SMARTPHONE USAGE AND EFFECTIVENESS OF LEARNING APP FOR STUDYING MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS OF MIZORAM

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram

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Submitted

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CERTIFICATE

This is to certify that the thesis entitled '**Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram**' submitted by **Lalnuntluanga Colney, Regn. No**. **MZU/Ph.D/1565 of 22.10.2020** for the Degree of Doctor of Philosophy in Education of the Mizoram University, Aizawl, India embodies the record of original investigations carried out by him under my supervision. He has been duly registered and the thesis presented is worthy of being considered for the award of a Ph.D. degree. This research work has not been submitted to any other university for any degree.

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DECLARATION

I, Mr Lalnuntluanga Colney, hereby declare that the subject matter of this thesis is the record of work done by me, that the contents of this thesis did not form basis of the award of any previous degree to me or to do the best of my knowledge to anybody else, and that the thesis has not been submitted by me for any research degree in any other University/Institute.

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CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

APK – Android Package Kit

AVD - Android Virtual Device

CPU – Central Processing Unit

Df. – Degrees of Freedom

HOTS - Higher Order Thinking Skills

ICT - Information and Communication Technology

L – Long Answer

MB – Megabyte

MBSE - Mizoram Board of School Education

NCERT - National Council of Educational Research and Training

NCF - National Curriculum Framework

NEP - National Education Policy

NPE - National Policy on Education

O – Objectives

OXFAM – Oxford Committee for Famine Relief

S1 – Short Answer I

S2 – Short Answer II

SPSS - Statistical Package for the Social Sciences

SUS - Smartphone Usage Scale

XML – Extensive Markup Language

CHAPTER I

INTRODUCTION

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INTRODUCTION

1.1 Background of the study

Education is essential for individuals to reach their full potential and for a nation or society to progress. The fundamental requirement and the cornerstone for improvement in all spheres of life is access to high-quality education. The Indian government took this education as an important source for the country's improvement in many ways. In the near future, considering the current rate of increase in population i.e. 209.3% in the past 60 years from 1961 to 2021 (The World Bank, 2022), India is projected to have the largest population of young people globally, thinking that giving quality and best education equally to all is a must for the development of the nation.

Students’ minds are nourished through education. A student's personality and aptitude can develop more fully due to education. The goals, objectives, and other key metrics for advancing the nation's young, gifted kids alter as education advances in line with society. For each stage of schooling, there are different goals and objectives. Due to age disparities and the different stages of mental and emotional development of students, elementary, secondary, and higher education have different goals and purposes.

1.1.1 Secondary Education in India

Secondary education in India serves as a critical phase in the journey of students' education, bridging the gap between primary education and higher education. It plays a pivotal role in shaping the future of young individuals, providing them with the knowledge, skills, and attitudes they need to navigate and succeed in the modern world. This phase not only prepares students for higher academic pursuits but also fosters critical thinking, creativity, and social responsibility, laying a strong foundation for their future careers and personal growth.

After the independence of India, secondary education in our nation saw significant, notable changes. Soon after gaining independence, the Indian government established several commissions and committees to reform the secondary education system. Several committees offered a few ideas for enhancing secondary education on both a quantitative and qualitative level. The report of the university education commission (December 1948 – August 1949) chaired by Dr. S. Radhakrishnan remarked that “our secondary education remains the weakest link in our educational machinery and needs urgent reform” (Ministry of Education Government of India, 1950, p. 82).

The report of the Secondary Education Commission (1952–1953) is a key document in the reconstruction of secondary education in India. Under the Chairmanship of Dr. A. Lakshmanswami Mudaliar, the commission was established by the Government of India on September 23, 1952, to examine the shortcomings in secondary education and provide recommendations for their improvement. Since secondary education is the most crucial phase of a student's overall education, the Commission insisted that it should be a stage all by itself. According to the Ministry of Education Government of India (1956), the following are some of the relevant Secondary Education Commission recommendations on the structure of secondary education and higher education:

- Under the structure, education should commence after a four or five-year period of Primary or Junior Basic education and should include (a) the Middle or Senior Basic or Junior Secondary stage of 3 years, and (b) the Higher Secondary stage of 4 years.
- The present Intermediate stage should be replaced by the Higher Secondary stage which should be of four years' duration, one year of the present Intermediate being included in it.
- Multi-purpose schools should be established wherever possible to provide varied courses of interest to students with diverse aims, aptitudes and abilities.
- The mother tongue or the regional language should generally be the medium of instruction throughout the Secondary school stage, subject to the provision that

for linguistic minorities special facilities should be made available on the lines suggested by the Central Advisory Board of Education.

- At the High school or Higher Secondary stage, diversified courses of instruction should be provided for the pupils.
- The diversified curriculum should begin in the second year of the High school or Higher Secondary school stage.
- The methods of teaching in schools should aim not merely at the imparting of knowledge in an efficient manner, but also at inculcating desirable values and proper attitudes and habits of work in the students.

According to the Indian Education Commission (1964-1966) recommendations, education was overhauled to promote the nation's economic and cultural development. By connecting the classroom with the students' actual lives, emphasis was placed on the qualitative growth of secondary education. Both the National Policy on Education (NPE) of 1986 and its 1992 revision addressed the overall goals and objectives of education. some of which apply to secondary education.

Presently, secondary education is divided into two mainstreams, i.e., secondary level (high school) & higher secondary level. At the secondary level, which is class 9 and class 10, the students need to learn English, Mathematics, Social Science, Science, a language subject, and another elective subject that will vary between schools and educational boards. Computer Applications, Physical Education, Economics, Environmental Science, and Commerce are some of the most popular elective subjects in the country. Within the curriculum, work/pre-vocational education, art education and physical education are also included. Secondary schools are affiliated to the state or central education board where the students need to face board exams in order to get to the higher level.

Those students who get through those board exams at the secondary level can get admission to a higher secondary level and choose the subject based on their interests and performance at the secondary level. During the 12th standard, another board exam was conducted to test whether they could pursue further studies or not. The curriculum for the Higher Secondary Certificate Examination is determined by the boards of secondary education. Due to the nationwide entrance examinations like the National Eligibility Entrance Test (NEET) and Joint Entrance Examination (JEE) conducted by the educational authority, the syllabus for the science stream at the higher secondary level is the same for both the state and central education board.

In the upcoming years, secondary education in India will undergo change once the National Education Policy (NEP) 2020 is in full force. The educational model will be somewhat reminiscent of the American secondary education system. However, certain regional modifications have been made. The following NEP characteristics correspond to secondary education in India:

- It will be referred to as the secondary stage of education.
- The 9th, 10th, 11th, and 12th grades will fall under the secondary stage and it will be studied by students of the 14-18 age group.
- Students in grades 9 and 10 will be categorized as junior high school students.
- The 11th and 12th graders will be classified as junior college or senior high school students. The curriculum will differ from the current ones, preferred subjects will replace streams, and the same procedure will be mandated for colleges.
- The NEP's primary goal is to eliminate rote learning.
- From class 8 onwards, students will have the freedom to choose subjects of their interest. (Ministry of Human Resources Development, 2020)

1.1.2 Mathematics Education at School

Mathematics is essential in our daily lives, and we rely on it constantly. It also holds significant importance in secondary education. Without Mathematics, subjects such as science, social science, and even languages lose their relevance due to their interdisciplinary nature. As such, Mathematics is indispensable in the academic curriculum. A solid understanding of Mathematics enhances students' ability to comprehend and excel in other subjects, particularly in science, where mathematical concepts are integral to exploring and understanding scientific phenomena.

In order to solve problems in Mathematics, students need to have good critical thinking ability as every step in Mathematics is related to each other which will develop their intellectual ability. Students must know how to interrelate all the techniques to have good problem-solving abilities. If the students at least know mathematics till the secondary level, they become responsible citizens and help them in decision making.

The Education Commission (1964 - 1966) placed a strong focus on the importance of mathematics education. The Commission believed that mathematics occupied a central place in contemporary education as quantification is one of the most notable aspects of scientific culture. In addition to its contribution to the development of physical science, it is currently becoming more and more significant in the advancement of biological sciences. This century's scientific-industrial revolution, which was sparked by automation and cybernetics, makes it even more crucial to give mathematics studies special attention. Schools need to lay the right foundations for proper understanding. Additionally, it was recommended that "science and mathematics should be taught on a compulsory basis to all pupils as part of general education during the first ten years of schooling" (Ministry of Education Government of India, 1966, pp. 197-198). Making mathematics a compulsory subject of study for all students up to the secondary level was another idea put up in the National Policy on Education (NPE) 1986.

According to the National Curriculum Framework (NCF) 2005, the primary objective of mathematics education is to increase students' capacity for mathematization. Mathematics in schools has two aims: a narrow aim and a higher aim. The narrow aim of school mathematics is to acquire "useful" skills, especially those connected to numeracy, number operations, measurements, decimals, and percentages. The higher aim is to strengthen the child's capacity for mathematical thought and reasoning, as well as his or her ability to manage abstractions and follow presumptions to their logical conclusion.

As per the NCERT (2005) document, the vision of NCF 2005 for school mathematics is as follows:

- Children learn to enjoy mathematics rather than fear it.
- Children learn important mathematics: Mathematics is more than formulas and mechanical procedures.
- Children see mathematics as something to talk about, to communicate through, to discuss among themselves, and to work together on.
- Children pose and solve meaningful problems.
- Children use abstractions to perceive relationships, to see structures, to reason out things, and to argue the truth or falsity of statements.
- Children understand the basic structure of Mathematics: Arithmetic, algebra, geometry and trigonometry, the basic content areas of school Mathematics, all offer a methodology for abstraction, structuration and generalisation.
- Teachers engage every child in class with the conviction that everyone can learn mathematics.

1.1.3 Mathematics Curriculum at Secondary Level of Education

The curriculum serves as a tool to carry out the goals for teaching a specific subject. The curriculum can be understood as the totality of experiences a child gains through both formal and informal activities at school, home, and within society. An essential component of the overall school curriculum is the mathematics curriculum. As a result of its crucial contribution to the development of our civilization, it has always held an important position at the school stage.

With its own language and structure, mathematics is a self-contained, independent study. It is not only a stand-alone discipline but also has many applications in other fields of study. Mathematics exposes underlying patterns that aid in our comprehension of the outside world. Thus, mathematics is the study of patterns and order involving numbers, geometrical objects, shapes, algorithms, chance, and change. Mathematical modelling of natural events, human behaviour, and social systems is one of the many topics covered by the discipline today. It is more than just the study of arithmetic, algebra, and geometry.

At the secondary stage, mathematics is a compulsory subject and the students start to perceive Mathematics as an academic discipline. At this stage, students are aware of the structure of Mathematics, leaving behind the method of rote learning gradually, thereby entering this stage with understanding. Here, they have the knowledge to practise and apply Mathematics terms, formulae, signs and symbols. They started getting to be aware of Geometry and Trigonometry and that led to having a deeper knowledge and understanding of Algebra which they already learnt at the elementary level. Students can identify and understand the relationship between algebra and what they learnt from Geometry and Trigonometry, as well as with Mathematics and other subjects.

To fulfil the changing needs of students in all categories, the current revised curriculum was created following the National Curriculum Framework of 2005 and the recommendations made by the Focus Group on Teaching Mathematics. The areas included in the mathematics curriculum at the secondary level prescribed by the National Council of Educational Research and Training (NCERT) are Number systems, Algebra, Coordinate geometry, Geometry, Mensuration, Trigonometry, Statistics and Probability. Each of these subjects is designed to provide students with a solid foundation in mathematical concepts, equipping them with the skills necessary for higher education and real-world applications.

Meanwhile, Mathematics is an optional subject at a higher secondary level but with prior knowledge of various utilizations of mathematics on reaching this stage, they are being guided to why, where and how they should apply that knowledge to different fields. Various subjects such as Physics, Chemistry, Biology, Economics, Commerce, Astronomy, Computer science, etc and their interlinking with Mathematics are given preference, so this stage is the gateway to start their career and hence it is an utmost and critical work to prepare them for their future. Advanced Mathematics at the higher secondary stage includes integration, differentiation, quadratic equations, logarithms, and coordinate geometry in the syllabus.

1.1.4 Learning Resources in Mathematics

There are various concepts, views, beliefs and approaches to learning mathematics, but it is hard to point out the best approach to learning mathematics. Developing and maintaining students' enthusiasm for mathematics is one of a teacher's hardest concerns. However, one thing that will benefit the students in learning mathematics is by monitoring the student's mathematical learning capabilities and understanding how they prefer to learn this subject. Moreover, teaching various learning styles in mathematics gives the students a sense of excitement. Since mathematics subjects are active and constructive learning, it should be noted that secondary school students should not be passive learners only, learning by doing needs to be practically followed as well. Therefore, it is essential to explore additional learning resources that can enhance the study of mathematics, make it more engaging, help eliminate students' fear of math, and achieve both specific and broader educational objectives.

Learning materials or resources are materials that instructors can use to carry out instruction and help students achieve their educational goals. Both teachers and students can use these resources to learn more about a specific topic (Gupta, 2022). Resources can also be thought of as things that are used to accomplish goals. When it comes to learning mathematics, learning resources can include textbooks and workbooks, which offer structured content and practice problems. Digital resources, such as online tutorials and educational apps make complex concepts more accessible and understandable, allowing students to learn at their own pace and reinforcing their understanding through interactive and engaging platforms. Interactive tools like graphing calculators and related software help visualize and perform calculations. Manipulatives and visual aids, including algebra tiles and charts, make abstract concepts tangible. Supplementary materials, such as mathematics guidebooks and mathematical journals, provide deeper insights. Collaborative platforms, including study groups and online forums, enable discussion and shared learning among students.

Learning resources in mathematics are diverse and multifaceted, each playing a crucial role in enhancing understanding and proficiency in the subject. By leveraging a mix of traditional, digital, interactive, and collaborative tools, educators can provide a comprehensive learning experience that meets the needs of all students. As technology evolves, the range and quality of mathematical learning resources are expected to improve, offering even more opportunities for students to explore and enjoy the fascinating world of mathematics.

1.1.5 Digital Learning Resources in Mathematics

The introduction of several learning resources has simplified the learning process for students. Digital learning resources in mathematics, facilitated by Information and Communication Technology (ICT), have significantly transformed the landscape of mathematics education by offering innovative tools that enhance understanding and engagement. ICT includes the hardware and software technologies used for communication, conversion, development and storage of information in digital form. Internet, wireless networks, computers, laptops, smartphones, and social networking sites are some of the examples. (Rouse, 2023)

These digital resources encompass a variety of platforms and applications designed to support learning at various levels. It provides structured lessons and interactive exercises across all levels of mathematical proficiency, from basic arithmetic to advanced calculus. Educational apps leverage ICT to offer instant solutions and detailed explanations for mathematical problems, fostering independent learning and problem-solving skills. Collaborative learning platforms enrich learning mathematics learning through shared knowledge and diverse perspectives.

Moreover, ICT-driven adaptive learning technologies provide customized learning pathways based on individual student needs, providing targeted remediation and tracking progress over time. Together, these ICT-enhanced resources encourage active student participation in mathematical learning, fostering deeper understanding, critical thinking, and preparation for success in an increasingly interconnected digital environment.

ICT plays a crucial role in the field of education. The practice of depending upon library books and printed materials has been changed to searching for materials through the Internet. Searching for information on the internet saves time and energy, especially for those who do not have access to the library. We can get any type of information we want at anytime and anywhere. Also, online teaching is made possible with the help of ICT and the COVID-19 pandemic has made clear how important ICT resources are for the teaching and learning process in education.

The Govt of India has also realised the importance of digital learning resources in education. According to the revised guidelines of the ICT@ School Scheme published by the Ministry of Human Resources Development (2011), since 1972 the scheme of Educational Technology (ET) has been implemented in 6 different states. In addition, the Computer Literacy and Studies in Schools (CLASS) Project was launched as a pilot project in 1984–1985 in acknowledgement of the significance of the role of ICT in education. The ICT@School Scheme was a flagship programme launched by the government in 2004 to modernise the secondary and higher secondary education system in the nation. In 2010 this scheme was revised and merged with RMSA and now it has been implemented all over the country under Centrally Sponsored Scheme. Under this scheme, every school is given items to establish a good ICT infrastructure, smart classrooms are built and efficient ICT teachers are recruited. National Awards for the Teachers using ICT for Innovations in Education are given to secondary school teachers and the development of e-content is given utmost importance.

The NCF 2005 has also recognised the vital role that ICT may play in classroom education. The National Policy on ICT in School Education (2012) advocated web-based digital repositories to hold a variety of digital content agreeable to the needs of various levels of pupils and teachers. National Education Policy 2020 has also declared that education and technology is bi-directional and an autonomous body of the National Educational Technology Forum (NETF) is to be created to provide a platform for the free exchange of ideas on the use of technology to enhance learning, assessment, planning, administration, and so on. (Ministry of Human Resources Development., 2020).

1.1.6 Smartphones as Educational Resources

As of now the smartphone has become one of the most widely used ICT devices and has become a part of our daily life. It is a portable electronic gadget with a cellular network connection that can perform many of the same tasks as a computer. It has a touchscreen interface, internet access, and an operating system that can run downloaded programmes. Processors and computer chips powered the majority of smartphones. The brain of the phone is essentially the CPU, which manages all of the device's capabilities. Its primary use was for communication but it is now used for playing games, videos, listening to music, and also provides access to social media and a wide range of other activities. The functioning of a smartphone is largely dependent on the operating system, among which iPhone, Android and Windows phones are the most common operating systems.

The impact of smartphones can be witnessed all around the world among varying age groups, especially adolescents. The compatibility and multifaceted functions of the smartphone lead to widespread use, which is reflected in the data released by TRAI in April 2022 where 1,167.82 million people were reported to have mobile connections in India, out of which there are 1,142.66 million wireless subscribers at the end of April 2022. (Telecom Regulatory Authority of India, 2022). An aggregate of 97% of the Internet users in India access the Internet from their mobile device resulting in the huge growth of the smartphone industry within a span of 4yrs. (India Cellular and Electronics Association, 2020). As per the report of Start.io, 55.8% of smartphone users in India fall under the age group of 18-24 years. (Smartphone Users in India, n.d). It was evident that the population of smartphone users showed a rise in young adults or adolescents. And it is no surprise that school-going children can be found to use different types of smartphones.

The immense growth in the number of smartphone users can be attributed to several factors including the lowering price of mobile data and smartphones, the increase in the number of users from rural areas, and a variety of govt initiatives that enhance accessibility. A study on smartphone usage patterns analysis of mobile data traffic across India reveals that the majority (70-80%) of mobile data is used for video streaming which is followed by internet browsing and accessing social media. (India Cellular and Electronics Association, 2020).

The growth in smartphone usage has resulted in the existence and development of educational applications. Educational applications in India have brought about a revolutionary transformation in these times when everything is accessible with just one click. For the benefit of students, numerous educational applications have been created. While some of these programmes must be purchased, some can be downloaded for free.

Smartphones have become increasingly important as educational resources over time, and in the years to come, they are likely to be the most helpful tools for learning. The role of smartphones in education will be determined by their compatibility, ease of access to learning resources outside of the classroom, and their wide geographic coverage. In addition to these reasons, smartphones are one of the most sought-after ICT tools for education because of their portability, ease of use, extended battery life, and speed.

The development of educational applications has had rapid growth over the last few decades, and numerous educational apps are now accessible to users of all ages, some of the most reliable and commonly used applications for students in India are: Google Classroom, Meritnation, BYJU’S - The Learning App, Brainly-Scan & Solve Study App, Unacademy Learner App, my CBSE guide- CBSE papers and NCERT Solutions, Vedantu-Live online tutoring, Vidyakul, Toppr, Doubtnut, Khan Academy and Coursera: Online courses (VdoCipher, 2023). However, most of these educational apps need an internet connection, and no educational applications based on the Mizoram Board of School Education syllabus were available on Google Play.

1.1.7 Functions of Educational Apps

The teaching-learning process would be significantly improved if we could combine e-learning with the current traditional educational system. The functions of the educational apps depend upon the target audience and it may differ according to the design of the apps. However, there is a common function of different educational apps besides the educational content in the apps some of which are:

- Educational apps reduced many gaps in our education system, especially the gap between teachers, students and parents are significantly reduced, this helps particularly in passing information among themselves.
- While there is a specific school hour with a routine where a particular subject is being taught at a particular set time in a normal school, there is no time specified for using educational apps, students can access educational apps at anytime and anywhere, also the student can choose the subject of their like according to their conveniences.
- Educational app follows systematic learning and this allows the students to learn their lesson systematically and at their own pace. Traditional method of learning needs paper, pen, pencil etc, learning apps do not need all of these and the materials required can be easily downloaded which is simpler yet more sustained.
- One platform where students can see and listen to lectures or chapter-by-chapter lessons that have been pre-recorded by teachers is educational apps. Students have convenient access to the classroom throughout the day in this fashion. Students can take advantage of useful features like zooming into a specific image and rewinding/fast-forwarding anywhere they wish when watching video content.
- Most educational apps offer mock tests and quizzes based on various topics and subjects. As tests are an essential component of learning, students can test their knowledge based on their ability and determine which chapters, themes, or subjects require more attention by using educational apps. Learning is now more enjoyable and involved than it has ever been thanks to educational apps.
- Interactive session with teachers or tutors is also an integral part of educational apps. Students who may have questions about a subject or a specific issue can get those questions answered in a live interactive session. An app provides a comprehensive learning experience by providing virtual classrooms with live tutorials and chat sessions with the tutors.

1.2 Rationale of the study

The massive growth in digital literacy and its impact on different areas of the world is a known fact. India has also become a major beneficiary and the increase in online education is testimony to this fact. The growing use of smartphones among secondary school students has recently drawn significant attention. It might not be completely incorrect to assume that the majority of secondary school students are familiar with using smartphones. In fact, the majority has become reliant on smartphones as a result of the COVID-19 pandemic which prevented opening schools for more than a year and necessitated emergency digital-based education throughout the world. Understanding the length of time students spend with their smartphones as well as the merits and demerits of smartphone usage, are key considerations for teachers, policymakers, administrators, and anyone else involved in the education sector.

The NEP 2020 mentioned that “a rich variety of educational software will be developed and made available for students and teachers at all levels to improve teaching and learning” (Ministry of Human Resources Development, 2020). Moreover, researchers and policymakers must understand the effectiveness of this software in the teaching and learning process. With this view, a research study to find out the effectiveness of technology integration in education will be helpful for the successful implementation of the National Education Policy 2020.

However, despite this overwhelming digital advancement, many areas in Mizoram, mostly in the remote and rural areas, are still unable to benefit from and experience all that digital advancement has to offer due to a lack of or poor internet connection, which prevents students from using the internet as effectively as they could in areas with a good internet connection. The COVID-19 pandemic made many classes and study materials only accessible through online classes, which made the problem worse. As a result, creating an offline application will be crucial for learning in both these challenging situations and in those where an internet connection is not an issue because offline applications are so accessible.

Mathematics education is of another great importance. All sciences are built on the foundation of mathematics, so anyone who wants to pursue technical education must first comprehend this subject thoroughly. The relevance of mathematics for students' futures is further increased by the fact that nations around the world are now competing with one another, making technological advancement of considerable consequence. It may be accurate to state that among secondary school students, mathematics is the subject they fear the most. Therefore, it is crucial for researchers to create a new approach to teaching and learning mathematics so that the student may quickly understand the subject and like mathematics rather than the opposite.

Since it is clear that smartphones are here to stay, preventing students from using them would be a useless feat. What is more important would be to channel this activity into a worthwhile one. Therefore, it becomes a major concern to not only understand the level of usage of smartphones by secondary school students but also devise some way to manipulate students’ affinity with smartphones in a way that would benefit their ability to understand mathematics. With these thoughts in mind, the researcher has decided to take up a research work that would successfully combine the two elements i.e., smartphone usage and mathematics learning and come up with results that would be of practical use for students and even other researchers and policymakers.

1.3 Statement of the Problem

The problem of the study is entitled ‘Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram’.

1.4 Operational Definition of Key Terms

Effectiveness – Effectiveness means finding out if using the mathematics application produced a desired outcome or benefit.

Gender – Gender in the proposed study refers to males and females based on biological characteristics.

Learning App – A Learning app is software that enables virtual teaching and self-learning through a smartphone.

Locality – Locality refers to either urban or rural location where the sample student is presently studying. The term urban and rural may mean all the areas covered under these two according to the Department of Economics and Statistics.

Secondary School Students- Secondary school students are adolescents with age ranging from 14 to18 years studying at secondary school which comprise of four years of multidisciplinary study from class 9 to class 12.

Smartphone - A smartphone is an electronic device that can be easily held by hand, capable of providing s a cellular connection and can perform many functions of a computer, which have a screen that responds to touch, access to the internet, and a sophisticated system that can download certain applications that may even be used in the absence of internet.

Studying Mathematics - Studying Mathematics refers to the process of learning and spending time on Mathematics in order to understand the nature and concept of different topics. Mathematics is one of the school subjects which deals with digits, figures, information, scales and also activities that run on logic.

Usage - Usage refers to the usual way a smartphone is used.

1.5 Research Questions

1. What is the major purpose for smartphone usage among secondary school students of Mizoram?
2. What is the level of smartphone usage among secondary school students of Mizoram?
3. Is there any difference on the level of smartphone usage between male and female secondary school students of Mizoram?
4. Is there any difference on the level of smartphone usage between rural and urban secondary school students of Mizoram?
5. Is there any difference on the level of smartphone usage between private and government secondary school students of Mizoram?

6. Is it possible to develop a learning app on mathematics for secondary school students of Mizoram?
7. What is the effectiveness of learning app on mathematics among secondary school students?
8. Will there be a difference in the effectiveness of learning app on mathematics between male and female secondary school students?

