths lab activities are adequate for acquiring mathematical concepts Activities in the IT Maths lab are helpful in assessing the understanding of each unit of math
6	Reasoning /logical thinking	It is possible to achieve more conceptual clarity by studying mathematics using the IT Maths Lab Complex maths problems are made clearer through maths lab activity Activities in the IT Maths lab help to understand abstract concepts in mathematics
7	Problem solving	IT Maths lab has helped to give more confidence in problem solving Mathematical concepts acquired through the IT Maths lab are helpful in solving similar problems Activities in the IT Maths lab are designed to clear doubts in math Activities in the IT Maths lab help in solving complex problems Maths learning with the help of IT Maths lab gives confidence in problem solving Maths learning with the help of IT Maths lab helps in higher level problem solving

Planning of the Tool/ Scale

Perceived effectiveness is taken as one of the variable of the study. The investigator went through several books, journals in mathematics and education, research methodology and other materials to find out the details regarding the tool construction. The researcher identified the various method of constructing the research tool and selected one for the preparation of the present tool. The draft tool

was prepared taking mainly the seven thrust areas of mathematics teaching learning process. These areas were considered under seven dimensions that is **Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking and Problem solving.**

Since the authenticity of the study depends on the quality of tools, the investigator took much care in preparing the tool. The investigator prepared large number of statements under seven dimensions that is Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking and Problem solving. After thorough discussion with the supervising teacher and other experts the items which were ambiguous, irrelevant and defective were either discarded or modified. So a total of 40 statements finally selected for the tryout of the tool which included 7 statement in Participation, 4 statement in Practicability, 5 statement in Understanding, 5 statement in Self-assessment, 6 statement in Concept formation, 3 statement in Reasoning /logical thinking and 6 statement in Problem solving.

The researcher prepared the tool along with the response for each which consisted of respondent's personal data and the responses to the statements in a five point scale with alternative responses as strongly agree (SA), agree (A) undecided (UD), disagree (DA) and strongly disagree (SD). The drafts of the scale was prepared in English as well as in Malayalam version.

Selection of the Suitable Sample for the Try Out

The samples for the Pilot study were selected from Darul Uloom Higher

Secondary School, Panakkad and GBHSS Manjery of Malappuram districts of Kerala considering all aspects of variables. The number of samples for Pilot study was fixed as 160 higher secondary school students. Most care was given for due representation to all the sub samples of the population. The detailed distribution of sample for the Pilot study is given in Table 8.

Table 8

Try out sample for the Perceived Effectiveness Scale

Batch	Name of the School	Stream of education	Govt./ Aided	No. of Boys	No. of Girls	Total
1	Darul Uloom Higher Secondary School, Panakkad	Biological Science	Aided	20	20	40
		Computer Science	Aided	20	20	40
2	GBHSS Manjery	Biological Science	Government	20	20	40
		Computer Science	Government	20	20	40

Try Out

The draft was tried out on a sample of 160 students studying in standard XII drawn from government schools and aided management schools covering both male and female students who opted the stream of education as Biological Science or Computer science with Mathematics as one the optional subject. The test was administered among students in one sitting. Clear instructions such as the need of the information, method of responding the statement and the confidentiality of the

responses were given to the students before conducting the test. They were asked to respond to each statement by choosing one of the alternative responses as strongly agree (SA), agree (A) undecided (UD), disagree (DA) and strongly disagree (SD).

There were time limit for the test and the students were informed that their work must stop within the prescribed time limit. After the prescribed time limit the tool were collected. Students and teachers cooperatively helped to accomplish the task. The collected responses were scored with the help of scoring key.

Scoring Scheme

Against each statement five types of responses – Strongly Agree (SA), Agree (A), Undecided (UD), Disagree (DA), Strongly Disagree (SD) were given in the response sheets. The respondents were directed to express their responses by putting X mark in the concerned column provided with the numbers of each statement.

The responses were marked along with the five point scale. There were positive and negative items in the scale. For positive statements the scoring was 5, 4, 3, 2, 1 respectively for the responses Strongly Agree, Agree, Undecided, Disagree and Strongly Disagree. For negative statements the scoring was 1, 2, 3, 4, 5, respectively for the responses strongly Agree, Agree, Undecided, Disagree and Strongly disagree. The scores of all the items were summated to obtain the Perceived effectiveness of *IT Maths Lab*. The draft form of the tool (Perceived effectiveness of *IT Maths Lab*) is given as Appendix I. The scoring pattern for Perceived effectiveness scale is shown in the Table 9.

Table 9*Scoring pattern for the Perceived Effectiveness Scale*

S No.	Responses	Positive Score	Negative Score
1	Strongly Agree	5	1
2	Agree,	4	2
3	Undecided	3	3
4	Disagree	2	4
5	Strongly Disagree	1	5

Item Analysis

In the tool preparation, item analysis benefits to shorten a test and increases validity and reliability of the tool by indicating the entry that can be discovered or included. To know whether the test item has the difficulty value or not; the developed item should be analyzed. This was done by arranging the scores of selected students from highest to lowest. For the purpose of item analysis the response of the 160 Higher Secondary Students were selected and scored. Based on their performance they were classified as high and low groups. The highest 27 percent were selected as the upper group and the lowest 27 percent were selected as the lower group. The middle groups were discarded. The t-value of each item was calculated using the formula.

$$t = \frac{M_1 - M_2}{\sqrt{\left[\frac{\sum fx_1^2 - \frac{(\sum fx_1)^2}{N_1}}{N_1} \right] + \left[\frac{\sum fx_2^2 - \frac{(\sum fx_2)^2}{N_2}}{N_2} \right]}}$$

$$N(N-1)$$

Where ,

M_1 = the mean score of the higher group for a given statement

M_2 = the mean score of the lower group for a given statement

x_1 = the score of an individual in the higher group for the statement

x_2 = the score of an individual in the lower group for the statement

N_1 = number of subjects in the higher group

N_2 = number of subject in the lower group

Based on the t-value of each statement, the statement for final tool Perceived Effectiveness of the IT Maths lab were selected. The items with a t-value of 1.96 and above were selected and the items with t-value less than 1.96 were rejected at 0.05 level of significance. The items with a t-value of 1.96 and above possess internal consistency and discriminating power. The t-value of the items of Perceived Effectiveness of IT Maths lab (Draft) is shown in Table 10.

Table 10

Result of the item analysis of Perceived Effectiveness Scale of IT Math Lab

Statements	Lower		Upper		t-value	Result
	Mean	SD	Mean	SD		
1	2.12	0.99	4.85	0.36	14.82	Accepted
2	1.76	0.94	4.58	0.56	14.83	Accepted
3	2.00	0.94	4.76	0.50	14.92	Accepted
4	1.85	0.91	4.21	0.74	11.61	Accepted
5	2.45	1.35	4.36	0.60	7.42	Accepted
6	1.85	0.87	4.48	0.57	14.59	Accepted
7	1.88	0.86	4.45	0.71	13.28	Accepted
8	1.73	0.84	4.42	0.56	15.35	Accepted

Statements	Lower		Upper		t-value	Result
	Mean	SD	Mean	SD		
9	1.82	0.77	4.24	0.56	14.64	Accepted
10	1.85	0.94	1.82	0.77	1.23	Rejected
11	1.67	0.69	4.21	0.48	17.30	Accepted
12	1.85	0.94	4.33	0.69	12.23	Accepted
13	2.15	1.18	4.27	0.80	8.56	Accepted
14	1.73	0.80	4.39	0.50	16.25	Accepted
15	1.67	0.82	4.15	0.44	15.38	Accepted
16	1.82	0.81	4.27	0.45	15.22	Accepted
17	1.91	0.98	4.39	0.61	12.37	Accepted
18	1.82	0.92	4.15	0.51	12.79	Accepted
19	1.64	0.78	4.36	0.74	14.52	Accepted
20	2.00	0.97	4.36	0.78	10.90	Accepted
21	1.73	0.72	4.42	0.56	16.99	Accepted
22	1.79	0.78	4.18	0.58	14.10	Accepted
23	1.73	0.72	3.85	0.71	12.04	Accepted
24	2.21	1.40	2.95	1.12	2.15	Accepted
25	2.00	1.15	2.94	1.03	3.50	Accepted
26	1.64	0.74	3.70	0.68	11.73	Accepted
27	1.91	0.98	3.42	1.06	6.02	Accepted
28	1.79	0.99	4.45	0.51	13.75	Accepted
29	2.03	1.05	4.45	0.51	11.99	Accepted
30	1.76	0.97	4.30	0.53	13.24	Accepted
31	2.07	0.97	2.15	0.71	1.31	Rejected
32	1.64	0.74	3.91	0.68	12.98	Accepted
33	1.52	0.62	4.15	0.44	19.93	Accepted
34	1.85	1.00	4.06	0.50	11.35	Accepted
35	1.42	0.66	3.91	0.52	16.92	Accepted
36	1.61	0.79	3.79	0.42	14.07	Accepted
37	1.48	0.71	3.91	0.77	13.32	Accepted
38	1.67	0.92	4.15	0.67	12.52	Accepted

After item analysis 36 statements were selected for the final Perceived Effectiveness Scale. Out of the 36 statements 2 are negative statements and the remaining 34 are positive statements. The English version of the final form of the Perceived Effectiveness Scale of *IT Maths Lab* is given as Appendix II and Malayalam version is given in Appendix III. The number of items in each dimensions of Perceived Effectiveness Scale is shown in the Table 11.

Table 11

Component wise distribution of the items of Perceived Effectiveness Scale

Components	Sl. No of Statement	No of items	Test value
Participation	1 3 4 5 6 18 23	7	21
Practicability	24 26 27 28	4	12
Understanding	10 12 14 22 29	5	15
Self-assessment	7 11 17 21 32	5	15
Concept formation	13 16 19 20 25 31	6	18
Reasoning /logical thinking	2 8 30	3	9
Problem solving	9 15 33 34 35 36	6	18

Validity and Reliability of the Tool

a) Validity

The validity of the test represents the extent to which a test measure what it purports to measure. The validity of the instrument has many different forms. They are face validity (instrument appears to measure what it indent to measure), content validity (covers all aspects of the concept), predictive validity (predicts an outcome),

concurrent validity (correlates with results measured at the same time) and construct validity (truly measures a theoretical concept). Content validity is the principle form of validity for the functional psychometrics and is the main basis by which any test programme is judged.

The content validity of the present inventory was established based upon careful analysis of the sufficient coverage of the content, judgment of several subject experts and test specialists.

b) Reliability

Reliability is the degree to which a test consistently measures whatever it is measuring. In this study, Chronbach alpha was calculated for determining the reliability of the test. The reliability coefficient of the whole test is found to be **0.859**, it shows higher level of reliability.

A Scale on the Attitude of Mathematics Teachers towards IT Maths Lab

The investigator developed a five-point Likert-type scale comprising 42 statements to gauge the attitudes of higher secondary school mathematics teachers towards IT Maths lab introduced in the higher secondary schools. These statements varied in degrees of favorability or unfavorability. The scale construction involved drafting items based on different dimensions related to IT Maths lab activities. The rating scale was prepared to study the attitude mathematics teachers, at higher secondary school level educational sector of Kerala, regarding the Participation of Learners, Motivation, Resources, Concept Formation, Transaction, Evaluation and Training of the IT Maths lab activities. This categorization helped to ensure that the

scale comprehensively covered relevant aspects of mathematics teacher attitudes towards the IT Maths lab activities.

Participation of Learners

Participation of learners refers to the active involvement and engagement of students or participants in various educational activities.

Motivation

Motivation denotes to the factors which is either internal or external that drive individuals to initiate and withstand behavior towards attaining definite goals or outcomes.

Resources

Resources for an IT Maths lab typically include a combination of physical tools, software applications, and digital resources designed to support learning, experimentation, and problem-solving in mathematics.

Concept

Concept formation in an IT Maths lab involves the cognitive process through which students develop and refine their understanding of mathematical ideas and principles using information technology tools.

Transaction

In the context of education, a transaction refers to interactions between learners, educators, and educational materials that result in the transfer or exchange

of knowledge, skills, or attitudes. In the IT Maths context, Student-Content Interaction refers to the engagement of students with educational content such as textbooks, online resources, videos, and other learning materials. It encompasses activities like reading, watching instructional videos, and completing exercises or assessments.

Evaluation

Evaluation in education is the systematic process of assessing and measuring the effectiveness of teaching methods, learning outcomes, educational programs, and instructional materials. It aims to understand the extent to which educational goals and standards are being met.

Training

Training in an IT Maths lab typically involves preparing educators or students to effectively use information technology tools and resources for teaching, learning, and exploring mathematical concepts.

The initial draft of the scale included 43 items across various dimensions, which were then reviewed by experts for refinement. A copy of the draft form of attitude scale is given as Appendix IV. The result of item analysis of the attitude scale is given in Table 12.

Table 12*The t-value of the items of Attitude Scale (Draft)*

Statement	t value	Accept/ Reject	Statement	t value	Accept/ Reject
1	2.40	Accepted	23	3.52	Accepted
2	2.52	Accepted	24	2.97	Accepted
3	1.96	Accepted	25	2.69	Accepted
4	2.40	Accepted	26	2.69	Accepted
5	0.51	Rejected	27	2.69	Accepted
6	2.40	Accepted	28	2.97	Accepted
7	2.69	Accepted	29	5.34	Accepted
8	3.24	Accepted	30	2.69	Accepted
9	2.69	Accepted	31	5.07	Accepted
10	2.69	Accepted	32	2.97	Accepted
11	2.11	Accepted	33	3.52	Accepted
12	2.97	Accepted	34	2.63	Accepted
13	5.03	Accepted	35	2.11	Accepted
14	2.81	Accepted	36	3.24	Accepted
15	3.52	Accepted	37	2.40	Accepted
16	2.40	Accepted	38	2.34	Accepted
17	2.97	Accepted	39	3.47	Accepted
18	2.40	Accepted	40	5.44	Accepted
19	2.91	Accepted	41	2.97	Accepted
20	4.21	Accepted	42	3.52	Accepted
21	3.52	Accepted	43	3.52	Accepted
22	3.52	Accepted			

Following item analysis and consultations with experts, the final version of the scale was streamlined to include 42 items, all of which were positive statements.

Separate columns are provided for the ratings of all the seven areas. A copy of the

draft form of attitude scale is given as Appendix V. The number of items in each dimensions of Attitude Scale is shown in the Table 13.

Table 13

Component wise distribution of the items of Attitude Scale

No.	Statement	Sl. No of statements	No of statement
	Participation of Learners	1 – 4	4
	Motivation	5 – 12	8
	Resources	13 – 17	5
	Concept	18 – 23	6
	Transaction	24 – 32	9
	Evaluation	33 – 37	5
	Training	38 – 42	5
	Total		42

Interview Schedule

An interview schedule was developed to identify the functioning of IT Maths Lab in the higher secondary schools for teaching learning process. The components considered for the study are infrastructure facilities, training and management, and problems faced by the teachers, students while implementing the lab activities. The socio-demographic profile of the school was also collected by the researcher to understand the background of the institute.

The interview schedule consists of three parts viz., i) **profile of the school**, ii) **infrastructure facility in the IT Maths lab** and iii) **training and management**.

Part one contains ten questions, mainly focusing on the profile of the school and strength of teachers and students in the school. Part two consists of nineteen questions focusing on the infrastructure facilities and power supply availability in the IT Maths lab. Part three also consists of nineteen questions directing on the Training and Management of IT Maths lab. It focuses on the availability of training to the teachers, implementation method of IT Maths lab activities, time management, evaluation of the functioning of the IT Maths lab and maintenance of IT Maths lab. Problem faced by the teachers and students while implementing the lab activities and IT lab examination are also elicited in this part. A copy of the Interview schedule is given as Appendix VI.

A detailed interview was conducted with Research Officer, SCERT Kerala, experts and participants of IT Maths Lab activities as well as manual developers. The objectives of the interview and considered topics are a) factors that lead to develop and implements practical in the mathematics of higher secondary school curriculum, b) previous model considered to develop the concept of IT Maths lab, c) Pedagogical consideration, d) Rational behind to selection of the software, e) Content area considered to develop practical lab activity, f) Possibility of introducing IT oriented practical lab in all content of mathematics, g) Advantages of introducing IT Maths lab in HS curriculum of mathematics, i) Challenges faced while developing Maths lab program, j) Challenges face while implementing the program throughout the state, k) Expected outcome and l) method of evaluation.

Procedure for Data Collection

The investigator collected the data directly from the respondents through visiting the selected higher secondary schools in Kerala. The investigator made rapport with the principals and mathematics teachers from the chosen schools to coordinate and schedule the administration of tools. Discussions were held to ensure the smooth execution of the tool administration, and the investigator requested the necessary support from the teachers involved.

A sufficient number of copies of the tools needed for data collection were obtained beforehand. Prior to administering the tools, the investigator explained the research objectives and significance to the students, ensuring their understanding and active participation. The tools were administered with the assistance of the concerned teachers. Throughout the process, strict adherence to predefined rules and procedures was maintained across all schools to ensure consistency in the administering tool.

Each tool administration in all the schools adhered a consistent steps:

1. The tool was distributed to the respondents.
2. Clear instructions were provided for filling out necessary information on the response sheet.
3. Students were familiarized with the response sheet and the method for entering their responses.
4. Any questions from students were addressed, and additional instructions were given as needed.

5. INDEPENDENT responses were strictly marked to maintain integrity.
6. Finally, the test materials were collected back from the students.

These steps were meticulously followed during the administration of each tool to ensure uniformity and reliability across all respondents.

Statistical Techniques Used for Analyzing the Data

The data collected were subjected to the following statistical techniques:

1. Calculation of Percentage of the Responses of Students and Teachers

The percentages of responses of mathematics teachers and students based of the variables were used.

2. Calculation of Mean and Standard Deviation of the Perceived Effectives Score as well as the Attitude Score

The mean and standard deviation of the **perceived effectives score of the students as well as the attitude score** of the teachers in the sample and sub samples were computed to get first-hand information.

3. t - test

As a preliminary step in this data analysis, the **perceived effectives score as well as the attitude score** were compared based of the variables gender, locale and management of school using t-test for testing the significance of their means, for the sample selected and the sub samples.

The formula is

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

Where,

M_1 = Mean of the first sample

M_2 = Mean of the Second Sample

σ_1 = Standard Deviation of first sample

σ_2 = Standard Deviation of second sample

N_1 & N_2 = Number of subject in the respective samples.

4. Analysis of Variance

Analysis of Variance was applied test the variation based on the grade in mathematics of the students in their perceived effectiveness. Similarly the attitude of the teachers based on the age group and experience was tested using analysis of variance.

Analysis of variance (ANOVA) is an operational way to define whether the mean of more than two samples are too dissimilar to attribute the sampling error. The assumptions to work Analysis of variance (ANOVA) are a) Samples are randomly distributed; b) Population is normally distributed; c) Samples are independent; d) Samples have a common variation; and e) The Total Variation (TV) can split in to two components, each of which has a certain source of variation.

Within sample Variation (WV)

Between sample Variation (BV)

$$TV = WV + BV$$

The procedure of One-way ANOVA is through the following step-wise calculation.

Step 1: Total sum of squares $SS_t = \sum X^2 - \frac{(\sum x)^2}{N}$

Step 2: Between group sum of square

$$SS_b = \frac{(\sum x_1)^2}{n_1} + \frac{(\sum x_2)^2}{n_2} + \frac{(\sum x_3)^2}{n_3}$$

Step 3: Within group's sum of squares $SS_w = SS_t - SS_b$

Step 4: Mean square between $MS_b = \frac{SS_b}{df_b}$

Step 5: Mean square within $MS_w = \frac{SS_w}{df_w}$

Step 6: F-ratio, $F = \frac{MS_b}{MS_w}$

Conclusion

The research design of the present investigation involved the objectives, hypotheses, population and selection of the sample, development and item selection of appropriate tools for data collection, administration of the tools, selection and identification of the relevant statistical tools and techniques for tabulation and analysis of the collected data.

RESULTS AND DISCUSSIONS

- *Technological elements of IT Maths Lab and its evolution*
- *Perceived effectiveness of IT Maths Lab*
- *Attitude of teachers towards IT Maths Lab*
- *Challenges and problems in the implementation of IT Maths Lab activities*

Present chapter is arranged for the analysis of the data with regard to all the objectives and the hypotheses set for the study. The study focuses on the **A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA**. For this purpose, the researcher analysed the functioning of *IT MATHS LAB FOR TEACHING LEARNING PROCESS*, Attitude of the teachers towards *IT MATHS LAB FOR TEACHING LEARNING PROCESS* and Perceived Effectiveness among the Mathematics students of Higher Secondary Schools in Kerala. After the review of the existing studies, the researcher determined to have a mixed method for collecting the data from Higher Secondary School Students of Kerala state, India.

Objectives of the Study

The objectives set forth for the present study are the following:

1. To identify the technological elements of *IT Maths Lab* and its evolution.
2. To identify the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools.
3. To identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.
4. To compare the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools students of

subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.

5. To identify the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary schools.
6. To compare the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.
7. To identify the challenges and problems in the implementation of the *IT Maths Lab* activities in Higher Secondary Schools of Kerala.

Hypotheses of the Study

The hypotheses formulated for the present study are the following:

- 1) The Instructional method using *IT Maths Lab* is significantly effective for the transaction of the content among higher secondary school students.
- 2) The Instructional method using *IT Maths Lab* is significantly effective in enhancing abstract thinking among higher secondary school students.
- 3) There is no significant difference in the perceived effectiveness of *IT Maths Lab* for learning mathematics among higher secondary school students of subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.
- 4) Attitude of higher secondary school teachers towards the *IT Maths Lab* for teaching learning process is significantly high.

- 5) There is no significant difference in the attitude towards the *IT Maths Lab* of higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.

Analysis and Interpretation

The collected data was analyzed using appropriate statistical tool considering the objectives and hypothesis.

Technological Elements of *IT Maths Lab* and its Evolution

Objective 1 To identify the technological elements of *IT Maths Lab* and its evolution.

Teaching Learning Resources

The constructivist learning approach demands for the widespread use of various teaching learning resources not only for the teachers as self-learning material but also for the learners to get hands-on experience in classrooms. Abundant use of learning resources, especially ICT enabled resources gains attention of learners in the learning processes and at the same time it helps the teacher to sustain the involvement of learners in learning.

The major learning resource available and used in the Mathematics teaching learning class rooms are the text books, workbooks and teacher text prepared by State and Central Government. Along with these a number of other learning resources are also available.

Other Resources

First Bell and Kite Victers are initiatives by the Kerala Infrastructure and Technology for Education (KITE) to support digital learning in the state of Kerala, India. These platforms are designed to provide educational content to students, especially in the context of remote learning.

First Bell is a digital classroom initiative started by KITE to ensure that students in Kerala have access to quality education during the COVID-19 pandemic. It includes:

Digital Classes: Lessons for students from grades 1 to 12, broadcasted through various mediums.

YouTube Channel: Recorded classes are available on YouTube for students to watch at their convenience.

E-resources

There are many e-resources available for Mathematics teaching that cater to different educational levels and teaching styles. The resources include interactive websites, personalized learning materials, softwares and mobiles applications. Using these e-resources can help enhance the teaching and learning of Mathematics, making it more engaging and effective for students.

ICT-enabled Resources in Mathematics Textbook

Integrating Information and Communication Technology (ICT) in Mathematics textbooks can greatly enhance the learning experience by providing

interactive and engaging content. ICT-enabled resources that can be included in a Mathematics textbook are:

QR Codes and Links to Online Resources: Embed QR codes or URLs that link to instructional videos, interactive simulations, or additional exercises. Students can scan these codes with a smartphone or tablet to access the content directly.

Digital Textbooks with Embedded Multimedia: E-books with embedded videos, animations, and interactive exercises. This can include step-by-step video tutorials for solving problems or animations that illustrate mathematical concepts.

Number of ICT Activities in the Secondary School Text Books

Number of ICT activities included in the secondary school Mathematics text books is presented in Table 14.

Table 14

Number of ICT activities in the secondary school text books

Class	Volume	No of chapters	No of activities
8	1,2,3	10	9
9	1,2	13	22
10	1,2	11	42

Chapter-wise Number of ICT Activities in the Eight Standard Mathematics Text Books

Chapter-wise Number of ICT activities included in the eight standard Mathematics text books is presented in Table 15.

Table 15*Chapter-wise Number of ICT activities in the eight standard text books*

Class	Chapter	Name	No of activities
8	1	Equal triangles	6
	2	Equations	-
	3	Polygons	3
	4	Identities	-
	5	Money mathematics	-
	6	Construction of quadrilateral	-
	7	Ratio	-
	8	Area of quadrilaterals	-
	9	Negative numbers	-
	10	Statistics	-
Total	10		9

In the eight standard Mathematics text book, there are 10 chapters in which only two chapters included the nine ICT enabled activities. ICT enabled (geogebra) activities included chapters are Equal Triangles and Polygons.

Chapter-wise Number of ICT Activities in the Ninth Standard Mathematics Text Books

Chapter-wise Number of ICT activities included in the ninth standard Mathematics text books is presented in Table 16.

Table 16*Chapter-wise Number of ICT activities in the ninth standard text books*

Class	Chapter	Name	No of activities
9	1	Area	2
	2	Fractions	-
	3	Pairs of equations	-
	4	New numbers	1
	5	Circles	4
	6	Parallel lines	2
	7	Similarity of triangles	3
	8	Polynomials	1
	9	Circle measures	5
	10	Real numbers	-
	11	Solids	2
	12	Proportion	2
	13	Statistics	-
Total	13		22

In the ninth standard Mathematics text book, there are 13 chapters in which nine chapters included the 22 number of ICT enabled activities. ICT enabled (geogebra) activities included chapters are Area (2), New numbers (1), Circles (4), Parallel lines (2), Similarity of triangles (3), Polynomials (1), Circle measures (5), Solids (2), and Proportion (2). There is no mentioning of ICT enabled activities in the chapters Fractions, Pairs of equations, Real numbers and Statistics.

Chapter-wise Number of ICT Activities in the Tenth Standard Mathematics Text Books

Chapter-wise Number of ICT activities included in the tenth standard Mathematics text books is presented in Table 17.

Table 17

Chapter-wise Number of ICT activities in the tenth standard text books

Class	Chapter	Name	No of activities
10	1	Sequence	3
	2	Circles	7
	3	Mathematics of chance	-
	4	Second degree equation	-
	5	Trigonometry	3
	6	Coordinates	11
	7	Tangents	8
	8	Solids	6
	9	Coordinate geometry	4
	10	Polynomials	-
	11	Statistics	-
Total	11		42

It is seen that, there are eleven chapters in the Mathematics text book of standard ten and 42 number of ICT enabled activities are included in the textbook. ICT enabled (geogebra) activities included chapters are Sequence (3), Circles (7), Trigonometry (3), Coordinates (11), Tangents (8), Solids (6) and Coordinate geometry (4). There is no mentioning of ICT enabled activities in the chapters Mathematics of chance, Second degree equation, Polynomials and Statistics.

Inclusion of QR Code in the Maths Text Book

These Quick Response codes are two-dimensional and are used for identifying or tracking items to a website or application. The State Council of Educational Research and Training (SCERT) has developed Class 9 and 10 textbooks that include QR codes, which can be scanned using smartphones. (Standard X, Mathematics Text Book, Government of Kerala, Department of General Education, 2019)

Inclusion of IT Maths Lab in the Higher Secondary Curriculum

Kerala is currently making maximum use of the potential of Information Communication Technology (ICT) in Mathematics education up to class 10. Children are introduced to the possibilities of software like GeoGebra in the Mathematics textbook and children use them in the IT lab. But the opportunity for children to get these opportunities is limited at the higher secondary level where it can be most beneficial.

It was this realization that led to the idea of using ICT to master Mathematics at the Higher Secondary level as well. Those who enter higher education after Higher Secondary education and use ICT possibilities in the classroom get a visual experience of knowledge and children get direct participation in the construction of knowledge and Mathematics learning reaches a higher level of knowledge construction from mere classroom experience. To make this possible, IT Maths lab is an idea proposed in Higher Secondary Mathematics.

A roadmap for implementation of IT Maths lab system with efficient use of advanced software in Mathematics education has been prepared in collaboration with the State Council for Education Research and Training (SCERT) and Kerala Infrastructure and Technology for Education (KITE).

The 50th State School Curriculum Steering Committee approved the guidelines and suggested to examine the feasibility of implementing the idea by using the existing computer lab instead of building a new lab. In addition, all the software required for the implementation of the project like GeoGebra, Libero Office and *Samagra Portal* were made available free of cost. From the month of June 2019, the Government has issued an order implementing IT Maths lab in Higher Secondary/Vocational Higher Secondary Schools of the State where Mathematics is an optional subject (Higher Secondary IT Maths Lab Manual, SCERT Kerala, 2019) and steps have been taken to implement this scheme in all schools.

Although dynamic software such as GeoGebra has become the way math lessons are used today, children are still mere spectators in classrooms. It should be possible for the IT Maths lab to overcome this limitation. Math Lab will certainly provide an opportunity to transform children's extraordinary talent into mathematical abilities to assimilate and apply innovative technologies. A child gains the confidence to apply concepts as he acquires knowledge through experience. The IT Maths lab opens up great possibilities for such experiences to the children.

Weightage to Content

Weightage given to the content of various chapters in the first year Mathematics syllabus is given in Table 18.

Table 18

Weightage given to the content of various chapters in the first year Mathematics

Chapter	Name of the chapter	Score	Percent	Lab activities
1	Sets	7	8.75	Nil
2	Relations & Functions	7	8.75	24
3	Trigonometry	6	7.5	22
4	Complex Numbers	4	5	4
5	Linear inequalities	3	3.75	1
6	Permutation & Combination	7	8.75	Nil
7	Binomial Theorem	4	5	Nil
8	Sequence & Series	4	5	2
9	Straight lines	6	7.5	4
10	Conics	7	8.75	18
11	Three Dimensional Geometry	3	3.75	6
12	Limits & Derivatives	9	11.25	15
13	Statistics	6	7.5	Nil
14	Probability	7	8.75	Nil
Total		80	100.00	96

Table reveals that out of total 14 chapters of the first year Mathematics text book, nine chapters have 96 number of the lab activities. Sets, Permutation &

Combination, Binomial Theorem, Statistics and Probability has not given any type of lab activity.

Weightage given to the content of various chapters in the second year Mathematics syllabus is given in Table 19.

Table 19

Weightage given to the content of various chapters in the second year Mathematics

Chapter	Name of the chapter	Score	Percentage	Lab activities
1	Relations and Functions	7	8.75	14
2	Inverse Trigonometric Functions	4	5.00	15
3	Matrices	7	8.75	3
4	Determinants	9	11.25	6
5	Continuity and Differentiability	6	7.50	10
6	Applications of Derivatives	6	7.50	16
7	Integrals	6	7.50	12
8	Application of Integrals	4	5.00	8
9	Differential Equations	4	5.00	6
10	Vector Algebra	7	8.75	9
11	Three Dimensional Geometry	7	8.75	10
12	Linear Programming	6	7.50	4
13	Probability	7	8.75	4
Total Weightage including choices		80	100	107

Table reveals that a total of 107 IT lab activities are distributed to all the 13 chapters of the second year Mathematics text book. Concept wise distribution of the lab activities for the first year Mathematics text book is presented in Table 20.

Table 20*Practical Work in Mathematics syllabus for First year students*

Units		Lab activities
Sets	Sets and their Representations	
	The Empty Set	
	Finite and Infinite Sets	
	Equal Sets	
	Subsets	Nil
	Universal Set	
	Venn Diagrams	
	Operations on Sets	
	Complement of a Set	
Relations & Functions	Cartesian Product of Sets	Indirect
	Relations	Indirect
	Functions	Direct
Trigonometry	Angles	Direct
	Trigonometric Functions	Direct
	Trigonometric Functions of Sum and Difference of Two Angles	Indirect
Complex Numbers	Complex Numbers	Indirect
	Algebra of Complex Numbers	Direct
	The Modulus and the Conjugate of a Complex Number	no
	Argand Plane and Polar Representation	
Linear inequalities	Inequalities	Direct
	Algebraic Solutions of Linear Inequalities in One Variable	Direct
	and their Graphical Representation	
Permutation & Combination	Fundamental Principle of Counting	Nil
	Permutations	
	Combinations	
Binomial	Binomial Theorem for Positive Integral	Nil

Units		Lab activities
Theorem	Indices	
	Sequences	Indirect
Sequence & Series	Series	Nil
	Geometric Progression (G.P.)	Indirect
	Relationship Between A.M. and G.M.	Nil
	Slope of a Line	Indirect
Straight lines	Various Forms of the Equation of a Line	Direct
	Distance of a Point From a Line	Direct
	Sections of a Cone	Direct
Conics	Circle	Direct
	Parabola	Direct
	Ellipse	Direct
	Hyperbola	Direct
Three Dimensional Geometry	Coordinate Axes and Coordinate Planes in Three Dimensional Space	Direct
	Coordinates of a Point in Space	Direct
	Distance between Two Points	Indirect
	Intuitive Idea of Derivatives	Indirect
Limits & Derivatives	Limits	Direct
	Limits of Trigonometric Functions	Direct
	Derivatives	Direct
Statistics	Measures of Dispersion	Nil
	Range	
	Mean Deviation	
	Variance and Standard Deviation	
Probability	Event	Nil
	Axiomatic Approach to Probability	
Total		

Concept wise distribution of the lab activities for the second year Mathematics text book is presented in Table 21.

Table 21

Practical Work in Mathematics syllabus for Second year students

Units	Concepts	Lab activities
Relations and Functions	Types of Relations	
	Types of Functions	Direct
	Composition of Functions and Invertible Function	Direct
Inverse Trigonometric Functions	Basic Concepts	Direct
	Properties of Inverse Trigonometric Functions	Direct
Matrices	Matrix	Direct
	Types of Matrices	Direct
	Operations on Matrices	Direct
	Transpose of a Matrix	Direct
	Symmetric and Skew Symmetric Matrices	Indirect
	Invertible Matrices	Direct
Determinants	Determinant	Direct
	Area of a Triangle	Direct
	Minors and Cofactors	direct
	Adjoint and Inverse of a Matrix	
	Applications of Determinants and Matrices	direct
Continuity and Differentiability	Continuity	Direct
	Differentiability	Direct
	Exponential and Logarithmic Functions	Direct
	Logarithmic Differentiation	Nil
	Derivatives of Functions in Parametric Forms	Direct
	Second Order Derivative	Nil
Applications of Derivatives	Rate of Change of Quantities	Indirect
	Increasing and Decreasing Functions	Direct
	Maxima and Minima	Direct

Units	Concepts	Lab activities
Integrals	Integration as an Inverse Process of Differentiation	Nil
	Methods of Integration	Nil
	Integrals of Some Particular Functions	Nil
	Integration by Partial Fractions	Nil
	Integration by Parts	Nil
	Definite Integral	Direct
	Fundamental Theorem of Calculus	Indirect
	Evaluation of Definite Integrals by Substitution	Indirect
	Some Properties of Definite Integrals	Indirect
Application of Integrals	Area under Simple	Direct
Differential Equations	Basic Concepts	Direct
	General and Particular Solutions of a Differential Equation	Direct
	Methods of Solving First Order, First Degree 306 Differential Equations	Direct
Vector Algebra	Some Basic Concepts	Direct
	Types of Vectors	Indirect
	Addition of Vectors	Indirect
	Multiplication of a Vector by a Scalar	Indirect
	Product of Two Vectors	Direct
Three Dimensional Geometry	Direction Cosines and Direction Ratios of a Line	Indirect
	Equation of a Line in Space	Indirect
	Angle between Two Lines	Direct
	Shortest Distance between Two Lines	Indirect
Linear Programming		Direct
	Linear Programming Problem and its Mathematical Formulation	
Probability	Conditional Probability	Direct
	Multiplication Theorem on Probability	Indirect
	Independent Events	Indirect
	Bayes' Theorem	Direct

Perceived Effectiveness of *IT Maths Lab* for the Transaction of the Content in Mathematics among Higher Secondary Schools

To measure the effectiveness *IT Maths Lab* for the transaction of the content in Mathematics among Higher Secondary Schools as perceived by the Higher Secondary School Students, the researcher developed a tool and it was used. The scorings are done as per the indicators developed in the tool and it is analysed based on the objectives and hypothesis.

Objective 2 To identify the effectiveness of *IT Maths Lab* for the transaction of the content in Mathematics among Higher Secondary Schools.

Identifying the Normality of the Variables

For applying inferential statistics it is necessary to identify the normality of the variables. As the main step of analysis, the key statistical constants such as Mean, Median, Mode, Standard Deviation, Skewness and Kurtosis of the variables were determined for the total sample. Details of the coefficients obtained regarding the variables parenting are presented in Table 22.

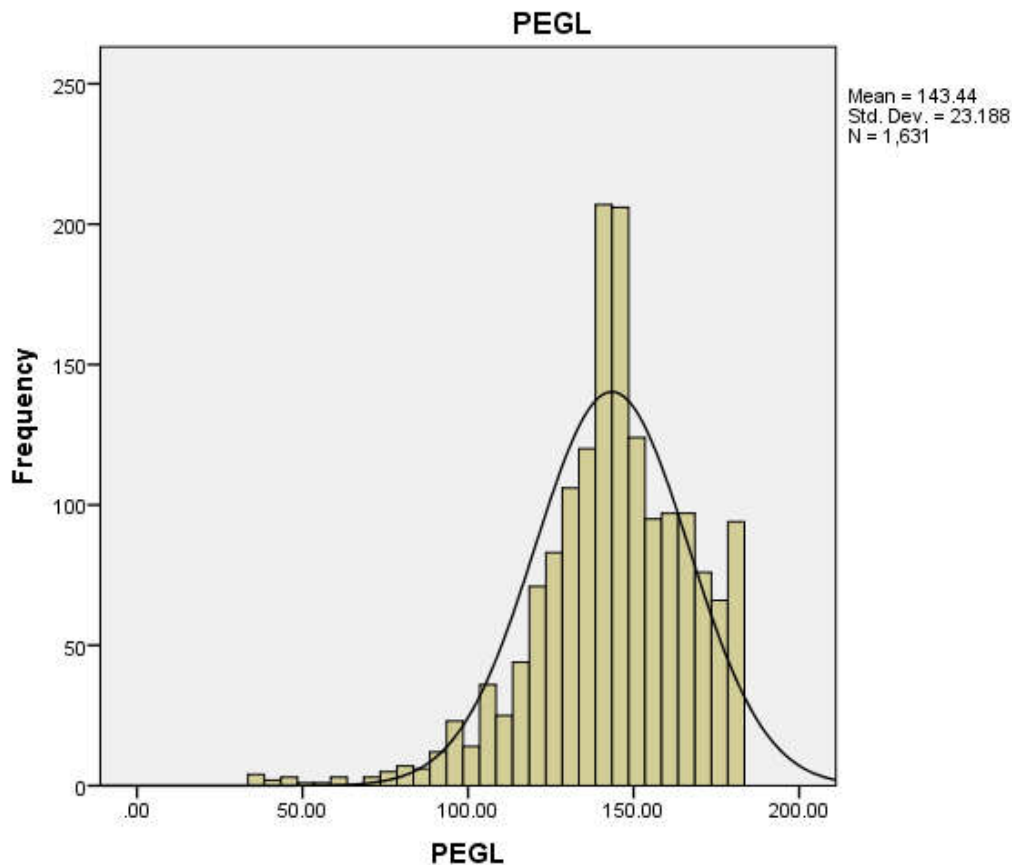
Table 22*Statistical Constants of the Variable Perceived Effectiveness of IT Maths Lab*

Statistical Constant	Perceived Effectiveness score
Mean	143.44
Median	144.00
Mode	180.00
Std. Deviation	23.18
Skewness	-0.908
Kurtosis	1.011

The Table 22 shows that the mean, median and mode of ***Perceived Effectiveness score*** of Higher Secondary School Students are 143.44, 144.00 and 180 respectively. In this distribution the mean, median and the mode fall more or less at the same point. The skewness for the score is -0.908, hence the sample distribution is found to be slightly skewed negatively and the kurtosis value is 1.011. Graphical representation of the distribution of the ***Perceived Effectiveness score*** of Higher Secondary School Students for the total sample is presented in Figure 1.

Figure 1

Graphical representation of the distribution of the Perceived Effectiveness score of Higher Secondary School Students for the total sample



Effectiveness of IT Maths Lab for learning Mathematics among Higher Secondary School Students was studied by collecting data from Higher Secondary Students by administering Perceived Effectiveness Tool prepared by the investigator. Student *Perceived Effectiveness* was defined as to have seven components such as *Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking, and Problem solving*. As such the level Perceived Effectiveness of *IT Maths Lab* for learning Mathematics among Higher Secondary

school Mathematics stream students on each of these seven component variables and as a composite score of all the seven were estimated as mean scores and standard deviations of each and then by applied one sample t-test of significance to these mean scores. These were done for the total sample and comparison was done for the subsamples of students based on the four classificatory variables viz., Gender, Type of school Management, School Locale and Grade in Mathematics of SSLC examination.

Participation

For measuring the Perceived Effectiveness of IT Maths Lab in the participation of class room activities, the researcher used the seven statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component participation for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test (middle score is considered as the assumed mean/test value) is presented in Table 23.

Table 23

Level of Participation of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
There is an opportunity to study Mathematics with the help of IT Math Lab	4.35	0.78	3	69.831	.000
Learning maths using the IT Maths lab has made learning more enjoyable.	4.36	0.82	3	66.437	.000
All units of Mathematics can be studied in conjunction with the IT Maths Lab.	3.77	1.04	3	30.100	.000
It is possible to do the work in the IT Maths lab by yourself.	4.19	0.90	3	53.123	.000
There has been an increased interest in learning through Mathematics learning using the IT Math Lab.	4.18	0.91	3	52.420	.000
Maths learning with the help of maths lab inculcates interest in maths in us.	4.10	0.94	3	47.257	.000
Difficulty using IT Maths lab for math learning.	2.99	1.31	3	-0.150	.881
Participation	27.99	4.44	21	63.507	.000

From the Table 23, it is seen that the mean score of participation is 27.99 with standard deviation 4.44. The calculated mean score (27.99) is greater than the assumed mean score of test value (21) and the p-value ($t=63.507$; $p=0.000$) is less than 0.05. Hence it can be concluded that participation of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Participation Based on Gender

The component of the Perceived Effectiveness – participation – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 24.

Table 24

Comparison of participation of the students based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	28.08	4.77	0.570	0.569
Female	1161	27.95	4.30		

Table 24 projects the fact about the participation of based on Gender of the Higher Secondary School Students. The mean score of male students is 28.08, with Standard Deviation of 4.77, while the mean score of the female students is 27.95, with Standard Deviation of 4.30. The calculated t-value is 0.570 and the p-value is 0.569. Hence, the result reveals that there is no significant difference in the participation of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of Participation based on Management of the School

The component of the Perceived Effectiveness – participation – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 25.

Table 25*Comparison of participation based on management of the school*

Management	N	Mean	SD	t-value	p-value
Government	905	28.00	4.45	0.127	0.899
Aided	726	27.97	4.43		

From the Table 25 it is revealed that the calculated mean score for Government school students is 28.00 with standard deviation of 4.45 and mean score for Aided school students is 27.97 with standard deviation of 4.43. The calculated t-value is 0.127 and p-value is 0.899 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on participation of IT Maths Lab for learning Mathematics.

Comparison of Participation Based on Locality of the School

The component of the Perceived Effectiveness – participation – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 26.

Table 26*Comparison of participation based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	28.03	4.23	0.499	0.618
Urban	711	27.92	4.70		

The Table 26 reveals that the mean score of participation for rural school students is 28.03 with standard deviation of 4.23 and for urban school students is 27.92 with standard deviation of 17.13. Independent sample t-test reveals that the calculated t-value is 0.499 and the p-value is 0.618 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in Perceived Effectiveness on participation of *IT Maths Lab* for learning Mathematics.

Comparison of Participation based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – participation – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 27.

Table 27

Comparison of participation based on Grade in Mathematics of SSLC exam

Grade	N	Mean	SD	F-value	p-value
A Plus	1296	28.11	4.36	1.390	0.235
A	136	27.36	4.38		
B Plus	114	27.74	4.54		
B	49	27.67	4.03		
Below B	36	27.16	6.92		
Total	1631	27.99	4.44		

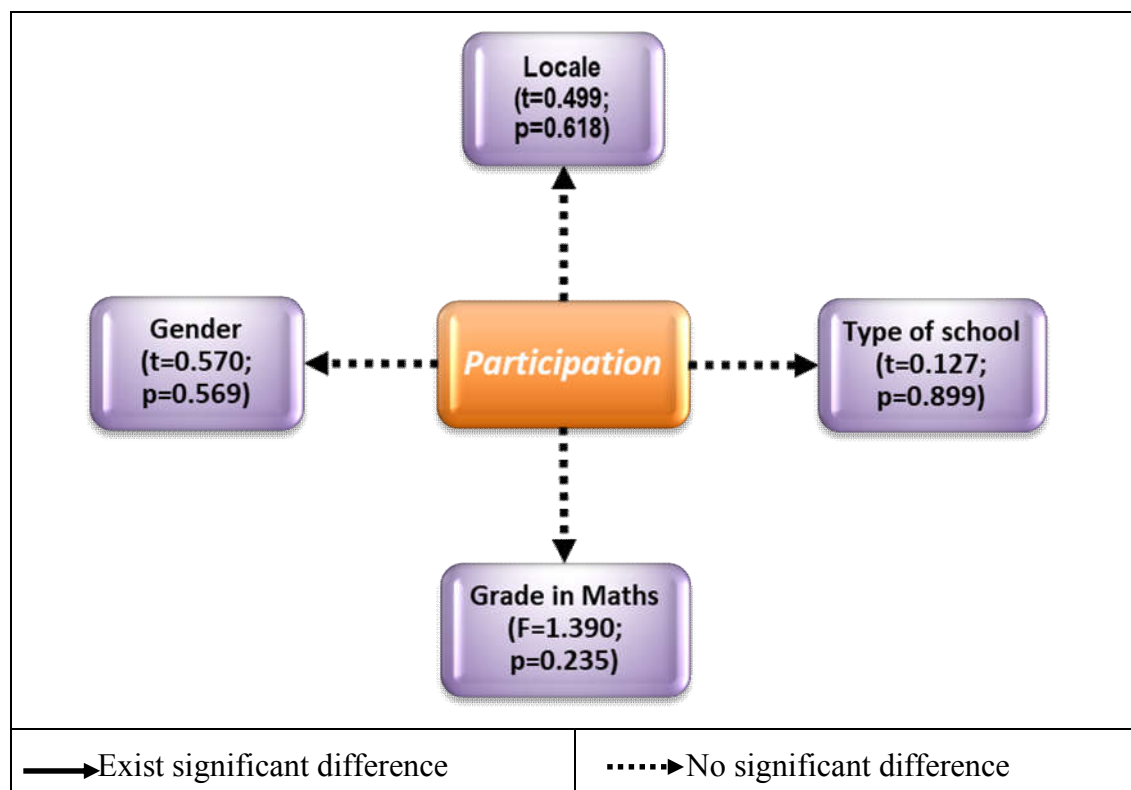
The Table 27 furnishes the results of comparison of Perceived Effectiveness participation of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for participation

varying between 28.11 and 27.16 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus grade students (28.11) and lowest mean score for below B-grade students (27.16). Analysis of variance reveals that the calculated F-value is 1.390 and p-value is 0.235 which is greater than 0.05. Hence it can be concluded that there is no significant variation in the Perceived Effectiveness of participation based on Grade in Mathematics of SSLC examination.

Consolidated result of the comparison of participation in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 2.

Figure 2

Pictorial representation of Participation in IT Maths Lab activities based on variable



Consolidated result shows that Gender, locality of the school, type of school Management and Grade in Mathematics has significant role on participation of IT Maths Lab activities.

Practicability

For measuring the Perceived Effectiveness of IT Maths Lab in the practicability of class room activities, the researcher used the four statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component practicability for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 28.

Table 28

Level of practicability of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Software used to understand Mathematics with the help of IT Maths lab is difficult to manage.	2.95	1.28	3	-1.508	.132
The time allotted is sufficient for the acquisition of Mathematics subjects with the help of IT Maths Lab.	3.69	1.08	3	25.830	.000
The work book/manual provided in the IT Maths lab can be used to master the math concepts.	4.08	0.96	3	45.615	.000
IT Maths lab activities are easy to understand.	4.19	0.83	3	57.789	.000
Practicability	15.02	2.85	12	42.738	.000

From the Table 28, it is seen that the mean score of practicability is 15.02 with standard deviation of 2.85. The calculated mean score (15.02) is greater than the assumed mean score of test value (12) and the p-value ($t=42.738$; $p=0.000$) is less than 0.05. Hence it can be concluded that practicability of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Practicability Based on Gender

The component of the Perceived Effectiveness – **Practicability** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 29.

Table 29

Comparison of Practicability based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	15.11	3.13	0.807	0.420
Female	1161	14.98	2.73		

Table 29 discloses that the comparison of the component of Perceived Effectiveness – practicability – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 15.11, with Standard Deviation of 3.13, and the average score of the female students is 14.98, with Standard Deviation of 2.73. Independent sample t-test gives that the calculated t-value is 0.807 and the p-value is 0.420 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the practicability of the Higher

Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of Practicability Based on Management of the School

The component of the Perceived Effectiveness – practicability– was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 30.

Table 30

Comparison of practicability based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	14.94	2.90	-1.303	0.193
Aided	726	15.12	2.79		

From the Table 30 it is revealed that the calculated mean score for Government school students is 14.94 with standard deviation of 2.90 and mean score for Aided school students is 15.12 with standard deviation of 2.79. The calculated t-value is 1.303 and p-value is 0.193 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on practicability of IT Maths Lab for learning Mathematics.

Comparison of Practicability Based on Locality of the School

The component of the Perceived Effectiveness – practicability – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 31.

Table 31*Comparison of practicability based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	14.97	2.85	0.823	0.411
Urban	711	15.09	2.86		

The Table 31 reveals that the mean score of practicability for rural school students is 14.97 with standard deviation of 2.85 and for urban school students is 15.09 with standard deviation of 2.86. Independent sample t-test reveals that the calculated t-value is 0.823 and the p-value is 0.411 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in Perceived Effectiveness on practicability of *IT Maths Lab* for learning Mathematics.

Comparison of Practicability based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – practicability – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 32.

Table 32*Comparison of practicability based on Grade in Mathematics of SSLC exam*

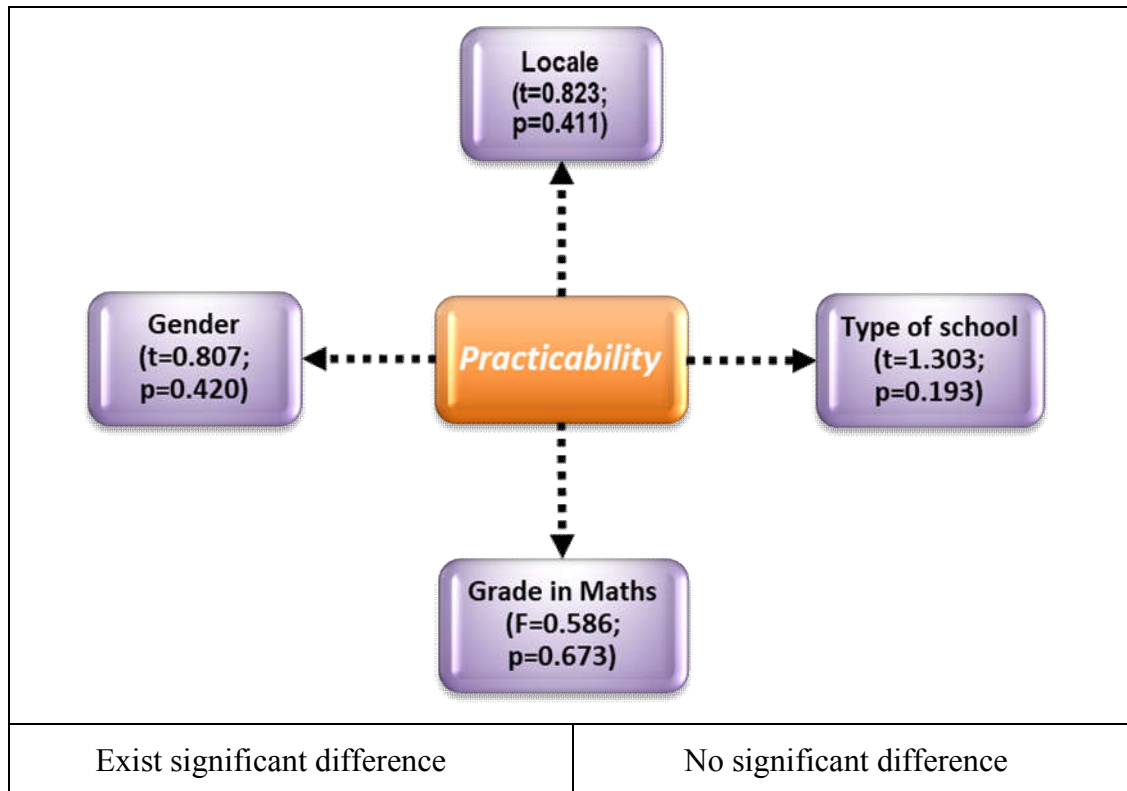
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	15.03	2.89	0.586	0.673
A	136	14.88	2.57		
B Plus	114	15.31	2.50		
B	49	14.65	2.61		
Below B	36	14.94	3.96		
Total	1631	15.02	2.85		

The Table 32 furnishes the results of comparison of Perceived Effectiveness **practicability** of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for **practicability** varying between 15.31 and 14.65 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for B-plus Grade students (15.31) and lowest mean score for B-grade students (14.65). Analysis of variance reveals that the calculated F-value is 0.586 and p-value is 0.673 which is greater than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of **practicability** based on grade in Mathematics of SSLC examination.

Consolidated result of the comparison of practicability in *IT Maths Lab* activities based of Gender, locale of the students, type of Management of the school and Grade in Mathematics of SSLC examination is presented in Figure 3.

Figure 3

Pictorial representation of Practicability in IT Maths Lab activities based on variable



Consolidated result shows that Gender, locality of the school, type of Management of the school and Grade in Mathematics has significant role on practicability of IT Maths Lab activities.

Understanding

For measuring the Perceived Effectiveness of IT Maths Lab in the understanding of class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component understanding for the Total sample of Higher Secondary School Mathematics

Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 33.

Table 33

Level of understanding of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Mathematics study using IT Maths lab helps to clear existing doubts.	3.98	0.90	3	43.676	.000
I have a clear understanding of the workings of the IT Maths lab.	4.05	0.92	3	45.785	.000
With the help of activities in the IT Maths Lab, Mathematics concepts can be covered in depth.	4.01	0.91	3	44.432	.000
All units of Mathematics can be understood through the activities of the IT Maths Lab.	3.75	1.04	3	29.448	.000
Activities in the IT Maths lab help in understanding the basic concept of math.	4.10	0.84	3	52.428	.000
Understanding	19.90	3.69	15	53.604	.000

From the Table 33, it is seen that the mean score of understanding is 19.90 with standard deviation 3.69. The calculated mean score (19.90) is greater than the assumed mean score of test value (15) and the p-value ($t=53.604$; $p=0.000$) is less than 0.05. Hence it can be concluded that participation of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Understanding Based on Gender

The component of the Perceived Effectiveness – **Understanding** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 34.

Table 34

Comparison of Understanding based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	19.88	4.02	0.153	0.878
Female	1161	19.91	3.56		

Table 34 discloses that the comparison of the component of Perceived Effectiveness – understanding – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 19.88, with Standard Deviation of 4.02, and the average score of the female students is 19.91, with Standard Deviation of 3.56. Independent sample t-test gives that the calculated t-value is 0.153 and the p-value is 0.878. Hence, the result reveals that there is no significant difference in the understanding of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of Understanding based on Management of the School

The component of the Perceived Effectiveness – understanding – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 35.

Table 35*Comparison of understanding based on management of the school*

Management	N	Mean	SD	t-value	p-value
Government	905	19.88	3.74	0.308	0.758
Aided	726	19.94	3.64		

From the Table 35 it is revealed that the calculated mean score for Government school students is 19.88 with standard deviation of 3.74 and mean score for Aided school students is 19.94 with standard deviation of 3.64. The calculated t-value is 0.308 and p-value is 0.758 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on understanding of IT Maths Lab for learning Mathematics.

Comparison of Understanding Based on Locality of the School

The component of the Perceived Effectiveness – understanding – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 36.

Table 36*Comparison of understanding based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	20.07	3.54	2.020	0.044
Urban	711	19.69	3.88		

The Table 36 reveals that the mean score of understanding for rural school students is 20.07 with standard deviation of 3.54 and for urban school students is 19.69 with standard deviation of 3.88. Independent sample t-test reveals that the calculated t-value is 2.02 and the p-value is 0.044 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in Perceived Effectiveness on understanding of *IT Maths Lab* for learning Mathematics.