1.6 Objectives of the Study

1 To find out the major purpose for smartphone usage among secondary school students of Mizoram.

2 To find out the level of smartphone usage among secondary school students of Mizoram.

3 To compare the level of smartphone usage among secondary school students of Mizoram based on gender.

4 To compare the level of smartphone usage among secondary school students of Mizoram based on locality.

5 To compare the level of smartphone usage among secondary school students of Mizoram based on management of school.

6 To develop a learning app on mathematics for secondary school students of Mizoram.

7 To find out the effectiveness of learning app on mathematics among secondary school students.

8 To compare the effectiveness of learning app on mathematics among secondary school students in terms of gender.

9 To suggest measures for the improvement of Mathematics learning in Mizoram.

1.7 Hypotheses of the Study

1. There is a significant difference in the level of smartphone usage between male and female secondary school students of Mizoram.
2. There is a significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram.
3. There is a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram.
4. There is a significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app.
5. There is a significant difference in the effectiveness of learning app on mathematics between male and female secondary school students.

1.8 Delimitations of the Study

The study is delimited to investigate only class X students and the application has been developed only for the Android operating system due to the limitations of time and practical difficulties.

CHAPTER II

REVIEW OF RELATED STUDIES

CHAPTER II

REVIEW OF RELATED STUDIES

2.1 Introduction

Analysing, relating, and contrasting the current study with previous research in the same field by other researchers is essential to producing relevant and useful research. The literature review serves as a connecting thread between the two research for this reason. This enables the researcher to examine the research topic and provides evidence that has already been gathered by prior research, thus aiding in gaining and understanding the context of the existing research and discovering the missing link or area that needs to be addressed. It also offers a relevant research question on a particular topic of study, all of which lead to moulding the current research in the proper perspective.

In the present study, a review of the literature was done based on the selected objectives. As such the reviewed literature highlighting the major objectives and their findings have been divided under the following heads:

i. Studies related to smartphone usage among students.
ii. Studies related to mathematics learning at the secondary level of education.
iii. Studies related to mathematics learning using digital resources.

Additionally, the review distinguishes between studies conducted in India and those from outside the country, providing a comparative analysis. Where applicable, research conducted within the state of Mizoram has been categorized under separate sub-heads to highlight region-specific findings and insights. This structured approach allows for a comprehensive understanding of the current landscape and the relevance of existing research to the study's objectives.

A gestalt view of the total number of studies done and where they were done is represented in Table 2.1.

Table 2.1

Gestalt View of Related Study

Areas of Study	**Studies conducted in Mizoram**	**Studies conducted within India**	**Studies conducted outside India**	**Total No. of Study**
Smartphone usage among Students.	0	10	14	24
Mathematics learning at the secondary level of education.	1	11	11	23
Mathematics Learning using digital resources.	1	6	12	19
Total No. of Study	2	27	37	66

Note: This table presents a comprehensive overview of studies related to smartphone usage and mathematics learning across different geographical areas.

2.2 Studies related to Smartphone usage among students

2.2.1 Studies conducted within India

Mahalakshmi (2013) conducted a study on the adoption and usage of mobile phones among youth in Chennai, India. The survey results showed that

i) youth differed in terms of their demographics, social, and cultural orientation, motivation and technology in adoption and usage of mobile phones.

ii) A larger percentage of youth acquired cell phones for social interaction; safety and emergency needs, text messaging; media devices personal entertainment and for sharing content

iii) perceived and used cell phones as status symbols for enhancing their social image and to attract and make new friends.

iii) youth in Chennai irrespective of age, gender and other aspects considered mobile phones as their personal items.

Savio (2016) conducted a study to find out the trends in the usage of Smartphones among students Nature of mobile phone usage among college students in Goa. Some of the major findings of the field study were as follows:

i) The majority of the students own a mobile phone, with the majority owning smartphones

ii) There was a very strong association between gender and the amount spent on mobile phones per month, with the boys spending significantly more than girls

iii) The most popular and frequently used app was WhatsApp (used by 94.6 per cent of respondents). other popular purposes for which mobile phones were used were games (81.6 per cent), online shopping (79 per cent), Facebook (76.2 per cent), online videos (62.6 per cent) and Video calling (56.46 per cent).

Saraswathi (2017) conducted a study to find out the trends in the usage of Smartphones among students and to determine the brand preference; and how frequently students use smartphones in two Telengana cities of Hyderabad and Secunderabad. Results indicate that

i) In college, taking pictures, making a phone call, sending text messages and studying are among the top purposes of usage.

ii) At home, participants use to download software, listen to music and take videos. Taking pictures has the lowest score.

iii) At other places, participants use smartphones for watching videos, listening to music, taking videos and checking e-mails. Making phone calls has the lowest score.

iv) Majority of the students opined that smartphones are useful for education. More than 50 per cent of the students always use smartphones.

vii) 44.7 per cent of students own a smartphone with an Android operating system and 40.7 per cent of students use Windows operating system followed by 9.3 per cent Symbian and 5.3 per cent iOS.

Subramanian and Rajesh (2017) conducted research to analyse the merits and demerits of smartphone usage among college students mainly its impact on health in Chennai. The result shows that

i) The majority of students have used Smartphones for 3-5 years (65%).

ii)77% of the subjects were using their smartphone for more than 5 hours a day,

iii) 72% of the participants have used it for academic purposes,

iv) 79% of students used their smartphones at home and 14% of students used smartphones at the college.

v) Regarding the health complaints of college students 79% had a headache due to continued mobile usage, and 51% got anxiety after 47% lack of concentration,35% had sleeplessness, 43% had neck& arm pain, and 54% had eye pain while using phone.

Dilip and Javalkar (2018) conducted a study designed to find out the pattern of mobile phone usage and to evaluate the prevalence of mobile phone dependence among school-going adolescents in Davanagere, Karnataka. The findings of the study show that

i) Majority of the participants possessed a smartphone 205(81%).

ii) The average time spent on mobile phones per day is 101 minutes with the mean duration of usage in years 3.26yrs

iii) The prevalence of mobile phone dependency was found to be 170(67.2%).

Kaur (2018) conducted a research study focused on examining the extent of Mobile Phone usage and its influence on the academic performance of the students at Chandigarh University, Gharuan. The findings of the study show that

i) College-going students are influenced by Mobile phone usage to a greater extent and due to this their academic activities are left to suffer.

ii) 70% of the respondents accepted that Mobile Phone usage distracts them from their studies.

iii) Mobile Phone usage has become an addiction among young students.

Nayak (2018) conducted a study in India to find out how smartphone addiction on students' academic performance has been measured and the effect of gender and relationship status on smartphone usage and addiction has also been checked. Smartphone usage has been measured with the help of the amount of time spent on the phone and monthly bills. Results show that

i) the usage is more in the case of females than male students. However, the effect on performance is found to be severe in the case of male students.

ii) Apart from behavioural changes female students were found to have hardly any effect of Smartphone addiction on them, unlike the male students who were found to neglect work, feel anxious and lose control of themselves.

Negi (2019) conducted a study on mobile phone usage by undergraduate students and its relationship to their personality and values in Uttarkhand, India. The findings of the study reveal that

i) All Undergraduate students (100%) are using Mobile phones.

ii) It is a positive sign that most of the students are using mobile phones for educational purposes.

iii) Male Undergraduate students spend more time using mobile phones as compared to female undergraduate students.

iv) There is a positive relationship found between extroversion characteristics of the personality of the students and mobile phone usage.

Rekha (2019) conducted research to find out the Study habits, social competence and general well-being in relation to mobile phone usage among senior secondary school students in Jhajjar and Rohtak districts of Haryana. The findings of the study show that

i) There is a significant negative relationship between Study Habits and Mobile Phone Usage among Senior Secondary School Students indicating that more usage of Mobile Phones leads to worsening the Study Habits of students.

ii) There is a significant negative relationship between Social Competence and Mobile Phone Usage among Senior Secondary School Students indicating that as usage of Mobile Phones increases Social Competence decreases and vice versa.

iii) There is a significant negative relationship between General Well-Being and Mobile Phone Usage among Senior Secondary School Students. Indicating that as usage of Mobile Phones increases Social Competence of students decreases and vice-versa.

iv) Students of Govt. and Non-Govt. senior secondary schools were found to have Mobile Phone Usage to the same extent.

v) Students of Senior Secondary Schools in Rural and Urban Areas were found to have Mobile Phone Usage to the same extent.

vi) Male Senior Secondary School Students were found to have a higher level of Mobile Phone Usage than Female Senior Secondary School Students.

Bhanderi et. al. (2021) conducted a study to estimate the prevalence of smartphone use and its addiction among adolescents in the 16–19 years of age group in Vallabh Vidyanagar, Gujarat. The result showed that

i) Out of 496 participants, 416 (83.9%) were using smartphones. It was associated with age, area of residence, discipline, use of hands-free kits, and parents' education and income.

ii) The smartphone addiction rate was reported to be 37%. It was found to be associated with age, area of residence, place of education, duration of smartphone use, daily hours of use, the perception that smartphone use is harmful to health, and parents' education and income.

2.2.2 Studies conducted outside India

Alfawareh and Jusoh (2014) conducted a study on trends in smartphone usage among university students in Saudi Arabia. 94.4% (n=305 /324) of participants owned a smartphone. Based on this data, the trends were evaluated by categorizing usage into 2 types; normal usage and usage for learning. Results indicated that

i) The majority of students in Saudi Arabia use smartphones as a regular mobile phone, as a computer with an internet connection, and as a digital camera.

ii) 91.69% of students used smartphones to log in to their academic portal. Results also indicated that 60.89% of participants never used smartphones for Blackboard, 66.01% of students never used smartphones as a means for taking notes in a classroom and 66.89% of participants never used smartphones to record class lectures. A better percentage is shown for downloading class materials, where 54.49% of the participants used smartphones for downloading class materials.

Al-Barashdi et.al., (2015) conducted a review of the growing literature on Smartphone addiction among university undergraduates to identify trends. The paper also reviews the relationship between Smartphone addiction among undergraduates and their academic achievement. The findings reveal that

i) While some studies have shown gender differences in Smartphone addictive use, others have proved that gender and Smartphone use are not significantly related.

ii) A few studies have examined the relationship between addiction and students' field of study. Some of these have found that humanities students have a higher addiction level than physical science students.

iii) The results regarding Smartphone usage and family income showed contrary indications. Nor is there agreement about the results regarding Smartphone use and parental education.

Haug et al., (2015) conducted a research study in Switzerland to investigate the indicators of smartphone use, smartphone addiction, and their associations with demographic and health behaviour-related variables in young people. The finding shows that

i) Smartphone addiction occurred in 256 (16.9%) of the 1,519 students. On a typical day, the duration of smartphone use is longer and a shorter period until the first smartphone use in the morning and social networking is the most personally relevant smartphone function associated with smartphone addiction.

ii) Smartphone addiction was more prevalent in younger adolescents (15-16 years) compared with young adults (19 years and older).

Jesse (2015) conducted a study that discusses the relationships between smartphone usage and the effects smartphones have on student's social lives, education lives, and physical activity in the USA. Furthermore, it explores student preferences on their most and the least useful smartphone apps. This explanatory study yielded four significant findings;

i) 52% of the students own Android Operating System smartphone

ii) approximately 25 apps are installed

iii) The most useful apps are Utility Apps (calculate, convert, translate, etc.)

iv) least useful are Travel Apps (airplane tickets, tourist guides, public transportation info, etc.)

v) most used are social media, open Primary app 6 times a day, and Facebook is the primary social media app.

Thomas and Muñoz (2016) conducted a study to examine the survey responses of 628 high school students in a large urban school district in the USA to determine their perceptions of mobile phone use in the classroom. Findings indicated that

i) the majority of students (90.7%) were using a variety of mobile phone features for school-related work.

ii) Student support for instructional uses of phones, however, was not universal.

iii) Only 73.8% of the students supported integrating mobile phones into classroom instruction, while 70.6% believed that mobile phones supported learning. Iv) Students had serious concerns about the disruptions caused by using mobile phones in the classroom and by inappropriate usage.

Fakokunde (2017) conducted a research study to examine secondary school students' awareness of the educational use of mobile phones and their use of the device in Nigeria. The result showed that

i) The majority of the respondents are aware of the educational use of mobile phones though, the frequency of the use for learning is not encouraging.

ii) there is a significant relationship between the student's level of awareness and their use of mobile phones for learning.

Ng et al., (2017) conducted a study examining the extent to which students in one Malaysian university use smartphones to support their school-related learning and how these activities relate to CGPA. The result showed that

i) Significant differences were found in the use of smartphones depending on the academic program.

ii) the more students utilized their smartphones for university learning activities, the lower their CGPA.

Cha and Seo (2018) conducted a study aimed at examining smartphone use patterns, smartphone addiction characteristics, and the predictive factors of smartphone addiction in middle school students in South Korea. According to the Smartphone Addiction Proneness Scale scores,

i) 563 (30.9%) were classified as a risk group for smartphone addiction and 1261 (69.1%) were identified as a normal user group.

ii) The adolescents used mobile messengers for the longest, followed by Internet surfing, gaming, and social networking service use.

iii) The two groups showed significant differences in smartphone use duration, awareness of game overuse, and purposes of playing games.

iv) The predictive factors of smartphone addiction were daily smartphone and social networking service use duration, and the awareness of game overuse.

Zhao et al., (2018) conducted a study to understand the association between smartphone use for learning activities and academic performance (measured by cumulative GPA) in a sample of tertiary students in Singapore. Results showed that

i) there is a significant association between smartphone use for learning activities and student's cumulative Grade Point Average (CGPA) ($p < 0.05$).

ii) female students used smartphones more frequently for learning compared to male students and international students made more frequent use of smartphones for learning compared to local students.

iii) students who used smartphones for learning had higher academic performance (CGPA). Variables such as gender and nationality of students played a role in smartphone use for learning and impacted students' CGPA.

Kim et al., (2019) conducted a study to understand smartphone usage in college classrooms: A long-term measurement study in Korea. The data collection and processing tool for usage logging, mobility tracking, class evaluation, and class attendance detection was developed. The results reveal that

i) students use their phones for more than 25% of effective class duration, and phone distractions occur every 3–4 min for over a minute in duration.

ii) the key predictors of in-class smartphone use are daily usage habits and class characteristics, and in-class phone usage is negatively correlated with student grades.

Soegoto (2019) conducted a study to obtain an illustration and explanation of the usage of smartphones among college students in Indonesia. The result of the study confirmed that

i) students choose a smartphone because of its comprehensive features, affordable price, popularity, operating system, quality, games and camera features.

ii) Students spent nearly 6 hours per day with their smartphones. They took only 2 to 6 hours for social activities.

iii) students read their course for less than 2 hours.

iv) The applications that are frequently accessed using smartphones are Instagram, line, and WhatsApp.

Sabron et al., (2020) conducted a study to determine the influence of smartphone usage among secondary school students in Malaysia. The findings showed that

i) smartphone usage increases compassionate teaching with significant student engagement through the enhancement of the learner's cognitive capacity, motivation to study in both formal and informal settings, autonomy, and confidence, as well as the promotion of personalized learning in helping low-achieving students to reach their academic performance goals.

ii) The implications verified that implementing smartphone usage in the classroom will result in an effective and proper process in the learning environment.

Fook et.al., (2021) conducted a study aimed to examine problematic smartphone use, hours spent, factors and activities involved, and argue the possible risks of phone addiction among Malaysian university students. The results indicated that

i) most of them somewhat agreed that they used smartphones without any compelling reasons at every hour and that it induced emotional stability.

ii) the students were somewhat addicted to smartphones but did not use their smartphones for academic purposes.

Lee et al., (2021) conducted a study that aims to examine smartphone use and addiction among secondary school students in Malaysia. The findings from this study showed that

i) the long duration of smartphone use was detected during the weekend with more than three hours per day and social media (81.8%) was the most frequently visited function in the smartphones.

ii) more than half of the students (57.6%) have a high risk of smartphone addiction.

iii) There is also a significant negative weak correlation between smartphone use and smartphone addiction during weekdays and weekends with ($p < 0.05$; r2 -0.354, -0.360), respectively.

2.3 Studies related to Mathematics learning at the Secondary level of Education:

2.3.1 Studies conducted in Mizoram

Lalremmawii (2021) conducted a study on Mathematics education in secondary schools of Mizoram: status, problems and prospects. The findings of the study showed that

i) The syllabus for mathematics at this stage was hugely inferior to the one suggested by CBSE for this level of education in terms of content.

ii) Majority of the Secondary students had a negative attitude towards mathematics

iii) Untrained mathematics teachers were still teaching in the classrooms of secondary schools in Mizoram.

iv) Only 28.50 % of secondary schools had not 8 mathematics classes in a week.

v) Gender disparity was seen in the teachers because male teachers dominated mathematics education within the state.

vi) As shown by the results of five academic years studied by the investigator, students appearing for HSLC had poor performance in mathematics subjects.

vii) The dismal performances of mathematics education that were found in the study were explained by the questionnaire on the attitude of students towards the subject where it was revealed that students still had quite a low understanding of mathematics subject. At the HSLC level where mathematics is a compulsory subject, most students have a problem in mathematics.

2.3.2 Studies conducted within India

Nair (2009) conducted a study intended to enhance academic achievement through the discovery learning model (DLM) in Geometry at the secondary level. The results of the study found that

i) experimental group students had better-improved achievement scores than control group students.

ii) the DLM method of teaching is effective in the cognitive domain.

iii) the DLM method of teaching is effective in the psychomotor domain.

iv) the DLM method of teaching is effective in the affective domain.

Das and Baruah (2010) described the prevailing academic scenarios of a representative group of secondary schools in Assam (India) with special references to student’s performance in general and mathematics performance in particular on their paper. The study reveals that

i) In general, academic performances as well as mathematics performances of the government and private schools are better than the schools not getting government aid.

ii) mathematics performances of schools are positively correlated with (a) the academic performance of school indicated by school leaving pass percentage and also (b) with the performances in subjects other than mathematics.

iii) On the other hand, the student and teacher ratio seems not to affect the mathematics performance of the schools.

Babu (2013) studied the effect of attention-based activities on achievement in mathematics among secondary school students in Kerela. There was one control group taught through the existing curricular strategy other experimental groups were taught through attention-based activities. The results revealed that

i) the achievement in mathematics of students taught through Attention-based activity is better than that of students taught through Prevailing Methods.

ii) There is no significant difference in the achievement of boys and girls when they are taught through attention-based learning activities.

iii) there is a significant difference in the development of achievement in mathematics among different levels of Achievers when they are taught through Attention-based learning activities.

Sheela (2013) conducted a study on the impact of mind map teaching strategy on achievement in mathematics and certain select variables of high school students. The study revealed that

i) The study reveals that the Mind map teaching strategy is more effective in enhancing the Achievement in Mathematics of High school students than the Conventional lecture method.

ii) there is a significant correlation between Problem-solving ability in Mathematics and Achievement in Mathematics of High school students.

iii) there is a significant correlation between achievement in Mathematics and attitude towards Mind map strategy of High school students.

Ramesha (2014) investigated the effect of tutorial teaching strategies on the achievement and interest in mathematics of secondary school students. The investigator employed the experimental design. The results revealed that

i) group tutorial teaching strategy (GTTS) improved mathematics achievement and enhanced the interest in mathematics of the students.

ii) The supervised tutorial teaching strategy (STTS) improved the mathematics achievement and they did not enhance the interest in mathematics.

Bhowmik (2015) conducted a study in India to determine the effect of collaborative learning towards achievement in mathematics and also the attitude towards collaborative learning of mathematics among the hostel students of class nine in secondary school. In result

i) there was a significant difference in their academic achievement.

ii) collaborative learning had an effective positive attitude on student academic achievement in the classroom.

Ghosh (2015) described a study which was undertaken to investigate the impact of teaching mathematics using mathematical modelling and applications at the senior secondary school level in India. The study shows that

i) the use of modelling and applications enabled by technology enhanced students' understanding of concepts and led them to explore mathematical ideas beyond their level.

ii) Using this approach, a balanced use of technology and paper-pencil skills led to a deeper understanding of the subject.

Maghy (2015) analysed the effect of mnemonics on achievement of students in mathematics at the high school level. In this study, the method adopted here was a pre-test post-test non-equivalent group experimental design. Both groups were pre-tested before the start of the experiment. The experimental group was exposed to the mnemonics strategy and the control group was taught through the lecture method. Both groups were post-tested after the experiment. The result showed that the mnemonic strategy is more effective than the lecture method.

Ashim and Ahmed (2018) conducted a study to explore the effects of parental involvement on secondary school students‟ academic achievements in mathematics in Karbi Anglong district of Assam. Results from the study show that

i) there exists no significant relationship between parents' communication with school or teachers regarding students' education and mathematics achievement of students (i.e. $p = 0.182 > 0.05$).

ii) Parents' Attitude towards Mathematics is a significant factor related to the mathematics achievement of school students ($p = 0.000 < 0.05$.

iii) On the other hand parents helping with homework do not affect mathematics achievement $p = 0.051 > 0.05$.

Mamatha, M. (2018) conducted a study to find out the effectiveness of teaching Mathematics with transitional background music on mathematical achievement interest in learning Mathematics and attitude towards Mathematics among secondary school students in Koppa, Karnataka. The result shows that

i) The transitional background Music approach is an effective learning approach to develop Academic Achievement among secondary school students.

ii) The conventional approach is also an effective learning approach to develop Academic Achievement among secondary school students.

iii) The transitional background Music approach (28.26) is more effective than the Conventional approach (17.83) in developing Mathematical Achievement among secondary school students.

iv) The transitional background Music approach is a more effective learning approach than the conventional approach to developing an Interest in Learning Mathematics among secondary school students.

v) The transitional background Music approach is a more effective learning approach than the conventional approach to developing an Attitude towards Mathematics among secondary school students.

Dongre (2019) conducted a study on the Effect of a Cooperative Learning Strategy on Achievement in Mathematics Attitude towards Mathematics and Perceived Self-efficacy of Secondary School Students. The findings of the study show that

i) that Cooperative Learning helped in increasing the Achievement in Mathematics of students than the Conventional Approach of teaching.

ii) It also helped students develop a positive Attitude towards Mathematics and enhance Perceived Self-Efficacy of students in comparison to the Conventional Approach.

iii) Cooperative Learning does not influence gender and it produces similar positive results for both male and female students.

2.3.3 Studies conducted outside India

Saritas and Akdemir (2009) in their research work to Identify Factors Affecting the Mathematics Achievement of Students for Better Instructional Design in Turkey concluded that

i) instructional strategies and methods, teacher competency in math education, and motivation or concentration were the three most influential factors that should be considered in the design decisions.

ii) The results highlight the need to customize instruction to optimize the performance of each student. Instructional designers need to develop flexible teaching and learning based on awareness of students' experience and background, subject matter, and instructional communications and technology.

Zakaria et. al. (2010) investigated the effects of cooperative learning on students' mathematics achievement and attitude towards mathematics. The quasi-experimental study was carried out on two form one class in Miri, Sarawak, Malaysia. The result of the study showed that

i) the cooperative learning approach resulted in higher achievement than the traditional teaching approaches.

ii) the cooperative learning approach increases attitude towards mathematics.

Marchis (2011) conducted a study to investigate the factors that influence secondary school students' attitudes to mathematics in Romania. The findings show that

i) the most important factor is the teacher: the teacher’s attitude to mathematics and the amount of confidence and support he/she gives to the pupil influence their attitude towards mathematics.

ii) Another important factor is how pupils think about the utility of mathematics in their everyday lives.

iii) Self-efficacy and self-judgment also influence pupils’ attitudes towards learning mathematics.

Chukwuyenum (2013) conducted a study on the impact of critical thinking on performance in mathematics among senior secondary school students in Lagos State, Nigeria. The study revealed that

i) there was a significant difference in Mathematics performance test scores among the experimental groups.

ii) there was no significant gender difference in the mathematics performance test.

iii) Critical Thinking Skills were also an effective means of enhancing students’ understanding of Mathematics concepts.

Voinea and Purcaru (2014) conducted a study titled Boosting Romanian Students’ Interest in Learning Mathematics through the constructivist approach aims to describe the dynamics of student interest in mathematics over the levels of education, focusing on identifying the pedagogical factors involved in teaching and learning mathematics. The study concluded that the constructivist approach with emphasis on the affective dimension of learning, and the positive motivation, on solving concrete tasks, keeps "up" the students' interest in mathematics.

Sriwongchai, Jantharajit and Chookhampaeng (2015) conducted a study by Developing the Mathematics Learning Management Model for Improving Creative Thinking in Thailand. The study purposes were: 1) To study the current states and problems of relevant secondary students in developing a mathematics learning management model for improving creative thinking, 2) To evaluate the effectiveness of the model about a) efficiency of the learning process, b) comparisons of pre-test and post-test on creative thinking and achievement of students, and c) comparison of creative thinking and achievement between the experimental group and control group. The findings indicated that

i) The effectiveness of the model based on achievement score was 76.25%, and based on creative thinking was 61.67%.

ii) The average post-test in learning achievement and creative thinking abilities of the experimental group was higher than the pre-test, and the experimental group showed higher creative thinking than the control group at the 0.01 level of significance.

Holmes and Hwang (2016) conducted a study to explore the effects of project-based learning in secondary mathematics education. The focus of the study was academic skill development (algebra- and geometry-assessment scores) and other factors related to secondary mathematics learning, with comparable traditional high schoolers serving as the control group. Results showed that

i) at-risk and minority students benefited greatly from PBL in learning mathematics.

ii) The academic performance gap was present, but its width diminished significantly. Compared to their public-school counterparts, PBL students were more intrinsically motivated, showed significantly higher critical thinking skills, and appreciated peer learning.

Ling et. al. (2016) conducted research in Malaysia to find out the effectiveness of student teams-achievement division (STAD) cooperative learning on mathematics comprehension among school students. The findings of this research have shown that

i) STAD techniques in Mathematics learning can increase Mathematics comprehension.

ii) STAD cooperative learning techniques play important roles as an active pedagogy to increase Mathematics comprehension.

iii) STAD encourages the students and teachers to be innovative and creative to improve the teaching and learning of Mathematics in the classroom.