Comparison of Understanding Based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – understanding – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 37.

Table 37*Comparison of understanding based on Grade in Mathematics of SSLC exam*

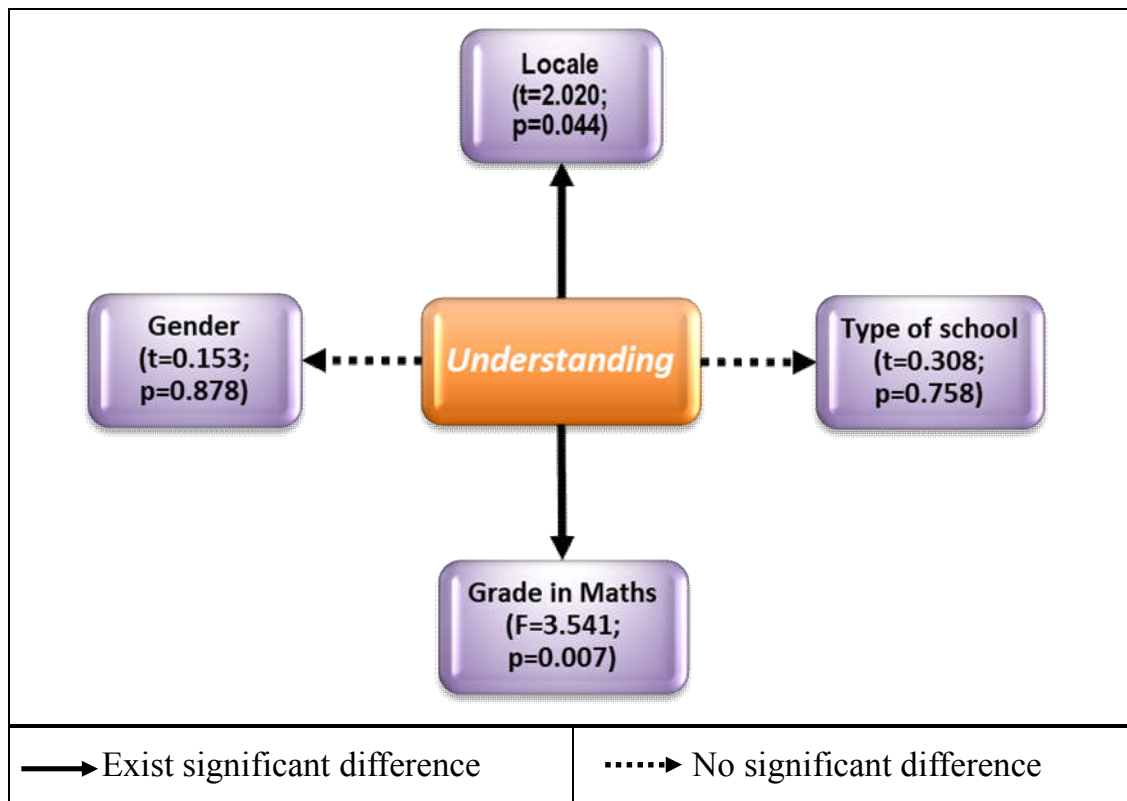
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	20.07	3.67	3.541	0.007
A	136	19.09	3.53		
B Plus	114	19.62	3.49		
B	49	19.28	3.34		
Below B	36	18.86	5.29		
Total	1631	19.90	3.69		

The Table 37 furnishes the results of comparison of Perceived Effectiveness understanding of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for understanding varying between 20.07 and 18.86 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus Grade students (20.07) and lowest mean score for below B-grade students (18.86). Analysis of variance reveals that the calculated F-value is 3.541 and p-value is 0.007 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of understanding based on grade in Mathematics of SSLC examination.

Consolidated result of the comparison of understanding in *IT Maths Lab* activities based of Gender, locale of the students, type of Management of the school and Grade in Mathematics of SSLC examination is presented in Figure 4.

Figure 4

Pictorial representation of Understanding in IT Maths Lab activities based on variable



Consolidated result shows that Gender and locality of the school has no significant role on understanding of mathematical concept; type of management of the school and Grade in Mathematics has significant role on understanding of mathematical concept through IT Maths Lab activities.

Self-assessment

For measuring the Perceived Effectiveness of IT Maths Lab in the self-assessment of class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component

self-assessment for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 38.

Table 38

Level of self-assessment of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
With the help of the IT Maths lab, math concepts can be explained to the classmates.	4.12	0.92	3	49.261	.000
Math learning activities discussed in the classroom can be done independently in the IT Maths lab.	4.03	0.98	3	42.533	.000
Math Lab activities are designed to be self-paced.	4.06	0.90	3	47.654	.000
The activities of the IT Maths lab enable self-assessment of the achievement achieved in the Math class.	4.04	0.86	3	48.937	.000
Activities in the IT Maths lab are helpful in assessing whether each concept in math has been mastered.	3.97	0.89	3	44.008	.000
Self-Assessment	20.24	3.63	15	58.341	.000

From the Table 38, it is seen that the mean score of self-assessment is 20.24 with standard deviation 3.63. The calculated mean score (20.24) is greater than the assumed mean score of test value (15) and the p-value ($t=58.341$; $p=0.000$) is less

than 0.05. Hence it can be concluded that self-assessment of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Self-assessment Based on Gender

The component of the Perceived Effectiveness – **Self-assessment** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 39.

Table 39

Comparison of Self-assessment based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	20.08	3.79	1.123	0.262
Female	1161	20.31	3.56		

Table 39 discloses that the comparison of the component of Perceived Effectiveness – self-assessment – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 20.08, with Standard Deviation of 3.79, and the average score of the female students is 20.31, with Standard Deviation of 3.56. Independent sample t-test gives that the calculated t-value is 1.123 and the p-value is 0.262. Hence, the result reveals that there is no significant difference in the self-assessment of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of self-assessment based on management of the school

The component of the Perceived Effectiveness – self-assessment – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 40.

Table 40

Comparison of self-assessment based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	20.21	3.67	0.432	0.666
Aided	726	20.28	3.57		

From the Table 40 it is revealed that the calculated mean score for Government school students is 20.21 with standard deviation of 3.67 and mean score for Aided school students is 20.28 with standard deviation of 3.57. The calculated t-value is 0.432 and p-value is 0.666 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on self-assessment of IT Maths Lab for learning Mathematics.

Comparison of self-assessment based on locality of the school

The component of the Perceived Effectiveness – self assessment – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 41.

Table 41*Comparison of self-assessment based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	20.41	3.43	2.103	0.036
Urban	711	20.03	3.86		

The Table 41 reveals that the mean score of self-assessment for rural school students is 20.41 with standard deviation of 3.43 and for urban school students is 20.03 with standard deviation of 3.86. Independent sample t-test reveals that the calculated t-value is 2.103 and the p-value is 0.036 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in Perceived Effectiveness on self-assessment of *IT Maths Lab* for learning Mathematics.

Comparison of self-assessment based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – self-assessment – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 42.

Table 42*Comparison of self-assessment based on Grade in Mathematics of SSLC exam*

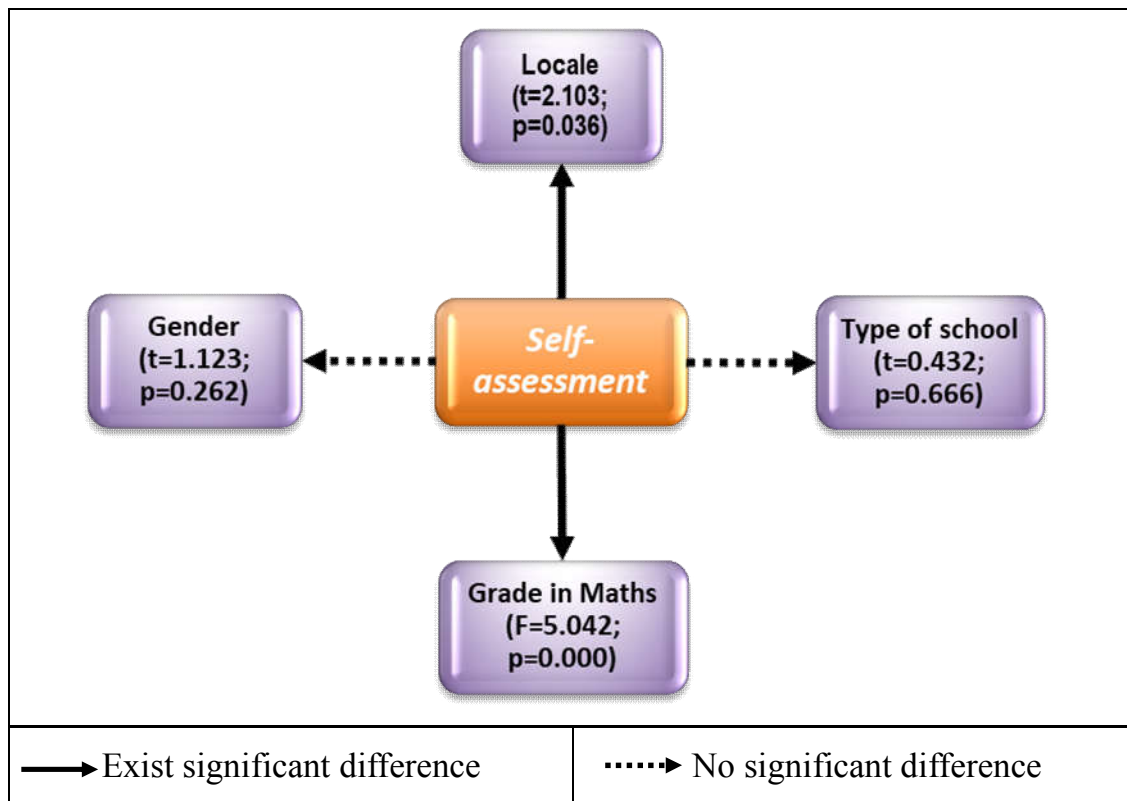
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	20.43	3.58	5.042	0.000
A	136	19.22	3.68		
B Plus	114	19.99	3.31		
B	49	19.46	3.38		
Below B	36	19.22	5.32		
Total	1631	20.24	3.63		

The Table 42 furnishes the results of comparison of Perceived Effectiveness self-assessment of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for self-assessment varying between 20.43 and 19.22 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus grade students (20.43) and lowest mean score for below B-grade students (19.22). Analysis of variance reveals that the calculated F-value is 5.042 and p-value is 0.000 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of self-assessment based on Grade in Mathematics of SSLC examination.

Consolidated result of the comparison of self-assessment in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 5.

Figure 5

Pictorial representation of Participation in IT Maths Lab activities based on variable



Consolidated result shows that Gender and type of Management of the school has no significant role on self-assessment of IT Maths Lab activities. Whereas locality of the school and Grade obtained for Mathematics in SSLC examination has significant role on self-assessment of IT Maths Lab activities.

Concept formation

For measuring the Perceived Effectiveness of IT Maths Lab in the concept formation of class room activities, the researcher used the six statements. The

Estimated Means and Standard Deviations of Perceived Effectiveness component concept formation for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 43.

Table 43

Level of concept formation of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
The activities included in the IT Maths lab are helpful in achieving learning outcomes.	4.18	0.82	3	58.133	.000
Mathematics can be easily understood when presented with the help of IT Maths lab.	4.19	0.83	3	57.691	.000
A mathematical concept can be fully grasped when it is presented through visualization.	4.22	0.81	3	61.008	.000
Understanding is possible by relating classroom activities to math lab activities.	4.13	0.85	3	53.633	.000
Existing IT lab activities are adequate for acquiring mathematical concepts.	3.80	0.99	3	32.713	.000
Activities in the IT Maths lab are helpful in assessing the understanding of each unit of math.	3.88	0.95	3	37.240	.000
<i>Concept formation</i>	24.43	4.14	18	62.667	.000

From the Table 43, it is seen that the mean score of concept formation is 24.43 with standard deviation 4.14. The calculated mean score (24.43) is greater

than the assumed mean score of test value (18) and the p-value ($t=62.667$; $p=0.000$) is less than 0.05. Hence it can be concluded that concept formation of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Concept formation based on Gender

The component of the Perceived Effectiveness – **Concept formation** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 44.

Table 44

Comparison of Concept formation based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	24.15	4.55	1.784	0.075
Female	1161	24.55	3.96		

Table 44 discloses that the comparison of the component of Perceived Effectiveness – concept formation – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 24.15, with Standard Deviation of 4.55, and the average score of the female students is 24.55, with Standard Deviation of 3.96. Independent sample t-test gives that the calculated t-value is 1.784 and the p-value is 0.075 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the concept formation of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of concept formation based on management of the school

The component of the Perceived Effectiveness – concept formation – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 45.

Table 45

Comparison of concept formation based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	24.33	4.19	1.108	0.268
Aided	726	24.56	4.08		

From the Table 45 it is revealed that the calculated mean score for Government school students is 24.33 with standard deviation of 4.19 and mean score for Aided school students is 24.56 with standard deviation of 4.08. The calculated t-value is 1.108 and p-value is 0.268 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on concept formation of IT Maths Lab for learning Mathematics.

Comparison of concept formation based on locality of the school

The component of the Perceived Effectiveness – concept formation – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 46.

Table 46*Comparison of concept formation based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	24.66	3.95	2.545	0.011
Urban	711	24.14	4.37		

The Table 46 reveals that the mean score of concept formation for rural school students is 24.66 with standard deviation of 3.95 and for urban school students is 24.14 with standard deviation of 4.37. Independent sample t-test reveals that the calculated t-value is 2.545 and the p-value is 0.011 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in Perceived Effectiveness on concept formation of *IT Maths Lab* for learning Mathematics.

Comparison of concept formation based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – concept formation – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 47.

Table 47*Comparison of concept formation based on Grade in Mathematics of SSLC exam*

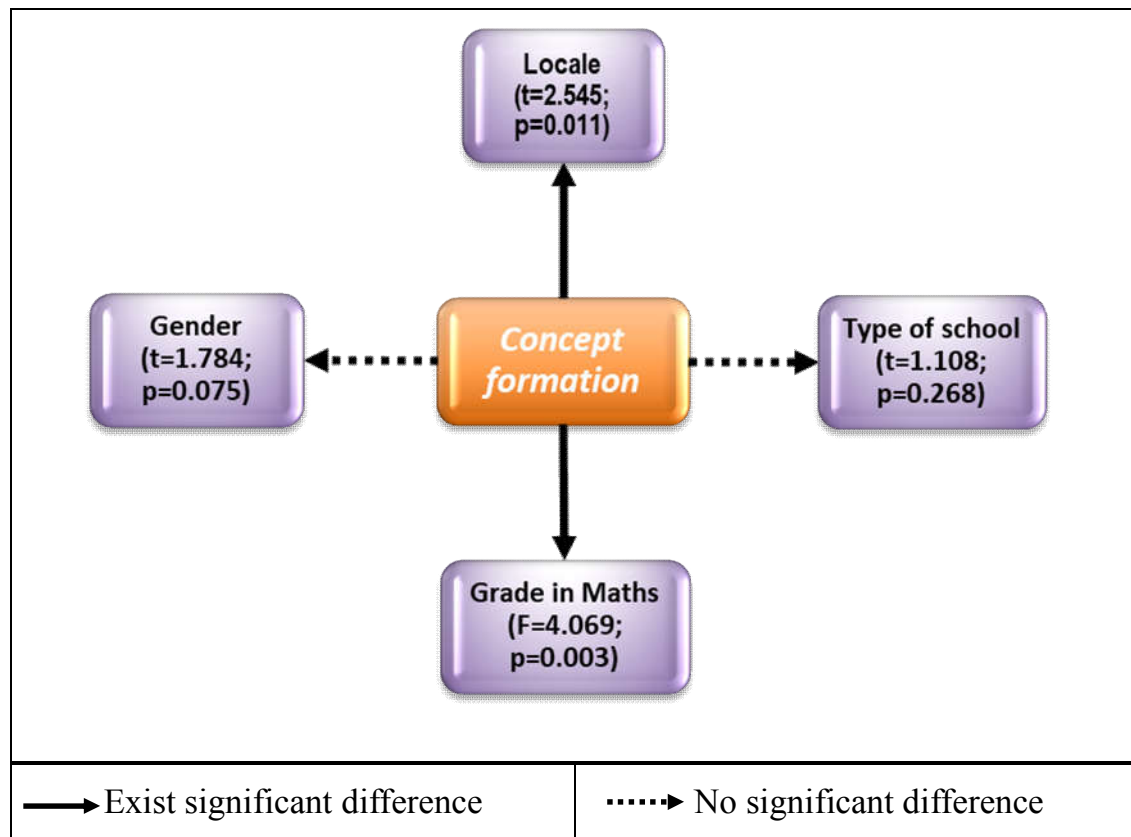
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	24.63	4.13	4.069	0.003
A	136	23.39	3.79		
B Plus	114	24.12	3.73		
B	49	23.77	3.95		
Below B	36	23.27	6.35		
Total	1631	24.43	4.14		

The Table 47 furnishes the results of comparison of Perceived Effectiveness concept formation of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for concept formation varying between 24.63 and 23.27 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus Grade students (24.63) and lowest mean score for below B-grade students (23.27). Analysis of variance reveals that the calculated F-value is 4.069 and p-value is 0.003 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of concept formation based on Grade in Mathematics of SSLC examination.

Consolidated result of the comparison of concept formation in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 6.

Figure 6

Pictorial representation of Participation in IT Maths Lab activities based on variable



Consolidated result shows that Gender and type of Management of the school has no significant role on concept formation of IT Maths Lab activities. Whereas locality of the school and Grade obtained for Mathematics in SSLC examination has significant role on concept formation of IT Maths Lab activities.

Reasoning /logical thinking

Objective 3 To identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.

For measuring the Perceived Effectiveness of IT Maths Lab in the reasoning/ logical thinking of class room activities, the researcher used the three statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component reasoning/ logical thinking for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 48.

Table 48

Level of reasoning/ logical thinking of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
It is possible to achieve more conceptual clarity by studying Mathematics using the IT Math Lab.	4.28	0.81	3	63.116	.000
Complex math problems are made clearer through math lab activity.	4.08	0.91	3	47.736	.000
Activities in the IT Maths lab help to understand abstract concepts in Mathematics.	3.83	0.93	3	35.755	.000
<i>Reasoning/ logical thinking</i>	12.19	2.22	9	57.983	.000

From the Table 48, it is seen that the mean score of reasoning/ logical thinking is 12.19 with standard deviation 2.22. The calculated mean score (12.19) is greater than the assumed mean score of test value (9) and the p-value ($t=57.983$; $p=0.000$) is less than 0.05. Hence it can be concluded that reasoning/ logical

thinking of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Reasoning /logical thinking based on Gender

The component of the Perceived Effectiveness – **Reasoning /logical thinking** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 49.

Table 49

Comparison of Reasoning /logical thinking based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	12.14	2.43	0.556	0.578
Female	1161	12.21	2.13		

Table 49 discloses that the comparison of the component of Perceived Effectiveness – reasoning/ logical thinking – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 12.14, with Standard Deviation of 2.43, and the average score of the female students is 12.21, with Standard Deviation of 2.13. Independent sample t-test gives that the calculated t-value is 0.556 and the p-value is 0.578 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the reasoning/ logical thinking of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of reasoning/ logical thinking based on management of the school

The component of the Perceived Effectiveness – reasoning/ logical thinking – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 50.

Table 50

Comparison of reasoning/ logical thinking based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	12.15	2.27	0.771	0.441
Aided	726	12.24	2.16		

From the Table 50 it is revealed that the calculated mean score for Government school students is 12.15 with standard deviation of 2.27 and mean score for Aided school students is 12.24 with standard deviation of 2.16. The calculated t-value is 0.771 and p-value is 0.441 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on reasoning/ logical thinking of IT Maths Lab for learning Mathematics.

Comparison of reasoning/logical thinking based on locality of the school

The component of the Perceived Effectiveness – reasoning/ logical thinking – was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 51.

Table 51*Comparison of reasoning/ logical thinking based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	12.30	2.08	2.351	0.019
Urban	711	12.04	2.38		

The Table 51 reveals that the mean score of reasoning/ logical thinking for rural school students is 12.30 with standard deviation of 2.08 and for urban school students is 12.04 with standard deviation of 2.38. Independent sample t-test reveals that the calculated t-value is 2.351 and the p-value is 0.019 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in Perceived Effectiveness on reasoning/ logical thinking of *IT Maths Lab* for learning Mathematics.

Comparison of reasoning/ logical thinking based on Grade in Mathematics of SSLC exam

The component of the Perceived Effectiveness – reasoning/ logical thinking – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 52.

Table 52

Comparison of reasoning/ logical thinking based on Grade in Mathematics of SSLC exam

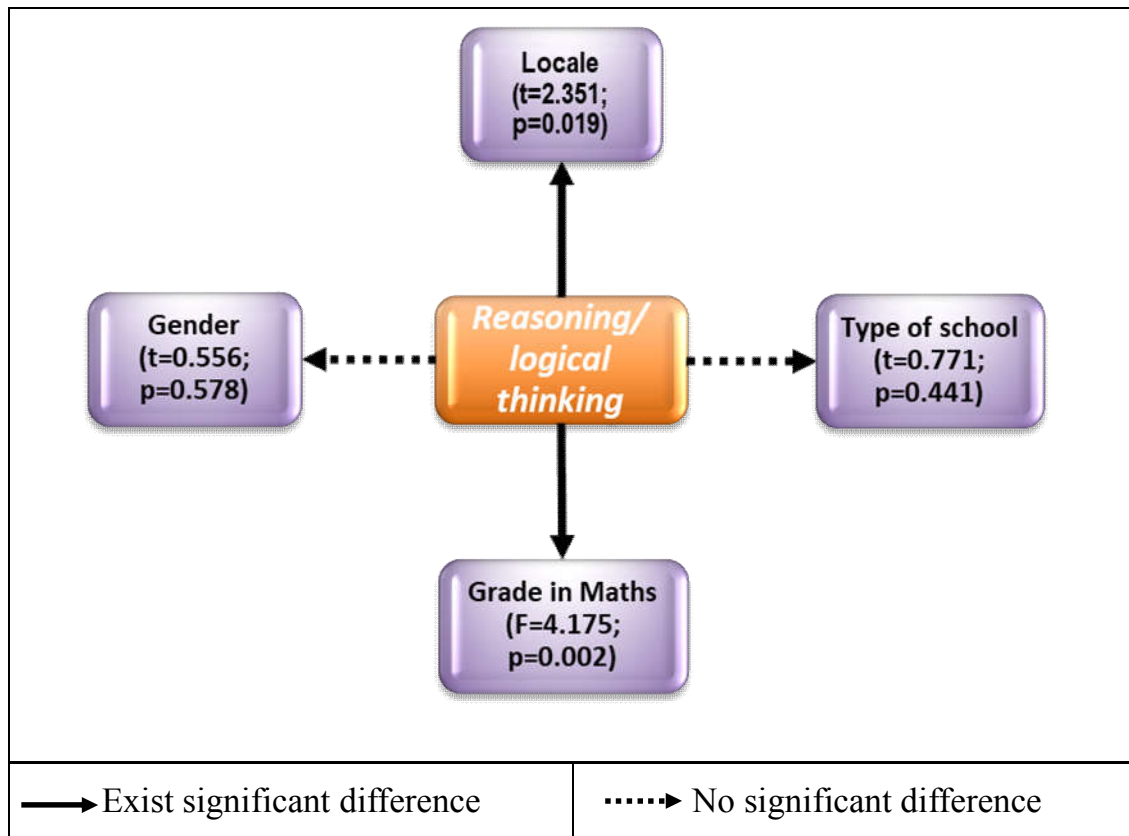
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	12.30	2.20	4.175	0.002
A	136	11.69	2.22		
B Plus	114	12.01	2.17		
B	49	11.79	1.80		
Below B	36	11.41	3.15		
Total	1631	12.19	2.22		

The Table 52 furnishes the results of comparison of Perceived Effectiveness **reasoning/ logical thinking** of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for **reasoning/ logical thinking** varying between 12.30 and 11.41 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus grade students (12.30) and lowest mean score for below B-grade students (11.41). Analysis of variance reveals that the calculated F-value is 4.175 and p-value is 0.002 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of **reasoning/ logical thinking** based on Grade in Mathematics of SSLC examination.

Consolidated result of the comparison of reasoning/ logical thinking in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 7.

Figure 7

Pictorial representation of Reasoning/ logical thinking in IT Maths Lab activities based on variable



Consolidated result shows that Gender and type of Management of the school has no significant role on reasoning/ logical thinking of IT Maths Lab activities. Whereas locality of the school and Grade obtained for Mathematics in SSLC examination has significant role on reasoning/ logical thinking of IT Maths Lab activities.

Problem Solving

For measuring the Perceived Effectiveness of IT Maths Lab in the problem solving of class room activities, the researcher used the six statements. The Estimated Means and Standard Deviations of Perceived Effectiveness component problem solving for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 53.

Table 53

Level of problem solving of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
IT Maths lab has helped to give more confidence in problem solving.	3.97	0.92	3	42.697	.000
Mathematical concepts acquired through the IT Maths lab are helpful in solving similar problems.	3.98	0.88	3	45.128	.000
Activities in the IT Maths lab are designed to clear doubts in math.	3.89	0.93	3	38.701	.000
Activities in the IT Maths lab help in solving complex problems.	3.86	0.93	3	37.389	.000
Maths learning with the help of IT Maths lab gives confidence in problem solving.	3.96	0.92	3	42.071	.000
Maths learning with the help of IT Maths lab helps in higher level problem solving	3.95	0.96	3	39.822	.000
Problem <i>solving</i>	23.63	4.53	18	50.180	.000

From the Table 53, it is seen that the mean score of problem solving is 23.63 with standard deviation 4.53. The calculated mean score (23.63) is greater than the assumed mean score of test value (18) and the p-value ($t=50.18$; $p=0.000$) is less than 0.05. Hence it can be concluded that problem solving of the Higher Secondary school student in IT Maths Lab is significantly high.

Comparison of Problem Solving based on Gender

The component of the Perceived Effectiveness – **Problem solving** – was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 54.

Table 54

Comparison of Problem solving based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	23.58	4.97	0.303	0.762
Female	1161	23.65	4.34		

Table 54 discloses that the comparison of the component of Perceived Effectiveness – problem solving – based on Gender of the Higher Secondary School Students. The average score obtained for male students is 23.58, with Standard Deviation of 4.97, and the average score of the female students is 23.65, with Standard Deviation of 4.34. Independent sample t-test gives that the calculated t-value is 0.303 and the p-value is 0.762 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the problem solving of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of Problem Solving Based on Management of the School

The component of the Perceived Effectiveness – problem solving – was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 55.

Table 55

Comparison of problem solving based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	23.67	4.58	0.352	0.725
Aided	726	23.59	4.48		

From the Table 55 it is revealed that the calculated mean score for Government school students is 23.67 with standard deviation of 4.58 and mean score for Aided school students is 23.59 with standard deviation of 4.48. The calculated t-value is 0.352 and p-value is 0.725 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness on problem solving of IT Maths Lab for learning Mathematics.

Comparison of Problem Solving Based on Locality of the School

The component of the Perceived Effectiveness – problem solving– was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 56.

Table 56*Comparison of problem solving based on locality of the school*

Location	N	Mean	SD	t-value	p-value
Rural	920	23.81	4.37	1.845	0.065
Urban	711	23.40	4.72		

The Table 56 reveals that the mean score of problem solving for rural school students is 23.81 with standard deviation of 4.37 and for urban school students is 23.40 with standard deviation of 4.72. Independent sample t-test reveals that the calculated t-value is 1.845 and the p-value is 0.065 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in Perceived Effectiveness on problem solving of *IT Maths Lab* for learning Mathematics.

Comparison of Problem Solving Based on GRADE in Mathematics of SSLC

Exam

The component of the Perceived Effectiveness – problem solving – was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 57.

Table 57*Comparison of problem solving based on Grade in Mathematics of SSLC exam*

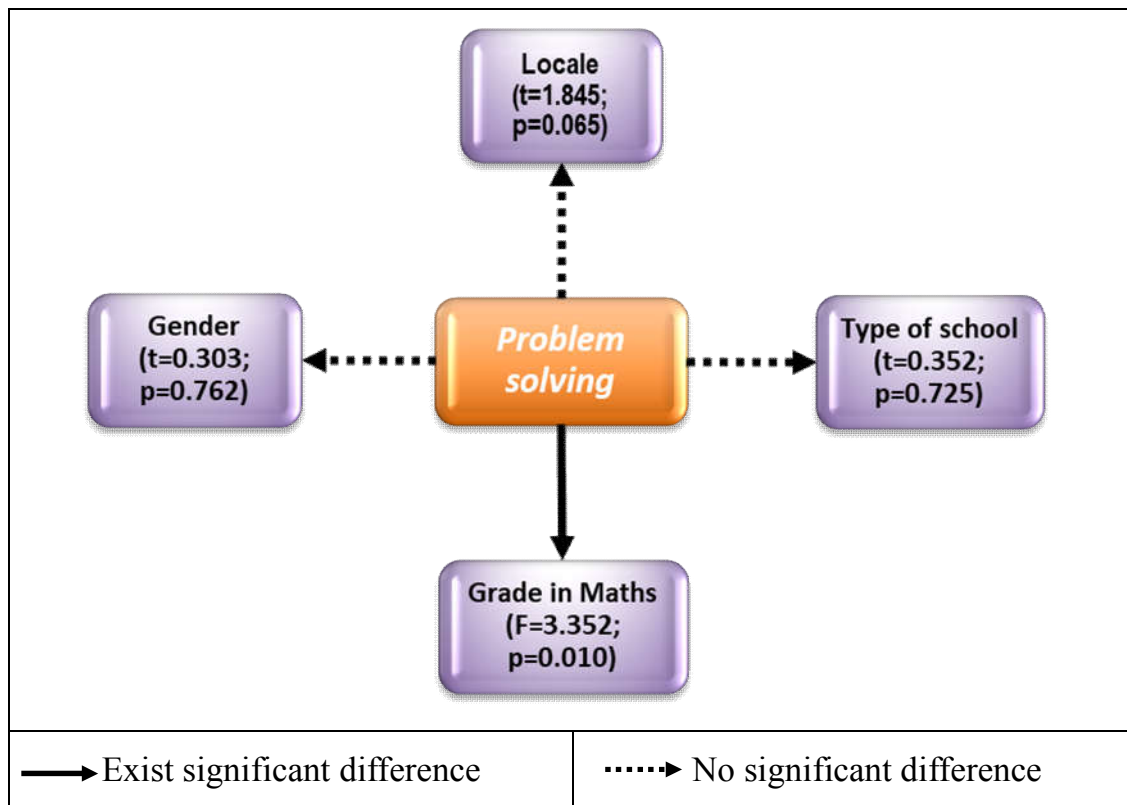
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	23.81	4.51	3.352	0.010
A	136	22.48	4.59		
B Plus	114	23.57	4.15		
B	49	23.10	3.83		
Below B	36	22.58	6.16		
Total	1631	23.63	4.53		

The Table 57 furnishes the results of comparison of Perceived Effectiveness **problem solving** of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for **problem solving** varying between 23.81 and 22.48 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus Grade students (23.81) and lowest mean score for A-grade students (22.48). Analysis of variance reveals that the calculated F-value is 3.352 and p-value is 0.010 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of **problem solving** based on grade in Mathematics of SSLC examination.

Consolidated result of the comparison of problem solving in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 8.

Figure 8

Pictorial representation of Problem solving in IT Maths Lab activities based on variable



Consolidated result shows that Gender and type of Management of the school has no significant role on problem solving of IT Maths Lab activities. Whereas locality of the school and Grade obtained for Mathematics in SSLC examination has significant role on problem solving of IT Maths Lab activities.

Perceived Effectiveness

For measuring the Perceived Effectiveness of IT Maths Lab in the class room activities, the researcher used the aggregate score of the seven components such as

Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking, and Problem solving. The Estimated Means and Standard Deviations of Perceived Effectiveness of the components for the Total sample of Higher Secondary School Mathematics Stream Students and the test results of significance of the Means using one tailed one sample t-test is presented in Table 58.

Table 58

*Level of **Perceived effectiveness** of students in IT Maths Lab activities for learning Mathematics*

Components	Mean	SD	Test-value	t-value	p-value
<i>Participation</i>	27.99	4.44	21	63.507	.000
<i>Practicability</i>	15.02	2.85	12	42.738	.000
<i>Understanding</i>	19.90	3.69	15	53.604	.000
<i>Self-assessment</i>	20.24	3.63	15	58.341	.000
<i>Concept formation,</i>	24.43	4.14	18	62.667	.000
<i>Reasoning /logical thinking</i>	12.19	2.22	9	57.983	.000
<i>Problem solving</i>	23.63	4.53	18	50.180	.000
Perceived effectiveness	143.44	23.18	108	50.18	.000

From the Table 58, it is seen that the mean score of Perceived Effectiveness is 143.44 with standard deviation of 23.18. The calculated mean score (143.44) is greater than the assumed mean score of test value (108) and the p-value ($t=50.18$; $p=0.000$) is less than 0.05. Hence it can be concluded that Perceived Effectiveness of the Higher Secondary school student in IT Maths Lab is significantly high.

Objective 4 To compare the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools students of subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.

Comparison of Perceived Effectiveness Based on Gender

The Perceived Effectiveness was compared based on the Gender of the Higher Secondary School Students using independent sample t-test and it is presented in Table 59.

Table 59

Comparison of Perceived effectiveness based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	470	143.05	25.41	0.423	0.672
Female	1161	143.59	22.23		

Table 59 discloses that the comparison of the Perceived Effectiveness IT Maths Lab based on Gender of the Higher Secondary School Students. The average score obtained for male students is 143.05, with Standard Deviation of 25.41, and the average score of the female students is 143.59, with Standard Deviation of 22.23. Independent sample t-test gives that the calculated t-value is 0.423 and the p-value is 0.672 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the Perceived Effectiveness of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students.

Comparison of Perceived Effectiveness Based on Management of the School

The Perceived Effectiveness was compared based on the management of the Higher Secondary school using independent sample t-test and it is presented in Table 60.

Table 60

Comparison of Perceived Effectiveness based on management of the school

Management	N	Mean	SD	t-value	p-value
Government	905	143.20	23.44	0.456	0.648
Aided	726	143.73	22.88		

From the Table 60 it is revealed that the calculated mean score for Government school students is 143.20 with standard deviation of 23.44 and mean score for Aided school students is 143.73 with standard deviation of 22.88. The calculated t-value is 0.456 and p-value is 0.648 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between Government and Aided school students in Kerala in their Perceived Effectiveness of IT Maths Lab for learning Mathematics.

Comparison of Perceived Effectiveness Based on Locality of the School

The Perceived Effectiveness was compared based on the locality of the Higher Secondary school using independent sample t-test and it is presented in Table 61.

Table 61

Comparison of Perceived Effectiveness based on locality of the school

Location	N	Mean	SD	t-value	p-value
Rural	920	144.29	21.99	1.687	0.092
Urban	711	142.34	24.62		

The Table 61 reveals that the mean score of Perceived Effectiveness for rural school students is 144.29 with standard deviation of 21.99 and for urban school students is 142.34 with standard deviation of 24.62. Independent sample t-test reveals that the calculated t-value is 1.687 and the p-value is 0.092 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in the Perceived Effectiveness of *IT Maths Lab* for learning Mathematics.

Comparison of Perceived Effectiveness based on Grade in Mathematics of SSLC exam

The Perceived Effectiveness was compared based on the Grade obtained for Mathematics of SSLC examination of the Higher Secondary School Students using Analysis of Variance (ANOVA) and the result is presented in Table 62.

Table 62

Comparison of Perceived Effectiveness based on Grade in Mathematics of SSLC exam

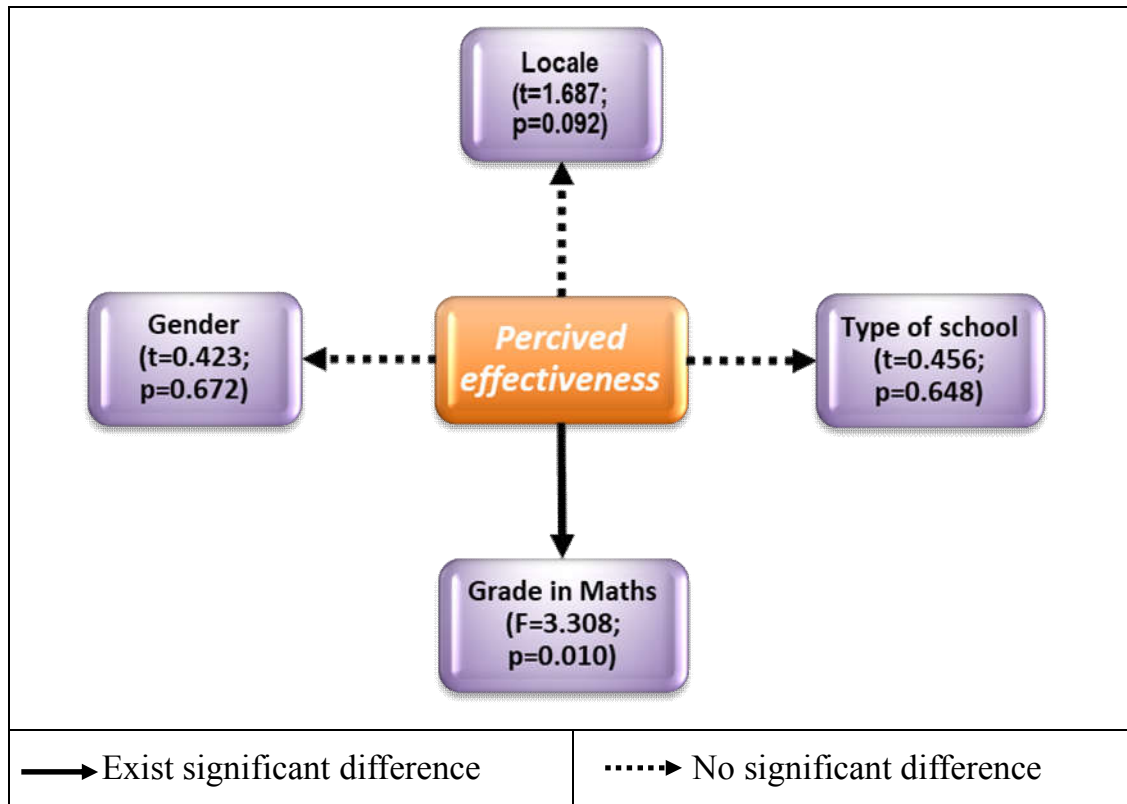
Grade	N	Mean	SD	F-value	p-value
A Plus	1296	144.39	22.98	3.308	0.010
A	136	138.13	22.08		
B Plus	114	142.39	21.64		
B	49	139.75	20.87		
Below B	36	137.47	35.97		
Total	1631	143.44	23.18		

The Table 62 furnishes the results of comparison of Perceived Effectiveness of Higher Secondary School Students based on Grade obtained Mathematics in the SSLC examination. The mean score obtained for **Perceived Effectiveness** varying between 144.39 and 137.47 based on the Grade in Mathematics of SSLC examination among Higher Secondary School Students. The highest mean score is for A-plus Grade students (144.39) and lowest mean score for below B-grade students (137.47). Analysis of variance reveals that the calculated F-value is 3.308 and p-value is 0.010 which is less than 0.05. Hence it can be concluded that there exist significant variation in the Perceived Effectiveness of higher IT Maths Lab activities among Higher Secondary school Mathematics students based on Grade in Mathematics of SSLC examination.

Consolidated result of the comparison of Perceived Effectiveness in *IT Maths Lab* activities based of Gender, locale of the students, type of management of the school and Grade in Mathematics of SSLC examination is presented in Figure 9.

Figure 9

Pictorial representation of Perceived effectiveness in IT Maths Lab activities based on variable



Consolidated result shows that Gender and type of Management of the school has no significant role on Perceived Effectiveness of IT Maths Lab activities. Whereas locality of the school and Grade obtained for Mathematics in SSLC examination has significant role on Perceived Effectiveness of IT Maths Lab activities.

Attitude of Teachers towards IT Maths Lab

To measure the Attitude of teachers towards *IT Maths Lab* for the transaction of the content in Mathematics among Higher Secondary Schools,

the researcher developed a tool and it was used. The scorings are done as per the indicators developed in the tool and it is analysed based on the objectives and hypothesis.

Objective 5 To identify the Attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among Higher Secondary Schools.

Identifying the Normality of the Variables

For applying inferential statistics it is necessary to identify the normality of the variables. As the main step of analysis, the key statistical constants such as Mean, Median, Mode, Standard Deviation, Skewness and Kurtosis of the variables were determined for the total sample. Details of the coefficients obtained regarding the variables parenting are presented in Table 63.

Table 63

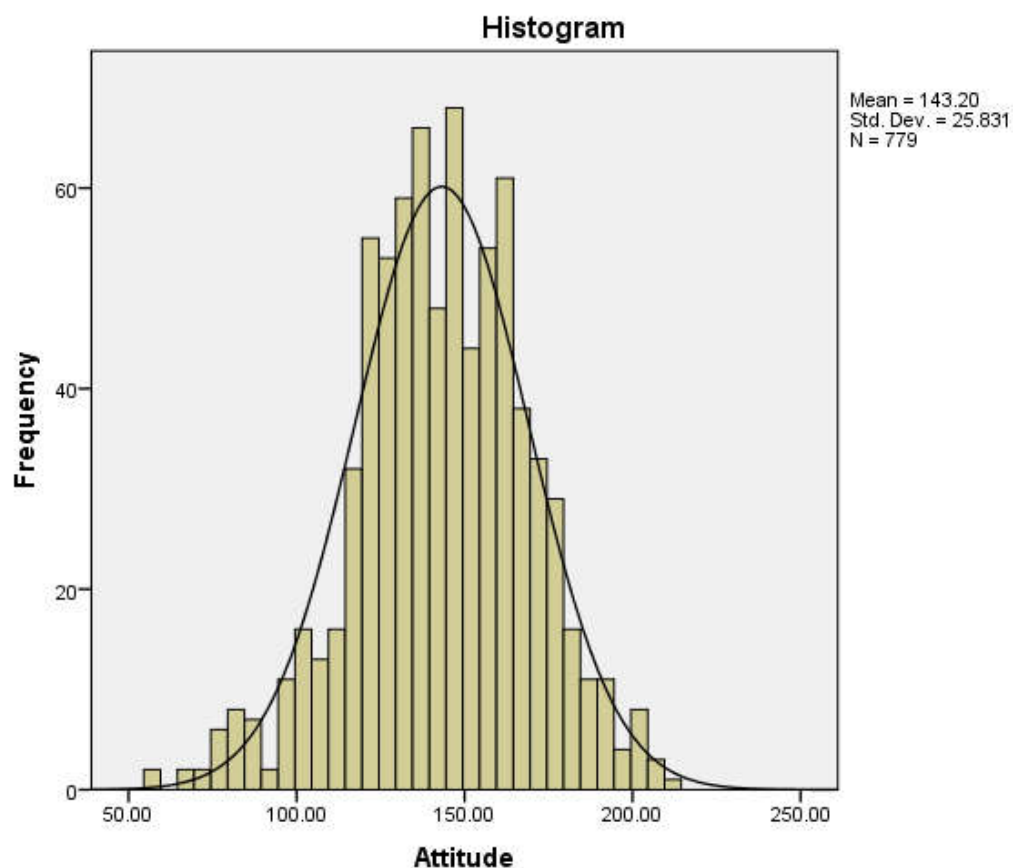
Statistical Constants of the Variable Attitude towards IT Maths Lab

Statistical Constant	<i>Attitude towards IT Maths Lab</i>
Mean	143.20
Median	143.00
Mode	163.00
Std. Deviation	25.83
Skewness	-0.251
Kurtosis	0.262

The Table 63 shows that the mean, median and mode of the variable *Attitude towards IT Maths Lab score* of Higher Secondary School Teachers are 143.20, 143.00 and 163 respectively. In this distribution the mean, median and the mode fall more or less at the same point. The skewness for the score is -0.251, hence the sample distribution is found to be slightly skewed negatively and the kurtosis value is 0.262. Graphical representation of the distribution of the *Attitude towards IT Maths Lab score* of Higher Secondary School Teachers for the total sample is presented in Figure 10.

Figure 10

Graphical representation of the distribution of the Attitude score of Higher Secondary School Teachers towards IT Maths Lab



Attitude of teachers towards IT Maths Lab for learning Mathematics among Higher Secondary School Students was studied by collecting data from teachers by administering Attitude Scale prepared by the investigator. *Attitude of teachers towards IT Maths Lab* was defined as to have seven components such as **Participation of Learners, Motivation, Resources, Concept Formation, Transaction, Evaluation and Training.** As such the level of Attitude towards *IT Maths Lab* for learning Mathematics among Higher Secondary School Mathematics stream students on each of these seven component variables and as a composite score of all the seven were estimated as mean scores and standard deviations of each and then by applying one tailed one sample t-test of significance to these mean scores. These were done for the total sample and comparison was done for the subsamples of students based on the four classificatory variables viz., Gender, Type of school Management, School Locale, Experience and Age of Teachers.

Participation of Learners

For measuring the Attitude of teachers towards participation of learners in the class room activities, the researcher used the four statements. The Estimated Means and Standard Deviations of Attitude score of participation of learners for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 64.

Table 64

Level of Attitude of teachers towards Participation of learners in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Mathematics teaching through IT Maths Lab contributes to the level of participation of learner	3.61	0.83	3	20.411	.000
Mathematics teaching through IT Maths Lab has increased their level of involvement of learner in the subject of Mathematics	3.57	0.93	3	17.059	.000
Mathematics teaching through IT Maths Lab encourages the learner to self-doing activities	3.52	0.97	3	15.155	.000
Mathematics teaching through IT Maths Lab provides the learners a lot of concept related additional activities	3.59	0.93	3	17.963	.000
Participation	14.31	3.05	12	21.131	.000

From the Table 64, it is seen that the mean score of *Attitude of teachers towards Participation of learners in IT Maths Lab activities for learning Mathematics* is 14.31 with standard deviation 3.05. The calculated mean score (14.31) is greater than the assumed mean score of test value (12) and the p-value ($t=21.131$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards Participation of learners in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Participation of Learners in IT Maths Lab Based on Gender

Attitude of teachers towards Participation of learners in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 65.

Table 65

Comparison of *Attitude of teachers towards Participation of learners in IT Maths Lab* based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	14.28	3.61	0.146	0.884
Female	592	14.32	2.85		

Table 65 shows that the mean score of the Attitude of teachers *towards Participation of learners in IT Maths Lab* of Male is 14.28 with standard deviation of 3.61 and that of Female is 14.32 with standard deviation of 2.85. Independent sample t-test discloses that there is no significant difference between the male and female teachers in their *Attitude towards participation of learners in IT Maths Lab*, since the p-value ($t = 0.146$; $p = 0.884$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards participation of learners in IT Maths Lab* based on Gender.

Comparison of *Attitude of Teachers Towards Participation of Learners in IT Maths Lab* Based on Type of Management of the School

Attitude of teachers towards participation of learners in IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 66.

Table 66

Comparison of Attitude of teachers towards Participation of learners in IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	14.36	3.09	0.460	0.646
Aided	409	14.26	3.01		

Table 66 discloses that the mean score of the Attitude of teachers *towards Participation of learners in IT Maths Lab* of Government school teachers is 14.36 with standard deviation of 3.09 and that of Aided school teachers is 14.26 with standard deviation of 3.01. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards participation of learners in IT Maths Lab*, since the p-value ($t = 0.460$; $p = 0.646$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards participation of learners in IT Maths Lab* based on type of management of the school.

Comparison of Attitude of Teachers Towards Participation of Learners in of IT Maths Lab Based on Location of School

Attitude of teachers towards Participation of learners in of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 67.

Table 67

Comparison of Attitude of teachers towards Participation of learners in of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	14.35	3.08	0.652	0.514
Urban	207	14.19	2.97		

Table 67 displays that the mean score of the Attitude of teachers *towards Participation of learners of IT Maths Lab* of Rural school teachers is 14.35 with standard deviation of 3.08 and that of urban school teachers is 14.19 with standard deviation of 2.97. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards Participation of learners of IT Maths Lab*, since the p-value ($t = 0.652$; $p = 0.514$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards Participation of learners of IT Maths Lab* based on locality of the school.

Comparison of Attitude of Teachers Towards Participation of Learners of IT Maths Lab Based on Teaching Experience Group

Attitude of teachers towards participation of learners of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 68.

Table 68

Comparison of Attitude of teachers towards Participation of learners of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Upto 10	200	14.48	3.01	0.417	0.659
10 to 20	342	14.26	3.10		
Above 20	237	14.23	3.02		
Total	779	14.31	3.05		

As per Table 68, the mean score of *Attitude of teachers towards Participation of learners of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 14.48, 14.26 and 14.23 with standard deviations of 3.01, 3.10 and 3.02 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards Participation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=0.417$, $p=0.659$) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards Participation of learners of IT Maths Lab* of teachers based on experience' is accepted at 0.05 level.

Comparison of Attitude of Teachers Towards Participation of Learners of IT Maths Lab Based on Age Group

Attitude of teachers towards Participation of learners of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 69.

Table 69

Comparison of Attitude of teachers towards Participation of learners of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	14.96	2.72	3.592	0.028
40 to 50	455	14.16	3.13		
Above 50	194	14.23	3.02		
Total	779	14.31	3.05		

Table 69 shows that the mean score of *Attitude of teachers towards Participation of learners of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 14.96, 14.16 and 14.23 with standard deviations of 2.72, 3.13 and 3.02 respectively. *Attitude of teachers towards Participation of learners of IT Maths Lab* is high among the teachers of age group Below 40 (14.96) and it is lower among the teachers of age group 40 to 50 (14.16). Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards Participation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=3.592$, $p=0.028$) is less than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards Participation of learners of IT Maths Lab* of teachers based on age group' is rejected at 0.05 level.

Motivation

For measuring the Attitude of teachers towards motivation of learners in the class room activities, the researcher used the eight statements. The Estimated Means and Standard Deviations of Attitude score of motivation of learners for the Total

sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one sample t-test is presented in Table 70.

Table 70

Level of Attitude of teachers towards motivation of students in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Teaching mathematical content through IT <i>Maths</i> Lab motivates teachers with regard to teach mathematical content	3.59	0.93	3	26.825	.000
Mathematics teaching through IT <i>Maths</i> Lab improves the motivation with regard to mathematical content	3.87	0.90	3	21.504	.000
Mathematics teaching through IT <i>Maths</i> Lab creates interest in learning Mathematics among students	3.67	0.87	3	22.071	.000
Mathematics teaching through IT <i>Maths</i> Lab provides visual exhibition of concepts and it motivates the learner.	3.73	0.92	3	38.395	.000
Teachers are concerned with the implementation of IT <i>Maths</i> lab along with teaching learning process.	4.11	0.81	3	18.221	.000
Teachers are confident in handling IT <i>Maths</i> lab activities for teaching mathematical concepts.	3.59	0.91	3	18.614	.000
Present IT <i>Maths</i> lab activities help to change the teacher student relationship.	3.60	0.91	3	12.867	.000
Present IT <i>Maths</i> lab activities help to influence the teaching learning process positively.	3.44	0.96	3	19.151	.000
Motivation	29.68	5.45	24	29.076	.000

From the Table 70, it is seen that the mean score of *Attitude of teachers towards Motivation of learners in IT Maths Lab activities for learning Mathematics* is 29.68 with standard deviation 5.45. The calculated mean score (29.68) is greater than the assumed mean score of test value (24) and the p-value ($t=29.076$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards Motivation of learners in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Motivation of Learners in IT Maths Lab Based on Gender

Attitude of teachers towards motivation of learners in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 71.

Table 71

Comparison of Attitude of teachers towards motivation of learners in IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	29.28	6.22	1.127	0.260
Female	592	29.80	5.18		

Table 71 shows that the mean score of the Attitude of teachers *towards motivation of learners in IT Maths Lab* of Male is 29.28 with standard deviation of 6.22 and that of Female is 29.80 with standard deviation of 5.18. Independent sample t-test reveals that there is no significant difference between the male and

female teachers in their *Attitude towards motivation of learners in IT Maths Lab*, since the p-value ($t = 1.127$; $p = 0.260$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards motivation of learners in IT Maths Lab* based on Gender.

Comparison of Attitude of Teachers Towards Motivation of Learners in IT Maths Lab Based on type of Management of the School

Attitude of teachers towards motivation of learners in IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 72.

Table 72

Comparison of Attitude of teachers towards motivation of learners in IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	29.81	5.67	0.635	0.526
Aided	409	29.56	5.24		

Table 72 discloses that the mean score of the Attitude of teachers *towards motivation of learners in IT Maths Lab* of Government school teachers is 29.81 with standard deviation of 5.67 and that of Aided school teachers is 29.56 with standard deviation of 5.24. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their

Attitude towards motivation of learners in IT Maths Lab, since the p-value ($t = 0.635$; $p = 0.526$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards motivation of learners in IT Maths Lab* based on type of management of the school.

Comparison of Attitude of Teachers towards Motivation of Learners in of IT Maths Lab Based on Location of School

Attitude of teachers towards motivation of learners in of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 73.

Table 73

Comparison of Attitude of teachers towards motivation of learners in of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	29.64	5.49	0.285	0.776
Urban	207	29.77	5.35		

Table 73 displays that the mean score of the Attitude of teachers *towards motivation of learners of IT Maths Lab* of Rural school teachers is 29.64 with standard deviation of 5.49 and that of urban school teachers is 29.77 with standard deviation of 5.35. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards motivation of learners of IT Maths Lab*, since the p-value ($t = 0.285$; $p = 0.776$) is greater than 0.05. Hence, it can be concluded that there is no significant

difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers Towards Motivation of Learners of IT Maths Lab* based on Teaching Experience Group

Attitude of teachers towards motivation of learners of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 74.

Table 74

Comparison of Attitude of teachers towards motivation of learners of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	30.21	5.02	1.640	0.195
10 to 20	342	29.65	5.76		
Above 20	237	29.27	5.31		
Total	779	29.68	5.45		

As per Table 74, the mean score of *Attitude of teachers towards motivation of learners of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 30.21, 29.65 and 29.27 with standard deviations of 5.02, 5.76 and 5.31 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=1.640$, $p=0.195$) is

greater than 0.05. Hence, the null hypothesis stated that, ‘There is no significant difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab of teachers* based on experience’ is accepted at 0.05 level.

Comparison of *Attitude of Teachers Towards Motivation of Learners of IT Maths Lab* Based on Age Group

Attitude of teachers towards motivation of learners of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 75.

Table 75

Comparison of Attitude of teachers towards motivation of learners of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	30.74	4.92	2.996	0.051
40 to 50	455	29.46	5.68		
Above 50	194	29.47	5.17		
Total	779	29.68	5.45		

Table 75 shows that the mean score of *Attitude of teachers towards motivation of learners of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 30.74, 29.46 and 29.47 with standard deviations of 4.92, 5.68 and 5.17 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab* among teachers of various age groups, since the p-value (F=2.996, p=0.051) is less than 0.05. Hence, the null hypothesis stated that, ‘There is no significant

difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab of teachers* based on age group' is accepted at 0.05 level.

Resources

For measuring the Attitude of teachers towards resources of IT Maths Lab for the class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Attitude score of teaches towards resources for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 76.

Table 76

Level of Attitude of teachers towards resources in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Application of information technology is essential in the learning process of Mathematics.	3.86	0.90	3	26.498	.000
The use of Mathematics learning resources given in the IT Maths lab helps to improve the learning process.	3.71	0.88	3	22.501	.000
In addition to the existing math lab activities, other activities should be included to teach more mathematical concepts.	3.23	1.08	3	6.105	.000
The software included in the present IT Maths lab activities are adequate to the teaching learning process.	3.30	0.93	3	9.045	.000
The present infrastructure facilities given in the present IT Maths lab are adequate to the teaching learning process.	2.60	1.08	3	10.310	.000
Resources	16.71	3.33	15	14.365	.000

From the Table 76, it is seen that the mean score of *Attitude of teachers towards resources available in IT Maths Lab activities for learning Mathematics* is 16.71 with standard deviation 3.33. The calculated mean score (16.71) is greater than the assumed mean score of test value (15) and the p-value ($t=14.365$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards resources available in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Resources in IT Maths Lab Based on Gender

Attitude of teachers towards resources in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 77.