Panicker (2016) in his work “Teaching of Mathematics through an integrated approach at secondary level for value inculcation” found that:

i) The integrated approach of teaching Mathematics was found to be effective in terms of students' conceptual knowledge of all the values for the present study like cooperation, determination, dignity of labour, discipline, equality, honesty, loyalty, regularity, simplicity, teamwork when taken as a whole.

ii) The integrated approach to teaching Mathematics was found to be effective in terms of students' perception of each of the taken values like cooperation, determination, dignity of labour, discipline, equality, honesty, regularity and simplicity.

iii) The integrated approach was found to be effective in terms of the achievement in mathematics of standard VIII students as the mean gain scores of achievements in mathematics of the experimental group were found significantly higher than those of the control group. The students of the experimental group had higher achievement in mathematics than the control group.

iv) The integrated approach in value inculcation through the teaching of mathematics was effective in terms of students' reaction towards the integrated approach, the effectiveness of the activities conducted, the relevance of the stories integrating with mathematical concepts and values, examples used for mathematics content, participation of the class, understanding and perception of values, value practice, explanation of values, classroom management, time management, learning experience, integration of mathematics with values.

Pratama and Setyaningrum (2018) conducted a study in Indonesia to investigate the different effects of the problem-solving model with or without game-based learning (GBL) in learning mathematics. Results indicated that

i) students who were exposed to game-based learning within problem-solving (PS+GBL) significantly outperformed their counterparts who were exposed based on textbooks within problem-solving (PS+TB).

ii) The positive effects of PS+GBL were observed on both tests of numeracy and applied problems in geometry.

iii) In addition, the findings show the positive effects of the PS+GBL method on both lower and higher achievers.

Abed et al. (2020) in their study on “Predicting Effect Implementing the Jugsaw Strategy on the Academic Achievement of Students in Mathematics Classes” found that:

i) Jigsaw strategy had a more positive effect on students’ overall mathematics achievement than the control group students.

ii) Experimental group students also exhibited a positive attitude towards the mathematics lessons.

iii) These overall findings have some implications for the learning and teaching of mathematics in the Iraq context.

iv) Teacher-centred method is obsolete and ineffective, especially in teaching mathematics.

2.4 Studies related to Mathematics learning using digital resources:

2.4.1 Studies conducted in Mizoram

Lalduhawma (2018) conducted a study on teaching and learning Mathematics through Technology to Senior Secondary School students of Synod Higher Secondary School, Aizawl, Mizoram, India by introducing open-source software, namely, GeoGebra. They discussed some of the problems from their textbook and analysed the impact of the training programme through the pre and post-questionnaires. it was observed that

i) the students were excited about the methodology and wanted more such training in future.

ii) They were able to clarify many mathematical concepts that they did not know earlier.

iii) They concluded that the teachers should try to motivate the students by using software or computer-based methods as far as possible.

2.4.2 Studies conducted within India

Kim et. al. (2012) investigated a comparative analysis of a game-based mobile learning model in low-socioeconomic communities in India. The findings reveal that

i) children with little or no previous exposure to technology were able to not only figure out the given mobile learning technology but also solve a series of incrementally challenging problems by playing math games without specific intervention or instruction by adults.

ii) various factors, including gender and group size, do affect children's ability to adapt and learn while presenting a unique set of learning interaction patterns.

Angel (2014) conducted a study on the effectiveness of ICT Infused Instructional Design IIID in the methodology of teaching mathematics at the secondary level in Madurai, Tamilnadu. The findings of the study include

i) The student teachers exposed to IIID-MTM have scored higher on techno pedagogical competency in teaching mathematics, all domains of knowledge on ICT, attitude towards ICT, confidence in using ICT and in all domains of ICT skills after the intervention.

ii) ICT Infused Instruction design in the methodology of teaching mathematics is effective in developing pre-service teachers‟ knowledge on ICT, confidence in using ICT, attitude towards ICT, ICT skills and techno-pedagogical competency in teaching mathematics when compared to the other two treatments. i.e., integrated and complementary models.

Sengamalaselvi (2016) conducted studies on the effectiveness of ICT with GeoGebra and Winplot as learning tools in primary school and Higher Secondary students of Kanchipuram District, India. The finding of the study reveals that

i) Conventional method of teaching when supported with open-source software helps a better understanding of Mathematical concepts.

ii) The introduction of two and three-dimensional graphical representation and animation simplifies and clarifies mathematical concepts like Analytical Geometry and Calculus.

iii) Instead of just imagining the figure as in the conventional method, the students can visualize it through Geogebra software.

iv) Even if the teacher was not present, students never wanted any other instruction. They were committed to their work. They came running to the class and started doing their work themselves.

Joshi (2017) investigated the Influence of ICT on mathematics teaching. The study concludes that

i) ICT supports mathematics teacher in improving their designation of lessons, teaching-learning tactics, updated subjective and pedagogical knowledge and expansion of other several relevant skills.

ii) It is also highly beneficial for students as stimulates and involves learning, assembles confidence in their mathematical capabilities, shares and develops several subjective ideas and others.

Kushwaha and Singhal (2017) conducted a study on the impact of teaching mathematics using ICT-enabled learning in Varanasi, India. The study was done on the students of 4 different schools of elementary grade standards. The data were collected using a questionnaire format on different concepts like, counting, addition, subtraction and patterns. Pre-test data was collected initially without giving any instruction to the students and post-test data were collected after classroom teaching to both control and experimental groups. The result of the study showed that,

i) significant differences between the scores of control and experimental groups were recorded.

ii) The experimental group had better achievement which had received instruction by ICT with computer-enabled learning in comparison to the control group which was instructed without any teaching-learning tools.

Senthamaraikannan (2019) conducted a study to find out the effect of computer-assisted learning on achievement and anxiety in Mathematics of secondary school students. The findings of the study revealed that

i) computer-assisted learning is more effective for learning mathematics at the secondary level compared to conventional teaching.

ii) computer-assisted learning has been very effective in helping students to increase their mathematical achievement scores and reduce their anxiety towards mathematics.

iii) the loss of scores was 4.1 in the experimental group, and the retention ability of the experimental group was high compared to the control group (loss score was 6.9).

2.4.3 Studies conducted outside India

Keong et. al. (2005) conducted a study on the use of ICT in mathematics teaching in Malaysia. They concluded that

i) The use of ICT in teaching mathematics can make the teaching process more effective as well as enhance the student's capabilities in understanding basic concepts.

ii) Nevertheless, implementing its use in teaching is not without problems as numerous barriers may arise. The types of barriers have been identified in the study

Bayaa and Daher (2009) accomplished a study to find out Students' Perceptions of Mathematics Learning Using Mobile Phones which took place at an Arab middle school in Israel. They found that

i) the novelty of the experiment and the use of mobile phones in mathematics learning were the main characteristics perceived by the students as influencing their decision to join the experiment.

ii) the students perceived various qualities of the mathematics learning that were enabled by the use of mobile phones:

(1) exploring mathematics independently

(2) learning mathematics through collaboration and teamwork; where the collaboration is on equal terms

(3) learning mathematics in a societal and humanistic environment

(4) learning mathematics in authentic real-life situations

(5) visualizing mathematics and investigating it dynamically

(6) carrying out diversified mathematical actions using new and advanced technologies

(7) learning mathematics easily and efficiently.

iii) overall, the students were positively impressed by the potentialities and capabilities of the mobile phones used in the mathematics learning process.

Li and Ma (2010) conducted a study to examine the effects of computer technology on school students' mathematics learning. This result shows that

i) statistically significant positive effects of computer technology (CT) on mathematics achievement are indicated by the learners.

ii) CT showed an advantage in promoting mathematics achievement of elementary over secondary school students.

iii) CT showed larger effects on the mathematics achievement of special needs students than that of general education students.

iv) the positive effect of CT was greater when combined with a constructivist approach to teaching than with a traditional approach to teaching, and studies that used non-standardized tests as measures of mathematics achievement reported larger effects of CT than studies that used standardized tests.

v) The weighted least squares univariate and multiple regression analyses indicated that mathematics achievement could be accounted for by a few technology, implementation and learner characteristics in the studies.

Safdar et. al. (2011) conducted a study in Pakistan to find out the effectiveness of information and communication technology (ICT) in teaching mathematics at the secondary level. The students of the experimental group were exposed to the teaching through ICT, whereas the students of the control groups were taught through the traditional method of teaching in the subject of mathematics. The units taught to both groups were Sets, Algebraic Expressions, and Logarithms, chosen from the prescribed syllabi for class IX by the Federal Board of Intermediate and Secondary Education. ICT was found effective as compared to the traditional method of teaching mathematics at the secondary level for private sector schools.

Kalloo and Mohan (2012) presented “MobileMath”, a mobile learning application designed to help secondary school students improve their performance in algebra in the Caribbean. The application, which is available on mobile phones with internet access, offers lessons, examples, tutorials, quizzes and games that support users to practice certain mathematical skills. The results reveal that

i) the students were able to improve their performance and they were excited about using a mobile device for learning. They adapted well to using this method of learning for the first time.

ii) The students who improved were those who had done algebra in a previous school term but may have been failing the subject.

iii) The mobile application did not make a significant impact on students who were learning the algebraic content for the first time.

Shin et. al. (2012) conducted a study to find out the effects of game technology on elementary student learning in mathematics in the USA. A quasi-experimental control-group design with repeated measures analysis of variance and analysis of covariance was employed to explore performance differences between groups. The second study examined student learning in relation to characteristics such as their game performance, attitudes toward the game and toward mathematics, and gender and ethnicity. Results from the two studies revealed that using a technology-based game in the classroom was beneficial to students of all ability levels in learning arithmetic skills.

Cheung and Slavin (2013) conducted a review examining research on the effects of educational technology applications on mathematics achievement in K-12 classrooms. A total of 74 qualified studies were included in the final analysis with a total sample size of 56,886 K-12 students: 45 elementary studies (N = 31,555) and 29 secondary studies (N = 25,331). The findings suggest that

i) educational technology applications generally produced a positive, though modest, effect (ES = +0.15) in comparison to traditional methods. However, the effects may vary by educational technology type.

ii) Among the three types of educational technology applications, supplemental Computer Assisted Instruction had the largest effect with an effect size of +0.18. The other two interventions, computer-management learning and comprehensive programs had a much smaller effect size, +0.08 and +0.07, respectively.

iii) Differential impacts by various studies and methodological features are also discussed.

Ozdamli et. al (2013) investigated the effect of technology-supported collaborative learning settings on the behaviour of students towards Mathematics learning in Cyprus. Students were taught algebraic expression in detail at the beginning of this academic year. Then dividing the students into groups of four or five, they were given projects related to the given topic. In the projects, the students were needed to search for their project topic with their friends in their group, discuss and then prepare a presentation cooperatively. The presentations of the students were shared and discussed in the setting of Wikispaces by themselves. According to the pre-testing and post-testing results, it is pointed out that technology-supported Mathematics education has a positive effect on students.

Saadati et. al. (2014) investigated the Utilization of Information and Communication Technologies in Mathematics Learning in Iran. The study attempted to examine what is engineering students' perception regarding the use of Information and Communication Technologies (ICT) in mathematics learning as well as investigate their opinion about how ICT can be integrated to improve teaching and learning processes. The finding showed

i) they are fully aware of the importance of ICT in teaching and learning mathematics.

ii) Whilst, they were feeling comfortable and confident with technology, they did not have more experience of using technology in mathematics classes before.

iii) The findings supported the other studies, which indicated the potential of ICT to facilitate students' learning, improve teaching, and enhance institutional administration as established in the literature.

Moreno-Guerrero et al., (2020) conducted a study on E-Learning in the Teaching of Mathematics: An Educational Experience in Adult High School to identify the effectiveness of the e-learning method in the teaching of mathematics with adults who are in high school, in contrast to the traditional expository method. The results show that

i) the use of the e-learning method has a positive influence on motivation, autonomy, participation, mathematical concepts, results and grades.

ii) the e-learning method leads to improvement in adult students who are studying mathematical subjects in the educational stage of high school, provided that it is compared with the expository method. Therefore, this method is considered effective for its implementation in adults.

Murtiyasa et. al. (2020) conducted a study by designing mathematics learning media based on mobile learning for ten graders of vocational high schools in Central Java, Indonesia. The results of this study can be described as follows:

i) the rating of media experts with an average value of 67.5 is included in the excellent category;

ii) the material experts' assessment with an average score of 75 is included in the excellent category;

iii) the students' evaluation with an average grade of 70,119 is included in the excellent category.

iv) Moreover, based on the analysis of a pre-experimental design, it can be concluded the media improves students' scores in the topic of matrix operations.

Ilmi et. al. (2021) conducted a study titled 'Development of an Android-Based for Math E-Module by using Adobe Flash Professional CS6 for Grade X Students of Senior High School' in Indonesia. The results of the study were

i) The Android-based e-module was valid, practical, and effective. The validity of e-modules was classified based on the results of the experts' evaluation. The practicality of the e-module was classified based on the questionnaire responses of teachers and students, who can use the e-module well, can help students understand the material, and are interested in using it.

ii) The effectiveness of e-modules was classified by the percentage of students' completeness learning after using e-modules more than 70%.

2.5 Overview of Related Studies

A review of literature related to smartphone usage among students, mathematics learning at the secondary level of education and mathematics learning using ICT was done by the scholar to know more about the status of research done and also to understand the findings of other researchers on the topic. For a period of 16 years spanning from 2005 to 2021, a total of 66 related research works could be traced. From a review of 66 studies, with 2 in Mizoram, 27 in the rest of India, and 37 outside India, the most researched area was smartphone usage among students (24 studies), followed by mathematics learning at the secondary level (23 studies), and mathematics learning using digital resources (19 studies). While there is substantial research in India and globally, significant gaps exist, particularly in Mizoram. This underscores the need for more localized studies in Mizoram to address these research deficiencies. No research had been conducted in the northeast area on mathematics learning using a smartphone. There was no single research where the researcher used a self-developed application that covered the syllabus prevailing in a particular region. Furthermore, there was no combined study to find out the level of smartphone usage among students as well as the use of smartphones to study mathematics. Keeping these research gaps in mind to also answer other research questions that may arise, the importance of conducting this research became even more. Therefore, the present research, besides the objectives that have already been stated, has the potential to fill much-needed research gaps and pave the way for other research in the same field for future researchers.

CHAPTER III

METHODOLOGY AND PROCEDURE

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3.1 Introduction

A sound methodology is important for carrying out different types of research and helping the researcher achieve their objectives. Additionally, the researcher's methodology affects the trustworthiness of the findings. The present chapter covered various methodological topics, including research methodology, population and sample, data collection tools, and mode of data collection and analysis.

3.2 Research Design

The present study used descriptive research design to investigate the major purpose of smartphone usage and the level of smartphone usage among secondary school students in Mizoram as it required survey and test findings. To find out the effectiveness of learning app on mathematics among secondary school students, the researcher used a quasi-experimental research design. The approach was of a mixed type as both quantitative as well as qualitative methods were employed for data analysis.

3.3 Population and Sample

3.3.1 Population

The population of the present study comprised all the secondary school students of both Govt. and Non-govt. schools in Mizoram. As per the report on the Unified District Information System for Education Plus (UDISE+) 2021-2022, the total enrolment of secondary school students in Mizoram was 40605 as stated by the Department of School Education and Literacy, Gov't of Mizoram in the year 2022. The recommended sample size for a population of 40605 with a 99% confidence level, 5% margin of error, and 50% population proportion is 653 or more.

3.3.2 Sample

There were two kinds of samples for the present study to realize different objectives:

i. Sample for administration of questionnaire: This sample was taken to find out the level and major purposes of smartphone usage among secondary school students of Mizoram. A sample of 700 secondary school students was randomly selected from the population. Sampling was done based on a multistage simple random sampling method.

In the first stage, the whole of Mizoram was clustered into 11 existing districts: Aizawl, Lunglei, Siaha, Champhai, Kolasib, Serchhip, Lawngtlai, Mamit, Saitual, Khawzawl, and Hnahthial. To ensure a representative sample, four districts were randomly selected for the primary sampling units. The selected districts were Aizawl, Lunglei, Champhai, and Mamit.

In the second stage, all the secondary schools within the selected districts were listed and divided into two groups i.e. government and private schools. From Lunglei, Champhai, and Mamit districts, a total of six secondary schools (three from government and three from private) were selected. In the Aizawl district, eight secondary schools (four from government and four from private) were chosen. This selection process employed a simple random sampling method to ensure a representative and unbiased sample for the secondary sampling units.

In the third stage, all students within the selected school were listed and 160 students, 80 each from schools managed by the government and schools managed by private bodies were selected randomly from Lunglei, Champhai and Mamit districts. A sample of 220 students 110 each from government managed and privately managed schools within Aizawl district were randomly selected for the ultimate sampling units.

Table 3.1 provides detailed information on the sample selected for the study, specifically focusing on secondary school students in Mizoram.

Table 3.1

Selected Sample for determining the level and major purposes of smartphone usage among secondary school students of Mizoram

District	Aizawl		Lunglei		Champhai		Mamit	
Total	220		160		160		160	
Management	Govt.	Private	Govt.	Private	Govt.	Private	Govt.	Private
	110	110	80	80	80	80	80	80
Gender	Male	Female	Male	Female	Male	Female	Male	Female
	112	108	69	91	77	83	87	73
Locality	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
	129	91	67	93	96	64	90	70

Overall Samples

Management		**Gender**		**Locality**	
Govt.	Private	Male	Female	Urban	Rural
350	350	355	345	382	318

Note: This table illustrates the diverse demographics of the sample for analysing smartphone usage.

ii. Sample for quasi-experiment: This sample was taken to find out how effective the learning app was among secondary school students of Mizoram in their mathematics education. For this purpose, all secondary schools with a Class X enrolment higher than 90 during the academic year 2022-2023 in Mizoram were identified. Among these schools, one school was randomly selected to ensure an unbiased representation. From the chosen school, 90 students were randomly selected as the sample and later divided into two groups, namely, control and experimental.

3.4 Tools for Data Collection

In order to realize the different objectives of the study the following tools were used for data collection and for conducting experimental research.

1. Smartphone Usage Scale (SUS), developed and standardized by the researcher to find out the level and major purpose of smartphone usage among secondary school students.
2. Mathematics Achievement test for class X students developed by the researcher to measure the effectiveness of the mathematics learning app.
3. Android learning app called Learning Maths for studying Mathematics on a smartphone based on the MBSE class X syllabus developed by the researcher to find out the effectiveness of the mathematics learning app.

3.4.1 Smartphone Usage Scale

The term "smartphone usage" is quite broad, so the researcher needed to narrow it down for this study. To achieve this, the researcher specifically defined smartphone usage as the frequency and intensity to which students use their smartphones for personal and educational purposes. A smartphone usage scale encompasses items that assess the frequency and duration of smartphone use, the various activities performed on the device (such as social media, gaming, and texting), the perceived effects of smartphone use on daily life, and any withdrawal symptoms experienced when the smartphone is not accessible.

To know the major purposes of smartphone usage among secondary school students of Mizoram, the researcher added the following items seeking to capture the major purpose of students' smartphone usage as information schedule along with the student's personal information in the Smartphone Usage Scale (SUS), developed by the researcher.

As example, one item for choosing the most appropriate answer may be given as follows:

I mainly use my smartphone (You can tick more than one)

☐ for social media (Facebook, WhatsApp, Instagram, TikTok).

☐ for playing games (Online and offline).

☐ for listening to music and watching videos/movies.

☐ for searching information on Google.

☐ for photography and video recording.

☐ for reading news and entertainment.

☐ for interaction with teacher.

☐ to access learning materials.

☐ for making phone calls and chatting.

Other: ___________________

The "Other" category introduces an element of individuality, allowing respondents to articulate additional, personalized uses beyond the provided options.

3.4.1.1 Content Validity of Smartphone Usage Scale: At the beginning 40 statements were prepared for the Smartphone Usage Scale under three dimensions, Extent of Smartphone usage for Studies, Extent of Smartphone use in Personal life, and Smartphone use in relationship with others. The content validity of the scale was established by five subject matter experts in the same field within Mizoram University and two experts from the outside i.e., from Gandhi Gram Rural University and the University of Calicut. Following the insightful recommendations from experts, one element was dismissed due to redundancy, and certain statements were adjusted based on the experts' viewpoints. The updated version of the assessment, encompassing 39 items measuring the extent of student’s smartphone usage was approved by the experts and used for the try-out.

3.4.1.2 Pilot Study: The preliminary draft of the Smartphone Usage Scale comprised 39 statements and was administered to a sample of 100 secondary school students in Mizoram. The total scores of all 100 respondents were ranked from highest to lowest. The top 27% (27 respondents) and the bottom 27% (another 27 respondents) were selected as the high and low groups, respectively, for item analysis. The responses were analysed by calculating the "t" value for each statement, a statistical measure that helps determine the significance of the differences between the groups. Statements that exhibited substantial t-values, specifically those exceeding the threshold of 1.676, were considered statistically significant and therefore retained.

As a result of this analysis, 29 out of the original 39 items were retained, as they effectively discriminated between different levels of smartphone usage among the students. Of the 29 retained items, 17 were formulated positively and 12 items held a negative connotation. The discarded 10 items did not meet the required t-value threshold and were considered less effective in contributing to the scale's overall reliability and validity.

3.4.1.3 Reliability of Smartphone Usage Scale: The reliability of the final scale was established using a test-retest method, an approach that evaluates the consistency of a measure over time. This method involved administering the Smartphone Usage Scale to a sample of 120 secondary school students, with a time gap of 14 days between the two testing occasions. The test-retest reliability was quantified by calculating Pearson’s correlation coefficient (r), which measures the degree to which the same individuals score similarly on the scale at both time points.

The analysis resulted in a Pearson’s correlation coefficient (r) of 0.813, signifying a strong positive correlation and demonstrating high reliability. This correlation coefficient suggests that the scale in question is highly consistent, meaning it produces stable and repeatable results over time. Such a high degree of correlation indicates that the variables being measured are closely related, and the scale used in the analysis is effective in capturing the intended data. This strong reliability is crucial for ensuring the validity of the findings, as it reflects the robustness and accuracy of the measurement tool employed in the study.

3.4.1.4 Scoring of Smartphone Usage Scale: The scheme of scoring response categories for the Smartphone Usage Scale involves differential weighting to ensure that the responses accurately reflect the intensity of the participant's behaviours or attitudes. For positive statements, the response categories are assigned weights as follows: ‘Always’ is given a weightage of 5, 4 for ‘Frequently’, 3 for ‘Sometimes’, 2 for ‘Rarely’ and 1 for ‘Never’.

To maintain balance and avoid bias in the scoring process, the scoring was reversed for negative statements. For these items, ‘Always’ received a weightage of 1, and ‘Never’ received a weightage of 5, reflecting the opposite impact on the overall score. This reversal reflects the opposite impact of these items on the overall score, ensuring that negative behaviours or attitudes are appropriately accounted for. Negative items were marked with a star to clearly distinguish them from positive items, aiding in accurate interpretation during the analysis.

The scoring system was designed to create a comprehensive range of possible scores, with a maximum possible score of 145 and a minimum possible score of 29. This range of 29 to 145 allowed for nuanced differentiation between varying levels of smartphone usage among the respondents.

3.4.1.5 Norms for Interpretation of Smartphone Usage Scale: The researcher developed z-score norms to aid in the interpretation of raw scores on the Smartphone Usage Scale. Z-scores standardize raw scores by indicating how far each score deviates from the mean, allowing for a clearer comparison of individual performance within the overall distribution. By converting raw scores into z-scores, the researcher provided a more meaningful context for understanding where each respondent stands relative to the group as a whole.

These z-scores were calculated and systematically presented in Table 3.2, offering a standardized method for interpreting the data and making it easier to compare results across different groups.

Table 3.2

z-score norms for Smartphone Usage Scale

Raw Score	Z - Score	Raw Score	Z - Score	Raw Score	Z – Score	Raw Score	Z - Score
52	-2.05706	65	-1.00332	78	0.050417	91	1.104158
53	-1.97601	66	-0.92227	79	0.131474	92	1.185215
54	-1.89495	67	-0.84121	80	0.212531	93	1.266272
55	-1.81389	68	-0.76015	81	0.293588	94	1.347329
56	-1.73284	69	-0.6791	82	0.374645	95	1.428386
57	-1.65178	70	-0.59804	83	0.455702	96	1.509443
58	-1.57072	71	-0.51698	84	0.536759	97	1.5905
59	-1.48967	72	-0.43592	85	0.617816	98	1.671557
60	-1.40861	73	-0.35487	86	0.698873	99	1.752614
61	-1.32755	74	-0.27381	87	0.77993	100	1.833671
62	-1.24649	75	-0.19275	88	0.860987	101	1.914728
63	-1.16544	76	-0.1117	89	0.942044	102	1.995785
64	-1.08438	77	-0.03064	90	1.023101	103	2.076842

In addition to Table 3.2, the norms for interpretation are detailed in Table 3.3, which provides benchmarks for categorising scores into meaningful groups, such as extremely high usage, high usage, above average usage, average usage, below average usage, low usage, and extremely low usage. These norms are crucial for understanding where an individual's smartphone usage falls within the broader context of the study population, aiding in identifying patterns and potential areas for intervention.

Table 3.3

Norms for interpretation of z-score for Smartphone Usage Scale

Sl. No.	Range of Raw score	Range of z-Score	Grade	Usage Level
1	103 and above	+2.01 and above	A	Extremely High
2	93 to 102	+1.26 to + 2.00	B	High
3	84 to 92	+0.51 to +1.25	C	Above Average
4	72 to 83	-0.50 to +0.50	D	Average
5	62 to 71	-0.51 to -1.25	E	Below Average
6	53 to 61	-1.26 to -2.00	F	Low
7	52 and below	-2.01 and below	G	Extremely Low

The scale comprehensively covered multiple dimensions of smartphone use. It assessed the extent of smartphone usage for academic purposes, helping to understand how students balanced their educational activities with their smartphone habits. It also evaluated the impact of smartphone use on personal life, capturing how much time and attention individuals devoted to their devices outside of academic contexts. Furthermore, the scale examined smartphone use in social relationships, exploring how smartphone habits influenced interactions and relationships with others.

This multidimensional approach ensured a thorough assessment of smartphone usage, making the scale a valuable tool for both personal and research purposes. This included individuals who are concerned about their smartphone habits and those who worry about the potential negative impacts of excessive smartphone use on their well-being. Researchers can also utilize this scale to measure the extent of smartphone usage among study participants, offering standardized measures that facilitate comparison across different studies.