Table 77

Comparison of Attitude of teachers towards resources in IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	16.91	3.57	0.964	0.335
Female	592	16.65	3.25		

Table 77 shows that the mean score of the Attitude of teachers *towards resources in IT Maths Lab* of Male is 16.91 with standard deviation of 3.57 and that of Female is 16.65 with standard deviation of 3.25. Independent sample t-test reveals that there is no significant difference between the male and female teachers

in their *Attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.964$; $p = 0.335$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* based on Gender.

Comparison of Attitude of Teachers Towards Resources of IT Maths Lab Based on Type of Management of the School

Attitude of teachers towards resources of IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 78.

Table 78

Comparison of Attitude of teachers towards resources of IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	16.66	3.40	0.378	0.706
Aided	409	16.75	3.27		

Table 78 discloses that the mean score of the Attitude of teachers *towards resources of IT Maths Lab* of Government school teachers is 16.66 with standard deviation of 3.40 and that of Aided school teachers is 16.75 with standard deviation of 3.27. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.378$; $p = 0.706$) is

greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* based on type of management of the school.

Comparison of *Attitude of teachers towards resources of IT Maths Lab* based on location of school

Attitude of teachers towards resources of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 79.

Table 79

Comparison of Attitude of teachers towards resources of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	16.77	3.35	0.876	0.381
Urban	207	16.54	3.26		

Table 79 displays that the mean score of the Attitude of teachers *towards resources of IT Maths Lab* of Rural school teachers is 16.77 with standard deviation of 3.35 and that of urban school teachers is 16.54 with standard deviation of 3.26. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.876$; $p = 0.381$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers Towards Resources of IT Maths Lab* Based on Teaching Experience Group

Attitude of teachers towards resources of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 80.

Table 80

Comparison of Attitude of teachers towards resources of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	17.11	3.17	2.714	0.067
10 to 20	342	16.71	3.42		
Above 20	237	16.37	3.29		
Total	779	16.71	3.33		

As per Table 80, the mean score of *Attitude of teachers towards resources of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 17.11, 16.71 and 16.37 with standard deviations of 3.17, 3.42 and 3.29 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* among teachers of various age groups, since the p-value (F=2.714, p=0.067) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* of teachers based on experience' is accepted at 0.05 level.

Comparison of *Attitude of Teachers towards Resources of IT Maths Lab* Based on Age Group

Attitude of teachers towards resources of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 81.

Table 81

Comparison of Attitude of teachers towards resources of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	17.63	3.01	6.214	0.002
40 to 50	455	16.47	3.50		
Above 50	194	16.67	3.02		
Total	779	16.71	3.33		

Table 81 shows that the mean score of *Attitude of teachers towards resources of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 17.63, 16.47 and 16.67 with standard deviations of 3.01, 3.50 and 3.02 respectively. *Attitude of teachers towards resources of IT Maths Lab* is high among the teachers of age group Below 40 (17.63) and it is lower among the teachers of age group 40 to 50 (16.47). Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards resources of IT Maths Lab* among teachers of various age groups, since the p-value ($F=6.214$, $p=0.002$) is less than 0.05. Hence, the null hypothesis stated that, ‘There is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* of teachers based on age group’ is rejected at 0.05 level.

Concept Formation

For measuring the Attitude of teachers towards concept formation of IT Maths Lab for the class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Attitude score of concept formation for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 82.

Table 82

Level of Attitude of teachers towards concept formation of learners in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Mathematics teaching through IT Maths Lab help in the learning of mathematical concepts among students	3.63	0.87	3	20.052	.000
Mathematics teaching through IT Maths Lab helps to strengthen the mathematical concepts among students	3.73	0.88	3	23.221	.000
Mathematics teaching through IT Maths Lab is helpful to concretise the abstract concepts among students.	3.75	0.86	3	24.459	.000
Through the visualisation in IT Maths lab activities, deep mathematical concepts can be fully conveyed to children.	3.59	0.91	3	18.249	.000
Mathematics teaching through IT Maths Lab contributes to the application of the mathematical concept in the context of problem solving.	3.43	0.93	3	12.906	.000
Lab activities are available to cover all the mathematical concept at the Higher Secondary level	2.89	1.01	3	-2.906	.000
Concept	21.04	4.39	18	19.348	.000

From the Table 82, it is seen that the mean score of *Attitude of teachers towards concept formation of learners in IT Maths Lab activities for learning Mathematics* is 21.04 with standard deviation 4.39. The calculated mean score (21.04) is greater than the assumed mean score of test value (18) and the p-value ($t=19.348$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards concept formation of learners in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Concept Formation of Learners in IT Maths Lab Based on Gender

Attitude of teachers towards concept formation of learners in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 83.

Table 83

Comparison of Attitude of teachers towards concept formation of learners in IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	20.91	4.92	0.461	0.645
Female	592	21.08	4.21		

Table 83 shows that the mean score of the Attitude of teachers *towards concept formation of learners in IT Maths Lab* of Male is 20.91 with standard deviation of 4.92 and that of Female is 21.08 with standard deviation of 4.21. Independent sample t-test reveals that there is no significant difference between the

male and female teachers in their *Attitude towards concept formation of learners of IT Maths Lab*, since the p-value ($t = 0.461$; $p = 0.645$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* based on Gender.

Comparison of Attitude of Teachers Towards Concept Formation of Learners of IT Maths Lab Based on Type of Management of the School

Attitude of teachers towards concept formation of learners of IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 84.

Table 84

Comparison of Attitude of teachers towards concept formation of learners of IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	21.17	4.47	0.765	0.444
Aided	409	20.92	4.31		

Table 84 discloses that the mean score of the Attitude of teachers *towards concept formation of learners of IT Maths Lab* of Government school teachers is 21.17 with standard deviation of 4.47 and that of Aided school teachers is 20.92 with standard deviation of 4.31. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards concept formation of learners of IT Maths Lab*, since the p-value

($t = 0.765$; $p = 0.444$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* based on type of management of the school.

Comparison of Attitude of Teachers towards Concept Formation of Learners of IT Maths Lab Based on Location of School

Attitude of teachers towards concept formation of learners of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 85.

Table 85

Comparison of Attitude of teachers towards concept formation of learners of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	21.03	4.47	0.073	0.942
Urban	207	21.06	4.16		

Table 85 displays that the mean score of the Attitude of teachers *towards concept formation of learners of IT Maths Lab* of Rural school teachers is 21.03 with standard deviation of 4.47 and that of urban school teachers is 21.06 with standard deviation of 4.16. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards concept formation of learners of IT Maths Lab*, since the p-value ($t = 0.073$; $p = 0.942$) is greater than 0.05. Hence, it can be concluded that there is no

significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* based on locality of the school.

Comparison of Attitude of Teachers Towards Concept Formation of Learners of IT Maths Lab Based on Teaching Experience Group

Attitude of teachers towards concept formation of learners of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 86.

Table 86

Comparison of Attitude of teachers towards concept formation of learners of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	21.42	3.80	1.152	0.317
10 to 20	342	20.99	4.69		
Above 20	237	20.79	4.39		
Total	779	21.04	4.39		

As per Table 86, the mean score of *Attitude of teachers towards concept formation of learners of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 21.42, 20.99 and 20.79 with standard deviations of 3.80, 4.69 and 4.39 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* among teachers of various age groups, since the p-value (F=1.152, p=0.317) is greater than 0.05. Hence, the null hypothesis stated that,

‘There is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* of teachers based on experience’ is accepted at 0.05 level.

Comparison of Attitude of Teachers Towards Concept Formation of Learners of IT Maths Lab Based on Age Group

Attitude of teachers towards concept formation of learners of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 87.

Table 87

Comparison of Attitude of teachers towards concept formation of learners of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	21.63	3.99	2.143	0.118
40 to 50	455	20.78	4.49		
Above 50	194	21.24	4.369		
Total	779	21.04	4.39		

Table 87 shows that the mean score of *Attitude of teachers towards concept formation of learners of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 21.63, 20.78 and 21.24 with standard deviations of 3.99, 4.49 and 4.36 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* among teachers of various age groups, since the p-value (F=2.143,

$p=0.118$) is greater than 0.05. Hence, the null hypothesis stated that, ‘There is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab of teachers* based on age group’ is accepted at 0.05 level.

Transaction

For measuring the Attitude of teachers towards transaction of content of IT Maths Lab for the class room activities, the researcher used the nine statements. The Estimated Means and Standard Deviations of Attitude score of transaction of the content among learners for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 88.

Table 88

Level of Attitude of teachers towards transaction of content among learners in IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	P-value
For the transaction of the mathematical content, make use of software (geogebra, python, spreadsheet, etc.)	3.34	0.91	3	10.413	.000
Use of IT <i>Maths</i> Lab can reduce time consumption in the transaction of the mathematical content	3.13	1.06	3	3.475	.001
Transaction of the mathematical content through IT <i>Maths</i> lab helps to enhance the logical thinking.	3.47	0.94	3	14.187	.000
Use of IT <i>Maths</i> Lab for the transaction of the mathematical content helps to enhance the freedom	3.36	0.92	3	11.050	.000

Statement	Mean	SD	Test-value	t-value	p-value
in self-learning skill.					
Activities included in the IT <i>Maths</i> lab are adequate to achieve mathematical content.	3.29	0.89	3	9.245	.000
IT <i>Maths</i> lab activities are arranged in a simple manner which help the students for self-learning.	3.35	0.94	3	10.317	.000
IT <i>Maths</i> lab activities are arranged in a simple manner which help the students for understanding the mathematical concepts.	3.42	0.92	3	12.813	.000
It is possible to complete the IT <i>Maths</i> lab activities along with the class room activities.	2.48	1.14	3	- 12.558	.000
Time allotted for the IT <i>Maths</i> lab activities are adequate.	2.21	1.10	3	- 19.852	.000
Transaction	28.08	6.43	27	4.727	.000

From the Table 88, it is seen that the mean score of *Attitude of teachers towards transaction of content among learners in IT Maths Lab activities for learning Mathematics* is 28.08 with standard deviation 6.43. The calculated mean score (28.08) is greater than the assumed mean score of test value (27) and the p-value ($t=4.727$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards transaction of content among learners in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of *Attitude of Teachers Towards Transaction of Content of Learners in IT Maths Lab* Based on Gender

Attitude of teachers towards transaction of content of learners in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 89.

Table 89

Comparison of Attitude of teachers towards transaction of content of learners in IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	27.97	7.01	0.284	0.776
Female	592	28.12	6.24		

Table 89 shows that the mean score of the Attitude of teachers *towards transaction of content of learners in IT Maths Lab* of Male is 27.97 with standard deviation of 7.01 and that of Female is 28.12 with standard deviation of 6.24. Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *Attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.284$; $p = 0.776$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* based on Gender.

Comparison of *Attitude of Teachers towards Transaction of Content of Learners of IT Maths Lab* Based on Type of Management of the School

Attitude of teachers towards transaction of content of learners of IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 90.

Table 90

Comparison of Attitude of teachers towards transaction of content of learners of IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	28.01	6.48	0.304	0.761
Aided	409	28.15	6.39		

Table 90 discloses that the mean score of the Attitude of teachers *towards transaction of content of learners of IT Maths Lab* of Government school teachers is 28.01 with standard deviation of 6.48 and that of Aided school teachers is 28.15 with standard deviation of 6.39. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.304$; $p = 0.761$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* based on type of management of the school.

Comparison of *Attitude of Teachers Towards Transaction of Content of Learners of IT Maths Lab* Based on Location of School

Attitude of teachers towards transaction of content of learners of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 91.

Table 91

Comparison of Attitude of teachers towards transaction of content of learners of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	28.17	6.56	0.600	0.549
Urban	207	27.85	6.05		

Table 91 displays that the mean score of the Attitude of teachers *towards transaction of content of learners of IT Maths Lab* of Rural school teachers is 28.17 with standard deviation of 6.56 and that of urban school teachers is 27.85 with standard deviation of 6.05. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.600$; $p = 0.549$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers Towards Transaction of Content of Learners of IT Maths Lab* based on Teaching Experience Group

Attitude of teachers towards transaction of content of learners of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 92.

Table 92

Comparison of Attitude of teachers towards transaction of content of learners of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	29.19	5.98	4.256	0.015
10 to 20	342	27.54	6.83		
Above 20	237	27.95	6.11		
Total	779	28.08	6.43		

As per Table 92, the mean score of *Attitude of teachers towards transaction of content of learners of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 29.19, 27.54 and 27.95 with standard deviations of 5.98, 6.83 and 6.11 respectively. Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=4.256$, $p=0.015$) is less than 0.05. Hence, the null hypothesis stated that, ‘There is no significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* of teachers based on experience’ is rejected at 0.05 level.

Comparison of *Attitude of Teachers Towards Transaction of Content of Learners of IT Maths Lab* Based on Age Group

Attitude of teachers towards transaction of content of learners of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 93.

Table 93

Comparison of Attitude of teachers towards transaction of content of learners of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	29.97	6.03	6.810	0.001
40 to 50	455	27.70	6.46		
Above 50	194	27.72	6.42		
Total	779	28.08	6.43		

Table 93 shows that the mean score of *Attitude of teachers towards transaction of content of learners of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 29.97, 27.70 and 27.72 with standard deviations of 6.03, 6.46 and 6.42 respectively. *Attitude of teachers towards transaction of content of learners of IT Maths Lab* is high among the teachers of age group Below 40 (29.97) and it is lower among the teachers of age group 40 to 50 (27.70). Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=6.810$, $p=0.001$) is less than 0.05. Hence, the null hypothesis stated that, ‘There is no significant difference in the

Attitude of teachers towards transaction of content of learners of IT Maths Lab of teachers based on age group' is rejected at 0.05 level.

Evaluation

For measuring the Attitude of teachers towards evaluation through IT Maths Lab for the class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Attitude score of evaluation of content for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 94.

Table 94

Level of Attitude of teachers towards evaluation in IT Maths Lab activities for learning mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Activities of IT <i>Maths</i> lab helps in the continuous evaluation of the learners.	3.05	0.98	3	1.598	.111
Activities of IT <i>Maths</i> lab helps in the comprehensive evaluation of the learners.	3.08	0.92	3	2.440	.015
Activities of IT <i>Maths</i> lab helps in the formative evaluation of the learners.	3.10	0.88	3	3.419	.001
Activities of IT <i>Maths</i> lab helps in the self-evaluation of the learners.	3.16	0.91	3	5.095	.000
IT <i>Maths</i> lab activities helps to enhance the quality of learning among the students.	3.42	0.92	3	12.684	.000
Evaluation	15.83	3.96	15	5.869	.000

From the Table 94, it is seen that the mean score of *Attitude of teachers towards evaluation in IT Maths Lab activities for learning Mathematics* is 15.83 with standard deviation 3.96. The calculated mean score (15.83) is greater than the assumed mean score of test value (15) and the p-value ($t=5.869$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards evaluation in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Evaluation of Learners in IT Maths Lab Based on Gender

Attitude of teachers towards evaluation of learners in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 95.

Table 95

Comparison of Attitude of teachers towards evaluation of learners in IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	15.58	4.26	0.991	0.322
Female	592	15.91	3.86		

Table 95 shows that the mean score of the Attitude of teachers *towards evaluation of learners in IT Maths Lab* of Male is 15.58 with standard deviation of 4.26 and that of Female is 15.91 with standard deviation of 3.86. Independent sample t-test reveals that there is no significant difference between the male and

female teachers in their *Attitude towards evaluation of learners of IT Maths Lab*, since the p-value ($t = 0.991$; $p = 0.322$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards evaluation of learners IT Maths Lab* based on Gender.

Comparison of Attitude of Teachers Towards Evaluation of Learners of IT Maths Lab Based on type of Management of the School

Attitude of teachers towards evaluation of learners of IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 96.

Table 96

Comparison of Attitude of teachers towards evaluation of learners of IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	15.94	3.92	0.720	0.472
Aided	409	15.73	3.99		

Table 96 discloses that the mean score of the Attitude of teachers *towards evaluation of learners of IT Maths Lab* of Government school teachers is 15.94 with standard deviation of 3.92 and that of Aided school teachers is 15.73 with standard deviation of 3.99. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards evaluation of learners of IT Maths Lab*, since the p-value ($t =$

0.720; $p = 0.472$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* based on type of management of the school.

Comparison of Attitude of Teachers towards Evaluation of Learners of IT Maths Lab Based on Location of School

Attitude of teachers towards evaluation of learners of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 97.

Table 97

Comparison of Attitude of teachers towards evaluation of learners of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	15.85	3.94	0.255	0.799
Urban	207	15.77	4.02		

Table 97 displays that the mean score of the Attitude of teachers *towards evaluation of learners of IT Maths Lab* of Rural school teachers is 15.85 with standard deviation of 3.64 and that of urban school teachers is 15.77 with standard deviation of 4.02. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards evaluation of learners of IT Maths Lab*, since the p-value ($t = 0.255$; $p = 0.799$) is greater than 0.05. Hence, it can be concluded that there is no significant

difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers towards Evaluation of Learners of IT Maths Lab* Based on Teaching Experience Group

Attitude of teachers towards evaluation of learners of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 98.

Table 98

Comparison of Attitude of teachers towards evaluation of learners of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	16.27	3.70	1.678	0.187
10 to 20	342	15.68	4.20		
Above 20	237	15.67	3.80		
Total	779	15.83	3.96		

As per Table 98, the mean score of *Attitude of teachers towards evaluation of learners of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 16.27, 15.68 and 15.67 with standard deviations of 3.70, 4.20 and 3.80 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=1.678$, $p=0.187$) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant

difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab of teachers* based on experience' is accepted at 0.05 level.

Comparison of *Attitude of Teachers Towards Evaluation of Learners of IT Maths Lab* Based on Age Group

Attitude of teachers towards evaluation of learners of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 99.

Table 99

Comparison of Attitude of teachers towards evaluation of learners of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	16.64	3.68	3.351	0.036
40 to 50	455	15.63	4.04		
Above 50	194	15.74	3.88		
Total	779	15.83	3.96		

Table 99 shows that the mean score of *Attitude of teachers towards evaluation of learners of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 16.64, 15.63 and 15.74 with standard deviations of 3.68, 4.04 and 3.88 respectively. *Attitude of teachers towards evaluation of learners of IT Maths Lab* is high among the teachers of age group Below 40 (16.64) and it is lower among the teachers of age group 40 to 50 (15.63). Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=3.351$, $p=0.036$) is less than 0.05. Hence, the null hypothesis stated that, 'There

is no significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab of teachers* based on age group' is rejected at 0.05 level.

Training

For measuring the Attitude of teachers towards training of IT Maths Lab for the class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Attitude score of training for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 100.

Table 100

Level of Attitude of teachers towards training of IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Department has given necessary training to the teachers for the functioning of IT <i>Maths</i> lab activities.	3.32	1.03	3	8.772	.000
Training given to the teachers for the functioning of IT <i>Maths</i> lab activities are effective.	3.46	0.99	3	13.126	.000
Continuous training to the teachers for the functioning of IT <i>Maths</i> lab activities are essential.	3.77	0.99	3	21.729	.000
Department has provided the manual to the teachers for the functioning of IT <i>Maths</i> lab activities along with training.	3.42	1.16	3	10.118	.000
Activities given in the manual are effective for the smooth functioning of IT <i>Maths</i> lab activities.	3.54	0.98	3	15.287	.000
Training	17.52	3.72	15	18.944	.000

From the Table 100, it is seen that the mean score of *Attitude of teachers towards training in IT Maths Lab activities for learning Mathematics* is 17.52 with standard deviation 3.72. The calculated mean score (17.52) is greater than the assumed mean score of test value (15) and the p-value ($t=18.944$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards training in IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Comparison of Attitude of Teachers Towards Training of IT Maths Lab Based on Gender

Attitude of teachers towards training in IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 101.

Table 101

Comparison of Attitude of teachers towards training of IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	17.04	4.06	2.051	0.041
Female	592	17.68	3.60		

Table 101 shows that the mean score of the Attitude of teachers *towards training of in IT Maths Lab* of Male is 17.04 with standard deviation of 4.06 and that of Female is 17.68 with standard deviation of 3.60. Independent sample t-test reveals that there exist significant difference between the male and female teachers

in their *Attitude towards training of IT Maths Lab*, since the p-value ($t = 2.051$; $p = 0.041$) is less than 0.05. Hence, it can be concluded that there is significant difference in the *Attitude of teachers towards training of IT Maths Lab* based on Gender.

Comparison of Attitude of Teachers Towards Training of IT Maths Lab Based on Type of Management of the School

Attitude of teachers towards training of IT Maths Lab activities was compared based on the **type of management of the school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 102.

Table 102

Comparison of Attitude of teachers towards training of IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	17.80	3.65	1.935	0.053
Aided	409	17.28	3.77		

Table 102 discloses that the mean score of the Attitude of teachers *towards training of IT Maths Lab* of Government school teachers is 17.80 with standard deviation of 3.65 and that of Aided school teachers is 17.28 with standard deviation of 3.77. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards training of IT Maths Lab*, since the p-value ($t = 1.935$; $p = 0.053$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the

Attitude of teachers towards training of IT Maths Lab based on type of management of the school.

Comparison of *Attitude of Teachers Towards Training of IT Maths Lab* Based on Location of School

Attitude of teachers towards training of IT Maths Lab activities was compared based on the **location of school** of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 103.

Table 103

Comparison of Attitude of teachers towards training of IT Maths Lab based on location of school

Location	N	Mean	SD	t-value	p-value
Rural	572	17.61	3.74	1.077	0.282
Urban	207	17.28	3.67		

Table 103 displays that the mean score of the Attitude of teachers *towards training of IT Maths Lab* of Rural school teachers is 17.61 with standard deviation of 3.74 and that of urban school teachers is 17.28 with standard deviation of 3.67. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards training of IT Maths Lab*, since the p-value ($t = 1.077$; $p = 0.282$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers Towards Training of IT Maths Lab* Based on Teaching Experience Group

Attitude of teachers towards training of IT Maths Lab activities was compared based on the **teaching experience** group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 104.

Table 104

Comparison of Attitude of teachers towards training of IT Maths Lab based on teaching experience group

Experience	N	Mean	SD	F-value	p-value
Below 10	200	17.87	3.68	2.376	0.094
10 to 20	342	17.61	3.65		
Above 20	237	17.11	3.83		
Total	779	17.52	3.72		

As per Table 104, the mean score of *Attitude of teachers towards training of IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 17.87, 17.61 and 17.11 with standard deviations of 3.68, 3.65 and 3.83 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* among teachers of various age groups, since the p-value (F=2.376, p=0.094) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* of teachers based on experience' is accepted at 0.05 level.

Comparison of *Attitude of Teachers Towards Training of IT Maths Lab* Based on Age Group

Attitude of teachers towards training of IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 105.

Table 105

Comparison of Attitude of teachers towards training of IT Maths Lab based on age group

Age	N	Mean	SD	F-value	p-value
Below 40	130	17.55	3.77	0.823	0.440
40 to 50	455	17.64	3.75		
Above 50	194	17.23	3.62		
Total	779	17.52	3.72		

Table 105 shows that the mean score of *Attitude of teachers towards training of IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 17.55, 17.64 and 17.23 with standard deviations of 3.77, 3.75 and 3.62 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* among teachers of various age groups, since the p-value ($F=0.823$, $p=0.440$) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* of teachers based on age group' is accepted at 0.05 level.

Attitude Total

For measuring the Attitude of teachers towards IT Maths Lab for the class room activities, the researcher used the five statements. The Estimated Means and Standard Deviations of Attitude score for the Total sample of Higher Secondary School Mathematics Teachers and the test results of significance of the Means using one tailed one sample t-test is presented in Table 106.

Table 106

Level of Attitude of teachers towards IT Maths Lab activities for learning Mathematics

Statement	Mean	SD	Test-value	t-value	p-value
Participation	14.31	3.05	12	21.131	.000
Motivation	29.68	5.45	24	29.076	.000
Resources	16.71	3.33	15	14.365	.000
Concept	21.04	4.39	18	19.348	.000
Transaction	28.08	6.43	27	4.727	.000
Evaluation	15.83	3.96	15	5.869	.000
Training	17.52	3.72	15	18.944	.000
Attitude	143.20	25.83	126	18.587	.000

From the Table 106, it is seen that the mean score of *Attitude of teachers towards IT Maths Lab activities for learning Mathematics* is 143.20 with standard deviation 25.83. The calculated mean score (143.20) is greater than the assumed mean score of test value (126) and the p-value ($t=18.587$; $p=0.000$) is less than 0.05. Hence it can be concluded that *Attitude of teachers towards IT Maths Lab activities for learning Mathematics* of the Higher Secondary school student is significantly high.

Objective 6 To compare the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.

Comparison of *Attitude of Teachers Towards IT Maths Lab* Based on Gender

Attitude of teachers towards IT Maths Lab activities was compared based on the Gender of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 107.

Table 107

Comparison of Attitude of teachers towards IT Maths Lab based on Gender

Gender	N	Mean	SD	t-value	p-value
Male	187	142.00	29.08	0.727	0.467
Female	592	143.58	24.73		

Table 107 shows that the mean score of the Attitude of teachers *towards IT Maths Lab* of Male is 142.00 with standard deviation of 29.08 and that of Female is 143.58 with standard deviation of 24.73. Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *Attitude towards IT Maths Lab*, since the p-value ($t = 0.727$; $p = 0.467$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards IT Maths Lab* based on Gender.

Comparison of *Attitude of Teachers Towards IT Maths Lab* Based on Type of Management of the School

Attitude of teachers towards IT Maths Lab activities was compared based on the type of management of the school of the Higher Secondary teachers using independent sample t-test and it is presented in Table 108.

Table 108

Comparison of Attitude of teachers towards IT Maths Lab based on type of management of the school

Management	N	Mean	SD	t-value	p-value
Government	370	143.77	26.32	0.583	0.560
Aided	409	142.68	25.39		

Table 108 discloses that the mean score of the Attitude of teachers *towards IT Maths Lab* of Government school teachers is 143.77 with standard deviation of 26.32 and that of Aided school teachers is 142.68 with standard deviation of 25.39. Independent sample t-test gives the result that there is no significant difference between the Government and Aided school teachers in their *Attitude towards IT Maths Lab*, since the p-value ($t = 0.583$; $p = 0.560$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards IT Maths Lab* based on type of management of the school.

Comparison of *Attitude of Teachers Towards IT Maths Lab* Based on Locality of the School

Attitude of teachers towards IT Maths Lab activities was compared based on the locale of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 109.

Table 109

Comparison of Attitude of teachers towards IT Maths Lab based on locale

Location	N	Mean	SD	t-value	p-value
Rural	572	143.45	26.25	0.461	0.645
Urban	207	142.49	24.68		

Table 109 displays that the mean score of the Attitude of teachers *towards IT Maths Lab* of Rural school teachers is 143.45 with standard deviation of 26.25 and that of urban school teachers is 142.49 with standard deviation of 24.68. Independent sample t-test gives the result that there is no significant difference between the rural and urban school teachers in their *Attitude towards IT Maths Lab*, since the p-value ($t = 0.461$; $p = 0.645$) is greater than 0.05. Hence, it can be concluded that there is no significant difference in the *Attitude of teachers towards IT Maths Lab* based on locality of the school.

Comparison of *Attitude of Teachers Towards IT Maths Lab* Based on Teaching Experience

Attitude of teachers towards IT Maths Lab activities was compared based on teaching experience of the Higher Secondary School Teachers using independent sample t-test and it is presented in Table 110.

Table 110

Comparison of Attitude of teachers towards IT Maths Lab based on teaching experience

Experience	N	Mean	SD	F-value	p-value
Below 10	200	146.57	23.58	2.413	0.090
10 to 20	342	142.47	27.29		
Above 20	237	141.41	25.30		
Total	779	143.20	25.83		

As per Table 110, the mean score of *Attitude of teachers towards IT Maths Lab* of experience group Below 10, 10 to 20 and Above 20 years are 146.57, 142.47 and 141.41 with standard deviations of 23.58, 27.29 and 25.30 respectively. Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards IT Maths Lab* among teachers of various age groups, since the p-value ($F=2.413$, $p=0.090$) is greater than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards IT Maths Lab* of teachers based on experience' is accepted at 0.05 level.

Comparison of Attitude of Teachers towards IT Maths Lab Based on Age Group

Attitude of teachers towards IT Maths Lab activities was compared based on the age group of the Higher Secondary School Teachers using Analysis of Variance (ANOVA) and it is presented in Table 111.

Table 111*Comparison of Attitude of teachers towards IT Maths Lab based on age group*

Age	N	Mean	SD	F-value	p-value
Below 40	130	149.14	23.27	4.184	0.016
40 to 50	455	141.87	26.74		
Above 50	194	142.32	24.83		
Total	779	143.20	25.83		

Table 111 shows that the mean score of *Attitude of teachers towards IT Maths Lab* of age group Below 40, 40 to 50 and Above 50 are 149.14, 141.87 and 142.32 with standard deviations of 23.27, 26.74 and 24.83 respectively. *Attitude of teachers towards IT Maths Lab* is high among the teachers of age group Below 40 (149.14) and it is lower among the teachers of age group 40 to 50 (141.87). Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards IT Maths Lab* among teachers of various age groups, since the p-value ($F=4.184$, $p=0.016$) is less than 0.05. Hence, the null hypothesis stated that, 'There is no significant difference in the *Attitude of teachers towards IT Maths Lab* of teachers based on age group' is rejected at 0.05 level.

Challenges and Problems in the Implementation of IT Maths Lab Activities

Objective 7 To identify the challenges and problems in the implementation of the IT Maths Lab activities in Higher Secondary Schools of Kerala.

To identify the challenges and problems in the implementation of the IT Maths Lab activities in Higher Secondary Schools of Kerala, responses was collected from the selected principals of higher secondary schools. Details of schools selected for the present investigation is given in Table 112.

Table 112

Profile of the respondents' principals of Higher Secondary Schools

		Number	Percentage
Locale of the school	Rural	30	85.71
	Urban	5	14.29
Management of school	Government	12	34.29
	Aided	23	65.71
Total		35	100.00

Locale of the School

Table 112 shows that out of the 35 respondents from the principals of Higher Secondary Schools included in this study, 85.71 percent of the respondents are from rural while 14.29 percent of the respondents are from urban location.

Management of the School

Table 112 shows that out of the 35 respondents of the principals of Higher Secondary Schools included in this study, 65.71 percent of the respondents are from Aided schools and the remaining 34.29 percent of the respondents are from Government schools.

Strength of the Students

Strength of the students and number of batches of the selected schools is presented in Table 113.

Table 113

Strength of the students and batches

	Total number of students	17752
Students	Number of students with Maths optional	7867
	Percentage of students with Maths optional	44.31
	Total number of batches	190
Batches	Number of batches with Maths optional	93
	Percentage of batches with Maths optional	48.94

Table 113 shows that from the total students of Higher Secondary Schools selected for the study, 44.31 percentage are studying Mathematics as the optional subject. It is also seen that 48.94 percentage of the higher secondary batches have Mathematics as one of the optional subject.

Infrastructure Facilities

Availability of the infrastructure facilities for the proper implementation of the IT Maths labs among Mathematics students of higher secondary school is given in Table 114.

Table 114

Infrastructure facilities available in the schools

Infrastructure	Yes		No	
	No	Percent	No	Percent
Separate IT Maths lab	14	40.00	21	60.00
Separate smart class room for IT Maths lab	6	17.14	29	82.86
Internet facility	33	94.29	2	5.71
Printer	22	62.86	13	37.14
Separate projector in the IT Maths lab	13	37.14	22	62.86
Separate computer for each students	11	31.43	24	68.57
Smart Boards in the IT Maths lab	5	14.29	30	85.71
White boards in the IT Maths lab	15	42.86	20	57.14
Reference materials for students	20	57.14	15	42.86
Consistent availability of power supply (SOLAR)	7	20.00	28	80.00
Consistent availability of power supply (Invertor)	21	60.00	14	40.00
Audio visual facility	20	57.14	15	42.86
Log book/ log register	24	68.57	11	31.43
Practical record	33	94.29	2	5.71
Adequate furniture in the IT Maths Lab	21	60.00	14	40.00
Adequate IT equipment in the IT Maths Lab	17	48.57	18	51.43

Table 114 shows that majority of the principals are opined that the facilities available for the implementation of IT Maths lab activities in the school are Internet facility (94.29%), Printer (62.86%), Reference materials for students (57.14%), Consistent availability of power supply (60.00%), Audio visual facility (57.14%), Log book/ log register (68.57%), Practical record (94.29%), and Adequate furniture in the IT Maths Lab (60.00%).

Table shows that majority of the principals are opined that the facilities not available in the school for the implementation of IT Maths lab activities are Separate IT Maths lab (60.00%), Separate smart class room for IT Maths lab (82.86%), Separate projector in the IT Maths lab (62.86%), Separate computer for each students (68.57%), Smart Boards in the IT Maths lab (85.71%), White boards in the IT Maths lab (57.14%), Consistent availability of power supply-SOLAR (80.00%), and Adequate IT equipment in the IT Maths Lab (51.43%).

Computer Available in the IT LAB

Computer available in the IT LAB and number of students occupied in the IT LAB in one practical session is presented in Table 115.

Table 115

Computer available in the IT LAB

Total number of computer available in the IT LAB	696
Maximum number of students occupied in the IT LAB in one practical session	1244
Ratio of computers to students	0.55

Table 115 shows that the ratio of the students to the available computer in the Higher Secondary Schools in Kerala to the implementation of the IT Maths lab is 0.55. Opinion of the principles regarding training, implementation, Attitude and feedback are presented in Table 116.

Table 116

Opinion of the principles regarding training, implementation, Attitude and feedback

Training	Yes		No	
	No	Percent	No	Percent
All teachers are availed the training in IT Maths Lab	30	85.71	5	14.29
Teachers are updating the training in each year	20	57.14	15	42.86
Effectively implementing the lab activities	31	88.57	4	11.43
Effectively utilising the IT Maths lab	32	91.43	3	8.57
Keeping log book for the utilisation of the LAB	22	62.86	13	37.14
Adequate time is allotted for the IT Maths lab	28	80.00	7	20.00
Effectively Coordinating various labs activities	32	91.43	3	8.57
Attitude of teachers are positive in the implementation of IT Maths lab activities	33	94.29	2	5.71
Face Problem in time table preparation	14	40.00	21	60.00
Utilisation of the IT Maths lab to other purpose / difficulty	19	54.29	16	45.71
Provides Extra time for slow learners	30	85.71	5	14.29
Provides additional activities for gifted learners	26	74.29	9	25.71
Keep the separate Practical history of each students	20	57.14	15	42.86
Regularly taking feedback from teachers	23	65.71	12	34.29
Regularly taking feedback from students	24	68.57	11	31.43

Training	Yes		No	
	No	Percent	No	Percent
Implementation of IT Maths Lab create Interest for learning Mathematics	30	85.71	5	14.29
Teachers conducting of separate practical evaluation other than board examination	31	88.57	4	11.43
Possible to conduct maintenance of the defective computers in time	25	71.43	10	28.57
Avail sufficient fund for the maintenance of IT Maths lab	7	20.00	28	80.00

Training: Majority (85.71%) of the principals are opined that, all teachers are availed the training in IT Maths Lab and 57.14 percentage teachers are updating the training in each year.

Implementation: Majority of the principals are opined that, the teachers are effectively implementing the lab activities (88.57%), effectively utilising the IT Maths lab (91.43%) and Keeping log book for the utilisation of the LAB (62.86).

Attitude: Majority (94.29%) of the principals are opined that, Attitude of teachers are positive in the implementation of IT Maths lab activities.

Consideration of slow learners and gifted learners: Result shows that majority (85.71%) of the principals opined that the teachers are providing extra time for slow learners and 74.29 percentage of the principals opined that the teachers are providing additional activities for gifted learners. More than half of the principals (57.14%) are keeping the separate Practical history of each students.

Feedback: Regarding the feedback, 65.71 percentage of principals opined that they regularly taking feedback from teachers and 68.57 percentage of principals opined that they are regularly taking feedback from students.

Maintenance of IT Maths Lab: Majority of the principals (71.43%) opined that it is possible to conduct maintenance of the defective computers in time. Majority of the principles (80%) also reported that they are not availing sufficient fund for the maintenance of IT Maths lab.

Problem Faced by the Teachers while Implementing the Lab Activities

Responses of the higher secondary school principals regarding the Problem faced by the teachers while implementing the lab activities is presented in Table 117.

Table 117

Problem faced by the teachers while implementing the lab activities

Problem	Major problem (%)	Minor problem (%)	Not a problem (%)
Teachers are not well equipped with lab activities	14.29	31.43	54.29
Insufficient time to complete the activities	57.14	20.00	22.86
Non availability of sufficient number of computers	62.86	22.86	14.29
Deputing teachers as external examiners during class hours	22.86	37.14	40.00
Common activities for biological/ computer science	25.71	31.43	42.86

Table 117 shows that, as per the opinion of the higher secondary school principals, insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers (62.86%) are the major problem faced by the teachers while implementing the lab activities.

Problem Faced by the Students while Implementing the Lab Activities

Responses of the higher secondary school principals regarding the Problem faced by the students while implementing the lab activities is presented in Table 118.

Table 118

Problem faced by the students while implementing the lab activities

Problem	Major problem (%)	Minor problem (%)	Not a problem (%)
Insufficient time to complete the activities	57.14	22.86	20.00
Non availability of sufficient number of computers based on the number of students	65.71	28.57	5.71
There is no observation record similar to other practical's	14.29	25.71	60.00
No correlation with theory and practical activities	14.29	31.43	54.29

Table 118 shows that, as per the opinion of the higher secondary school principals Insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers based on the number of students (65.71%) are the major problems faced by the students while implementing the lab activities.

Problem faced while Conducting IT Lab Examination

Responses of the higher secondary school principals regarding the Problem faced while conducting IT Lab examination is presented in Table 119.

Table 119

Problem faced while conducting IT Lab examination

Problem	Major problem (%)	Minor problem (%)	Not a problem (%)
Non availability of adequate physical infrastructure	51.43	34.29	14.29
Non availability of adequate number of computers	60.00	25.71	14.29
Power failure	22.86	45.71	31.43
Internet connection	17.14	34.29	48.57
Time slot allotment	22.86	37.14	40.00
Collision with other practical works	37.14	28.57	34.29

Table 119 discloses that Non availability of adequate physical infrastructure (51.43%), Non availability of adequate number of computers (60.00%) and Collision with other practical works (37.14%) are the major problems while conducting IT Lab examination. Power failure (45.71%) is the minor problem while conducting IT Lab examination.

Suggestions

The following suggestions are given by the principals of Higher Secondary Schools for the smooth implementation of the IT Maths lab activities.

- Government should provide enough facility to each school
- Separate Maths lab with all facilities
- Restructuring syllabus
- Start practical at the beginning itself
- Proper maintenance of equipment.
- Maths practical given along with theory class
- Reduce the activities to a minimum of 5
- There is not enough time to complete all activities
- Reduce portions
- Proper training should needed

Conclusion

The purpose of the study is to find out the Attitude of the Mathematics teachers towards IT Maths lab and to find out the Perceived Effectiveness of the IT Maths lab for teaching learning process among Higher Secondary Schools in Kerala. Study shows that *Attitude of teachers towards IT Maths Lab activities for learning Mathematics* of the higher secondary school student is significantly high and there is no significant difference in the *Attitude of teachers towards IT Maths Lab* based on Gender of the teachers, type of management of the school, locality of the school, and teaching experience of the teachers. Perceived effectiveness of the higher secondary

school student in IT Maths Lab is significantly high and there is no significant difference in the Perceived Effectiveness of the Higher Secondary School Students in *IT Maths Lab* activities based on Gender of the students, management of the school, and locality of the school.

SUMMARY, MAJOR FINDINGS, CONCLUSIONS AND SUGGESTIONS

- *Study in retrospect*
- *Major findings of the study*
- *Tenability of hypotheses*
- *Conclusion*
- *Educational implication of the study*
- *Policy Recommendations*
- *Suggestions for further research*

The purpose of the investigation is **A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA**. To arrive at inferences and generalization based on the analysis and interpretation, analysis of the data was carried out in previous chapters and need to be discussed in larger perspective of major findings. So in this chapter namely summary and conclusions includes study in retrospect, findings of the study, the conclusions the researcher has arrived at, generalization formulated on the basis of the study, the important findings and suggestions for further research.

Study in Retrospect

The prime objective of the present study is to **A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA**. The study has two phases in which first phase intended to assess the effectiveness of the IT Maths Lab for learning mathematics. For this purpose, the study was conducted on a sample of 1631 Higher Secondary School Mathematics Students studying in standard XII. Selection of the sample was made using the stratified random sampling technique. Standardized and adopted tools were administered on 1700 XII standard students from various districts of Kerala. In the second phase the attitude of mathematics teachers towards IT Maths Lab was assessed. For this purpose, the study was conducted on a sample of 779 Higher Secondary School Mathematics teachers. Selection of the sample was made using the stratified random sampling technique.

Appropriate statistical techniques were used for the analysis of data. The summary of the procedure, conclusion and suggestions are given below.

Variables of the Study

In the study perceived effectiveness and attitude were taken as the dependent variables and gender, locale, type or management of school, as the classificatory variable.

Objectives of the Study

The objectives set for the present study are the following:

1. To identify the technological elements of *IT Maths Lab* and its evolution.
2. To identify the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools.
3. To identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.
4. To compare the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools students of subsamples based on Gender, Locality, Management of School and Grade in Mathematics of SSLC examination.
5. To identify the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary schools.

6. To compare the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.
7. To identify the challenges and problems in the implementation of the *IT Maths Lab* activities in Higher Secondary Schools of Kerala.

Hypotheses of the Study

The hypotheses formulated for the present study are the following:

- 1) The Instructional method using *IT Maths Lab* is significantly effective for the transaction of the content among higher secondary school students.
- 2) The Instructional method using *IT Maths Lab* is significantly effective in enhancing abstract thinking among higher secondary school students.
- 3) There is no significant difference in the perceived effectiveness of *IT Maths Lab* for learning mathematics among higher secondary school students of subsamples based on Gender, Locality, Management of school and Grade in Mathematics of SSLC examination.
- 4) Attitude of higher secondary school teachers towards the *IT Maths Lab* for teaching learning process is significantly high.
- 5) There is no significant difference in the attitude towards the *IT Maths Lab* of higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers.

Methodology in Brief

Normative survey method was used for the study. The stratified random sampling technique was applied to select the sample in the study. Students of the Higher Secondary schools in Kerala state were taken as the population to assess the perceived effectiveness of *IT Maths Lab*. The data collected was consolidated and tabulated using appropriate statistical techniques.

Major Findings of the Study

The major findings arrived at from the study are the following:

Technological Elements of *IT Maths Lab* and its Evolution

- In the eight standard mathematics text book, there are 10 chapters in which only two chapters included the nine ICT enabled activities. ICT enabled (geogebra) activities included chapters are Equal triangles and polygons.
- In the ninth standard mathematics text book, there are 13 chapters in which nine chapters included the 22 number of ICT enabled activities. ICT enabled (geogebra) activities included chapters are Area (2), New numbers (1), Circles (4), Parallel lines (2), Similarity of triangles (3), Polynomials (1), Circle measures (5), Solids (2), and Proportion (2).
- There are eleven chapters in the mathematics text book of standard ten and 42 number of ICT enabled activities are included in the textbook. ICT enabled (geogebra) activities included chapters are Sequence (3), Circles (7),

Trigonometry (3), Coordinates (11), Tangents (8), Solids (6) and Coordinate geometry (4).

- In the first year Mathematics text book contains a total of 14 chapters in which nine chapters have a total of 96 lab activities.
- In the second year Mathematics text book contains a total of 13 chapters in which all the 13 chapters have a total of 107 ICT enabled (geogebra) lab activities.

Perceived Effectiveness

1. Participation

The calculated mean score (27.99) is greater than the assumed mean score of test value (21) and the p-value ($t=63.507$; $p=0.000$) is less than 0.05. Hence it can be concluded that participation of the higher secondary school student in IT Maths Lab is significantly high.

2. Comparison of Participation for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

The mean score of male students is 28.08, with Standard Deviation of 4.77, while the mean score of the female students is 27.95, with Standard Deviation of 4.30. The calculated t-value is 0.570 and the p-value is 0.569. Hence, the result reveals that there is no significant difference in the participation of the higher

secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.127 and p-value is 0.899 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on participation of *IT Maths Lab* for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 0.499 and the p-value is 0.618 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in perceived effectiveness on participation of *IT Maths Lab* for learning mathematics.

The mean score obtained for participation varying between 28.11 and 27.16 based on the grade in mathematics of SSLC examination among higher secondary school students. The highest mean score is for A-plus grade students (28.11) and lowest mean score for below B-grade students (27.16). Analysis of variance reveals that the calculated F-value is 1.390 and p-value is 0.235 which is greater than 0.05. Hence it can be concluded that there is no significant variation in the perceived effectiveness of participation based on grade in mathematics of SSLC examination.

1. *Practicability*

The calculated mean score (15.02) is greater than the assumed mean score of test value (12) and the p-value ($t=42.738$; $p=0.000$) is less than 0.05. Hence it can be concluded that practicability of the higher secondary school student in *IT Maths Lab* is significantly high.

2. Comparison of *Practicability* for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 0.807 and the p-value is 0.420 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the practicability of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 1.303 and p-value is 0.193 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on practicability of *IT Maths Lab* for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 0.823 and the p-value is 0.411 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in perceived effectiveness on practicability of *IT Maths Lab* for learning mathematics.

The highest mean score is for B-plus grade students (15.31) and lowest mean score for B-grade students (14.65). Analysis of variance reveals that the calculated F-value is 0.586 and p-value is 0.673 which is greater than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of **practicability** based on grade in mathematics of SSLC examination.

1. Understanding

The calculated mean score (19.90) is greater than the assumed mean score of test value (15) and the p-value ($t=53.604$; $p=0.000$) is less than 0.05. Hence it can be concluded that understanding of the higher secondary school student in IT Maths Lab is significantly high.

2. Comparison of *Understanding* for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

The average score obtained for male students is 19.88, with Standard Deviation of 4.02, and the average score of the female students is 19.91, with Standard Deviation of 3.56. Independent sample t-test gives that the calculated t-value is 0.153 and the p-value is 0.878. Hence, the result reveals that there is no significant difference in the understanding of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.308 and p-value is 0.758 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on understanding of IT Maths Lab for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 2.02 and the p-value is 0.044 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in perceived effectiveness on participation of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (20.07) and lowest mean score for below B-grade students (18.86). Analysis of variance reveals that the calculated F-value is 3.541 and p-value is 0.007 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of understanding based on grade in mathematics of SSLC examination.

1. *Self-assessment*

The calculated mean score (20.24) is greater than the assumed mean score of test value (15) and the p-value ($t=58.341$; $p=0.000$) is less than 0.05. Hence it can be concluded that self-assessment of the higher secondary school student in IT Maths Lab is significantly high.

2. Comparison of *Self-assessment* for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 1.123 and the p-value is 0.262. Hence, the result reveals that there is no significant difference in the self-assessment of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.432 and p-value is 0.666 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on self-assessment of IT Maths Lab for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 2.103 and the p-value is 0.036 which is less than the level of significance of 0.05. This shows that

there exist significant difference between rural and urban school students in perceived effectiveness on self-assessment of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (20.43) and lowest mean score for below B-grade students (19.22). Analysis of variance reveals that the calculated F-value is 5.042 and p-value is 0.000 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of self-assessment based on grade in mathematics of SSLC examination.

1. Concept Formation

The calculated mean score (24.43) is greater than the assumed mean score of test value (18) and the p-value ($t=62.667$; $p=0.000$) is less than 0.05. Hence it can be concluded that concept formation of the higher secondary school student in *IT Maths Lab* is significantly high.

2. Comparison of *Concept formation* for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 1.784 and the p-value is 0.075 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the concept formation of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 1.108 and p-value is 0.268 which is greater than the level of significance 0.05. This result reveals that there is no significant difference

between government and aided school students in Kerala in their perceived effectiveness on concept formation of IT Maths Lab for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 2.545 and the p-value is 0.011 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in perceived effectiveness on concept formation of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (24.63) and lowest mean score for below B-grade students (23.27). Analysis of variance reveals that the calculated F-value is 4.069 and p-value is 0.003 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of concept formation based on grade in mathematics of SSLC examination.

1. Reasoning /logical Thinking

The calculated mean score (12.19) is greater than the assumed mean score of test value (9) and the p-value ($t=57.983$; $p=0.000$) is less than 0.05. Hence it can be concluded that reasoning/ logical thinking of the higher secondary school student in IT Maths Lab is significantly high.

2. Comparison of Reasoning /logical thinking for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 0.556 and the p-value is 0.578 which is greater than 0.05. Hence, the result reveals that there is no

significant difference in the reasoning/ logical thinking of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.771 and p-value is 0.441 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on reasoning/ logical thinking of *IT Maths Lab* for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 2.351 and the p-value is 0.019 which is less than the level of significance of 0.05. This shows that there exist significant difference between rural and urban school students in perceived effectiveness on reasoning/ logical thinking of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (12.30) and lowest mean score for below B-grade students (11.41). Analysis of variance reveals that the calculated F-value is 4.175 and p-value is 0.002 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of **reasoning/ logical thinking** based on grade in mathematics of SSLC examination.

1. Problem Solving

The calculated mean score (23.63) is greater than the assumed mean score of test value (18) and the p-value ($t=50.18$; $p=0.000$) is less than 0.05. Hence it can be concluded that problem solving of the higher secondary school student in *IT Maths Lab* is significantly high.

2. Comparison of *Problem solving* for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 0.303 and the p-value is 0.762 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the problem solving of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.352 and p-value is 0.725 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness on problem solving of *IT Maths Lab* for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 1.845 and the p-value is 0.065 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in perceived effectiveness on problem solving of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (23.81) and lowest mean score for A-grade students (22.48). Analysis of variance reveals that the calculated F-value is 3.352 and p-value is 0.010 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of **problem solving** based on grade in mathematics of SSLC examination.

1. Perceived Effectiveness

The calculated mean score (143.44) is greater than the assumed mean score of test value (108) and the p-value ($t=50.18$; $p=0.000$) is less than 0.05. Hence it can be concluded that perceived effectiveness of the higher secondary school student in IT Maths Lab is significantly high.

2. Comparison of Perceived Effectiveness for Subsamples based on Gender, Type of school Management, School Locale, and Grade in Mathematics of SSLC examination.

Independent sample t-test gives that the calculated t-value is 0.423 and the p-value is 0.672 which is greater than 0.05. Hence, the result reveals that there is no significant difference in the perceived effectiveness of the higher secondary school students in *IT Maths Lab* activities based on gender of the students.

The calculated t-value is 0.456 and p-value is 0.648 which is greater than the level of significance 0.05. This result reveals that there is no significant difference between government and aided school students in Kerala in their perceived effectiveness of IT Maths Lab for learning mathematics.

Independent sample t-test reveals that the calculated t-value is 1.687 and the p-value is 0.092 which is greater than the level of significance of 0.05. This shows that there is no significant difference between rural and urban school students in the perceived effectiveness of *IT Maths Lab* for learning mathematics.

The highest mean score is for A-plus grade students (144.39) and lowest mean score for below B-grade students (137.47). Analysis of variance reveals that

the calculated F-value is 3.308 and p-value is 0.010 which is less than 0.05. Hence it can be concluded that there exist significant variation in the perceived effectiveness of higher IT Maths Lab activities among higher secondary school mathematics students based on grade in mathematics of SSLC examination.

Attitude of Teachers Towards IT Maths Lab

1. Participation of Learners

Study reveals that *attitude of teachers towards Participation of learners in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Participation of Learners for Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- There is no significant difference in the *attitude of teachers towards participation of learners in IT Maths Lab* based on gender.
- There is no significant difference in the *attitude of teachers towards participation of learners in IT Maths Lab* based on type of management of school.
- There is no significant difference in the *attitude of teachers towards Participation of learners of IT Maths Lab* based on locality of school

1. Motivation

It can be concluded that *attitude of teachers towards Motivation of learners in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Motivation for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- There is no significant difference between the male and female teachers in their *attitude towards motivation of learners in IT Maths Lab*, since the p-value ($t = 1.127$; $p = 0.260$) is greater than 0.05.
- Independent sample t-test gives the result that there is no significant difference between the government and aided school teachers in their *attitude towards motivation of learners in IT Maths Lab*, since the p-value ($t = 0.635$; $p = 0.526$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards motivation of learners of IT Maths Lab*, since the p-value ($t = 0.285$; $p = 0.776$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=1.640$, $p=0.195$) is greater than 0.05.

- There is no significant difference in the *Attitude of teachers towards motivation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=2.996$, $p=0.051$) is less than 0.05.

1. Resources

It can be concluded that *attitude of teachers towards resources available in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Resources for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.964$; $p = 0.335$) is greater than 0.05.
- There is no significant difference between the government and aided school teachers in their *attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.378$; $p = 0.706$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards resources of IT Maths Lab*, since the p-value ($t = 0.876$; $p = 0.381$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards resources of IT Maths Lab* among teachers

of various age groups, since the p-value ($F=2.714$, $p=0.067$) is greater than 0.05.

- There exist significant difference in the *Attitude of teachers towards resources of IT Maths Lab* among teachers of various age groups, since the p-value ($F=6.214$, $p=0.002$) is less than 0.05.

1. Concept Formation

It can be concluded that *attitude of teachers towards concept formation of learners in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Concept Formation for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *attitude towards concept formation of learners of IT Maths Lab*, since the p-value ($t = 0.461$; $p = 0.645$) is greater than 0.05.
- There is no significant difference between the government and aided school teachers in their *attitude towards concept formation of learners of IT Maths Lab*, since the p-value ($t = 0.765$; $p = 0.444$) is greater than 0.05.

- There is no significant difference between the rural and urban school teachers in their *attitude towards concept formation of learners of IT Maths Lab*, since the p-value ($t = 0.073$; $p = 0.942$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=1.152$, $p=0.317$) is greater than 0.05.
- There is no significant difference in the *Attitude of teachers towards concept formation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=2.143$, $p=0.118$) is greater than 0.05.

1. Transaction

It can be concluded that *attitude of teachers towards transaction of content among learners in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Transaction for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.284$; $p = 0.776$) is greater than 0.05.

- There is no significant difference between the government and aided school teachers in their *attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.304$; $p = 0.761$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards transaction of content of learners of IT Maths Lab*, since the p-value ($t = 0.600$; $p = 0.549$) is greater than 0.05.
- Analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=4.256$, $p=0.015$) is less than 0.05.
- There exist significant difference in the *Attitude of teachers towards transaction of content of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=6.810$, $p=0.001$) is less than 0.05.

1. Evaluation

It can be concluded that *attitude of teachers towards evaluation in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Evaluation for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *attitude towards evaluation of*

learners of IT Maths Lab, since the p-value ($t = 0.991$; $p = 0.322$) is greater than 0.05.

- There is no significant difference between the government and aided school teachers in their *attitude towards evaluation of learners of IT Maths Lab*, since the p-value ($t = 0.720$; $p = 0.472$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards evaluation of learners of IT Maths Lab*, since the p-value ($t = 0.255$; $p = 0.799$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=1.678$, $p=0.187$) is greater than 0.05.
- There exist significant difference in the *Attitude of teachers towards evaluation of learners of IT Maths Lab* among teachers of various age groups, since the p-value ($F=3.351$, $p=0.036$) is less than 0.05.

1. Training

It can be concluded that *attitude of teachers towards training in IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Training for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there exist significant difference between the male and female teachers in their *attitude towards training of IT Maths Lab*, since the p-value ($t = 2.051$; $p = 0.041$) is less than 0.05.
- There is no significant difference between the government and aided school teachers in their *attitude towards training of IT Maths Lab*, since the p-value ($t = 1.935$; $p = 0.053$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards training of IT Maths Lab*, since the p-value ($t = 1.077$; $p = 0.282$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* among teachers of various age groups, since the p-value ($F=2.376$, $p=0.094$) is greater than 0.05.
- There is no significant difference in the *Attitude of teachers towards training of IT Maths Lab* among teachers of various age groups, since the p-value ($F=0.823$, $p=0.440$) is greater than 0.05.

1. Attitude of Teachers Towards IT Maths Lab

It can be concluded that *attitude of teachers towards IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

2. Comparison of Attitude of teachers towards IT Maths Lab for Subsamples based Subsamples based on Gender, Type of school Management, School Locale, and Teaching Experience of Teachers.

- Independent sample t-test reveals that there is no significant difference between the male and female teachers in their *attitude towards IT Maths Lab*, since the p-value ($t = 0.727$; $p = 0.467$) is greater than 0.05.
- There is no significant difference between the government and aided school teachers in their *attitude towards IT Maths Lab*, since the p-value ($t = 0.583$; $p = 0.560$) is greater than 0.05.
- There is no significant difference between the rural and urban school teachers in their *attitude towards IT Maths Lab*, since the p-value ($t = 0.461$; $p = 0.645$) is greater than 0.05.
- Analysis of variance gives the result that there is no significant difference in the *Attitude of teachers towards IT Maths Lab* among teachers of various age groups, since the p-value ($F=2.413$, $p=0.090$) is greater than 0.05.