3.4.2 Achievement Test

As one objective of the study involved evaluating how effective a learning app can be for mathematics education among secondary school students, it was essential to find a suitable Achievement Test for this purpose. Despite the availability of numerous Achievement Tests in Mathematics for Class X students, the researcher opted to create one specifically for the current study. This decision was influenced by the fact that the topics to be covered were limited and chosen by the researcher due to various practical constraints inherent in the study. Hence, developing an achievement test based on the cited topic was deemed prudent to provide a clear assessment of student's progress and accomplishments without any uncertainty.

With this objective in mind, the researcher developed two sets of mathematics achievement tests for students, designed similarly, to serve as pre-test and post-test measures based on the syllabus of the Mizoram Board of School Education (MBSE). The pre-test aimed to determine the initial placement of students into either the control group or the experimental group. This initial assessment ensured that the groups were comparable in terms of their mathematical abilities before the intervention. The post-test was created to evaluate the effectiveness of a learning app on the mathematics performance of secondary school students in Mizoram. By comparing the post-test results between the control group and the experimental group, the researcher could assess the impact of the learning app, providing valuable insights into its efficacy in enhancing students' mathematical achievement.

3.4.2.1 Designing of the Achievement Test: The mathematics achievement test was designed to be completed within a maximum duration of 45 minutes and offers a maximum score of 25 marks. The test covered a range of content areas to ensure a comprehensive assessment of students' mathematical skills. These areas included topics in Arithmetic, such as Instalments, Time, Work, and Distance, which evaluate practical problem-solving abilities. Additionally, the test encompasses mathematical concepts that are included in the MBSE-prescribed textbook meant for Class X.

The weightage of marks was framed based on the same pattern for the distribution of marks set by the Mizoram Board of School Education (MBSE). The detailed distribution of weightage across various aspects of the curriculum is meticulously analysed and presented in Tables 3.4, 3.5 and 3.6.

Table 3.4

Marks carried by objectives of learning

Sl. No.	Learning Objectives	Marks	Percentage
1	Knowledge	7	28
2	Understanding	7	28
3	Application	7	28
4	Higher Order Thinking Skills (HOTS)	4	16
TOTAL		**25**	**100**

Table 3.5

Weightage to the content area

Sl. No.	Content Area	Marks	Percentage
1	Instalments	3	12
2	Time, Work and Distance	3	12
3	Polynomials	4	16
4	Linear Equation in Two Variables	4	16
5	Quadratic Equations	4	16
6	Arithmetic Progression (AP)	4	16
7	Sets	3	12
TOTAL		**25**	**100**

Table 3.6

Weightage to form of questions

Sl. No.	Form of Questions	No. of Questions	Marks	Total
1	Objectives	9	1	9
2	Short Answers I	3	2	6
3	Short Answers II	2	3	6
4	Long Answers	1	4	4
TOTAL		**15**		**25**

Table 3.4 highlights the allocation of marks to different learning objectives, emphasizing a balanced focus on knowledge, students' understanding of certain concepts, how applications are made, and higher-order thinking Skills (HOTS). Table 3.5 details the weightage assigned to different content areas, showcasing a strategic allocation that reflects the importance of each topic within the curriculum. Table 3.6 broke down the weightage according to the form of questions, illustrating a diverse range of question types to assess students' knowledge and skills. The comprehensive and balanced approach to weightage across learning objectives, content areas, and forms of questions ensured a robust and effective assessment strategy.

3.4.2.2 A Blueprint of the Achievement Test: The choices to be implemented, as demonstrated by the question format, were implemented through the blueprint. This stage primarily focused on deciding the quantity and allocation of questions across various objectives and content areas to achieve the predetermined weightage outlined in the design. The researcher ensured that the test measures the intended knowledge and skills effectively, maintained appropriate coverage of content areas, and adhered to established standards of validity and reliability.

Table 3.7

Blueprint for Mathematics Achievement Test

Forms of Questions/ Contents	Knowledge				Understanding				Application				HOTS				Total
	O	**S 1**	**S 2**	**L**	**O**	**S 1**	**S 2**	**L**	**O**	**S 1**	**S 2**	**L**	**O**	**S 1**	**S 2**	**L**	
Instalments	**1**	**1**															**3**
Time, Work and Distance	**1**									**1**							**3**
Polynomials	**1**						**1**										**4**
Linear Eqn. in 2 Variables																**1**	**4**
Quadratic Equations	**1**										**1**						**4**
Arithmetic Progression.					**1**	**1**			**1**								**4**
Sets	**1**				**1**				**1**								**3**
Total Marks	**5**	**2**	**0**	**0**	**2**	**2**	**3**	**0**	**2**	**2**	**3**	**0**	**0**	**0**	**0**	**4**	**25**
TOTAL	**7**				**7**				**7**				**4**				

Table 3.7 provides a detailed blueprint for the Mathematics Achievement Test, categorizing questions based on their content areas and cognitive levels of their knowledge, students' understanding of certain concepts, how applications are made, and higher-order thinking Skills (HOTS). Each question form was identified by specific topics within the mathematics syllabus as prescribed by MBSE.

The blueprint demonstrated a balanced distribution across different types of questions and cognitive levels. Each content area was represented, ensuring a comprehensive assessment of students' mathematical understanding and skills. The test included a mix of objective questions, short answer questions, and long answer questions, providing a variety of question formats to gauge different levels of student learning and ability. This structured approach ensured that the assessment was thorough and effectively measured student achievement in mathematics.

3.4.2.3 Validity of the Achievement Test: To verify the test's credibility and validity, experts in the field were consulted and provided with the tool for review. Their feedback was instrumental in refining the test, and adjustments were made accordingly to improve its reliability and effectiveness. This expert validation process helps ensure that the test measures what it has been intended to assess.

3.4.2.4 Scoring of the Achievement Test: For the Multiple-choice questions, the students were requested to tick the right answers for each item out of the four alternatives. One mark was given for each correct answer. For short-answer and long-answer questions, marks were given based on the correctness and clarity of the solution provided by the student. There was no negative marking. Wrong or unanswered questions were marked zero. The maximum mark for the test was 25.

3.4.3 Mathematics Learning App

The educational application called "LearningMaths" was prepared by the scholar specifically for this study. Designed for learning Mathematics through smartphones, its primary aim was to evaluate the effectiveness of this learning app for students studying mathematics in Mizoram. The application adhered to the class X mathematics curriculum prescribed by the MBSE. "LearningMaths" was a targeted tool created exclusively for this research, aiming to provide insights into the benefits and potential improvements in using smartphone-based applications for enhancing mathematics education among class X students in Mizoram.

The application was developed for the Android operating system and is not available for iPhone users. It was created using the Java programming language and developed in Android Studio, an open-source software that serves as the official integrated development environment (IDE) for building Android applications. After development in Android Studio, the app was compiled into APK format and distributed to users via WhatsApp for installation on their smartphones. The installation size was kept minimal at 3 MB to ensure compatibility with all Android devices

3.4.3.1 Structure of the learning app: The app focused on facilitating learning through various modes, including learning modules aligned with the textbook, quizzes, formulae, and instructional support. The learning modules incorporated app-based learning and external resources, such as YouTube videos, to supplement textbook content. Similarly, the quiz module engaged users in multiple-choice questions, providing feedback on their responses and concluding with a performance rating.

The app interface was designed in a way that is simple and user-friendly, buttons, menus, and features are labelled clearly to minimize confusion. The main interface of the app presented users with five buttons directing them to various functionalities, including accessing learning content, quizzes, formulae, and instructional support, or exiting the application. Each module followed a consistent design, providing essential information, calculator tools, solved exercises, and supplementary videos.

3.4.3.2 Content of the app: The researcher ensured that the content presented within the app was standardized across all participants. It involved using the same learning materials, exercises, quizzes, or assessments for all users.

The content of the learning app adopted the class X mathematics textbook from the MBSE which was based on the mathematics curriculum prescribed by NCERT. The contents of the learning app are:

Learning Module 1: Instalments
Learning Module 2: Time and Distance
Learning Module 3: Time and Work
Learning Module 4: Polynomials
Learning Module 5: Linear Equation in Two Variables
Learning Module 6: Quadratic Equations
Learning Module 7: Arithmetic Progression (AP)
Learning Module 8: Sets

3.4.3.3 Data Collection Mechanisms of the Learning app: The app used standardized methods for collecting data within the app. It included using built-in data quizzes with predefined response options automatically. The app implements validation checks within the app to ensure data accuracy and completeness. It validates user input to prevent errors or inconsistencies in responses.

In addition to the built-in data quizzes, the learning app employed a mechanism to collect data effectively and efficiently. This mechanism was designed to gather insights into user engagement, learning progress, and performance metrics. These quizzes were strategically placed within the app's lessons or exercises to assess users' understanding of key concepts. By automatically recording users' responses to these quizzes, the app could track their performance over time by collecting the responses in the researcher database.

3.4.3.4 Pilot Testing of the App: Before deploying the app for the experimental research, the investigator began a pilot test to evaluate the app's functionality and usability. This involved selecting a small group of participants who represented the required population for the app. Before the pilot test, the researcher conducted training sessions to familiarize participants with the app's features, navigation, and functionality. The training aimed to ensure that participants understood how to use the app consistently and accurately.

During the pilot test, participants were encouraged to explore the app independently and provide feedback on their user experience. The researcher closely observed participants' interactions with the app, noting any usability issues, ambiguities in instructions, or technical glitches that arose. Participants were also invited to share their thoughts and suggestions for improvement.

Based on feedback from the pilot testing phase, the researcher made crucial adjustments and refinements to the app. This cycle of testing and making improvements allowed the researcher to address any issues that arose and significantly enhance the app's usability and effectiveness before it was used for research purposes.

3.5 Mode of Data Collection

3.5.1 *Major Purpose and Degree of Smartphone Usage*

To find out the main purposes and the level of smartphone usage among secondary school students of Mizoram, the selected sample schools were visited by the researcher, after discussing the purpose of the study with the school authority or headmaster, written permission was obtained. Following Subsequently, a research schedule was established. On the fixed date, the researcher personally collected the data by distributing questionnaires to the selected students.

The students received concise guidance before the test regarding how to approach the answering format and be assured of the confidentiality and exclusive use of the data for the current research objectives. They were assured that there were no definitive correct or incorrect responses. From a selection of five options provided, they were instructed to select the one they believed most accurately reflected their smartphone usage. Following the instructions, the assessment tool was distributed to the students. Sufficient time was allocated for them to respond to the inventory items.

3.5.2 *Effectiveness of Learning App*

To find out how effective the learning app was on mathematics learning among secondary school students, the researcher personally visited a selected sample school (Govt. Zemabawk High School). After explaining and discussing the objectives and methodology of the study to the school headmaster, written approval was acquired and a schedule for the experimental study was set.

3.5.2.1 Schedule for Experimental Study:

Administration of pre-test: 1st Jun.2023

Module 1 : 5th Jun.2023 – 19th Jun.2023 :- ***Instalment*** (10 working days)

- 10th & 11th Jun. 2023 : Saturday and Sunday
- 15th Jun. 2023 : YMA Day
- 17th & 18th Jun. 2023 : Saturday and Sunday

Module 2 : 20th Jun.2023 – 5th Jul.2023 :– ***Time and Distance*** (10 working days)

- 24th & 25th Jun. 2023 : Saturday and Sunday
- 29th Jun. 2023 : Idu'l Zuha
- 30th Jun. 2023 : Remna Ni
- 1st & 2nd Jul 2023 : Saturday and Sunday
- 6th Jul. 2023 : MHIP Day

Module 3 : 7th Jul.2023 – 4th Aug.2023 :– ***Time and Work*** (10 working days)

- 8th & 9th Jul. 2023 : Saturday and Sunday
- 15th & 16th Jul. 2023 : Saturday and Sunday
- 17th – 31st Jul. 2023 : 1st term Examination
- 5th & 6th Aug. 2023 : Saturday and Sunday

Module 4 : 7th Aug.2023 – 25th Aug.2023 :– ***Polynomials*** (14 working days)

- 12th & 13th Aug. 2023 : Saturday and Sunday
- 15th Aug. 2023 : Independence Day
- 19th & 20th Aug. 2023 : Saturday and Sunday
- 26th & 27th Aug. 2023 : Saturday and Sunday

Module 5 : 28th Aug.2023 – 15th Sep.2023 :– ***Linear equation in two variables*** (14 working days)

- 2nd & 3rd Sep. 2023 : Saturday and Sunday
- 5th Sep. 2023 : Teachers Day
- 9th & 10th Sep. 2023 : Saturday and Sunday
- 16th & 17th Sep. 2023 : Saturday and Sunday

Module 6 : 18th .Sep.2023 – 9th .Oct.2023 :– ***Quadratic Equations*** (14 working days)

- 23rd & 24th Sep. 2023 : Saturday and Sunday
- 28th Sep.2023 : Prophet Mohamed's Birthday
- 30th Sep. & 1st Oct. 2023 : Saturday and Sunday
- 2nd Oct. 2023 : Mahatma Gandhi's Birthday
- 7th & 8th Oct.2023 : Saturday and Sunday

- 10^{th} – 13^{th} Oct. 2023 : District School Sports
- 14^{th} & 15^{th} Oct.2023 : Saturday and Sunday

Module 7 : 16^{th} .Oct.2023 – 31^{st} .Oct.2023 :– ***Arithmetic Progression*** (10 working days)

- 21^{st} & 22^{nd} Oct. 2023 : Saturday and Sunday.
- 24^{th} Oct.2023 : Dussehra.
- 27^{th} Oct.2023 : Zirlaite Ni.
- 28^{th} & 29^{th} Oct.2023 : Saturday and Sunday
- 1^{st} Nov.2023 – 24^{th} Nov.2023 : 2^{nd} Term Examination and Mizoram Legislative Assembly Election.
- 25^{th} & 26^{th} Nov. 2023 : Saturday and Sunday.

Module 8 : 27^{th}Nov.2023 – 7^{th} Dec.2023 :– ***Sets*** (9 working days)

- 2^{nd} & 3^{rd} Dec.2023 : Saturday and Sunday

Administration of post-test : 8^{th} Dec.2023.

Total: 91 working days.

3.5.2.2 Separation of Students into Two Equivalent Groups: A pre-test on mathematics competency was conducted on a randomly selected sample of Class X students in Government Zemabawk High School using the Mathematics Achievement Test developed by the researcher. After their scores had been recorded, they were divided into two equivalent groups i.e., control and experimental groups.

The separation of students into control groups and experimental groups was done manually by matching students in pairs or small groups based on similar achievement test scores, and other relevant variables like students having smartphones or not. Each pair or group was formed to ensure that the students were as similar as possible in these key factors, allowing for a more accurate comparison. Once the pairs or groups were established, one student from each pair or group was randomly assigned to the control group, while the other was placed in the experimental group, ensuring balanced and comparable groups for the study.

Table 3.8

Matching of groups based on pre-test scores

Groups	No. of Students	Mean	Standard Deviation	Df.	t - value	Significance Level
Control	45	6.7	2.676	88	0.019	Not Significant.
Experimental	45	6.689	2.801			

Source: Field Study

As indicated in Table 3.8, the t-value for pre-test scores in Mathematics achievement is 0.019, which was not significant at 0.05 levels of significance. It meant that there was no significant difference between the means of pre-test scores in Mathematics between the two groups. The lack of significant difference suggests that the groups were comparable in terms of their prior knowledge before the intervention. Therefore, it can be inferred that both groups started with a similar baseline level of understanding in Mathematics, as measured by the pre-test results, ensuring a fair comparison during the study.

3.5.2.2 Implementation of Experimental Research: The researcher was tasked with working alongside the mathematics teacher of the school to carry out the research procedure. Subsequently, the researcher engaged in a detailed discussion with the teacher and obtained permission to establish a WhatsApp group for research-related communication. The students in the experimental group were added to a WhatsApp group created by the researcher and were requested to install the Mathematics Learning app (LearningMaths), which the Android Package Kit (apk) was provided in the WhatsApp group. The researcher ensured that the learning app was installed on the smartphones of all the students of the experimental groups. Clear and proper instruction on the use learning app was given to the students. These instructions were carefully crafted in the form of a PDF document written in their native language, Mizo, ensuring that all students could easily understand the guidelines regardless of their proficiency in other languages.

The objective of the learning app was not to replace teacher and classroom teaching but rather to enrich the learning experience of the students. It tried to eliminate the tutoring system and make use of a self-learning methodology by providing the ability to learn anywhere and at any time. The students in both the control group and the experimental group attended the normal classes taken by the teacher at the school. The students of the experimental group revised the topics that were covered in the classroom by using the mathematics learning app on their smartphones during their free time. Throughout the intervention phase, the researcher monitored participants' progress and engagement with the learning app. They were monitored through the WhatsApp group and collected data on the app usage pattern by letting the students submit the self-assessment test done on the app.

The students were required to complete each module during a designated period as part of the study. After finishing each module, students were instructed to take a self-assessment test individually through the learning app. To ensure mastery of the material, students could only submit their self-assessment test results if they achieved a minimum score of 70% on each module. This threshold was set to encourage thorough understanding before moving on. Once the students met the required score, their test results were automatically submitted to the researcher’s database, allowing for real-time tracking and analysis of student progress throughout the study.

After 91 working days from the introduction of the intervention, which involved the use of the Learning app by the experimental group, and following the completion of all the learning modules, a post-test was administered to both the experimental and control groups. The post-test consisted of a mathematics achievement test specifically developed by the researcher to assess the student's knowledge after the intervention. The data obtained from this post-test were then used for further analysis and interpretation, aiming to evaluate the effectiveness of the Learning app in improving students' mathematics achievement compared to those students who were not using the app.

3.6 Data Analysis

In the data analysis phase, the researcher employed, where applicable, a quantitatively calculated method and a qualitatively analysed method to analyse the collected data comprehensively. The quantitative analysis involved the use of descriptive and inferential statistics to examine numerical data quantitatively. Descriptive statistics, such as percentages, means, and normality tests were utilized to summarize and present key findings from the data. Additionally, inferential statistics, such as t-tests and correlation, were applied to identify patterns, relationships, and differences between variables, where appropriate.

Microsoft Excel and Statistical Package for the Social Sciences (SPSS) were the primary tools utilized for conducting statistical tests and analyses. These software platforms provided the necessary functionality for performing a wide range of statistical procedures, from basic calculations to complex analyses. Excel was utilized for data organization, basic calculations, and simple statistical analyses, while SPSS offered more advanced statistical tools for conducting inferential analyses.

In addition to quantitative analysis, qualitative analysis techniques were employed to explore the richness and depth of qualitative data collected, such as open-ended survey responses. Qualitative data were analysed thematically to identify recurring themes, patterns, and insights that emerged from participants' responses.

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

CHAPTER IV

ANALYSIS AND INTERPRETATION OF DATA

4.1 Introduction

Analysis and Interpretation of Data is the pivotal point where the raw information collected during the research journey is transformed into meaningful insights and knowledge. This chapter serves as the analytical heart of the research, where the data gathered to address the research questions or objectives are meticulously dissected and deciphered.

The primary aim is to extract relevant findings and draw meaningful conclusions that shed light on the research problem or question at hand. Moreover, the necessary context and explanations are provided to ensure that the findings are not only statistically significant but also meaningful in the broader context of the research.

4.2 Objective 1: To find out the major purpose for smartphone usage among secondary school students of Mizoram

In a digital era of rapid advancements and connectivity, smartphones have emerged as versatile tools, influencing various aspects of students' lives. These handheld devices have become integral to the modern student experience, from social interactions and entertainment to educational pursuits. The researcher created a specific list of areas to find out the major purposes of smartphone usage among secondary school students of Mizoram, which is explained in the methodology section. Through this analysis, the researcher aimed to gain valuable insights into the major purposes behind smartphone usage, contributing to a comprehensive understanding of the digital dynamics in secondary education in Mizoram.

Within the sampled group of 700 students, each individual was granted the flexibility to choose from multiple areas specified by the researcher in the information schedule of the Smartphone Usage Scale. This freedom allowed students to indicate more than one primary purpose that aligned with their smartphone usage patterns. This approach acknowledged the varied and multifaceted nature of students' interactions with their smartphones, capturing a comprehensive range of activities and purposes. The inclusion of the "Other" category introduced a sense of individuality, enabling survey participants to express additional, customized uses that went beyond the predefined options. The data were qualitatively analyzed by the researcher and were presented in Table 4.1.

Table 4.1

Major purpose for smartphone usage among secondary school students of Mizoram

Use of Smartphone	No. of Students	Percentage
for social media (Facebook, WhatsApp, Instagram, TikTok).	631	90.14
for playing games (Online and offline).	384	54.86
for listening to music and watching videos/movies.	626	89.43
for searching information on Google.	507	72.43
for photography and video recording.	348	49.71
for reading news and entertainment.	285	40.71
for interaction with teacher.	135	19.29
to access learning materials.	273	39
for making phone calls and chatting.	512	73.14
Others: Editing, Business, Dictionary.	8	1.14

Source: Field Study

Table 4.1 presents the diverse uses of smartphones among students, with percentages reflecting the prevalence of each activity. A significant majority of students, 90.14%, used smartphones for social media (Facebook, WhatsApp, Instagram, and TikTok). The majority of students (89.43%) also used smartphones for entertainment purposes like listening to music and watching videos/movies. A large proportion (73.14%) of students used smartphones for traditional communication methods, such as making phone calls and chatting. A high percentage (72.43%) of students used smartphones to search for information on Google. About 54.86% of students used smartphones for playing games, both online and offline. Almost half of the students (49.71%) used smartphones for photography and video recording. A significant number (40.71%) of students used smartphones for reading news and entertainment. A slightly smaller number of students (39%) used smartphones to access learning materials. A smaller percentage (19.29%) of students used smartphones for interaction with teachers. This included communication through messaging apps, email, or other educational platforms. Only (1.14%) of students used smartphones for other purposes like editing, business-related activities, and using dictionaries.

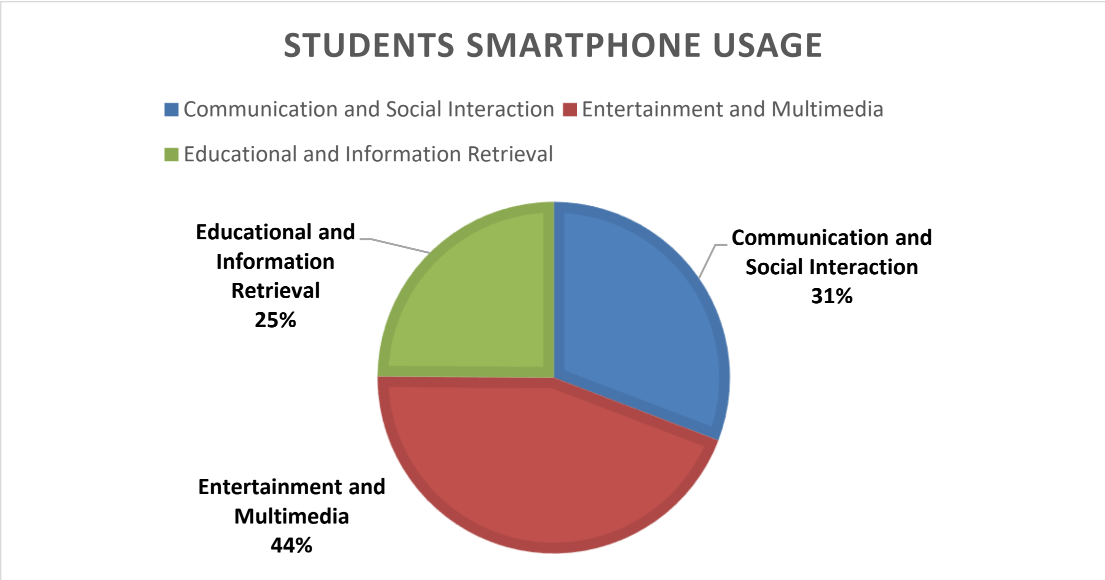
The data illustrated that smartphones were essential to students' lives, supporting various activities from social interaction to education. Secondary school students in Mizoram showed high engagement in social media and online communities, emphasizing the importance of multimedia content. Traditional communication methods like phone calls and chatting remained prevalent. Smartphones facilitated quick access to information and were key tools for information retrieval and gaming. They were also widely used as personal multimedia devices, keeping students informed and entertained.

The data in Table 4.1 was categorized into three broad areas: Communication and Social Interaction, Entertainment and Multimedia, and Education and Information Retrieval. Communication and Social Interaction included social media (Facebook, WhatsApp, Instagram, TikTok) and phone calls and chatting. Entertainment and Multimedia covered playing games (online and offline), listening to music, watching videos/movies, photography, video recording, and reading news. Education and Information Retrieval involved searching for information on Google, interacting with teachers, accessing learning materials, and other useful activities.

Figure 4.1 visually represents these categories in a pie chart, providing a clear overview of the major purposes for smartphone usage among secondary school students in Mizoram, highlighting how their usage is distributed across these different areas.

Figure 4.1

Major purpose for smartphone usage among secondary school students of Mizoram in terms of Category



Source: Table 4.1

Thus, it is found that the majority(75%) of the secondary school students in Mizoram used their smartphones for social interaction and entertainment purposes while only a smaller percentage of students use their smartphones for educational purposes.

4.3 Objective 2: To find out the level of smartphone usage among secondary school students of Mizoram

For the study, a smartphone usage scale developed and standardized by the researcher was used to measure the level of smartphone usage among secondary school students of Mizoram. It was a tool designed to assess the frequency and intensity of smartphone usage in individuals. The scale included items related to the frequency and extent of smartphone usage, types of activities engaged in on the smartphone (e.g., social media use, gaming, texting, learning), perceived impact on daily life, and potential withdrawal symptoms when the smartphone was not available. By incorporating these diverse elements, the scale provided a thorough understanding of how smartphones influenced the students' daily routines and their overall engagement with digital technology.