- There exist significant difference in the *Attitude of teachers towards IT Maths Lab* among teachers of various age groups, since the p-value ($F=4.184$, $p=0.016$) is less than 0.05.

Infrastructure Facilities

Majority of the principals are opined that the facilities available for the implementation of IT Maths lab activities in the school are Internet facility (94.29%), Printer (62.86%), Reference materials for students (57.14%), Consistent availability of power supply (60.00%), Audio visual facility (57.14%), Log book/ log register (68.57%), Practical record (94.29%), and Adequate furniture in the IT Maths Lab (60.00%).

Training: Majority (85.71%) of the principals are opined that, all teachers are availed the training in IT Maths Lab and 57.14 percentage teachers are updating the training in each year.

Implementation: Majority of the principals are opined that, the teachers are effectively implementing the lab activities (88.57%), effectively utilising the IT Maths lab (91.43%) and Keeping log book for the utilisation of the LAB (62.86).

Attitude: Majority (94.29%) of the principals are opined that, attitude of teachers are positive in the implementation of IT Maths lab activities.

Consideration of slow learners and gifted learners: Result shows that majority (85.71%) of the principals opined that the teachers are providing extra time for slow learners and 74.29 percentage of the principals opined that the teachers are

providing additional activities for gifted learners. More than half of the principals (57.14%) are keeping the separate Practical history of each students.

Feedback: Regarding the feedback, 65.71 percentage of principals opined that they regularly taking feedback from teachers and 68.57 percentage of principals opined that they are regularly taking feedback from students.

Maintenance of IT Maths Lab: Majority of the principals (71.43%) opined that it is possible to conduct maintenance of the defective computers in time. Majority of the principles (80%) also reported that they are not availing sufficient fund for the maintenance of IT Maths lab.

Problem faced by the Teachers while Implementing the Lab Activities

Insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers (62.86%) are the major problem faced by the teachers while implementing the lab activities.

Problem Faced by the Students while Implementing the Lab Activities

Insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers based on the number of students (65.71%) are the major problems faced by the students while implementing the lab activities.

Problem Faced while Conducting IT Lab Examination

Non availability of adequate physical infrastructure (51.43%), Non availability of adequate number of computers (60.00%) and Collision with other practical works (37.14%) are the major problems while conducting IT Lab examination. Power failure (45.71%) is the minor problem while conducting IT Lab examination.

Tenability of Hypotheses

The first hypothesis states that ‘The Instructional method using IT Maths Lab is significantly effective for the transaction of the content among higher secondary school students’.

Components	Mean	SD	Test-value	t-value	p-value
Perceived effectiveness	143.44	23.18	108	50.18	.000

It is seen that the mean score of perceived effectiveness is 143.44 with standard deviation of 23.18. The calculated mean score (143.44) is greater than the assumed mean score of test value (108) and the p-value ($t=50.18$; $p=0.000$) is less than 0.05. Hence it can be concluded that perceived effectiveness of the higher secondary school student in IT Maths Lab is significantly high.

Hence the first hypothesis states that ‘The Instructional method using IT Maths Lab is significantly effective for the transaction of the content among higher secondary school students’ is accepted.

The second hypothesis states that ‘The Instructional method using IT Maths Lab is significantly effective in enhancing abstract thinking among higher secondary school students’.

Components	Mean	SD	Test-value	t-value	p-value
<i>Reasoning /logical thinking</i>	12.1950	2.22534	9	57.983	.000

It is seen that the mean score of reasoning/ logical thinking is 12.19 with standard deviation 2.22. The calculated mean score (12.19) is greater than the assumed mean score of test value (9) and the p-value ($t=57.983$; $p=0.000$) is less than 0.05. Hence it can be concluded that reasoning/ logical thinking of the higher secondary school student in IT Maths Lab is significantly high.

Hence the second hypothesis states that ‘The Instructional method using IT Maths Lab is significantly effective in enhancing abstract thinking among higher secondary school students’ is accepted.

The third hypothesis states that ‘There is no significant difference in the perceived effectiveness of *IT Maths* Lab for learning mathematics among higher secondary school students of subsamples based on Gender, Locality, Management of school and Grade in Mathematics of SSLC examination’.

Demographic variable	Test	Test value	p-value	Significance
Gender	Independent sample t-test	0.423	0.672	Not significant
Locale	Independent sample t-test	0.456	0.648	Not significant
Type of School	Independent sample t-test	1.687	0.092	Not significant
Grade in the Maths test	ANOVA (F-test)	3.308	0.010	Significant

Hence the third hypothesis states that ‘There is no significant difference in the perceived effectiveness of IT Maths Lab for learning mathematics among higher

secondary school students of subsamples based on Gender, Locality, Management of school and Grade in Mathematics of SSLC examination' is accepted.

The fourth hypothesis states that 'Attitude of higher secondary school teachers towards the IT Maths Lab for teaching learning process is significantly high'.

Statement	Mean	SD	Test-value	t-value	p-value
Participation	14.31	3.05	12	21.131	.000
Motivation	29.68	5.45	24	29.076	.000
Resources	16.71	3.33	15	14.365	.000
Concept	21.04	4.39	18	19.348	.000
Transaction	28.08	6.43	27	4.727	.000
Evaluation	15.83	3.96	15	5.869	.000
Training	17.52	3.72	15	18.944	.000
Attitude	143.20	25.83	126	18.587	.000

The calculated mean score (143.20) is greater than the assumed mean score of test value (126) and the p-value ($t=18.587$; $p=0.000$) is less than 0.05. Hence it can be concluded that *attitude of teachers towards IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high.

Hence the fourth hypothesis stated 'Attitude of higher secondary school teachers towards the IT Maths Lab for teaching learning process is significantly high' is accepted.

The fifth hypothesis states that 'There is no significant difference in the attitude towards the IT Maths Lab of higher secondary school teachers of

subsamples based on Gender, Locality, Management of school, and Experience of the teachers’.

Demographic variable	Test	Test value	P-value	Significance
Gender	Independent sample t-test	t=0.727	0.467	Not significant
Locale	Independent sample t-test	t=0.583	0.560	Not significant
Type of School	Independent sample t-test	t=0.461	0.645	Not significant
Experience of the teachers	ANOVA (F-test)	F=2.413	0.090	Not significant

The test of significance of difference between the mean score of attitude of teachers towards IT Maths Lab based on Gender, Locality, Management of school, Experience of the teachers shows that there is no significant difference. Hence the fifth hypothesis states that ‘There is no significant difference in the attitude towards the IT Maths Lab of higher secondary school teachers of subsamples based on Gender, Locality, Management of school, and Experience of the teachers’ is accepted.

Conclusions of the Study

The following conclusions are drawn from the study:

Study shows that *attitude of teachers towards IT Maths Lab activities for learning mathematics* of the higher secondary school student is significantly high. Analysis reveals that that there is no significant difference in the *attitude of teachers*

towards IT Maths Lab based on gender of the teachers, type of management of school, locality of the school, and teaching experience of the teachers. But, analysis of variance gives the result that there exist significant difference in the *Attitude of teachers towards IT Maths Lab* among teachers of various age groups.

Study discloses that perceived effectiveness of the higher secondary school student in IT Maths Lab is significantly high. Result reveals that there is no significant difference in the perceived effectiveness of the higher secondary school students in *IT Maths Lab* activities based on gender of the students, management of the school, and locality of the school. But there is significant difference in the perceived effectiveness of the higher secondary school students in *IT Maths Lab* activities based on grade in mathematics of SSLC exam.

Majority of the principals are opined that the facilities available for the implementation of IT Maths lab activities in the school are Internet facility (94.29%), Printer (62.86%), Reference materials for students (57.14%), Consistent availability of power supply (60.00%), Audio visual facility (57.14%), Log book/ log register (68.57%), Practical record (94.29%), and Adequate furniture in the IT Maths Lab (60.00%).

Facilities not available in the school for the implementation of IT Maths lab activities are Separate IT Maths lab (60.00%), Separate smart class room for IT Maths lab (82.86%), Separate projector in the IT Maths lab (62.86%), Separate computer for each students (68.57%), Smart Boards in the IT Maths lab (85.71%), White boards in the IT Maths lab (57.14%), Consistent availability of power supply- SOLAR (80.00%), and Adequate IT equipment in the IT Maths Lab (51.43%).

According to the opinion of the higher secondary school principals, insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers (62.86%) are the major problem faced by the teachers while implementing the lab activities.

Insufficient time to complete the activities (57.14%) and Non availability of sufficient number of computers based on the number of students (65.71%) are the major problems faced by the students while implementing the lab activities.

Educational Implications of the Study

In view of the major findings of the present study and enrichment of the qualitative improvement of Education, academic achievement of the Higher Secondary Education, the investigator putforth the following recommendations for implementation during curriculum transaction at Higher Secondary level in the state of Kerala.

1. In the SCERT, Kerala text of VIII, IX and X the number of chapters are 10, 13 and 11 in which the number of ICT included chapters are 2, 9 and 7 respectively. Study discloses that the components of perceived effectiveness i.e., Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking and Problem solving are significantly high while using IT Maths lab. Hence it is recommended that maximum IT enabled learning activities should be included in the secondary school mathematics text book in the curriculum revision.

2. At the higher secondary level, the first year Mathematics text book contains 14 chapters in which nine chapters have lab activities. In the second year Mathematics text book contains a total of 13 chapters in which all the 13 chapters have ICT enabled (geogebra) lab activities. Consider lab activities in the remaining chapters of the first year text book and all the concepts of higher secondary level.
3. Analysis of the data shows that gender and locality of school has no significant role on understanding of mathematical concept; type of school and grade in Mathematics has significant role on understanding of mathematical concept through IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of understanding based on grade in mathematics of SSLC examination. The highest mean score in understanding of mathematical concept is for A-plus grade students (20.07) and lowest mean score for below B-grade students (18.86). Hence, provision for recurring activities for low graded students is to be considered as the remedial measures.
4. Result shows that gender and type of school has no significant role on concept formation in mathematics through IT Maths Lab activities. Whereas locality of school and grade obtained for Mathematics in SSLC examination has significant role on concept formation of IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of concept formation based on grade in mathematics of SSLC

examination. The highest mean score is for A-plus grade students (24.63) and lowest mean score for below B-grade students (23.27).

5. Result shows that gender and type of school has no significant role on perceived effectiveness of **reasoning/ logical thinking** in mathematics through IT Maths Lab activities. Whereas locality of school and grade obtained for Mathematics in SSLC examination has significant role on perceived effectiveness of **reasoning/ logical thinking** through IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of **reasoning/ logical thinking** based on grade in mathematics of SSLC examination. The highest mean score is for A-plus grade students (12.30) and lowest mean score for below B-grade students (11.41). Hence, provision for more activities to enhance **reasoning/ logical thinking** for low graded students is to be considered as the remedial measures.

Policy Recommendations

The present study has many advantages as it can be approached in several ways. It is also very important as it relates to mathematics education among higher secondary school students. Therefore, this study can be helpful and useful for students, teachers, academic content developers, policy makers, Government and finally to the society. The study will help to improve the teaching learning process especially in the subject of mathematics as it is considered as the difficult subject among students particularly at Higher Secondary level in Kerala. To make interest among learners of mathematics and to concretise the content of mathematics among

learners precautions to be taken in the development of mathematics curriculum and to make necessary interventions while formulating policies.

- It is recommended that maximum IT enabled learning activities should be included in the secondary school mathematics text book in the curriculum revision.
- Consider lab activities in all the chapters of the first year and second year text books and all the concepts of higher secondary level.
- Provision for recurring activities for low graded students is to be considered as the remedial measures.
- IT enabled learning activities should be included in the pre-service training and in-service training especially for the mathematics education.
- Ensure that schools have access to reliable internet and modern computing devices (e.g., computers, tablets). A strong technological foundation is necessary for integrating IT into mathematics education.
- Establish Dedicated Mathematics Labs, Create well-equipped math labs with necessary software, interactive whiteboards, and other tools to enhance learning in Mathematics.
- Develop continuous professional development programs that train teachers on using digital tools (e.g., GeoGebra, Spreadsheet, Python, MATLAB, etc.) to teach mathematics more effectively.

Suggestions for Further Study

Every study conducted in every field has advantages as well as some limitations. For further research the limitations of the earlier studies may be taken into considerations and the gap has to be filled to maintain solidarities in the academic research activity. In the light of the present study the investigator proposes the following suggestions for further study.

- 1) Comparison of achievement in Mathematics between CBSE school students and Kerala school students.
- 2) Advantages, problems and challenges while implementing the IT Maths Lab.
- 3) Identify the effectiveness of IT Maths lab using experimental/ application/ achievement test.
- 4) Feasibility of IT Maths lab activities in all the concepts of secondary level.

The investigator hopes that the findings of the study will help the Academicians in general and Educational Planners, Administrators, Curriculum Framers, Teachers and Parents in particular for upbringing the Academic Achievement of higher secondary school students.

RECOMMENDATIONS OF THE STUDY

- *Conclusions*
- *Educational implications of the study*
- *Recommendations for further research*

The purpose of the investigation is to know the attitude of the mathematics teachers towards IT Maths lab implemented in higher secondary curriculum in Kerala. This chapter namely recommendations and conclusions includes tenability of hypothesis, the important recommendations based on findings and suggestions for further research.

Overview of the Research

The present study is entitled as ‘A STUDY ON IT MATHS LAB FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA’. The objectives of the study are to identify the technological elements of *IT Maths Lab* and its evolution; to identify the attitude of teachers towards the *IT Maths Lab* as a part of teaching learning process among higher secondary schools; to identify the effectiveness of *IT Maths Lab* for the transaction of the content in mathematics among higher secondary schools and to identify the effectiveness of *IT Maths Lab* for the enhancement of abstract thinking through the transaction of the content in mathematics among higher secondary schools.

The study has two phases in which first phase intended to assess the effectiveness of the IT Maths Lab for learning mathematics. For this purpose, the study was conducted on a sample of 1631 Higher Secondary School Mathematics Students studying in standard XII. Selection of the sample was made using the stratified random sampling technique. Standardized tool was administered students from various districts of Kerala. In the second phase the attitude of mathematics

teachers towards IT Maths Lab was assessed. For this purpose, the study was conducted on a sample of 779 Higher Secondary School Mathematics teachers using the stratified random sampling technique. Appropriate statistical techniques were used for the analysis of data.

Educational Implications of the Study

In view of the major findings of the present study and enrichment of the qualitative improvement of Education, academic achievement of the Higher Secondary Education, the investigator putforth the following recommendations for implementation during curriculum transaction at Higher Secondary level in the state of Kerala.

1. In the SCERT, Kerala text of VIII, IX and X the number of chapters are 10, 13 and 11 in which the number of ICT included chapters are 2, 9 and 7 respectively. Study discloses that the components of perceived effectiveness i.e., Participation, Practicability, Understanding, Self-assessment, Concept formation, Reasoning /logical thinking and Problem solving are significantly high while using IT Maths lab. Hence it is recommended that maximum IT enabled learning activities should be included in the secondary school mathematics text book in the curriculum revision.
2. At the higher secondary level, the first year Mathematics text book contains 14 chapters in which nine chapters have lab activities. In the second year Mathematics text book contains a total of 13 chapters in which all the 13 chapters have ICT enabled (geogebra) lab activities. Consider lab activities

in the remaining chapters of the first year text book and all the concepts of higher secondary level.

3. Analysis of the data shows that gender and locality of school has no significant role on understanding of mathematical concept; type of school and grade in Mathematics has significant role on understanding of mathematical concept through IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of understanding based on grade in mathematics of SSLC examination. The highest mean score in understanding of mathematical concept is for A-plus grade students (20.07) and lowest mean score for below B-grade students (18.86). Hence, provision for recurring activities for low graded students is to be considered as the remedial measures.
4. Result shows that gender and type of school has no significant role on concept formation in mathematics through IT Maths Lab activities. Whereas locality of school and grade obtained for Mathematics in SSLC examination has significant role on concept formation of IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of concept formation based on grade in mathematics of SSLC examination. The highest mean score is for A-plus grade students (24.63) and lowest mean score for below B-grade students (23.27).
5. Result shows that gender and type of school has no significant role on perceived effectiveness of **reasoning/ logical thinking** in mathematics through IT Maths Lab activities. Whereas locality of school and grade

obtained for Mathematics in SSLC examination has significant role on perceived effectiveness of **reasoning/ logical thinking** through IT Maths Lab activities. It can be concluded that there exist significant variation in the perceived effectiveness of **reasoning/ logical thinking** based on grade in mathematics of SSLC examination. The highest mean score is for A-plus grade students (12.30) and lowest mean score for below B-grade students (11.41). Hence, provision for more activities to enhance **reasoning/ logical thinking** for low graded students is to be considered as the remedial measures.

Generalizations and Recommendations

The study explore how the integration of Information Technology (IT) into mathematics teaching, specifically through the use of digital math labs, impacts the learning and teaching process in Kerala's higher secondary schools. Integration of IT Maths lab activities (e.g., GeoGebra, Python) along with the theory has been found to significantly increase student interest and engagement in mathematics. The interactive and visual nature of these tools helps to break down complex concepts, making them more accessible and interesting. It foster a more interactive, hands-on learning environment where students can experiment and explore mathematical concepts at their own pace and their own time.

With the use of simulations and interactive software, learners are able to achieve a deeper understanding of difficult mathematical topics, as they could manipulate variables and observe the results in real-time. It is better to integrate the theory and practical with the help of IT Maths lab, which will help to minimize the

time consuming, real-time concept formation and to avoid the lackluster of the subject.

Higher secondary school Mathematics teachers in Kerala were found to be more confident in teaching mathematical content with the help of IT Maths Lab introduced after undergoing training. IT Math labs help teachers explain concepts more effectively, and teachers reported feeling more empowered in delivering lessons.

Many of the school not have the separate IT Maths lab. In the study it is seen that, in some of the higher secondary schools have limited access to IT labs and related resources such as computers, or the required software. This limits the effectiveness of IT Maths labs, especially in less-funded areas. Ensure that all schools, especially those in rural areas, necessary infrastructure to support IT Maths labs.

Recommendations for Further Research

Every study conducted in every field has advantages as well as some limitations. For further research the limitations of the earlier studies may be taken into considerations and the gap has to be filled to maintain solidarities in the academic research activity. In the light of the present study the investigator proposes the following suggestions for further study.

- 1) Comparison of achievement in Mathematics between CBSE school students and Kerala school students.
- 2) Advantages, problems and challenges while implementing the IT Maths Lab.

- 3) Identify the effectiveness of IT Maths lab using experimental/ application/ achievement test.
- 4) Feasibility of IT Maths lab activities in all the concepts of secondary level.

The investigator hopes that the findings of the study will help the Academicians in general and Educational Planners, Administrators, Curriculum Framers, Teachers and Parents in particular for upbringing the Academic Achievement of higher secondary school students.

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APPENDICES

Appendix I

PERCEIVED EFFECTIVENESS OF IT MATHS LAB (Draft- English)

Dr. Sunil Kumar A.S.

Professor,
NSS Training College, Ottapalam

Nuhman Shibli C

Research Scholar
NSS Training College Ottapalam

Dear Student,

As part of Ph.D. program, I am undertaking research on the topic “A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA” under the supervision of Dr. SUNIL KUMAR A.S, Professor, NSS Training College, Ottapalam. Kindly cooperate and provide proper responses (Strongly Agree/ Agree/ No Opinion/ Disagree/ Strongly Disagree) in the tool, while reading the statements regarding the IT Maths Lab activities. Your responses will be kept confident. The scale intends to know your Perceived Effectiveness of IT Maths Lab in teaching learning process and it has no other purpose whatsoever.

Name of the student :

Gender : Boy / Girl

Name of the school :

Type of Management of School : Government / Aided

Locality of the school : Urban / Rural

Grade in Mathematics at SSLC Examination :

Perceived effectiveness of IT Maths Lab Questions

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
1	There is an opportunity to study Mathematics with the help of IT Math Lab					
2	It is possible to achieve more conceptual clarity by studying mathematics using the IT Math Lab.					
3	Learning maths using the IT Maths lab has made learning more enjoyable.					
4	All units of Mathematics can be studied in conjunction with the IT Maths Lab.					
5	It is possible to do the work in the IT Maths lab by yourself.					
6	There has been an increased interest in learning through mathematics learning using the IT Math Lab.					
7	With the help of the IT Maths lab, math concepts can be explained to the classmates.					
8	Complex math problems are made clearer through math lab activity.					
9	IT Maths lab has helped to give more confidence in problem solving.					
10	Mathematical calculations made easy with the help of IT Maths lab					
11	Mathematics study using IT Maths lab helps to clear existing doubts.					
12	Math learning activities discussed in the classroom can be done independently in the IT Maths lab.					
13	I have a clear understanding of the workings of the IT Maths lab.					
14	The activities included in the IT Maths lab are helpful in achieving learning outcomes.					
15	With the help of activities in the IT Maths Lab, mathematics concepts can be covered in depth.					

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
16	Mathematical concepts acquired through the IT Maths lab are helpful in solving similar problems.					
17	Mathematics can be easily understood when presented with the help of IT Maths lab.					
18	Math Lab activities are designed to be self-paced.					
19	Maths learning with the help of maths lab inculcates interest in maths in us.					
20	Mathematical concept can be fully grasped when it is presented through visualization.					
21	Understanding is possible by relating classroom activities to math lab activities.					
22	The activities of the IT Maths lab enable self-assessment of the achievement achieved in the Math class.					
23	All units of mathematics can be understood through the activities of the IT Maths Lab.					
24	There is difficulty using IT Maths lab for math learning.					
25	Software used to understand mathematics with the help of IT Maths lab is difficult to manage.					
26	Existing IT lab activities are adequate for acquiring mathematical concepts.					
27	The time allotted is sufficient for the acquisition of mathematics subjects with the help of IT Maths Lab.					
28	The work book/manual provided in the IT Maths lab can be used to master the math concepts.					
29	IT Maths lab activities are easy to understand.					
30	Activities in the IT Maths lab help in understanding the basic concept of math.					
31	Activities in the IT Maths lab help in understanding the advanced concept of math.					

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
32	Activities in the IT Maths lab help to understand abstract concepts in mathematics.					
33	Activities in the IT Maths lab are helpful in assessing the understanding of each unit of math.					
34	Activities in the IT Maths lab are helpful in assessing whether each concept in math has been mastered.					
35	Activities in the IT Maths lab are designed to clear doubts in math.					
36	Activities in the IT Maths lab help in solving complex problems.					
37	Maths learning with the help of IT Maths lab gives confidence in problem solving.					
38	Maths learning with the help of IT Maths lab helps in higher level problem solving					

Appendix II

PERCEIVED EFFECTIVENESS OF IT MATHS LAB (Final - English)

Dr. Sunil Kumar A.S.

Professor,
NSS Training College, Ottapalam

Nuhman Shibli C

Research Scholar
NSS Training College Ottapalam

Dear Student,

As part of Ph.D. program, I am undertaking research on the topic “A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA” under the supervision of Dr. SUNIL KUMAR A.S, Professor, NSS Training College, Ottapalam. Kindly cooperate and provide proper responses (Strongly Agree/ Agree/ No Opinion/ Disagree/ Strongly Disagree) in the tool, while reading the statements regarding the IT Maths Lab activities. Your responses will be kept confident. The scale intends to know your Perceived Effectiveness of IT Maths Lab in teaching learning process and it has no other purpose whatsoever.

Name of the student :

Gender : Boy / Girl

Name of the school :

Type of Management of School : Government / Aided

Locality of the school : Urban / Rural

Grade in Mathematics at SSLC Examination :

Perceived effectiveness of Maths IT Lab Questions

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
1	There is an opportunity to study Mathematics with the help of IT Math Lab					
2	It is possible to achieve more conceptual clarity by studying mathematics using the IT Math Lab.					
3	Learning maths using the IT Maths lab has made learning more enjoyable.					
4	All units of Mathematics can be studied in conjunction with the IT Maths Lab.					
5	It is possible to do the work in the IT Maths lab by yourself.					
6	There has been an increased interest in learning through mathematics learning using the IT Math Lab.					
7	With the help of the IT Maths lab, math concepts can be explained to the classmates.					
8	Complex math problems are made clearer through math lab activity.					
9	IT Maths lab has helped to give more confidence in problem solving.					
10	Mathematics study using IT Maths lab helps to clear existing doubts.					
11	Math learning activities discussed in the classroom can be done independently in the IT Maths lab.					
12	I have a clear understanding of the workings of the IT Maths lab.					
13	The activities included in the IT Maths lab are helpful in achieving learning outcomes.					
14	With the help of activities in the IT Maths Lab, mathematics concepts can be covered in depth.					

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
15	Mathematical concepts acquired through the IT Maths lab are helpful in solving similar problems.					
16	Mathematics can be easily understood when presented with the help of IT Maths lab.					
17	Maths Lab activities are designed to be self-paced.					
18	Maths learning with the help of maths lab inculcates interest in maths in us.					
19	Mathematical concept can be fully grasped when it is presented through visualization.					
20	Understanding is possible by relating classroom activities to math lab activities.					
21	The activities of the IT Maths lab enable self-assessment of the achievement achieved in the Math class.					
22	All units of mathematics can be understood through the activities of the IT Maths Lab.					
23	There is difficulty using IT Maths lab for math learning.					
24	Software used to understand mathematics with the help of IT Maths lab is difficult to manage.					
25	Existing IT lab activities are adequate for acquiring mathematical concepts.					
26	The time allotted is sufficient for the acquisition of mathematics subjects with the help of IT Maths Lab.					
27	The work book/manual provided in the IT Maths lab can be used to master the math concepts.					
28	IT Maths lab activities are easy to understand.					
29	Activities in the IT Maths lab help in					

No	Statement	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
	understanding the basic concept of math.					
30	Activities in the IT Maths lab help to understand abstract concepts in mathematics.					
31	Activities in the IT Maths lab are helpful in assessing the understanding of each unit of math.					
32	Activities in the IT Maths lab are helpful in assessing whether each concept in math has been mastered.					
33	Activities in the IT Maths lab are designed to clear doubts in math.					
34	Activities in the IT Maths lab help in solving complex problems.					
35	Maths learning with the help of IT Maths lab gives confidence in problem solving.					
36	Maths learning with the help of IT Maths lab helps in higher level problem solving					

Appendix III

PERCEIVED EFFECTIVENESS OF IT MATHS LAB (Final - Malayalam)

Dr. Sunil Kumar A.S.

Professor,

NSS Training College, Ottapalam

Nuhman Shibli C.A.

Research Scholar

NSS Training College Ottapalam

Dear Student,

As part of Ph.D. program, I am undertaking research on the topic “A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA” under the supervision of Dr. SUNIL KUMAR A.S, Professor, NSS Training College, Ottapalam. Kindly cooperate and provide proper responses (Strongly Agree/ Agree/ No Opinion/ Disagree/ Strongly Disagree) in the tool, while reading the statements regarding the IT Maths Lab activities. Your responses will be kept confident. The scale intends to know your Perceived Effectiveness of IT Maths Lab in teaching learning process and it has no other purpose whatsoever.

കുട്ടിയുടെ പേര്:

ലിംഗം : ആൺ / പെൺ

സൂളിന്റെ പേര് :

സൂളിന്റെ തരം : ഗവർണ്മെന്റ് / ഗവർണ്മെന്റ് എയ്ഡഡ്

സൂൾ നിലകൊള്ളുന്ന സ്ഥലം : നഗരം / ഗ്രാമം

പത്താം തരം പരീക്ഷയിൽ ഗണിതത്തിന് ലഭിച്ച ഗ്രേഡ് :

Perceived effectiveness of IT Maths Lab Questions

No.	പ്രസ്താവനകൾ	പൂർണ്ണമായി യോജിക്കുന്നു	യോജിക്കുന്നു	അഭിപ്രായമില്ല	വിയോജിക്കുന്നു	പൂർണ്ണമായി വിയോജിക്കുന്നു
1	ഗണിതം ഐടി ഗണിത ലാബിന്റെ സഹായത്തോടെ പഠിക്കാൻ അവസരം ലഭിക്കുന്നുണ്ട്.					
2	ഐടി ഗണിത ലാബ് ഉപയോഗിച്ചുള്ള ഗണിത പഠനത്തിലൂടെ കൂടുതൽ ആശയ വ്യക്തത കൈവരിക്കാൻ സാധിക്കുന്നുണ്ട്.					
3	ഐടി ഗണിത ലാബ് ഉപയോഗിച്ചുള്ള ഗണിത പഠനത്തിലൂടെ പഠനം കൂടുതൽ ആസ്വാദ്യകരമായി തോന്നിയിട്ടുണ്ട്.					
4	ഗണിതത്തിലെ എല്ലാ യൂണിറ്റുകളും ഐടി ഗണിത ലാബുമായി ബന്ധപ്പെടുത്തി പഠിക്കാൻ സാധിക്കുന്നുണ്ട്.					
5	ഐടി ഗണിത ലാബിലെ പ്രവർത്തനങ്ങൾ സ്വയം ചെയ്യാൻ സാധിക്കുന്നതാണ്.					
6	ഐടി ഗണിത ലാബ് ഉപയോഗിച്ചുള്ള ഗണിത പഠനത്തിലൂടെ പഠിക്കാനുള്ള താല്പര്യം കൂടിയിട്ടുണ്ട്.					
7	ഗണിതാശയങ്ങൾ ഐടി ഗണിതലാബിന്റെ സഹായത്തോടെ സഹപാഠികൾക്ക് വിശദീകരിച്ചു നൽകാൻ സാധിക്കാറുണ്ട്.					
8	ഗണിത ലാബിന്റെ പ്രവർത്തനത്തിലൂടെ സങ്കീർണ്ണമായ ഗണിത പ്രശ്നങ്ങൾ കൂടുതൽ വ്യക്തമായി മനസ്സിലാക്കാൻ സഹായകമാണ്.					
9	പ്രശ്നനിർധാരണത്തിൽ കൂടുതൽ ആത്മവിശ്വാസം നൽകാൻ ഐ ടി ഗണിത ലാബ് സഹായകമായിട്ടുണ്ട്.					
10	ഐടി ഗണിത ലാബ് ഉപയോഗിച്ചുള്ള ഗണിത പഠനം നിലവിലുള്ള സംശയങ്ങൾ ദൂരീകരിക്കാൻ					

No.	പ്രസ്താവനകൾ	പൂർണ്ണമായി യോജിക്കുന്നു	യോജിക്കുന്നു	അഭിപ്രായമില്ല	വിയോജിക്കുന്നു	പൂർണ്ണമായി വിയോജിക്കുന്നു
	സഹായിക്കുന്നുണ്ട്.					
11	ക്ലാസ് മുറിയിൽ ചർച്ചചെയ്യുന്ന ഗണിത പഠന പ്രവർത്തനങ്ങൾ ഐടി ഗണിത ലാബിൽ സ്വയം ചെയ്യാൻ സാധിക്കാറുണ്ട്.					
12	ഐടി ഗണിത ലാബിന്റെ പ്രവർത്തനങ്ങളെക്കുറിച്ച് വ്യക്തമായ ധാരണ എനിക്കുണ്ട്.					
13	ഐടി ഗണിത ലാബിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ള പ്രവർത്തനങ്ങൾ പഠന നേട്ടങ്ങൾ കൈവരിക്കുന്നതിന് സഹായകമാണ്.					
14	ഐടി ഗണിത ലാബിലെ പ്രവർത്തനങ്ങളുടെ സഹായത്താൽ ഗണിതാശയങ്ങൾ വളരെ ആഴത്തിൽ ഉൾക്കൊള്ളാൻ സാധിക്കുന്നുണ്ട്.					
15	ഐടി ഗണിതലാബിലൂടെ നേടിയെടുത്ത ഗണിത ആശയങ്ങൾ സമാന രീതിയിലുള്ള പ്രശ്നപരിഹാരത്തിന് സഹായകമാണ്.					
16	ഗണിതാശയങ്ങൾ ഗണിതലാബിന്റെ സഹായത്തോടെ അവതരിപ്പിക്കുമ്പോൾ പെട്ടെന്ന് മനസ്സിലാക്കാൻ സാധിക്കുന്നു.					
17	സ്വയം പ്രവർത്തനത്തിന് ഉതകുന്ന രീതിയിലാണ് ഗണിത ലാബിന്റെ പ്രവർത്തനങ്ങൾ തയ്യാറാക്കിയിട്ടുള്ളത്.					
18	ഗണിത ലാബിന്റെ സഹായത്തോടെയുള്ള ഗണിത പഠനം ഞങ്ങളിൽ ഗണിതത്തോടുള്ള താൽപര്യം വളർത്തുന്നുണ്ട്.					
19	ദൃശ്യവൽക്കരണത്തിലൂടെ ഗണിത ആശയം അവതരിപ്പിക്കുമ്പോൾ പൂർണ്ണമായി ഉൾക്കൊള്ളാൻ സാധിക്കുന്നു.					

No.	പ്രസ്താവനകൾ	പൂർണ്ണമായി യോജിക്കുന്നു	യോജിക്കുന്നു	അഭിപ്രായമില്ല	വിയോജിക്കുന്നു	പൂർണ്ണമായി വിയോജിക്കുന്നു
20	ക്ലാസ് റൂം പ്രവർത്തനങ്ങളും ഗണിത ലാബ് പ്രവർത്തനങ്ങളും ബന്ധപ്പെടുത്തി മനസ്സിലാക്കാൻ സാധിക്കുന്നുണ്ട്.					
21	ഐടി ഗണിതലാബിന്റെ പ്രവർത്തനങ്ങൾ ഗണിത ക്ലാസിൽ നേടിയെടുത്ത ആശത്തിന്റെ സ്വയം വിലയിരുത്തലിന് സാധ്യമാണ്.					
22	ഗണിതത്തിലെ എല്ലാ യൂണിറ്റുകളും ഐടി ഗണിത ലാബിന്റെ പ്രവർത്തനങ്ങളിൽ കൂടി മനസ്സിലാക്കാൻ സാധിക്കുന്നുണ്ട്.					
23	ഗണിത പഠനത്തിന്റെ ഭാഗമായി ഐടി ഗണിത ലാബ് ഉപയോഗിക്കുന്നതിൽ പ്രയാസം അനുഭവിക്കുന്നുണ്ട്.					
24	ഗണിതാശയങ്ങൾ ഐടി ഗണിത ലാബിന്റെ സഹായത്തോടെ മനസ്സിലാക്കുന്നതിന് ഉപയോഗിക്കുന്ന സോഫ്റ്റ്‌വെയറുകൾ കൈകാര്യം ചെയ്യാൻ പ്രയാസപ്പെടുന്നുണ്ട്.					
25	നിലവിലുള്ള ഐടി ലാബ് പ്രവർത്തനങ്ങൾ ഗണിത ആശയങ്ങൾ നേടിയെടുക്കുന്നതിന് പര്യാപ്തമാണ്.					
26	ഗണിതങ്ങൾ ഐടി ഗണിത ലാബിന്റെ സഹായത്തോടെ നേടിയെടുക്കുന്നതിന് അനുവദിച്ച സമയം പര്യാപ്തമാണ്.					
27	ഗണിതാശയങ്ങൾ നേടിയെടുക്കുന്നതിനു വേണ്ടിയുള്ള ഐടി ഗണിതലാബിൽ നൽകിയ വർക്ക് ബുക്ക് / മാനുവൽ എന്നിവ ഉപയോഗപ്പെടുത്താൻ സാധിക്കാറുണ്ട്.					
28	ഐടി ഗണിതലാബിലെ പ്രവർത്തനങ്ങൾ എളുപ്പത്തിൽ മനസ്സിലാക്കാൻ സാധിക്കുന്നതാണ്.					
29	ഐടി ഗണിതലാബിലെ പ്രവർത്തനങ്ങൾ					

No.	പ്രസ്താവനകൾ	പൂർണ്ണമായി യോജിക്കുന്നു	യോജിക്കുന്നു	അഭിപ്രായമില്ല	വിയോജിക്കുന്നു	പൂർണ്ണമായി വിയോജിക്കുന്നു
	ഗണിതത്തിലെ പ്രാഥമിക ആശയം മനസ്സിലാക്കുന്നതിന് സഹായിക്കുന്നതാണ്.					
30	ഐടി ഗണിതലാബിലെ പ്രവർത്തനങ്ങൾ ഗണിതത്തിലെ അമൂർത്തമായ ആശയങ്ങൾ മനസ്സിലാക്കാൻ സഹായിക്കുന്നതാണ്.					
31	ഐടി ഗണിതലാബിലെ പ്രവർത്തനങ്ങൾ ഗണിതത്തിലെ ഓരോ യൂണിറ്റിലെയും ആശയധാരണ വിലയിരുത്തുന്നതിന് സഹായകമാണ്.					
32	ഐടി ഗണിത ലാബിലെ പ്രവർത്തനങ്ങൾ ഗണിതത്തിലെ ഓരോ ആശയവും നേടിയിട്ടുണ്ടോ എന്ന് വിലയിരുത്തുന്നതിന് സഹായകമാണ്.					
33	ഐടി ഗണിത ലാബിലെ പ്രവർത്തനങ്ങൾ ഗണിതശയത്തിലെ സംശയനിവാരണത്തിന് ഉതകുന്ന രീതിയിലാണ്.					
34	ഐടി ഗണിതലാബിലെ പ്രവർത്തനങ്ങൾ സങ്കീർണ്ണമായ പ്രശ്നപരിഹാരത്തിന് സഹായിക്കുന്നതാണ്.					
35	ഐടി ഗണിത ലാബിന്റെ സഹായത്തോടുള്ള ഗണിത പഠനം പ്രശ്ന പരിഹാരത്തിന് ആത്മവിശ്വാസം നൽകുന്നുണ്ട്.					
36	ഐടി ഗണിതലാബിന്റെ സഹായത്തോടെയുള്ള ഗണിത പഠനം ഉയർന്ന തലത്തിലുള്ള പ്രശ്ന പരിഹാരണത്തിന് സഹായകമാണ്					

Appendix IV

ATTITUDE OF MATHEMATICS TEACHERS TOWARDS IT MATHS LAB OF HIGHER SECONDARY SCHOOLS IN KERALA

(Draft)

Dr. Sunil Kumar A.S.

Professor,

NSS Training College, Ottapalam

Nuhman Shibli C.A.

Research Scholar

NSS Training College Ottapalam

Dear Teachers,

As part of Ph.D. program, I am undertaking research on the topic “A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA” under the supervision of Dr. SUNIL KUMAR A.S, Professor, NSS Training College, Ottapalam. Some statements related to attitude towards IT Maths lab introduced in the higher secondary schools are given below. Please read each statement and decide how far you agree with each statement using the responses as Very High (VH), High (H), Average (A), Low (L), and Very Low (VL). Your responses will be kept confidential. The scale intends to know your Attitude towards IT Maths Lab in teaching learning process and it has no other purpose whatsoever.

Part I: General Profile

Name of the teacher	:	
Name of school	:	
Locality of the school	:	Rural / Urban
District	:	
Gender	:	Male / Female / Transgender
Age	:	 Years
Experience (years)	:	
School Type	:	Government / Aided

Part II: Attitude towards IT Maths Lab

No.	Statement	VH	H	A	L	VL
	Participation of Learners					
1	Mathematics teaching through IT Maths Lab contributes to the level of participation of learner					
2	Mathematics teaching through IT Maths Lab has increased their level of involvement of learner in the subject of mathematics					
3	Mathematics teaching through IT Maths Lab encourages the learner to self-doing activities					
4	Mathematics teaching through IT Maths Lab provides the learners a lot of concept related additional activities					
5	Mathematics teaching through IT Maths Lab has increased active participation of learner in the classroom					
	Motivation					
6	Teaching mathematical content through IT Maths Lab motivates teachers with regard to teach mathematical content					
7	Mathematics teaching through IT Maths Lab improves the motivation with regard to mathematical content					
8	Mathematics teaching through IT Maths Lab creates interest in learning mathematics among students					
9	Mathematics teaching through IT Maths Lab provides visual exhibition of concepts and it motivates the learner.					
10	Teachers are concerned with the implementation of IT Maths lab along with teaching learning process.					
11	Teachers are confident in handling IT Maths lab activities for teaching mathematical concepts.					
12	Present IT Maths lab activities help to change the teacher student relationship.					
13	Present IT Maths lab activities help to influence the teaching learning process positively.					
	Resources					
14	Application of information technology is essential in					

No.	Statement	VH	H	A	L	VL
	the learning process of mathematics.					
15	The use of mathematics learning resources given in the IT Maths lab helps to improve the learning process.					
16	In addition to the existing math lab activities, other activities should be included to teach more mathematical concepts.					
17	The software included in the present IT Maths lab activities are adequate to the teaching learning process.					
18	The present infrastructure facilities given in the present IT Maths lab are adequate to the teaching learning process.					
	Concept					
19	Mathematics teaching through IT Maths Lab help in the learning of mathematical concepts among students					
20	Mathematics teaching through IT Maths Lab helps to strengthen the mathematical concepts among students					
21	Mathematics teaching through IT Maths Lab is helpful to concretise the abstract concepts among students.					
22	Through the visualisation in IT Maths lab activities, deep mathematical concepts can be fully conveyed to children.					
23	Mathematics teaching through IT Maths Lab contributes to the application of the mathematical concept in the context of problem solving.					
24	Lab activities are available to cover all the mathematical concept at the higher secondary level					
	Transaction					
25	For the transaction of the mathematical content, make use of software (geogebra, python, spreadsheet, etc.)					
26	Use of IT Maths Lab can reduce time consumption in the transaction of the mathematical content					
27	Transaction of the mathematical content through IT Maths lab helps to enhance the logical thinking.					
28	Use of IT Maths Lab for the transaction of the mathematical content helps to enhance the freedom in self-learning skill.					
29	Activities included in the IT Maths lab are adequate to					

No.	Statement	VH	H	A	L	VL
	achieve mathematical content.					
30	IT Maths lab activities are arranged in a simple manner which help the students for self-learning.					
31	IT Maths lab activities are arranged in a simple manner which help the students for understanding the mathematical concepts.					
32	It is possible to complete the IT Maths lab activities along with the class room activities.					
33	Time allotted for the IT Maths lab activities are adequate.					
	Evaluation					
34	Activities of IT Maths lab helps in the continuous evaluation of the learners.					
35	Activities of IT Maths lab helps in the comprehensive evaluation of the learners.					
36	Activities of IT Maths lab helps in the formative evaluation of the learners.					
37	Activities of IT Maths lab helps in the self-evaluation of the learners.					
38	IT Maths lab activities helps to enhance the quality of learning among the students.					
	Training					
39	Department has given necessary training to the teachers for the functioning of IT Maths lab activities.					
40	Training given to the teachers for the functioning of IT Maths lab activities are effective.					
41	Continuous training to the teachers for the functioning of IT Maths lab activities are essential.					
42	Department has provided the manual to the teachers for the functioning of IT Maths lab activities along with training.					
43	Activities given in the manual are effective for the smooth functioning of IT Maths lab activities.					

Appendix V

ATTITUDE OF MATHEMATICS TEACHERS TOWARDS IT MATHS LAB OF HIGHER SECONDARY SCHOOLS IN KERALA

(Final)

Dr. Sunil Kumar A.S.

Professor,

NSS Training College, Ottapalam

Nuhman Shibli C.A.

Research Scholar

NSS Training College Ottapalam

Dear Teachers,

As part of Ph.D. program, I am undertaking research on the topic “A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA” under the supervision of Dr. SUNIL KUMAR A.S, Professor, NSS Training College, Ottapalam. Some statements related to attitude towards IT Maths lab introduced in the higher secondary schools are given below. Please read each statement and decide how far you agree with each statement using the responses as Very High (VH), High (H), Average (A), Low (L), and Very Low (VL). Your responses will be kept confidential. The scale intends to know your Attitude towards IT Maths Lab in teaching learning process and it has no other purpose whatsoever.

Part I: General Profile

Name of the teacher	:	
Name of school	:	
Locality of the school	:	Rural / Urban
District	:	
Gender	:	Male / Female / Transgender
Age	:	 Years
Experience (years)	:	
School Type	:	Government / Aided

Part II: Attitude towards IT Maths Lab

No	Statement	VH	H	A	L	VL
	Participation of Learners					
1	Mathematics teaching through IT Maths Lab contributes to the level of participation of learner					
2	Mathematics teaching through IT Maths Lab has increased their level of involvement of learner in the subject of mathematics					
3	Mathematics teaching through IT Maths Lab encourages the learner to self-doing activities					
4	Mathematics teaching through IT Maths Lab provides the learners a lot of concept related additional activities					
	Motivation					
5	Teaching mathematical content through IT Maths Lab motivates teachers with regard to teach mathematical content					
6	Mathematics teaching through IT Maths Lab improves the motivation with regard to mathematical content					
7	Mathematics teaching through IT Maths Lab creates interest in learning mathematics among students					
8	Mathematics teaching through IT Maths Lab provides visual exhibition of concepts and it motivates the learner.					
9	Teachers are concerned with the implementation of IT Maths lab along with teaching learning process.					
10	Teachers are confident in handling IT Maths lab activities for teaching mathematical concepts.					
11	Present IT Maths lab activities help to change the teacher student relationship.					
12	Present IT Maths lab activities help to influence the teaching learning process positively.					
	Resources					
13	Application of information technology is essential in the learning process of mathematics.					
14	The use of mathematics learning resources given in the					

No	Statement	VH	H	A	L	VL
	IT Maths lab helps to improve the learning process.					
15	In addition to the existing math lab activities, other activities should be included to teach more mathematical concepts.					
16	The software included in the present IT Maths lab activities are adequate to the teaching learning process.					
17	The present infrastructure facilities given in the present IT Maths lab are adequate to the teaching learning process.					
	Concept					
18	Mathematics teaching through IT Maths Lab help in the learning of mathematical concepts among students					
19	Mathematics teaching through IT Maths Lab helps to strengthen the mathematical concepts among students					
20	Mathematics teaching through IT Maths Lab is helpful to concretise the abstract concepts among students.					
21	Through the visualisation in IT Maths lab activities, deep mathematical concepts can be fully conveyed to children.					
22	Mathematics teaching through IT Maths Lab contributes to the application of the mathematical concept in the context of problem solving.					
23	Lab activities are available to cover all the mathematical concept at the higher secondary level					
	Transaction					
24	For the transaction of the mathematical content, make use of software (geogebra, python, spreadsheet, etc.)					
25	Use of IT Maths Lab can reduce time consumption in the transaction of the mathematical content					
26	Transaction of the mathematical content through IT Maths lab helps to enhance the logical thinking.					
27	Use of IT Maths Lab for the transaction of the mathematical content helps to enhance the freedom in self-learning skill.					
28	Activities included in the IT Maths lab are adequate to achieve mathematical content.					

No	Statement	VH	H	A	L	VL
29	IT Maths lab activities are arranged in a simple manner which help the students for self-learning.					
30	IT Maths lab activities are arranged in a simple manner which help the students for understanding the mathematical concepts.					
31	It is possible to complete the IT Maths lab activities along with the class room activities.					
32	Time allotted for the IT Maths lab activities are adequate.					
	Evaluation					
33	Activities of IT Maths lab helps in the continuous evaluation of the learners.					
34	Activities of IT Maths lab helps in the comprehensive evaluation of the learners.					
35	Activities of IT Maths lab helps in the formative evaluation of the learners.					
36	Activities of IT Maths lab helps in the self-evaluation of the learners.					
37	IT Maths lab activities helps to enhance the quality of learning among the students.					
	Training					
38	Department has given necessary training to the teachers for the functioning of IT Maths lab activities.					
39	Training given to the teachers for the functioning of IT Maths lab activities are effective.					
40	Continuous training to the teachers for the functioning of IT Maths lab activities are essential.					
41	Department has provided the manual to the teachers for the functioning of IT Maths lab activities along with training.					
42	Activities given in the manual are effective for the smooth functioning of IT Maths lab activities.					

Appendix VI

Interview Schedule

A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA

Objective 4: To identify the functioning of IT Maths Lab in the higher secondary schools for teaching learning process. [In terms of infrastructure, training, management, evaluation]

Functioning of IT Maths Lab

Part I: PROFILE OF THE SCHOOL

Name of the school:

School code:

District:

Management of school: Government / Aided

Location of the school: Rural / Urban

Total number of students:

Total number of Teachers:

Total number of batches:

Number of batches with Maths optional:

Number of students with Maths optional:

Part II: INFRASTRUCTURE FACILITY IN THE MATHS IT LAB

Separate IT Maths lab:	Yes / No
Separate smart class room for IT Maths lab:	Yes / No
Internet facility:	Yes / No
Printer:	Yes / No
Separate projector in the IT Maths lab:	Yes / No
Separate computer for each students	Yes / No
Smart Boards in the IT Maths lab	Yes / No
White boards in the IT Maths lab	Yes / No
Reference materials for students	Yes / No
Consistent availability of power supply	
SOLAR	Yes / No
Invertor	Yes / No
Audio visual facility	Yes / No

Log book/ log register	Yes / No
Practical record	Yes / No
Adequate furniture in the IT Maths Lab:	Adequate / Partially / Not
Adequacy of the IT equipment in the IT Maths Lab	Adequate / Partially / Not

Total number of computer available in the IT LAB:

Maximum number of students occupied in the IT LAB in one practical session:

Total area of computer IT LAB:

Part III Training and Management

Variable	Statement	Response
Training	All teachers are availed the training in IT Maths Lab	Yes / No
	Teachers are updating the training in each year	Yes / No
Implementation	Effectively implementing the lab activities	Yes / No
	Effectively utilising the IT Maths lab	Yes / No
	Keeping log book for the utilisation of the LAB	Yes / No
	Adequate time is allotted for the IT Maths lab	Yes / No
	Effectively Coordinating various labs activities	Yes / No
	Attitude of teachers are positive in the implementation of IT Maths lab activities	Yes / No
	Face Problem in time table preparation	Yes / No
	Utilisation of the IT Maths lab to other purpose / difficulty	Yes / No
Time Management	Provides Extra time for slow learners	Yes / No
	Provides additional activities for gifted learners	Yes / No
	Keep the separate Practical history of each students	Yes / No
Evaluation	Regularly taking feedback from teachers	Yes / No
	Regularly taking feedback from students	Yes / No
	Implementation of IT Maths Lab create Interest for learning mathematics	Yes / No

	Teachers conducting of separate practical evaluation other than board examination	Yes / No
Maintenance	Possible to conduct maintenance of the defective computers in time	Yes / No
	Avail sufficient fund for the maintenance of IT Maths lab	Yes / No

Problem

What are the Problem faced by the teachers while implementing the lab activities?

Problem	Major	Minor	Not problem
Teachers are not well equipped with lab activities			
Insufficient time to complete the activities			
Non availability of sufficient number of computers			
Deputing teachers as external examiners during class hours			
Common activities for biological/ computer science			
Others (specify.....)			

What are the Problem faced by the students while implementing the lab activities?

Problem	Major	Minor	Not problem
Insufficient time to complete the activities			
Non availability of sufficient number of computers based on the number of students			
There is no observation record similar to other practical's			
No correlation with theory and practical activities			
Others (specify.....)			

What are the Problem faced while conducting the lab activities?

Problem	Major	Minor	Not problem
Non availability of adequate physical infrastructure			
Non availability of adequate number of computers			
Internet connection			
Power failure			
Time slot allotment			
Collision with other practical works			
Others (specify.....)			

What are the Problem faced while conducting IT Lab examination

Problem	Major	Minor	Not problem
Non availability of adequate physical infrastructure			
Non availability of adequate number of computers			
Internet connection			
Power failure			
Time slot allotment			
Collision with other practical works			
Others (specify.....)			

Effective suggestions for implementing the lab activities

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Appendix VII

A STUDY ON *IT MATHS LAB* FOR TEACHING LEARNING PROCESS IN MATHEMATICS AMONG HIGHER SECONDARY SCHOOLS OF KERALA

**Nuhman Shibli C A, Research scholar, Department of Education, NSS Training College,
Ottappalam**

Dr. Sunil Kumar A S., Associate Professor, NSS Training College, Ottappalam

Discussion Points:

1. Factors that you lead to develop and implements practical in the mathematics of higher secondary school curriculum.
2. Previous model considered to develop the concept of it maths lab.
3. Pedagogical consideration in the development of it maths lab.
4. Rational behind to selection of the software.
5. Content area considered to develop practical lab activity and rationale for the selection of the content
6. Possibility of introducing IT oriented practical lab in all content of mathematics.
7. Advantages of introducing IT Maths lab in HS curriculum of mathematics.
8. Challenges faced while developing maths lab program.
9. Challenges face while implementing the program throughout the state.
10. Expected outcome and method of evaluation.

Appendix VIII

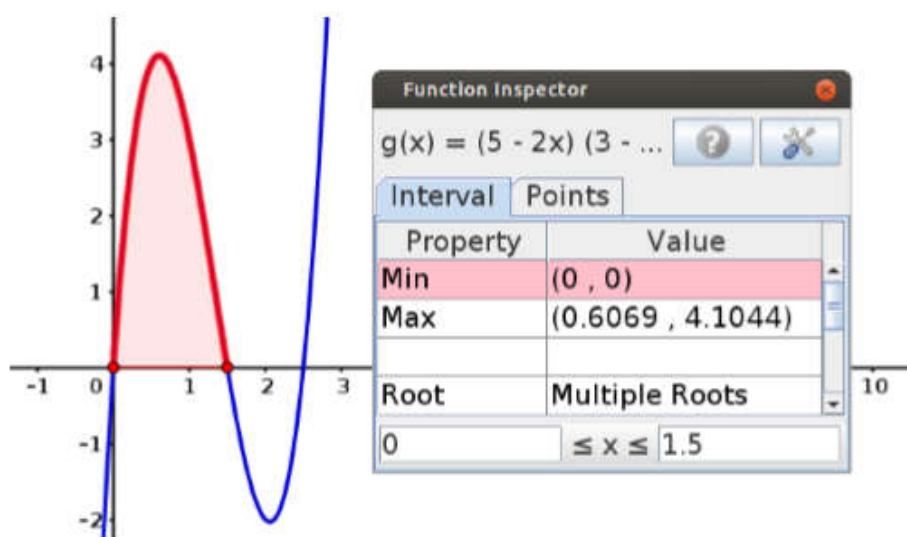
Selected Pages of IT Maths Lab Manual

(First Year, Page No 18)

Activity 3.B The Volume of a Box

Volume of the box is given by the function $v(x) = (5 - 2x)(3 - 2x)x$. Since x represents the length of the square cut away from the cardboard, its minimum value is 0 and maximum value is $\frac{1}{2}$ (either we can exclude these numbers, because no box is there at these values or we can include them by considering boxes of 0 volume). Hence we can take the domain as $[0, \frac{3}{2}]$ or $(0, \frac{3}{2})$.

Range of the function is obtained from the graph. We can use the 'Function Inspector' tool to find the maximum volume and the corresponding value of x .



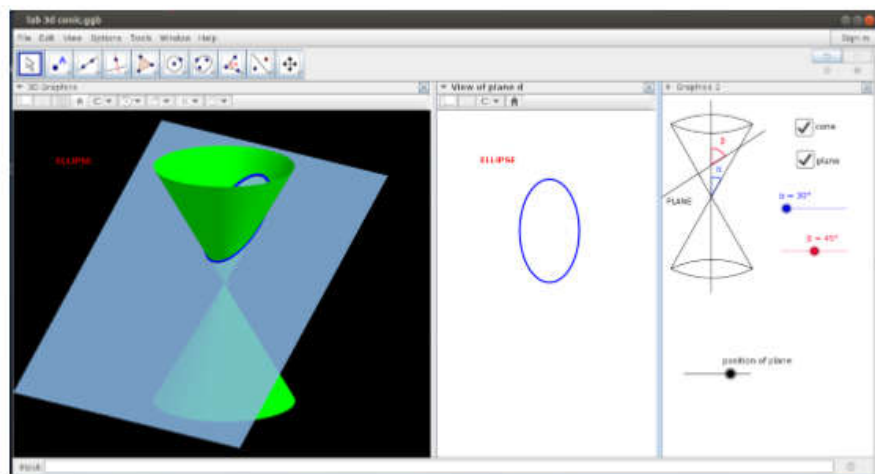
Click on the graph with the 'Function Inspector' tool and set the value of x in $[0, 1.5]$. The maximum volume is obtained is 4.1044 at $x = 0.6069$ (both are approximate values). The range of the function can be taken as $[0, 4.1044]$ or $(0, 4.1044]$.

(First Year, Page No 39)

Activity 9.1 Cutting of a Cone by a Plane

Use the Applet ML 9.1

About the applet:



In this applet we can see 3 open windows. **Graphics 2** , **3D Graphics** and the third one is **View of plane d**