To analyze the level of smartphone usage among the 700 sample students, the researcher calculated the mean and standard deviation of the collected data. This statistical analysis aimed to classify students into distinct categories: extremely high usage, high usage, above average usage, average usage, below average usage, low usage, and extremely low usage. The researcher had established specific norms for these classifications, which are detailed in Table 3.3.

The results of this analysis were comprehensively summarized and presented in Table 4.2. This table provided a clear overview of the distribution and intensity of smartphone usage among the students, illustrating how frequently and intensively different groups of students engaged with their smartphones. The detailed data presentation offered insights into the varying levels of smartphone use and its implications for secondary school students in Mizoram.

Table 4.2

Level of Smartphone usage among secondary school students of Mizoram

Range of Raw score	Range of z-Score	Grade	Usage Level	No. of Students	%
103 and above	+2.01 and above	A	Extremely High	17	2.43
93 to 102	+1.26 to +2.00	B	High	63	9
84 to 92	+0.51 to +1.25	C	Above Average	131	18.72
72 to 83	-0.50 to +0.50	D	Average	270	38.57
62 to 71	-0.51 to -1.25	E	Below Average	141	20.14
53 to 61	-1.26 to -2.00	F	Low	66	9.43
52 and below	-2.01 and below	G	Extremely Low	12	1.71

Source: Field Study

Looking at Table 4.2, Grade D, representing the "Average" usage level, had the highest number of students, with 270 individuals, constituting approximately 38.57% of the total student population. This indicated that a significant portion of students fell within the average level of smartphone usage range.

Grades C and E followed Grade D in terms of the student population, with 131 students (18.72%) falling into the "Above Average" category (Grade C) and 141 students (20.14%) categorized as "Below Average" (Grade E). These two grades collectively accounted for nearly 40% of the student population, highlighting a substantial portion of students performing slightly above or below the average level.

Grade A, indicating "Extremely High" smartphone usage, had the fewest students, with only 17 individuals, making up 2.43% of the total. Students in this category exhibited extremely high smartphone usage and were at the highest risk for negative consequences. Grade G, representing "Extremely Low" proficiency, consisted of just 12 students, accounting for 1.71% of the total. Students in this category had extremely low smartphone usage, avoiding the negative consequences of excessive use but potentially missing out on some benefits of technology.

Grades B and F, representing "High" and "Low" smartphone usage levels, respectively, fall between the extremes. Grade B has 63 students (9%) categorized as "High," while Grade F has 66 students (9.43%) categorized as "Low." These grades captured a moderate proportion of students performing above or below the average level but not to the extremes represented by Grades A and G. Students with high smartphone usage levels were also at significant risk for various negative consequences, although to a slightly lesser degree than those in the extremely high category. While students with low smartphone usage are unlikely to suffer from negative consequences related to excessive use.

Overall, the majority (77.43%) of students fall into grades C, D, and E, which encompassed the "Above Average," "Average," and "Below Average" usage levels, respectively. This distribution suggested a typical bell curve pattern, with the highest concentration of students clustered around the average usage level of smartphones. Specifically, this indicated that most students exhibited an average level of engagement with smartphones, as shown by their placement within the "Average" category. Thus, it is reasonable to conclude that the overall level of smartphone usage among secondary school students in Mizoram could be characterized as average. Indicating that the majority of students have typical smartphone usage with lesser risks for negative consequences.

4.4 Objective 3: To compare the level of smartphone usage among secondary school students of Mizoram based on gender

The researcher compared the level of smartphone usage among secondary school students of Mizoram based on gender by analysing the data independently for both male and female students on the level of their smartphone usage. The analysis was thoroughly detailed in Table 4.3 to provide a clear comparison of smartphone usage patterns between male and female students.

Table 4.3

Comparison of the level of smartphone usage among secondary school students of Mizoram based on gender

Smartphone Usage Level	Male	Female
Extremely High	7(2.03%)	10(2.82%)
High	39(11.31%)	24(6.76%)
Above Average	55(15.94%)	76(21.41%)
Average	133(38.55%)	137(38.59%)
Below Average	71(20.58%)	70(19.72%)
Low	36(10.43)	30(8.45%)
Extremely Low	4(1.16%)	8(2.25%)
Total	**345**	**355**

Source: Field Study

Table 4.3 showed that there was a comparable distribution of male and female students across the levels of smartphone usage. However, there were some noticeable differences. For instance, a higher percentage of female students fell into the "Above Average" smartphone usage level compared to male students (21.41% vs. 15.94%). Conversely, a slightly higher percentage of male students were categorized as "High" smartphone usage level compared to female students (11.31% vs. 6.76%).

Overall, gender does not strongly correlate with smartphone usage levels, as both male and female students show similar distribution patterns across the spectrum of smartphone usage. However, as percentages alone were deemed insufficient, the researcher opted to assess the statistical significance of the variance between male and female students concerning their smartphone usage levels. To achieve this, a t-test was employed, and the hypothesis which stated that "There is a significant difference in the level of smartphone usage between male and female secondary school students of Mizoram" was transformed into a null hypothesis as follows:

"There is no significant difference in the level of smartphone usage between male and female secondary school students of Mizoram."

The computation of the t-test to compare the mean scores of male and female students in the level of smartphone usage is illustrated in Table 4.4.

Table 4.4

Difference in the level of smartphone usage among secondary school students of Mizoram based on gender

Gender	No. of Students	Mean	Standard Deviation	Degrees of freedom	Calculated t - value	Significance Level
Male	345	77.81	12.512	698	0.403	Not Significant.
Female	355	78.19	12.776			

Source: Field Study

Table 4.4 shows that the calculated t-value for the significance of the difference in the level of smartphone usage among secondary school students of

Mizoram based on gender is 0.403. Since the calculated t-value is less than the critical t-value at both 0.05(1.96) and 0.01(2.58), it is not significant. Therefore, the null hypothesis stating “There is no significant difference in the level of smartphone usage between male and female secondary school students of Mizoram” is accepted. Despite slight disparities in mean scores between males and females, these differences lack statistical significance. Thus, it can be concluded that there is no significant difference between male and female secondary school students of Mizoram in the level of their smartphone usage.

4.5 Objective 4: To compare the level of smartphone usage among secondary school students of Mizoram based on locality

To compare smartphone usage levels among secondary school students in Mizoram based on locality, the researcher conducted an independent analysis of the data for students from rural and urban areas. This thorough examination is detailed in Table 4.5, which provides a comprehensive breakdown of usage levels by locality.

Table 4.5

Comparison of the level of smartphone usage among secondary school students of Mizoram based on locality

Smartphone Usage Level	Rural	Urban
Extremely High	10(3.15%)	7(1.83%)
High	24(7.55%)	39(10.2%)
Above Average	52(16.35%)	79(20.68%)
Average	119(37.42%)	151(39.53%)
Below Average	70(22.01%)	71(18.69%)
Low	36(11.32%)	30(7.85%)
Extremely Low	7(2.2%)	5(1.31%)
Total	**318**	**382**

Source: Field Study

Table 4.5 revealed distinct patterns in smartphone usage among secondary school students in Mizoram based on locality. In rural areas, 3.15% of students exhibited extremely high smartphone usage, compared to 1.83% in urban areas. High usage was seen in 7.55% of rural and 10.2% of urban students. Above-average usage was reported in 16.35% of rural and 20.68% of urban students. The majority of students demonstrated average usage, with 37.42% in rural and 39.53% in urban areas. Below-average usage was noted in 22.01% of rural and 18.69% of urban students. Low usage was reported in 11.32% of rural and 7.85% of urban students, while extremely low usage was observed in 2.2% of rural and 1.31% of urban students. To test the statistical significance, the hypothesis which stated that "There is a significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram" was transformed into a null hypothesis:

"There is no significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram."

The computation of the t-test is presented in Table 4.6.

Table 4.6

Difference in the level of smartphone usage among secondary school students of Mizoram based on locality

Locality	No. of Students	Mean	Standard Deviation	Degrees of freedom	Calculated t - value	Significance Level
Rural	318	76.92	13.192	698	2.079	Not Significant at 0.01 but significant at 0.05.
Urban	382	78.91	12.102			

Source: Field Study

Table 4.4 showed that the calculated t-value, which measured the difference between the means of two groups relative to the variation within the groups, was 2.079. The calculated t-value was greater than the critical value at 0.05 (1.96) level of significance and less than the critical value at 0.01 (2.58) level of significance, this indicated that the difference observed between rural and urban students was not strong enough to be considered statistically significant at the more stringent 0.01 significance level but was significant at the 0.05 level, suggesting that there might have been a meaningful difference between the groups. Therefore, the null hypothesis stating that “There is no significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram” is rejected at the 0.05 significance level but accepted at the 0.01 significance level. In other words, the null hypothesis was accepted only at the 0.01 significance level. However, at the 0.05 significance level, the null hypothesis was rejected, concluding that there was a statistically significant difference in smartphone usage between these two groups.

Overall, the results suggested that there might be a statistically significant difference between rural and urban students regarding the variable under consideration, though the effect size appeared relatively small. Specifically, the mean value of the variable for urban students was 78.91, indicating a slightly higher average score compared to rural students. This suggests that, on average, urban students might use their smartphones more extensively than their rural counterparts. Despite the statistical significance, the small effect size implies that while there is a measurable difference, it might not be substantial. Therefore, the extent of smartphone usage could be marginally higher in urban areas compared to rural areas.

4.6 To compare the level of smartphone usage among secondary school students of Mizoram based on management of school

This investigation aimed to discern patterns and differences in smartphone usage between these two types of school environments, thereby offering valuable insights into how school management influences students' technology habits. Table 4.7 presented a detailed comparison of smartphone usage levels, categorizing students by the type of school they attended: government or private. By examining these categories, the researcher sought to identify whether there were significant differences in smartphone usage that could be attributed to the type of school management.

Table 4.7

Comparison of the level of smartphone usage among secondary school students of Mizoram based on management of school

Smartphone Usage Level	Private School	Government School
Extremely High	8(2.29%)	9(2.57%)
High	38(10.86%)	25(7.14%)
Above Average	71(20.28%)	60(17.15%)
Average	142(40.57%)	128(36.57%)
Below Average	64(18.28%)	77(22%)
Low	24(6.86%)	42(12%)
Extremely Low	3(0.86%)	9(2.57%)
Total	**350**	**350**

Source: Field Study

The analysis of Table 4.7 revealed distinct patterns in smartphone usage levels among secondary school students in Mizoram, categorized by the type of school they attended: private or government. In private schools, the largest proportion of students fell into the "average" category, with 142 students (40.57%), followed by "above average" with 71 students (20.28%). Conversely, in government schools, the majority also fell into the "average" category, with 128 students (36.57%), but the next largest group was "below average," comprising 77 students (22%).

Private schools had a slightly higher percentage of students in the "high" category compared to government schools (10.86% vs. 7.14%). Additionally, 2.29% of private school students and 2.57% of government school students exhibited extremely high smartphone usage. Low and extremely low usage levels were more prevalent in government schools, with 12% and 2.57% of students, respectively, compared to 6.86% and 0.86% in private schools. The total number of students analyzed was equal for both school types, with 350 students each.

However, since relying solely on percentages was considered insufficient, the researcher chose to evaluate the statistical significance of the differences between the mean scores of the government and private school students regarding their smartphone usage levels. To accomplish this, a t-test was employed to compare the smartphone usage levels between the two groups. The original hypothesis, which stated that "There is a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram," was transformed into a null hypothesis for testing purposes. The null hypothesis was formulated as:

"There is no significant difference in the level of smartphone usage between private and government secondary school students of Mizoram."

The computation of the t-test is presented in Table 4.8.

Table 4.8

Difference in the level of smartphone usage among secondary school students of Mizoram based on management of school

Manage-ment of School	No. of Students	Mean	Standard Deviation	Degrees of freedom	Calculated t - value	Significance Level
Private	350	79.62	12.048	698	3.408	Significant.
Govt.	350	76.39	13.020			

Source: Field Study

Table 4.8 showed that the calculated t-value, which measured the difference between the means of two groups relative to the variation within the groups, was 3.408. Since the calculated t-value was greater than the critical value at 0.01 (2.58) level of significance, there was a significant difference in smartphone usage levels between students in private and government secondary schools. Consequently, the null hypothesis stating "There is no significant difference in the level of smartphone usage between private and government secondary school students of Mizoram" was rejected.

Furthermore, the mean value for private school students was 79.62, compared to 76.39 for government school students. This variation in mean values showed that private school students had higher levels of smartphone usage compared to their peers in government schools. Thus, it was concluded that there was a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram. This finding highlighted that school management type could influence students' engagement with smartphones.

4.7 Objective 6: To develop a learning app on mathematics for secondary school students of Mizoram

In light of the changing dynamics of education and the growing role of technology in teaching, the researcher believed that there was a need to create an all-encompassing educational app designed specifically for Mizoram's secondary school students, focusing on mathematics. Given that mathematics is a key component of the educational curriculum, promoting easy access and engagement with this subject was considered essential for students' academic achievement and prospects. Acknowledging the capability of technology to improve educational outcomes, this initiative aimed to utilize digital resources to assist students in understanding and excelling in mathematics.

4.7.1 Target Audience

The mathematics learning app was meticulously designed to cater to the educational needs of secondary school students in Mizoram, particularly those in Class X. Its development stemmed from a deep understanding of the specific curriculum, cultural context, and challenges faced by students in this region.

4.7.2 Topics Covered

The learning app focused on key chapters from the Class X mathematics textbook of the Mizoram Board of School Education (MBSE), aligning with the NCERT curriculum. Out of the 19 chapters in the textbook, the app prioritized the first eight chapters to accommodate time constraints while ensuring comprehensive coverage of essential concepts. The app's contents were structured into modules covering the first eight chapters in the textbook.

4.7.3 Target Operating System

The researcher decided to develop the learning app exclusively for the Android operating system. This decision was based on several considerations, including the target audience, development resources, and strategic objectives. Android held a significantly larger global market share compared to iOS (Sherif, 2024), making it an attractive platform for reaching a broader audience. By focusing solely on Android, the researcher could allocate resources more efficiently, tailoring the app's features and functionalities to the preferences and behaviours of the users.

The Android operating system is an open-source mobile platform developed by Google, primarily used in smartphones and tablets. It is based on the Linux kernel and offers a customizable and versatile environment for app development and usage (Singh, 2014). Android provides a rich set of features, including a user-friendly interface, multi-tasking capabilities, an extensive app ecosystem via the Google Play Store, and integration with Google services. It supports a wide range of hardware configurations and device form factors, making it adaptable to various devices. These among other features, make it worthwhile to be chosen.

4.7.4 Platform for the Development of Learning App

The researcher opted to utilize Android Studio as the primary platform for developing the mathematics learning app. Android Studio was freely available for developers to download and use for Android app development from the official website https://developer.android.com/studio (Google LLC, 2020). Being open-source software, Android Studio provided developers with exceptional adaptability and ease of access, allowing the researcher to fully utilize its capabilities without facing significant licensing costs. It supported the researcher through every stage, from code writing and debugging to testing and launching.

Android Studio served as the official integrated development environment (IDE) for Google's Android operating system. It was built on JetBrains' IntelliJ IDEA software, tailored exclusively for Android app development. This software could be accessed for installation across various operating systems including Windows, macOS, and Linux (Wikipedia contributors, 2024).

4.7.5 Programming Language

The primary programming language supported by Android Studio was Java, although Kotlin was also supported as an official language for Android development. Recognizing Java's object-oriented structure, extensive library support, and platform-independent capabilities, the researcher opted for Java to create applications within the Android Studio ecosystem. This choice was further reinforced by the researcher's familiarity with Java, which was known for facilitating efficient development processes and ensuring a high degree of application reliability.

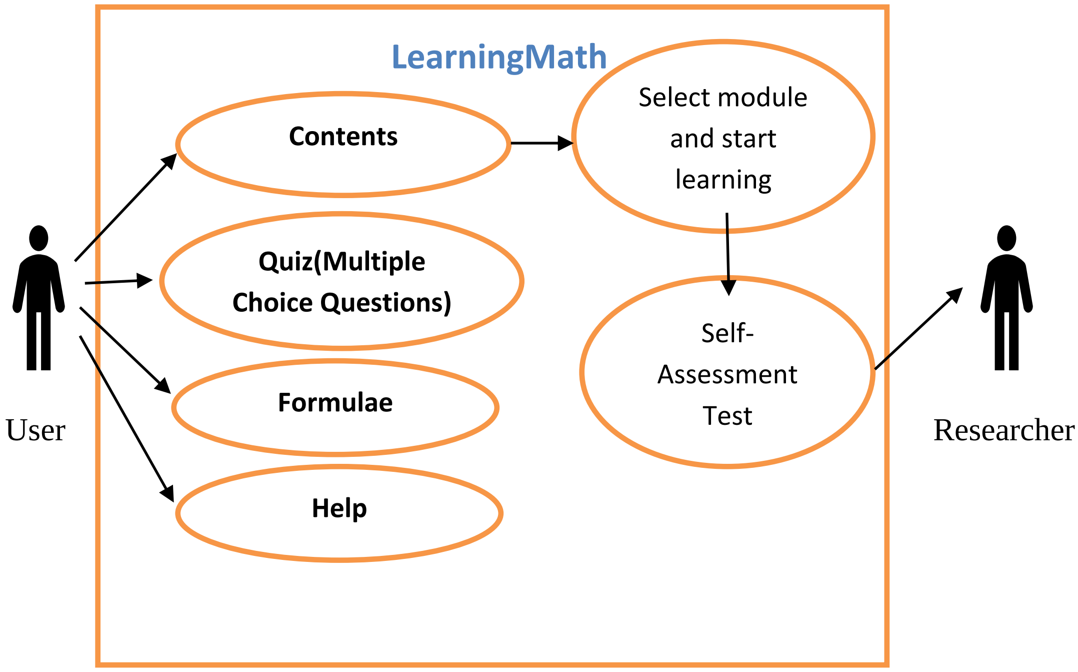
4.7.7 Design of the Learning App

The mathematics learning app was named “LearningMaths” by the researcher. It was designed with a focus on user-centricity, with secondary school students identified as the primary users. Through a user-friendly interface and interactive features, LearningMaths aims to cater to the diverse learning needs and preferences of students. Utilizing a structured approach, the app organized learning modules according to textbook chapters, facilitating alignment with the existing curriculum. Each module incorporated a range of activities, including app-based learning tools, access to external resources such as YouTube videos for supplementary explanations, and self-assessment tests to evaluate comprehension and progress.

The use case diagram (Figure 4.2) illustrated a visual representation of the potential ways in which the app could be engaged by a user. The users in focus were secondary school students, specifically chosen as the experimental group to engage with the app for learning class X mathematics. The primary function of the application's main activity was to present a user-friendly menu, allowing users to navigate various features through button clicks. By selecting the "Contents" button, users were directed to choose a Learning Module tailored to their curriculum. Each module included the option for users to submit their self-assessment tests directly to the researcher, facilitating feedback and progress tracking. Choosing the "Quiz" button guided users to a series of multiple-choice questions designed to test their knowledge. The "Formulae" button provided access to essential formulas sourced from the textbook, aiding in quick reference. Additionally, the "Help" button offered users comprehensive guidance on how to effectively utilize the application.

Figure 4.2

Use Case Diagram of LearningMaths



The flow chart for Learning Modules (Figure 4.3) illustrates the sequential steps within the learning modules. These modules were structured according to the textbook, with distinct content sets aligning with the exercises in the textbook. Broadly, each module encompassed two primary activities: app-based learning, which included key points, an app calculator, solved textbook exercises, solved multiple-choice questions, and self-assessment tests; and learning via external resources. In the case of external resource-based learning, relevant and legitimate YouTube videos were made available to offer supplementary explanations.

Despite featuring diverse content, each module maintained a consistent pattern and structure throughout. This uniformity ensured coherence and familiarity for users navigating through different sections of the application. This consistent approach enhanced the user experience by minimizing confusion and streamlining interaction with the app, ultimately contributing to a seamless and efficient learning environment.

Figure 4.3

Flow Chart for Learning Modules

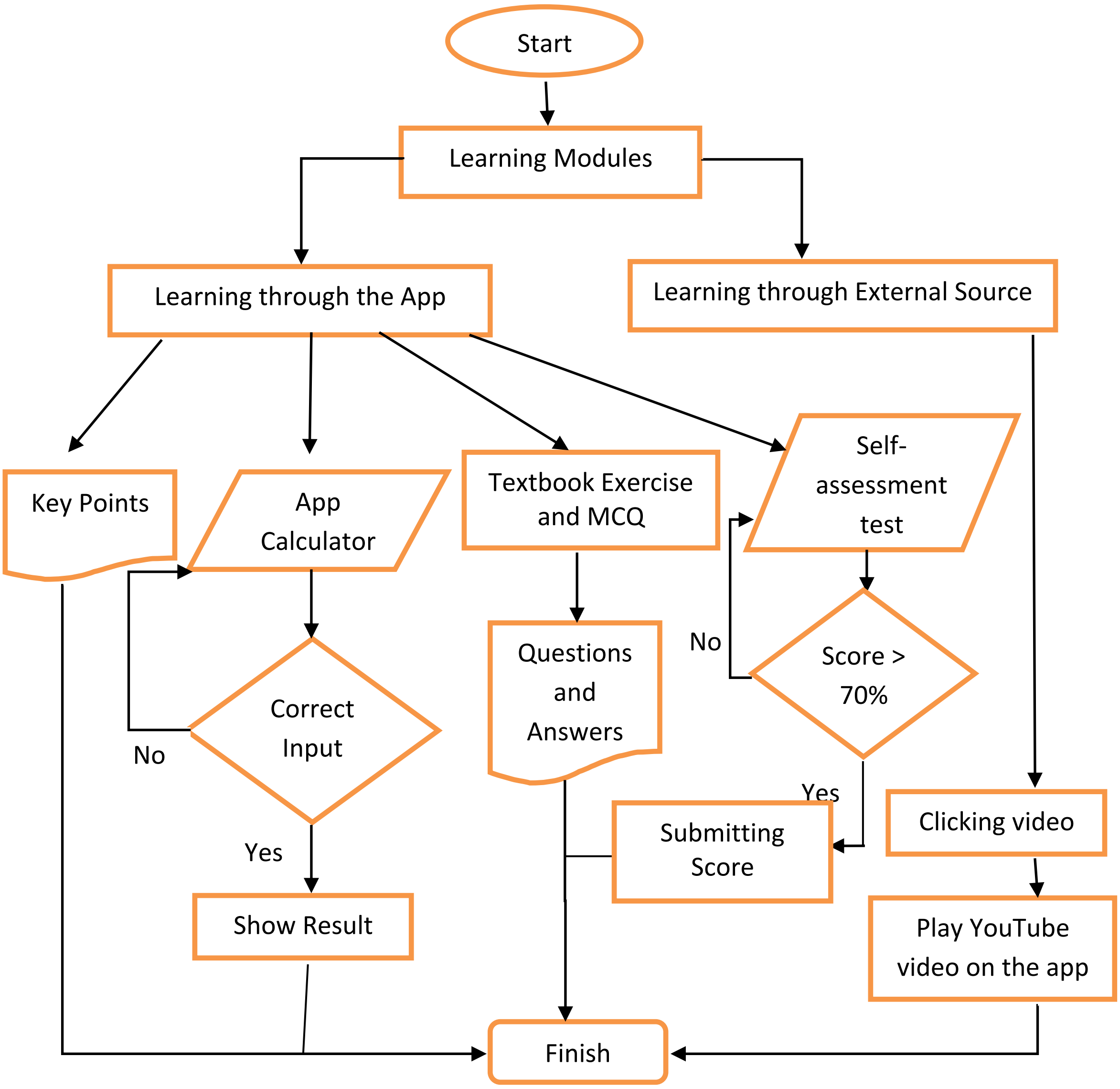


Figure 4.4

Flow Chart for Quiz(Multiple Choice Questions)

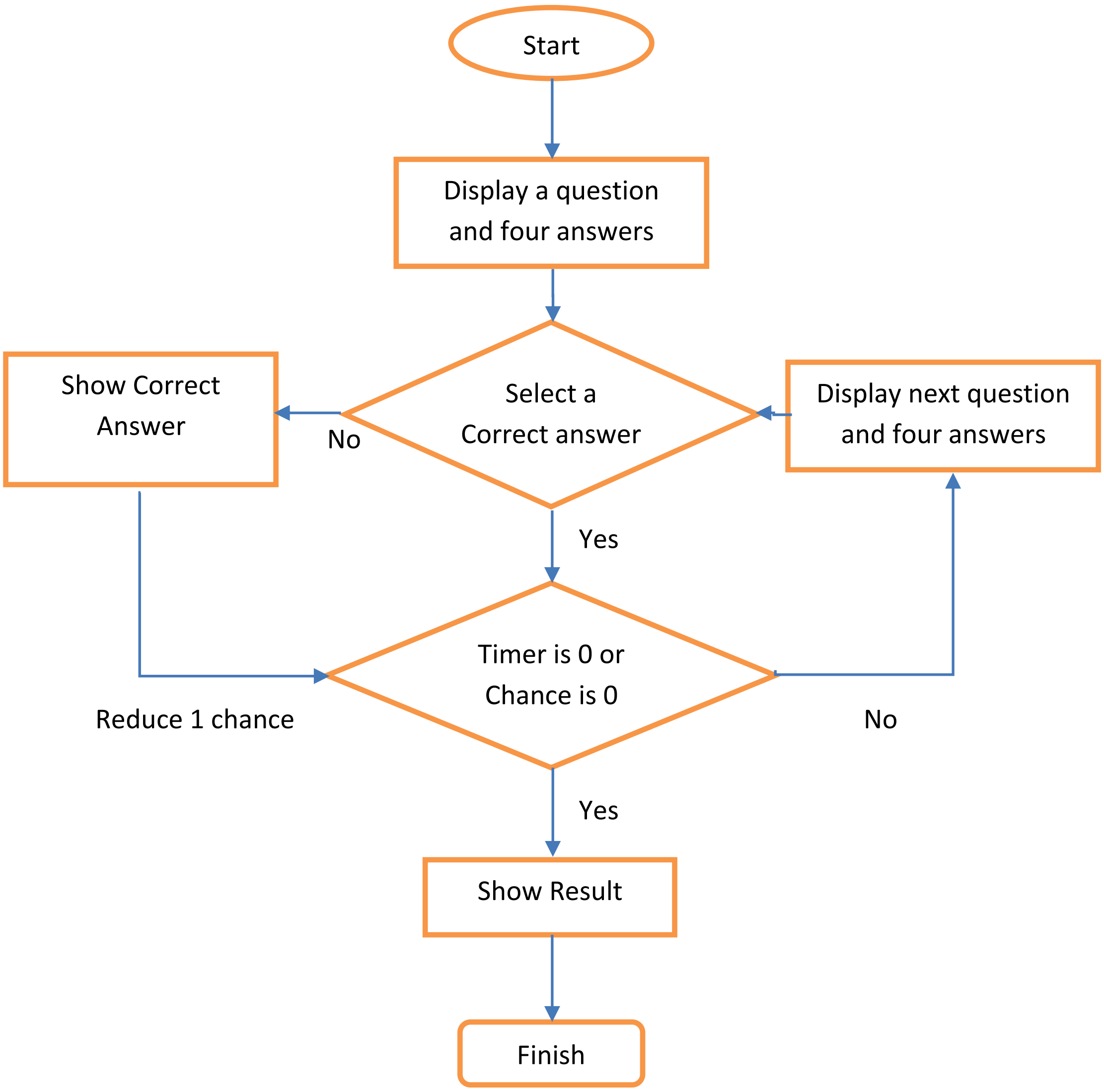


Figure 4.4 illustrates the flow of the multiple-choice question test module. The quiz (multiple-choice question) test necessitated user engagement through answer selection. The app presented a question along with four available options. Upon the user's selection of an answer choice, the app provided feedback on its correctness. When the answer was accurate, the user proceeded to the next question, earning a score increment of 1. Conversely, if the response was incorrect, a chance was deducted while the subsequent question continued to be accessible until all

chances were depleted. Users were allotted a total of 2 minutes for the multiple-choice question assessment. The test outcome was displayed either when the timer reached 0 or when the chances were exhausted, signifying the conclusion of the test.

The Self-Assessment Test within the learning module mirrored the Quiz in its structure, yet it differentiated by comprising only 10 questions per test. Furthermore, the calculation of scores was exclusively conducted at the end of the test.

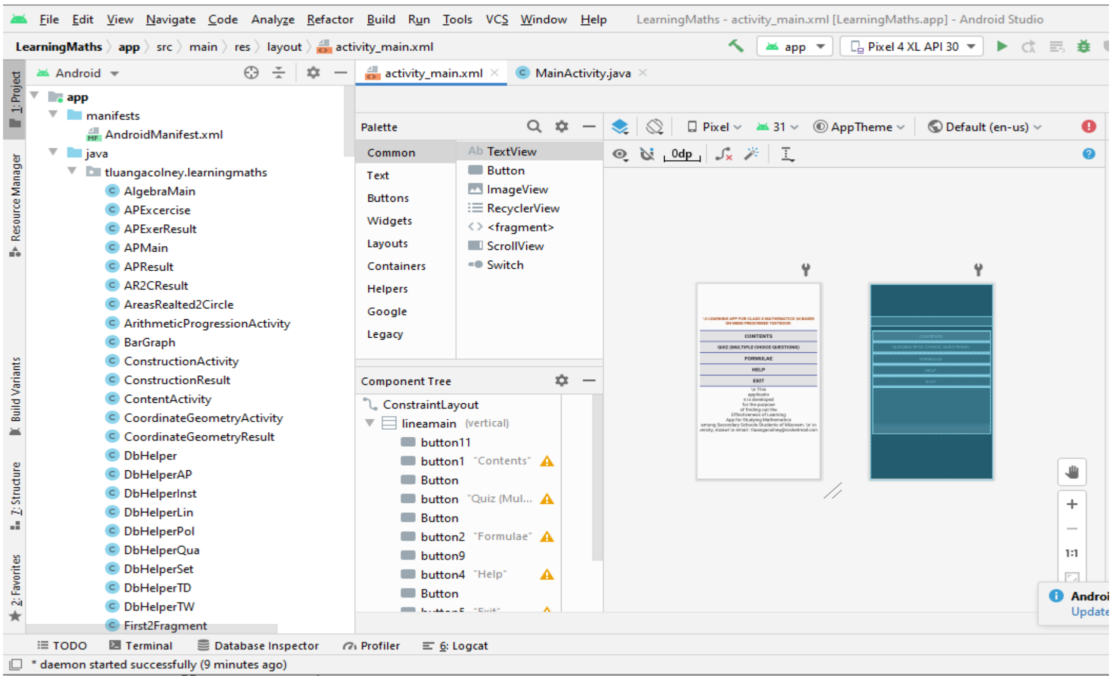
4.7.8 Development of LearningMaths software

Upon successful installation of Android Studio, the foundational tools necessary for Android development, including the Android Software Development Kit (SDK) Platform, Android Virtual Device (AVD), and essential Android Tools, were also installed. Initiating a new project was straightforward; the researcher selected "Start new Android Studio project" from the main menu. This action launched a wizard that guided the user through the process of defining essential project details, such as selecting the type of activity that served as the application's entry point, application name, package name, and programming language, and specifying the target Android devices and versions. Following this setup, Android Studio presented its workspace, equipped with all the tools and panels necessary for code development and resource management.

The workspace was where the developer's ideas came to life. For instance, in the development of LearningMaths, the workspace allowed for creating and editing key files such as MainActivity.xml and MainActivity.java. These files were pivotal in defining the app's user interface and logic. The MainActivity.xml file specified the layout and visual elements of the main screen. It detailed the arrangement of buttons, text fields, and other interactive components, ensuring the user interface was intuitive and visually appealing. The XML file also handled the styling aspects, such as colours, fonts, and spacing, contributing to a cohesive look and feel throughout the app. Meanwhile, the MainActivity.java file contained the code that dictated the app's behaviour. It connected the visual elements defined in the XML file to the underlying logic, enabling the app to respond dynamically to user inputs.

Figure 4.5(a)

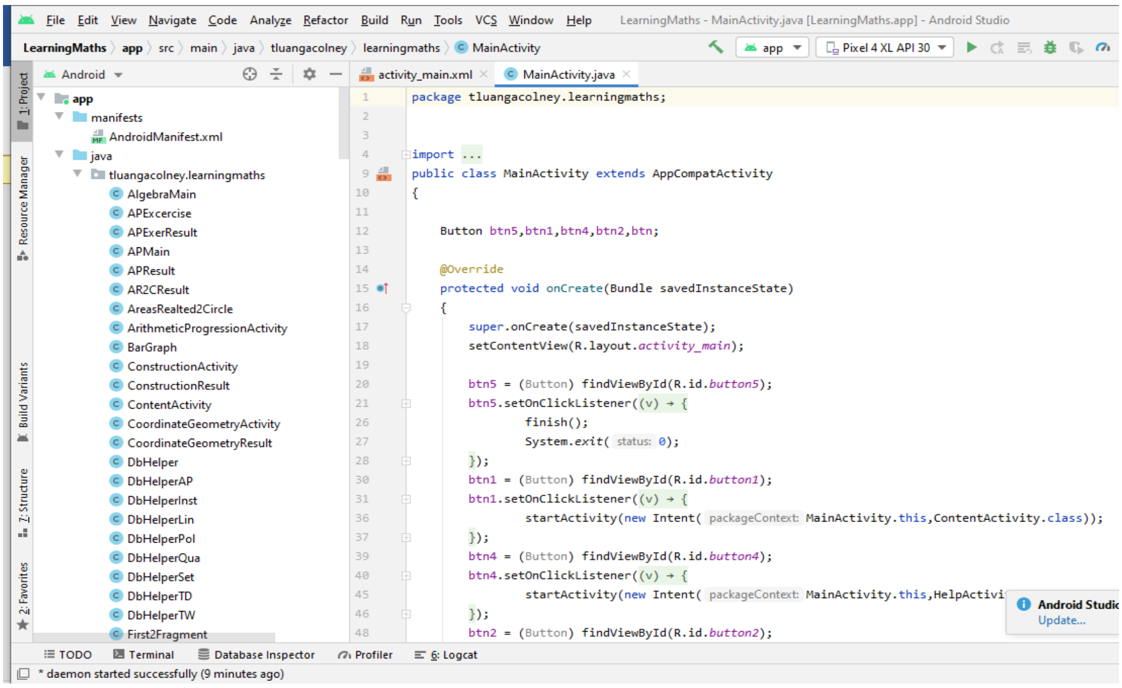
Screenshot of LearningMaths MainActivity.xml



Source: Android Studio

Figure 4.5(b)

Screenshot of LearningMaths Main Activity.java



Source: Android Studio

Figures 4.5(a) and 4.5(b) were screenshots of the comprehensive design layout of the LearningMaths application's primary interface, crafted using XML and Java in the Android Studio. These images illustrated the user interface components, including buttons, menus, text boxes, and visual elements, seamlessly integrated to facilitate efficient navigation and interaction. The XML and Java combination empowered the interface with dynamic functionality, enabling users to engage with the app content effectively.

Following the meticulous development of the main interface and the comprehensive learning modules as outlined in the project plan, efforts were focused on ensuring alignment with the structured design depicted in the use case diagram (Figure 4.2). The design process was guided by the specifications detailed in the flow charts (Figures 4.3 and 4.4), which provided a visual representation of the system's functionality and user interactions. This structured approach facilitated a well-organized and efficient development process, setting the stage for the subsequent phase of rigorous testing. This testing phase was critical for verifying that the application met the design specifications and delivered the intended educational outcomes effectively, ensuring a seamless user experience for the students.

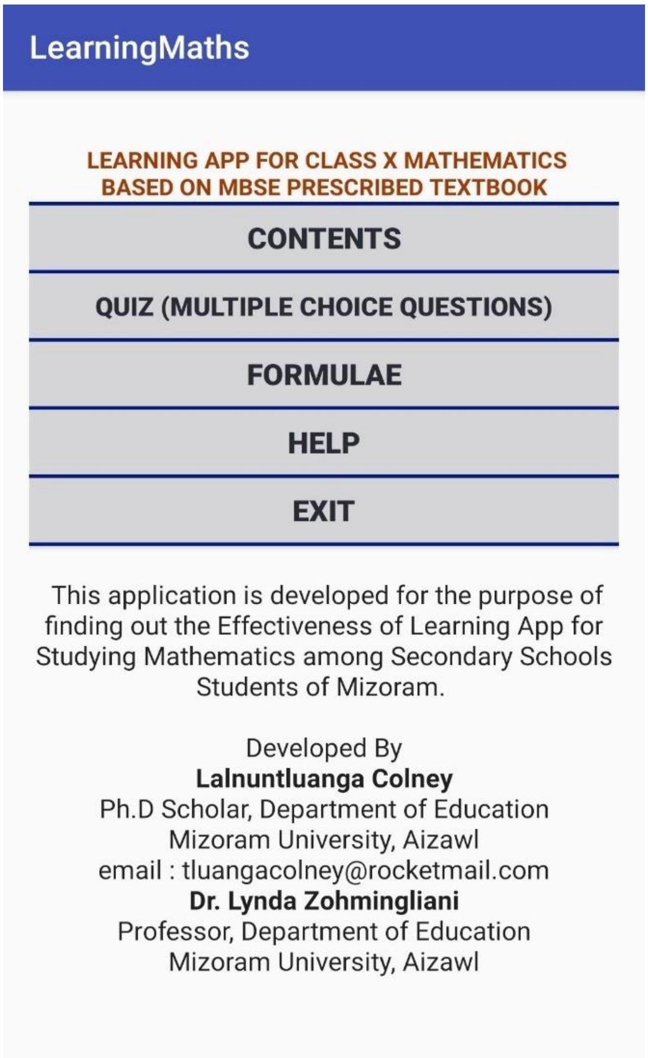
Initially, this involved deploying the application within an Android Virtual Device (AVD), an essential tool provided by Android Studio that emulates various Android device configurations. This simulation environment was instrumental in identifying and rectifying a wide array of functional and compatibility issues across different simulated devices, ensuring that the app's performance remained consistent and reliable. It allowed the researcher to observe how the app behaved under different conditions, including various screen sizes, resolutions, and Android versions. This phase also included debugging, where any detected issues were systematically addressed. The feedback from the AVD tests guided iterative improvements, refining the app's interface and functionality to meet the high standards set during the planning stages.

4.7.9 Testing of LearningMaths and Results

Following the successful validation in the AVD, the researcher proceeded to test the application on actual hardware. This phase involved transferring the Android package kit (.apk) of the app onto a real device. Testing in a real-world scenario was crucial, as it exposed the app to the intricacies of genuine device performance, including varying screen sizes, hardware capabilities, and user interactions, providing invaluable insights that were pivotal for fine-tuning the application's design and functionality.

Figure 4.6

Main Interface of LearningMaths

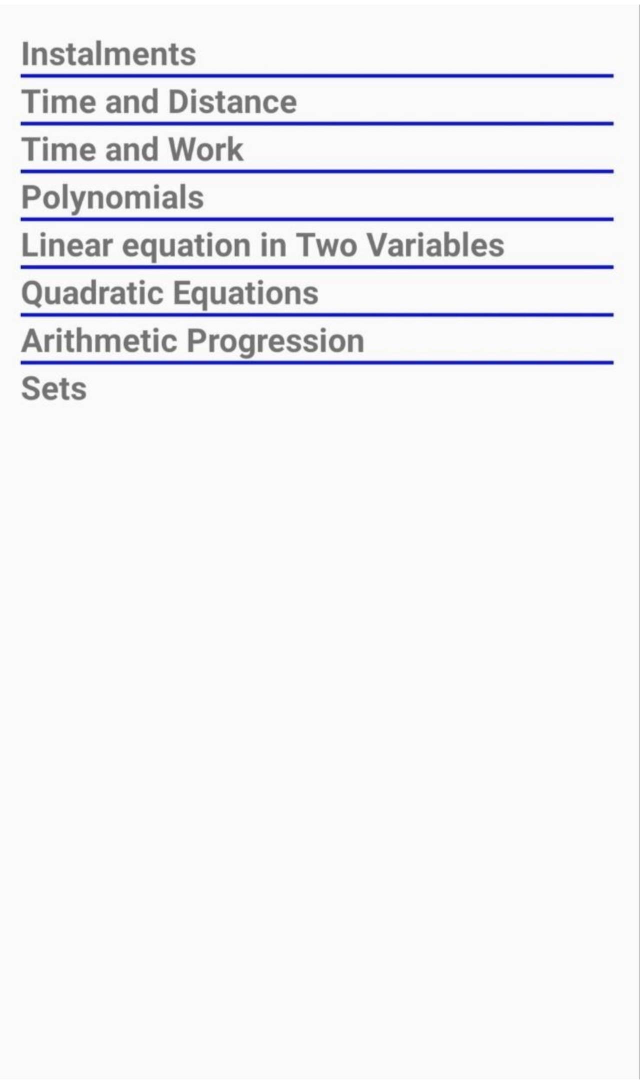


Source: LearningMaths

Figure 4.6 depicts the main interface of the app, upon initiation, the app's main interface greeted users with clarity and simplicity. Five distinct buttons adorned the screen: Contents, Multiple Choice Questions, Formulae, Help, and Exit. Each button held a specific function tailored to enhance the user's experience and engagement with the application.

Figure 4.7

Learning Module of LearningMaths



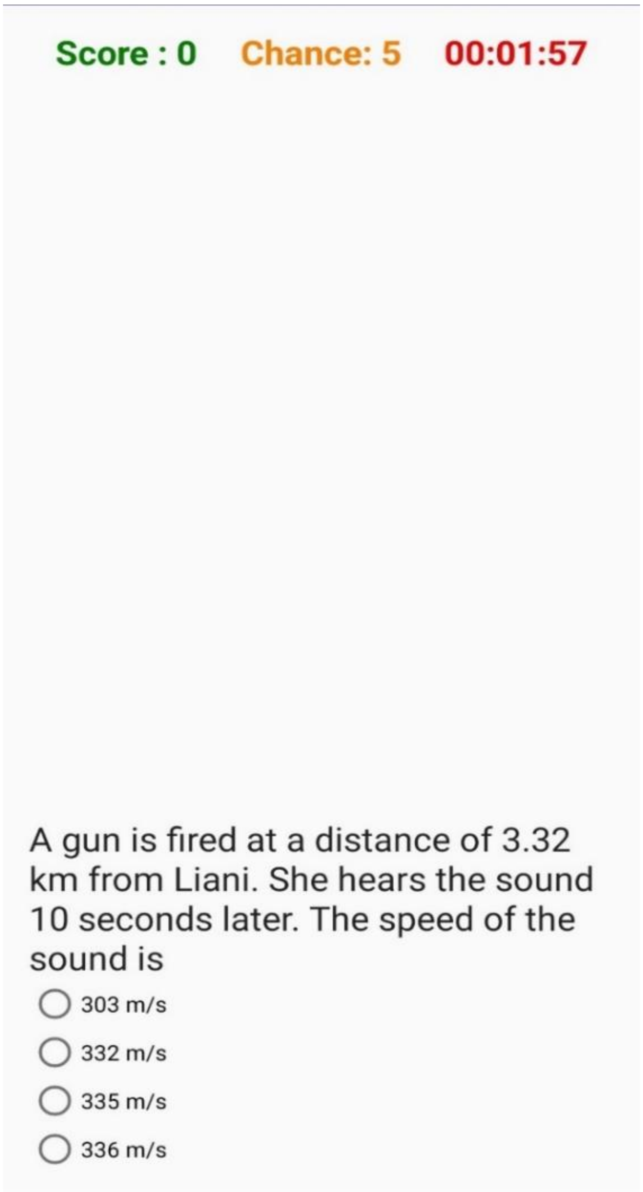
Source: LearningMaths

Figure 4.7 illustrates the learning module accessible upon clicking the Contents button. The Contents button served as the gateway to a treasure trove of learning modules, offering users access to a comprehensive repository of educational content. Clicking on this button ushered them into a structured learning environment, where topics were organized systematically for easy navigation and comprehension.

If the user opts for the Quiz (Multiple Choice Question) option on the main interface, the app displays the multiple-choice question menu illustrated in Figure 4.8.

Figure 4.8

LearningMaths Multiple Choice Questions



Source: LearningMaths

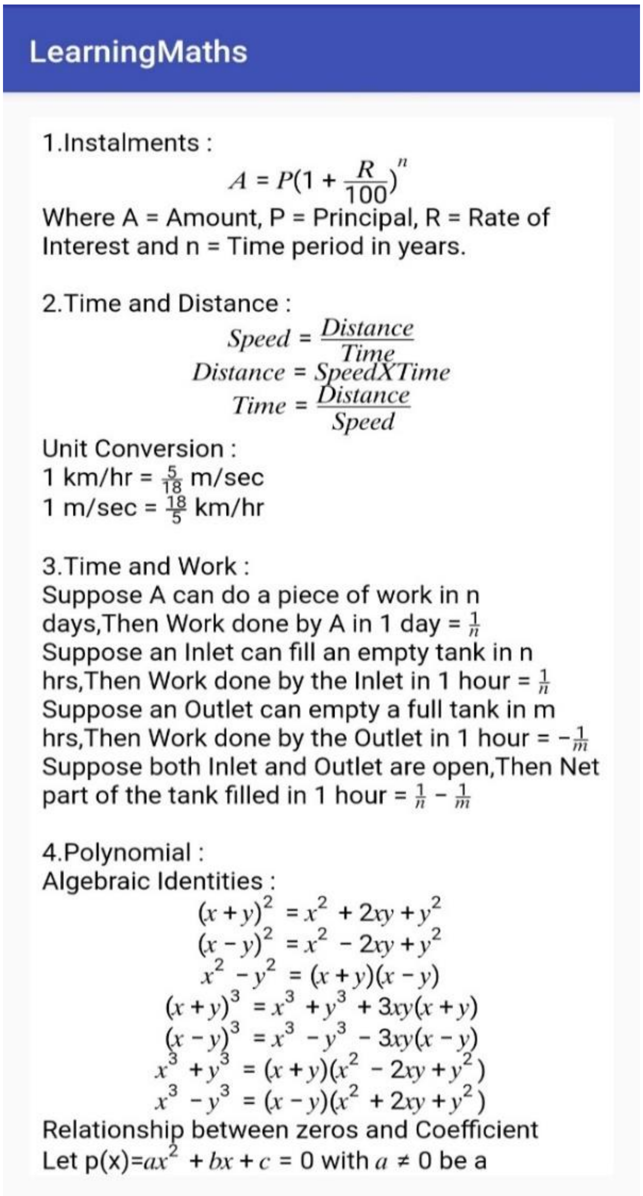
The Multiple Choice Questions button beckoned users to put their knowledge to the test, presenting them with a series of interactive quizzes designed to reinforce learning and assess understanding. Through carefully crafted questions and instant feedback, users could gauge their proficiency and identify areas for improvement.

After reading the question, the user picks an answer from the provided list of options. Subsequently, the next button becomes visible on the screen. The user has the flexibility to alter their chosen answer until they decide to click the next button. The test session concludes either when the timer countdown reaches zero or when the user exhausts all their chances, which are initially set to 5 for the multiple-choice question test. Following the test, the outcome is presented, featuring a user performance rating ranging from 0 to 5 stars and displaying the final score.

Meanwhile, the Formulae button catered to users seeking quick reference and clarification on mathematical formulas and concepts. With a simple tap, users could access a curated collection of formulas, the interface was structured to provide easy navigation, allowing users to swiftly locate and review the formulas they needed. Figure 4.9 illustrates the interfaces for the Formula section, showcasing how the app presented the information in an organized and user-friendly manner. This design choice aimed to enhance the educational experience by making critical mathematical concepts readily accessible and visually engaging, thereby supporting users in their learning journey with practical tools and resources.

Figure 4.9:

Formula button in LearningMaths

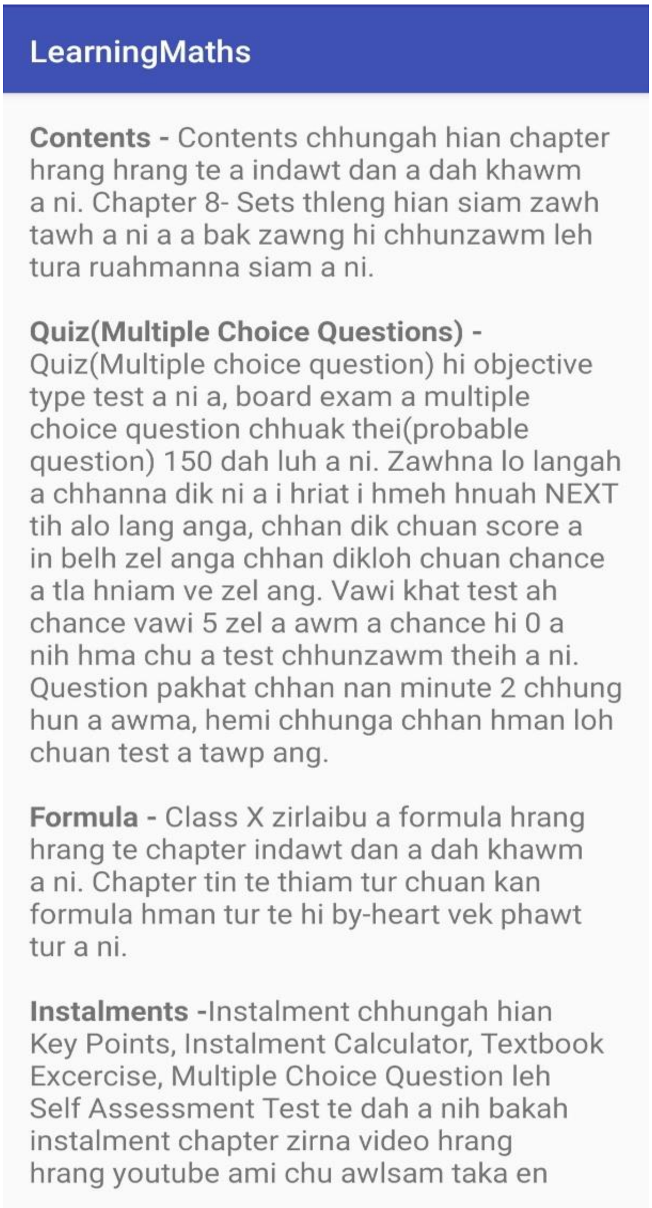


Source: LearningMaths

For those in need of guidance or assistance, the Help button stood ready to provide support and clarification on the use of the application which is written in Mizo language. Whether navigating the app's features or grappling with mathematical concepts, users could rely on this button, ensuring a seamless learning experience. Figure 4.10 illustrates the interfaces for the Help section.

Figure 4.10

Help button in Learningmaths



Source: LearningMaths

Lastly, the Exit button offered users a graceful exit from the application, allowing them to conclude their session with ease and simplicity. With a single tap, users could bid farewell to LearningMaths.

The app organized its learning modules based on textbook chapters, although not all textbook chapters were included due to limited resources and time constraints. The instalment module, designed to teach about instalments, was particularly emphasized and presented essential information. When users pressed the instalment button, shown in Figure 4.7, they were taken directly to the instalment module.

Figure 4.11: *Instalment module*

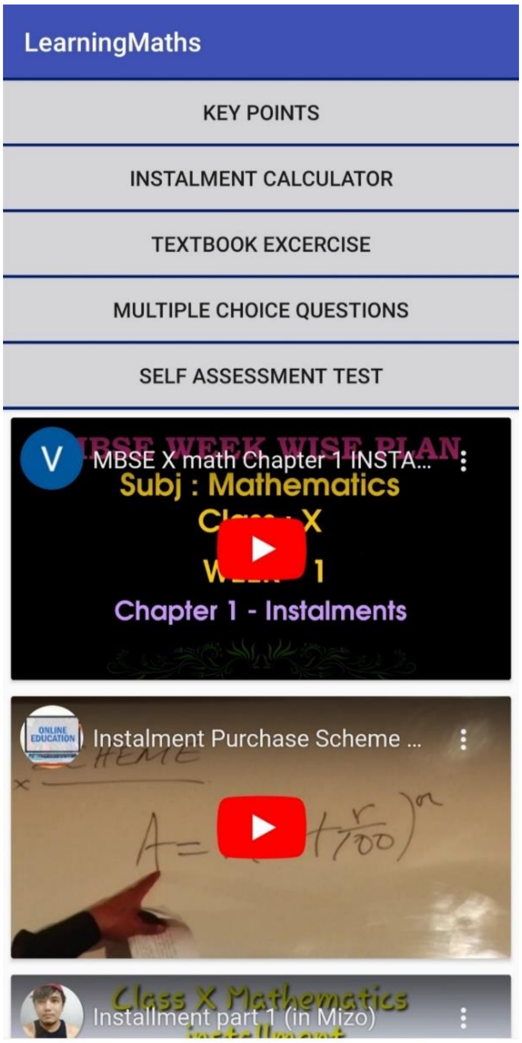
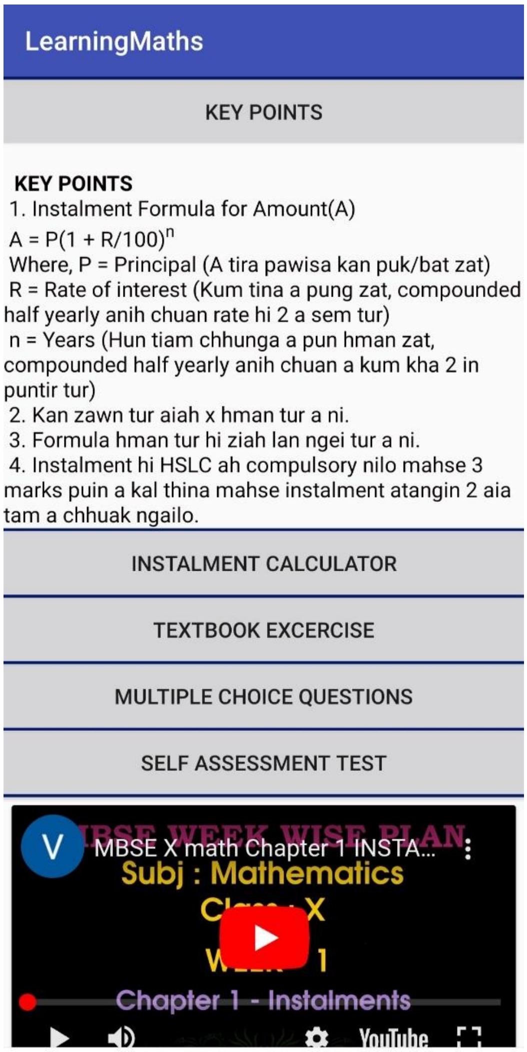


Figure 4.12: *Instalment Key Points*



Source: LearningMaths

The user interface of the instalment module was comprehensively illustrated in Figure 4.11. This figure provided a detailed view of the module's layout, showcasing the intuitive design and accessible features that facilitated user interaction. Meanwhile, Figure 4.12 delved into a more specific functionality within the same system; it depicted the user interface as it appeared upon clicking the "key points" button. This action triggered a distinct change in the interface, revealing critical information that was pivotal for the users' learning of the instalment module, which was written in Mizo language.

Figure 4.13: *Instalment calculator*

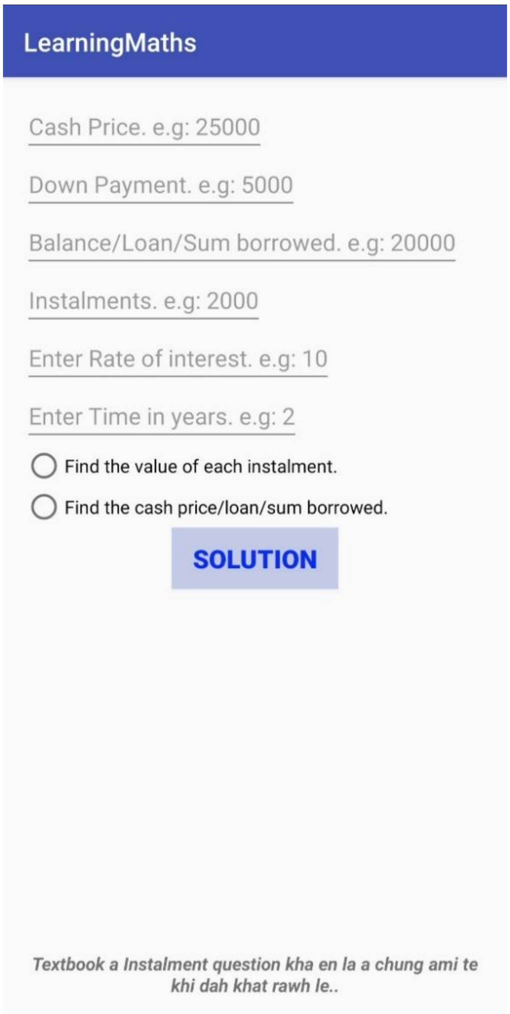
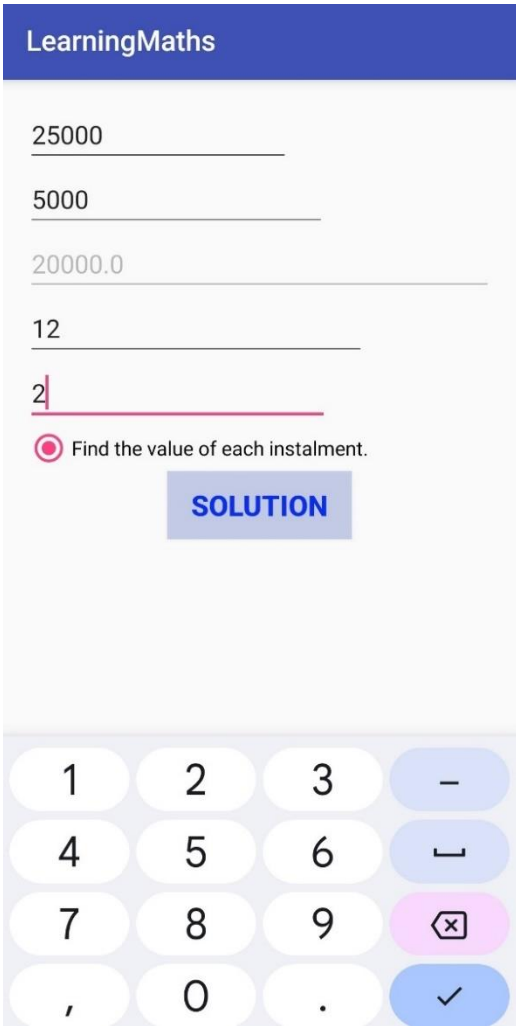


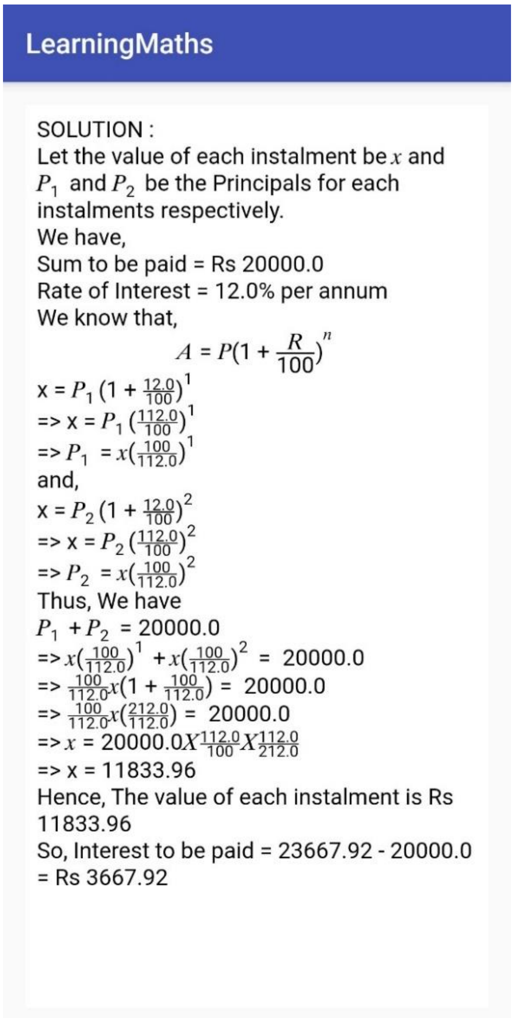
Figure 4.14: *User Input on Calculator*

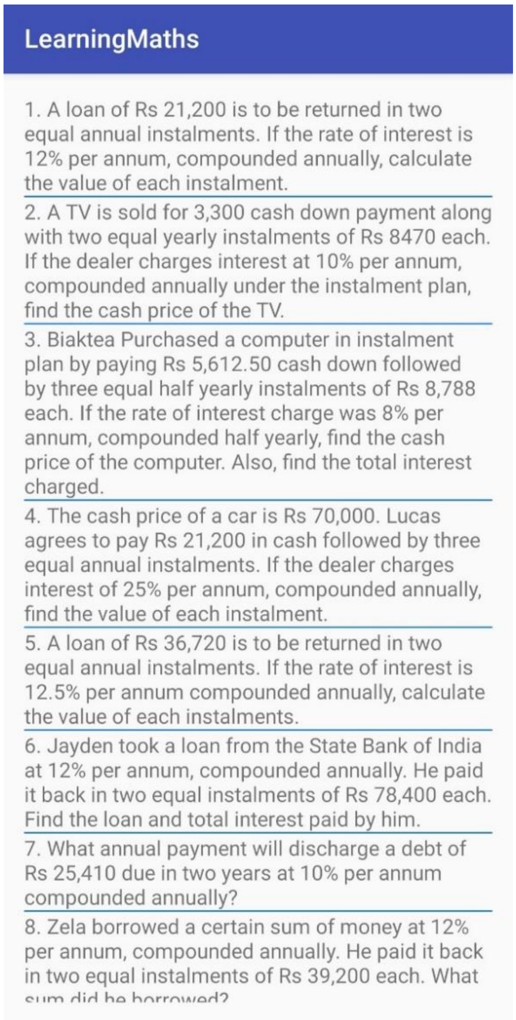


Source: LearningMaths

In Figure 4.13, the user interface for the instalment calculator is illustrated, providing users with a tool to solve various related problems with valid inputs. Based on the user inputs the app automatically calculates the value of each instalment or the cash price/loan/sum borrowed as depicted in Figure 4.14. This instalment calculator extends its utility beyond conventional textbook problems, enabling users to address instalment-related questions with real-world applications. The researcher provides random input as an example and the result is presented in Figure 4.15.

Figure 4.15: *User Input Result* **Figure 4.16:** *Instalment textbook Exercise*





Source: LearningMaths

Figure 4.15 showcases the outcomes generated by the instalment calculator based on the user inputs highlighted in Figure 4.14. This visual representation includes detailed results and breakdowns, illustrating how the app processes and presents data. Apart from calculations, users can access solved textbook exercises by clicking on the questions, as demonstrated in Figure 4.16. This feature enhances the learning experience by offering practical application opportunities and facilitating comprehension through examples.

Figure 4.17: *Solution of Textbook Exercise Question*

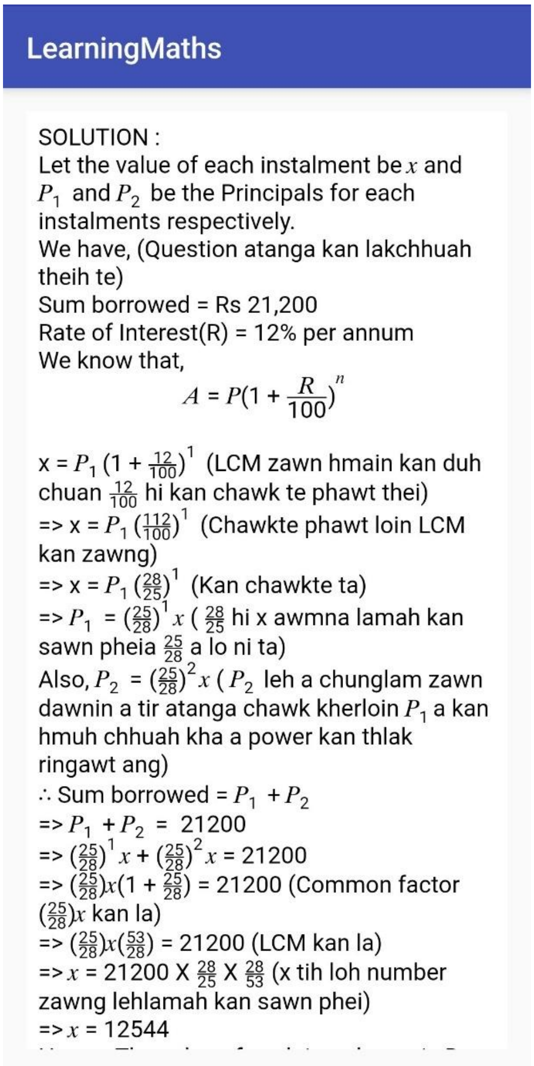
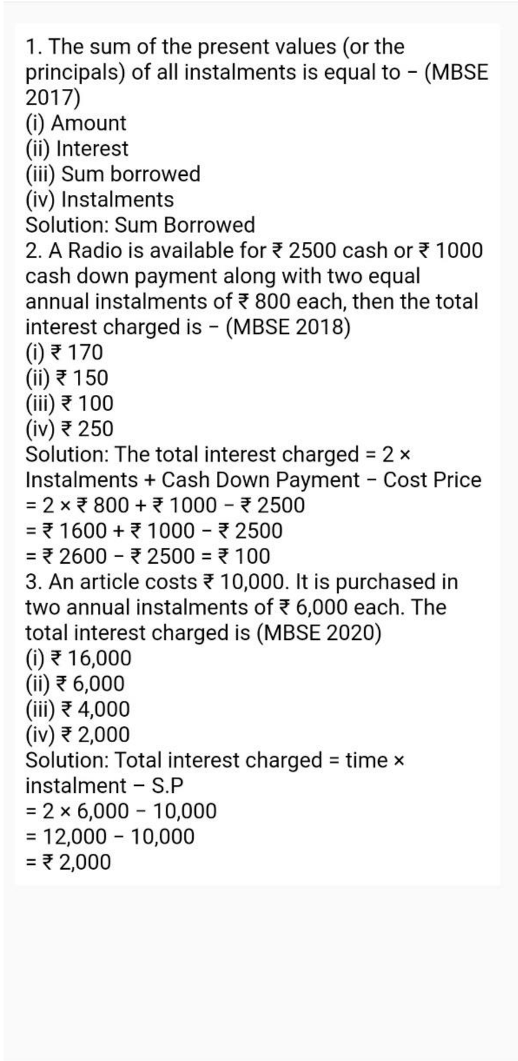


Figure 4.18: *Multiple Choice*



Source: LearningMaths

Figure 4.17 reveals the detailed solution for question number 1 from the textbook exercise, a continuation of what was initiated in Figure 4.16. This progression underscores the application's commitment to enhancing the educational journey of its users by integrating a diverse range of resources. Among these resources, the feature accessed through the "Multiple Choice Questions" button stands out. By engaging with this functionality, users are directed to a collection of meticulously solved multiple-choice exercises derived directly from the textbook, as vividly demonstrated in Figure 4.18.

Figure 4.19: *Self-Assessment Test*

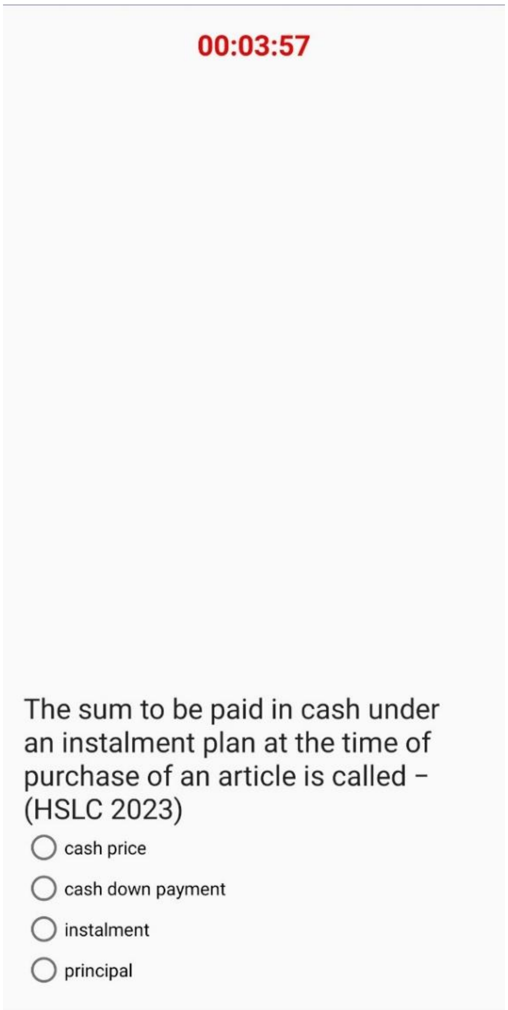
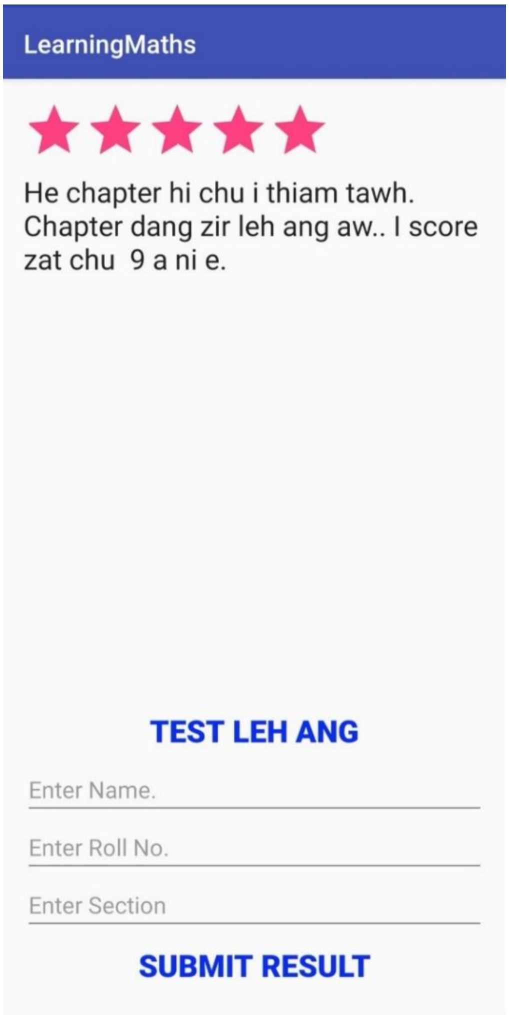


Figure 4.20: *Self-Assessment Test Result*

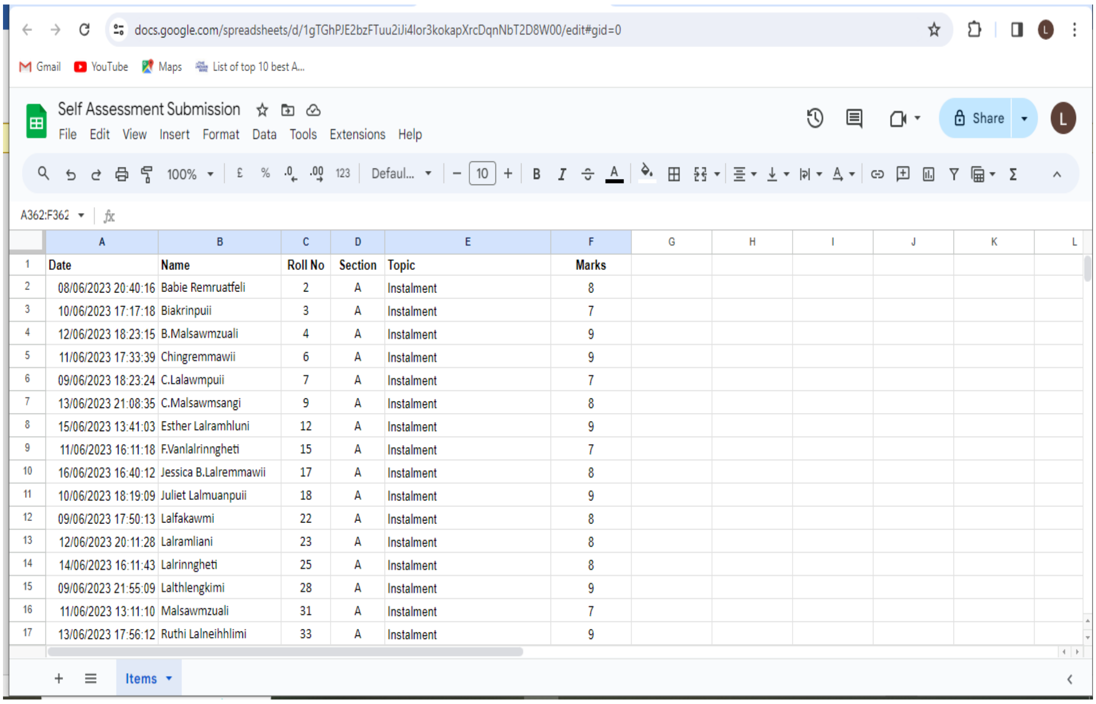


Source: LearningMaths

At the conclusion of each learning module, there is a self-assessment test button allowing students to take an objective-type test. This test concludes once all ten questions provided are answered. The self-assessment test specific to the instalment module is depicted in Figure 4.19. This feature facilitates an objective-type test to evaluate the learner's grasp of the material. Feedback on the self-assessment test results is promptly provided to the student upon test completion, as demonstrated in Figure 4.20. The "submit result" button becomes available only if the student scores above 70%; otherwise, they are prompted to retake the test until achieving the required score. Notably, the test results are seamlessly transmitted to the researcher database, as depicted in Figure 4.21.

Figure 4.21

Self-Assessment Test Result Database



Date	Name	Roll No	Section	Topic	Marks
08/06/2023 20:40:16	Babie Remruatfeli	2	A	Instalment	8
10/06/2023 17:17:18	Biakrinpuii	3	A	Instalment	7
12/06/2023 18:23:15	B.Malsawmzuali	4	A	Instalment	9
11/06/2023 17:33:39	Chingremmawii	6	A	Instalment	9
09/06/2023 18:23:24	C.Lalawmpuii	7	A	Instalment	7
13/06/2023 21:08:35	C.Malsawmsangi	9	A	Instalment	8
15/06/2023 13:41:03	Esther Lalramhluni	12	A	Instalment	9
11/06/2023 16:11:18	F.Vanlalrinngheti	15	A	Instalment	7
16/06/2023 16:40:12	Jessica B.Lalremmawii	17	A	Instalment	8
10/06/2023 18:19:09	Juliet Lalmuanpuii	18	A	Instalment	9
09/06/2023 17:50:13	Lalfakawmi	22	A	Instalment	8
12/06/2023 20:11:28	Lalramliani	23	A	Instalment	8
14/06/2023 16:11:43	Lalrinngheti	25	A	Instalment	8
09/06/2023 21:55:09	Lalthlengkimi	28	A	Instalment	9
11/06/2023 13:11:10	Malsawmzuali	31	A	Instalment	7
13/06/2023 17:56:12	Ruthi Lalneihhlimi	33	A	Instalment	9

Source: Google Drive

The application maintained a uniform design across all learning modules, each addressing distinct topics with a cohesive and intuitive interface. This consistent design approach ensured that users could navigate seamlessly between different sections of the app, enhancing overall usability and user experience. A notable feature of the app was its test result functionality, which effectively fulfilled all project requirements by providing a comprehensive evaluation and tracking system for student progress. This feature enabled educators and students to monitor performance, identify areas for improvement, and track progress over time.

The development of this learning app represented a collaborative effort to harness technology for educational advancement in Mizoram's secondary schools. By leveraging digital innovation, the initiative aimed to empower students with the necessary tools and resources to excel in mathematics and beyond. The app was designed to not only support academic achievement but also to engage and motivate students through interactive and accessible learning experiences.

Through ongoing refinement and feedback-driven iterations, the app endeavoured to remain responsive to the evolving needs of students and educators. This commitment to continuous improvement was integral to enhancing learning outcomes and educational experiences. By adapting to feedback and integrating new features, the app aimed to contribute meaningfully to the educational landscape in Mizoram, supporting the goal of improving mathematics education and fostering student success.

4.8 Objective 7: To find out the effectiveness of learning app on mathematics among secondary school students

In the research, a specially designed mathematics learning application named ‘LearningMaths,’ developed by the researcher, was introduced to a cohort of 90 secondary school students in Mizoram to assess its efficacy in enhancing mathematics competency. The study employed a pre-test and post-test design to evaluate changes in mathematical understanding. Initially, a sample of students underwent a pre-test to establish a baseline of their mathematics skills. Once their scores were recorded, the students were divided into two equivalent groups: a control group and an experimental group. Following this, the ‘LearningMaths’ app was deployed as an intervention tool within the experimental group.

The researcher developed a specific mathematics achievement test that was administered both before and after the application of the learning tool. Both tests consisted of multiple-choice questions as well as short answer and long-answer type question items. This approach allowed for a controlled comparison of student performance, ensuring that any changes in competency could be directly attributed to the use of the app. The outcomes from the post-test provided crucial data regarding the app’s effectiveness.

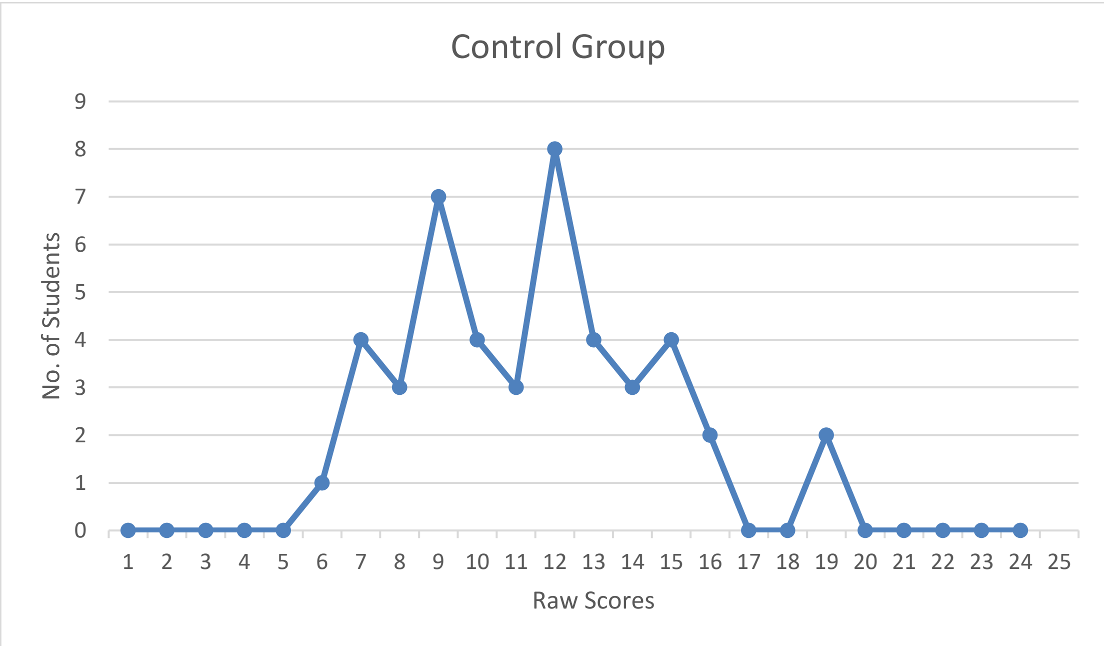
To accurately assess the effectiveness of the learning app, the normality of the post-test scores for both the control and experimental groups was evaluated. This preliminary analysis was crucial in deciding whether to apply parametric or non-parametric statistical tests to determine the significance of the results.

4.8.1 Normality of the control group scores in the post-test

The normality of the control group scores data was assessed by creating a frequency polygon. This graph plotted the raw scores of the control group on the X-axis and the number of students achieving those scores on the Y-axis. Figure 4.22 illustrates the frequency polygon of control group scores in the post-test.

Figure 4.22

Frequency polygon of control group scores in post-test



Source: Field Study

By examining the frequency polygon in Figure 4.22, it was not clear whether the distribution of the control group scores formed a normal probability curve. To obtain a more definitive assessment, this observation required further validation through statistical testing. For this, the researcher used the Shapiro-Wilk test to evaluate the normality of the data. This test provided a formal method to determine whether the distribution significantly deviated from a normal distribution, offering a more precise basis for subsequent statistical analyses and ensuring the robustness of the study's conclusions.

The Shapiro-Wilk test operated under the assumption of the null hypothesis that "the distribution does not significantly deviate from a normal distribution," meaning the data followed a normal distribution. If the significance value derived from this test was 0.05 or lower, it indicated rejection of the null hypothesis; otherwise, the null hypothesis was accepted.

The statistical results of the Shapiro-Wilk test for the control group was detailed in Table 4.9.

Table 4.9

Shapiro Wilk test of Normality for Control Group

Shapiro-Wilk Test for Control Group		
Statistic	**Degrees of freedom**	**Significance Value**
0.963	45	0.157

Source: Field Study

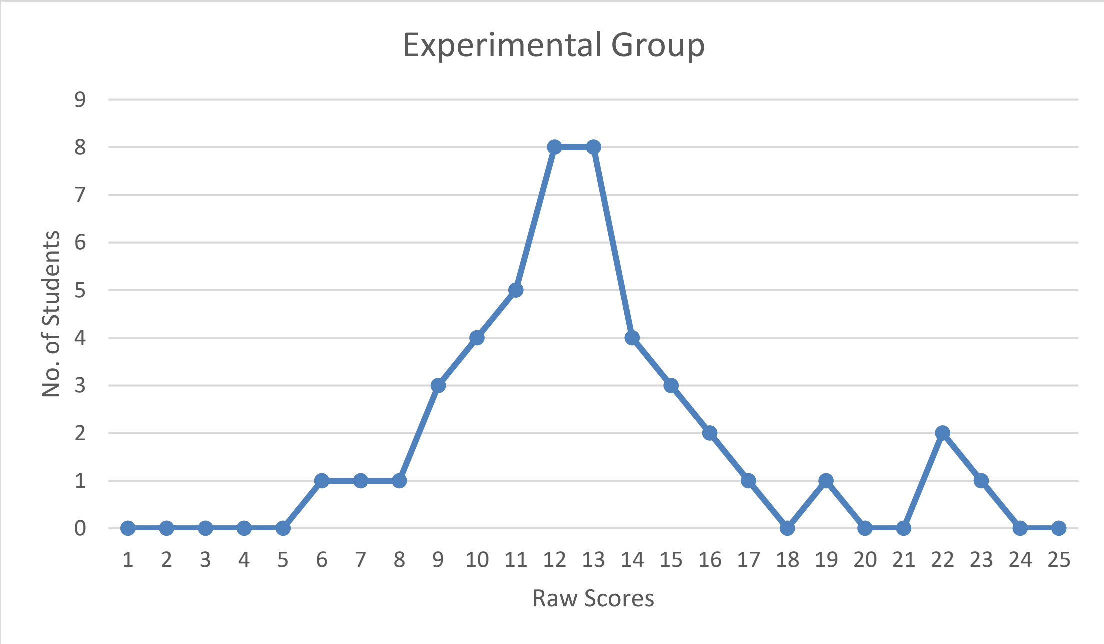
From Table 4.9, it is evident that the significance value of the Shapiro-Wilk test for the control group was 0.157, which is greater than the threshold of 0.05. As a result, the null hypothesis was retained. This outcome indicates that the distribution of the control group scores did not significantly deviate from a normal distribution. In other words, the data followed a normal distribution pattern, allowing for the use of parametric statistical tests in further analysis.

4.8.2 Normality of the experimental group scores in the post-test

The normality of the experimental group scores data was also assessed by creating a frequency polygon. This graph plotted the raw scores of the experimental group scores on the X-axis and the number of students achieving those scores on the Y-axis. Figure 4.23 illustrates the frequency polygon of experimental group scores in the post-test.

Figure 4.23

Frequency polygon of experimental group scores in post-test



Source: Field Study

In Figure 4.23, it was not clear whether the frequency polygon conformed to a normal probability curve. Following this, the observation needed to be further validated using the Shapiro-Wilk test.

Table 4.10

Shapiro Wilk test of Normality for Experimental Group

Shapiro-Wilk Test for Experimental Group		
Statistic	**Degrees of freedom**	**Significance Value**
0.915	45	0.003

Source: Field Study

From Table 4.10, it is evident that the value of the Shapiro-Wilk test (0.003) for the experimental group is less than 0.05, therefore the null hypothesis is rejected. This implies that the distribution deviates from a normal distribution.

4.8.3 Comparison of post-test scores between the control group and experimental group

Given that the data for the control group was normally distributed and the sample was convenient, the researcher determined that it was appropriate to use the t-test to compare the post-test scores between the control and experimental groups.

To test the statistical significance, the hypothesis which stated that “There is a significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app” was transformed into a null hypothesis as follows:

“There is no significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app.”

Table 4.11 shows the computation of the t-test for the comparison of the post-test results between the control group and experimental groups of students after the experimental group used the learning app.

Table 4.11

Comparison of the post-test results between the control group and experimental group using a t-test

Groups	No. of Students	Mean	Standard Deviation	Df.	t - value	Significance Level
Control	45	11.42	3.14	88	2.001	Not Significant at 0.01 but significant at 0.05
Experimental	45	12.84	3.59			

Source: Field Study

Table 4.9 showed that the calculated t-value was 2.001, which was used to evaluate the difference between the mean scores of the two groups compared to the variation within those groups. This t-value surpassed the critical value at the 0.05 significance level (1.99) but fell short of the critical value at the 0.01 level (2.64). This implies that the improvement in mathematics competency observed between the control group and the experimental group of secondary school students, following the implementation of the learning app in the experimental group, was significant enough to meet the 0.05 level criteria but not the more rigorous 0.01 level, indicating a potentially meaningful difference between the groups.

As a result, the null hypothesis, which stated that "There is no significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app" was rejected at the 0.05 significance level but not at the 0.01 level. In simpler terms, the null hypothesis was maintained at the 0.01 significance level, suggesting no significant difference at this stricter threshold. However, at the 0.05 level, the null hypothesis was rejected, concluding that there was a statistically significant difference in mathematics competency between the groups.

The analysis indicated that the use of the 'LearningMaths' app might have had a statistically significant effect on improving mathematics scores among secondary school students compared to those who did not use the app, provided the significance level was set at 0.05. This supported the original hypothesis that “there was a significant difference in mathematics competency between the control and experimental groups after the intervention with the learning app.”

4.9 Objective 8: To compare the effectiveness of learning app on mathematics among secondary school students in terms of gender

The researcher compared the effectiveness of the learning app on mathematics among secondary school students in terms of gender by analysing the data independently for both male and female students of the experimental group on the post-test scores. To determine if there was a statistically significant difference in mathematics competency between genders following the use of the learning app, the researcher compared the mean scores between male and female students.

To achieve this, a t-test was utilized, and the hypothesis which stated that “There is a significant difference in the effectiveness of learning app on mathematics between male and female secondary school students” was transformed into a null hypothesis as follows:

“There is no significant difference in the effectiveness of learning app on mathematics between male and female secondary school students.”

The computation of the t-test to compare the mean scores of male and female students in the post-test scores is illustrated in Table 4.12.

Table 4.12

Difference of the effectiveness of learning app on mathematics among secondary school students in terms of gender

Gender	No. of Students	Mean	Standard Deviation	Degrees of freedom	Calculated t – value	Significance Level
Male	19	12.447	2.1272	43	0.532	Not Significant.
Female	26	13.135	4.3853			

Source: Field Study

Table 4.4 showed that the calculated t-value was 0.532, which was less than the critical t-value at both 0.05 (2.02) and 0.01 (2.71). Hence, it was not significant. Therefore, the null hypothesis stating “there is no significant difference in the effectiveness of the learning app on mathematics between male and female secondary school students” had to be accepted. Despite slight disparities in mean scores between males and females, these differences lacked statistical significance. Thus, it could be concluded that there was no significant difference in mathematics competency between male and female secondary school students after using the learning app.

4.10 Objective 9: To suggest measures for the improvement of Mathematics learning in Mizoram

Since this objective was connected with suggestive measures, the suggested measures were not reflected in this chapter and were rather presented in Chapter V.

CHAPTER V

MAJOR FINDINGS AND DISCUSSIONS, SUGGESTIONS FOR FURTHER RESEARCH AND CONCLUSION

CHAPTER V

MAJOR FINDINGS AND DISCUSSIONS, SUGGESTIONS FOR FURTHER RESEARCH AND CONCLUSION

5.1 Introduction

This chapter provided a thorough analysis of the findings from the study on smartphone usage and the effectiveness of learning applications for studying mathematics among secondary school students in Mizoram. It provided a thorough discussion of the major findings by comparing empirical data against existing literature, elucidating how smartphones served as a tool in the educational process.

The chapter also identified gaps in the current research landscape, proposing areas for future investigation to enhance the integration of technology in education. Finally, it concluded by summarizing the study's contributions to educational practices and policy-making in the context of Mizoram, offering recommendations for educators, developers, and policymakers aiming to harness mobile technology for educational enhancement.

5.2 Major findings and discussions

Major findings and discussions of the study are arranged in the following order:

5.2.1 Major findings and discussions regarding the finding of major purpose for smartphone usage among secondary school students of Mizoram.

5.2.2 Major findings and discussions regarding the finding of the level of smartphone usage among secondary school students of Mizoram.

5.2.3 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on gender.

5.2.4 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on locality.

5.2.5 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on management of school.

5.2.6 Major findings and discussions regarding the development of a learning app on mathematics for secondary school students of Mizoram.

5.2.7 Major findings and discussions regarding the finding of effectiveness of learning app on mathematics among secondary school students.

5.2.8 Major findings and discussions regarding Comparisons of the effectiveness of learning app on mathematics among secondary school students in terms of gender.

5.2.1 Major findings and discussions regarding the finding of major purpose for smartphone usage among secondary school students of Mizoram

This study revealed that-

– 90.14% of secondary school students in Mizoram used smartphones for social media (Facebook, WhatsApp, Instagram, and TikTok).
– 89.43% of secondary school students in Mizoram used smartphones for entertainment purposes like listening to music and watching videos/movies.
– 73.14% of secondary school students in Mizoram used smartphones for traditional communication methods, such as making phone calls and chatting.
– 72.43% of secondary school students in Mizoram used smartphones to search for information on Google.
– 54.86% of secondary school students in Mizoram used smartphones for playing games, both online and offline.
– 49.71% of secondary school students in Mizoram used smartphones for photography and video recording.
– 40.71% of secondary school students in Mizoram used smartphones for reading news and entertainment.
– 39% of secondary school students in Mizoram used smartphones to access learning materials.

- 19.29% of secondary school students in Mizoram used smartphones for interaction with teachers.
- 1.14% of secondary school students in Mizoram used smartphones for other purposes like editing, business-related activities, and using dictionaries.

The majority of the secondary school students in Mizoram use their smartphones for social interaction and entertainment purposes while only a smaller percentage of students use their smartphones for educational purposes.

Discussion: The findings regarding smartphone usage among secondary school students in Mizoram underscored a prevalent trend towards social interaction and entertainment over educational pursuits. This aligned with broader research on adolescent smartphone usage, which often highlighted a preference for social media engagement, entertainment consumption, and gaming over academic activities (Harfield et al., 2014; Cha and Seo, 2018; Fook et al., 2021).

The high percentage of students using smartphones for social media platforms (90.14%) and entertainment purposes (89.43%) echoed global trends where platforms like Facebook, WhatsApp, and TikTok dominated adolescent digital socialization (Mahalakshmi, 2013; Jesse, 2015; Savio, 2016; Soegoto, 2019). Similarly, the substantial portion of students using smartphones for gaming (54.86%) mirrored findings suggesting that gaming was a primary recreational activity among youth (Liu et al., 2016).

Contrastingly, the lower percentages of students using smartphones for educational purposes (39% for accessing learning materials and 19.29% for interaction with teachers) indicated a potential disparity between the integration of technology into education and its adoption by students for learning purposes. This highlighted the importance of understanding barriers to educational technology adoption and designing interventions that promoted its effective utilization in academic settings (Ertmer, 1999). In other words, it is important to identify ways and means to make optimum use of educational technology by students.

5.2.2 Major findings and discussions regarding the finding of the level of smartphone usage among secondary school students of Mizoram

This study revealed that-

- Grade A, representing the "Extremely High" smartphone usage level, has a small proportion (2.43%) of students. These students have raw scores significantly above the mean, indicating heavy dependence or usage.
- Grade B, representing the "High" smartphone usage level, has a moderate group (9%) of students, with raw scores well above average, suggesting frequent use.
- Grade C, representing the "Above Average" smartphone usage level, has a significant portion (18.72%) of students with raw scores more than the average student, but not excessively.
- Grade D, representing the "Average" smartphone usage level, has the largest group (38.57%) of students, indicating a balanced or typical use among these students.
- Grade E, representing "Below Average" smartphone usage level, has a considerable number (20.14%) of students who used their smartphones less than average, which might indicate moderate or restricted use.
- Grade F, representing the "Low" smartphone usage level, has a smaller group (9.43%) of students, suggesting limited interaction with their devices.
- Grade G, representing the "Extremely Low" smartphone usage level, has a very small fraction (1.71%) of students, which could indicate minimal dependency or access to smartphones.
- Overall, the majority (77.43%) of students fall into Grades C, D, and E, representing "Above Average," "Average," and "Below Average" usage levels.

Thus, it can be concluded that the overall level of smartphone usage among secondary school students in Mizoram is categorized as average, indicating typical smartphone use with lesser risks for negative consequences.

Discussion: The findings of the study indicated that the majority (77.43%) of secondary school students in Mizoram exhibited average levels of smartphone usage, with Grade D encompassing the largest group, followed by Grades C and E, while smaller percentages of students fell into the extremes of either very high or very low usage. This distribution showed that while a significant portion of students used smartphones moderately, there were notable variances in usage patterns among different groups, suggesting that while smartphone usage was prevalent, extreme behaviours (both high and low) were less common among secondary school students in Mizoram. This indicated that the smartphone usage of secondary school students in Mizoram was balanced between personal and educational needs, and their screen time was average at the time this research was carried out.

Grades A and B, representing extremely high and high usage levels, encompassed a small portion of students (11.43% combined). These figures were comparable to those in similar studies, such as one conducted by Haug et al. (2015), which found that smartphone addiction occurred in 16.9% of students. This subgroup often demonstrated higher risks for issues such as sleep disturbances, anxiety, and academic challenges due to their heavy dependence on their devices.

The finding aligned with global research on smartphone addiction among students. Heo and Lee (2018) found that 24.7% of high school students were in the risk group for smartphone addiction, while 75.3% were normal users. Similarly, Cha and Seo (2018) reported that 30.9% of students were classified as at risk for smartphone addiction, with 69.1% identified as normal users. In contrast, Lee et al. (2021) conducted a study in Malaysia and found that over half of the students (57.6%) were at high risk of smartphone addiction. These discrepancies could stem from variations in geographic regions or differences in the timeframes of the studies.

The overall level of smartphone usage among secondary school students in Mizoram was predominantly average, suggesting that while smartphones were a significant part of their lives, the risks associated with excessive use were relatively contained. This balanced usage reflected a healthy integration of technology into daily life, with most students managing to avoid the pitfalls of extreme smartphone dependence. Understanding these patterns was crucial for educators and policymakers aiming to promote healthy smartphone usage habits.

5.2.3 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on gender

A comparison of the level of smartphone usage among secondary school students of Mizoram based on gender revealed that-

- The proportion of female students classified as 'Extremely High' was slightly higher than that of male students (2.82% vs. 2.03%).
- A higher percentage of female students also fell into the 'Above Average' category compared to male students (21.41% vs. 15.94%).
- Conversely, more male students were categorized as 'High' compared to female students (11.31% vs. 6.76%).
- The largest group for both genders fell under the 'Average' category, with nearly identical percentages (38.55% for males and 38.59% for females).
- In the lower performance categories ('Below Average', 'Low', 'Extremely Low'), males were slightly more represented than females, particularly in the 'Low' category (10.43% vs. 8.45%).
- The mean scores for male and female students were relatively close, with females scoring slightly higher on average (78.19 vs. 77.81).
- The calculated t-value of 0.403 with 698 degrees of freedom indicated a statistically non-significant difference in mean scores between male and female students at both the 0.01(2.58) and 0.05(1.96) significance levels.

Thus, it can be concluded that there is no significant difference between male and female secondary school students of Mizoram in the level of their smartphone usage. Suggesting that gender does not play a major role in influencing the extent of smartphone use among these students, highlighting the uniformity in technology adoption and utilization across genders in this context.

Discussion: The lack of statistical significance in the difference between the mean scores of male and female secondary school students of Mizoram in the level of their smartphone usage suggested that, overall, gender may not have been a strong determinant in this context. The non-significant difference in smartphone usage between genders implied that any potential concerns or benefits associated with smartphone usage might have affected both male and female students equally. A study conducted by Al-Barashdi et al. (2015) concluded that “while some studies had shown gender differences in smartphone addictive use, others had proved that gender and smartphone use were not significantly related.”

However, it was essential to note that other research findings presented a more complex picture of the relationship between gender and smartphone usage. For instance, Nayak (2018) reported that female students tended to use smartphones more than their male counterparts. This study suggested that there might have been gender-specific preferences or needs influencing smartphone usage, such as the types of applications used, social media engagement, or communication habits.

Contrastingly, other studies found the opposite trend. Research by Savio (2016), Negi (2019), and Rekha (2019) concluded that male students spent more time using smartphones compared to female students. These studies often attributed the higher usage among males to gaming, technical interest, or social interactions facilitated through digital platforms. The disparity in these findings indicated that gender differences in smartphone usage were not uniform and might have been influenced by various factors including cultural norms, regional differences, and the specific demographic characteristics of the study populations.

5.2.4 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on locality

A comparison of the level of smartphone usage among secondary school students of Mizoram based on locality revealed that-

- Urban students generally have higher percentages in the upper categories ("Above Average," "High," and "Extremely High") compared to their rural counterparts. Specifically, urban students have 20.68% in the "Above Average" category versus 16.35% for rural, and 10.2% in the "High" category versus 7.55% for rural.
- Conversely, urban students show a slightly lower percentage in the "Low" and "Extremely Low" categories (7.85% and 1.31% respectively) compared to rural students (11.32% and 2.2% respectively).

- The mean score for urban students (78.91) is higher than that for rural students (76.92). Additionally, The standard deviation, which measures variability in scores, is lower in urban students (12.102) compared to rural students (13.192).
- The calculated t-value of 2.079 with 698 degrees of freedom indicated a statistically significant difference in the means of rural and urban student scores at the 0.05 significance level but not at the 0.01 level.

The analysis suggested a modest difference in smartphone usage between urban and rural students, though the effect size was not large enough to be substantial. Therefore, it was reasonable to conclude that the level of smartphone usage was higher in students from urban as compared to students from rural areas.

Discussion: The findings highlighted the performance gap between rural and urban students in smartphone usage, with urban students generally exhibiting higher usage across most categories. The finding was in line with a study conducted by Bhanderi et. al. (2021) in Himachal Pradesh, which concluded that smartphone usage was associated with the area of residence. Specifically, urban students had greater access to and utilized smartphones more extensively than their rural counterparts. This disparity highlighted a broader digital divide between urban and rural students in India, emphasizing the challenges rural students faced in accessing and benefiting from essential digital resources in today's technology-driven educational environment.

The broader implications of these findings were significant. According to the Digital Divide: Inequality Report 2022 by OXFAM India, only 31 per cent of the rural population used the Internet compared to 67 per cent of the urban population. This stark contrast highlighted the uneven distribution of digital infrastructure and access across different regions of the country. A digital divide existed across both rural and urban areas, affecting access to digital education and economic opportunities. The digital divide was also found between under-resourced urban areas and affluent residential areas (Laskar, 2023). The lower smartphone and internet usage among rural students could be attributed to several factors, including inadequate digital infrastructure, lower socioeconomic status, and limited availability of affordable devices and internet services in rural areas.

However, it is important to note that the digital divide in India might not have been uniform across all states. For instance, a study conducted by Rekha (2019) found that students in Senior Secondary Schools in both rural and urban areas of Haryana had similar levels of mobile phone usage. This indicated that the extent of the digital divide could vary significantly based on regional factors, including state-level policies, local infrastructure development, and community initiatives aimed at bridging the digital gap. Some states might have implemented more effective measures to ensure equitable access to digital resources, thereby mitigating the disparities observed at the national level.

5.2.5 Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on management of school

A comparison of the level of smartphone usage among secondary school students of Mizoram based on management of school revealed that-

- The secondary school students in private schools displayed a broader spread in the middle categories, with the largest percentage (40.57%) scoring in the "Average" category. Notably, fewer students in private schools were in the lowest performance category ("Extremely Low") with only 0.86% compared to government schools.
- A higher percentage of students in government schools were found in both the lowest ("Extremely Low" at 2.57%) and highest ("Extremely High" at 2.57%) performance categories. There was also a higher percentage (12%) of students scoring in the "Low" category compared to their private school counterparts (6.86%).
- The mean score for students in private schools was 79.62, with a standard deviation of 12.048, indicating less variability in scores. Students in government schools had a lower mean score of 76.39 and a higher standard deviation of 13.020, suggesting greater variability in their academic performances.
- A t-test comparing the mean scores of students from private and government schools yielded a calculated t-value of 3.408. With 698 degrees of freedom, this difference is statistically significant at both the 0.01 and 0.05 levels.

Thus, it can be concluded that there is a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram, with private school students exhibiting significantly higher usage than their government school counterparts.

Discussion: The study underscored significant differences in smartphone usage between private and government school students in Mizoram, revealing a disparity that favoured private school students. The observed differences could be attributed to several factors. Students in private schools often came from more affluent backgrounds, facilitating greater access to smartphones and related technologies. In contrast, government schools, serving a more diverse and economically disadvantaged student population, faced challenges in providing consistent access to digital resources.

The finding aligned with broader research indicating disparities in technology access and usage based on socioeconomic status. For instance, a study by Tewathia et al. (2020) found that ICT ownership and usage varied significantly across socio-economic groups in India. Additionally, Sharma and Banerjee (2022) revealed a substantial gap in computer knowledge, computer and internet use, and English language skills across existing social and economic marginalities in India. This suggested that “India's prevailing socioeconomic divide was a significant source of its wide digital divide”, as highlighted by Laskar (2023).

The implications of this digital divide were far-reaching. In private schools, the higher rate of smartphone ownership and usage enhanced students' educational experiences, providing access to a wealth of online resources, educational apps, and communication tools that supported learning. On the other hand, government school students, who were less likely to own smartphones, missed out on these opportunities. The variability in smartphone usage among government school students highlighted the need for targeted interventions to bridge this digital divide.

5.2.6 Major findings and discussions regarding the objective: To develop a learning app on mathematics for secondary school students of Mizoram

This objective was successfully realized and a learning app on mathematics for secondary school students was developed by the researcher with the hope that this application presents an opportunity to enhance educational outcomes through technology.

– The app, named "LearningMaths," was developed specifically for Class X students in Mizoram, aligning with the Mizoram Board of School Education curriculum.
– Developed exclusively for the Android operating system, the app benefited from the platform's extensive reach and developer-friendly environment.
– Utilizing Android Studio as the primary development platform, the researcher opted for Java as the primary programming language, given its versatility and the researcher's familiarity.
– Emphasizing user-centric design, the app featured structured learning modules, interactive quizzes, formula references, and language support in Mizo.
– LearningMaths contained only eight learning modules, which covered the first eight chapters of the textbook. Each module adheres to a consistent structural design.
– Thorough development and testing phases ensured the app's compatibility across various devices, providing a seamless learning experience.
– The app included self-assessment tests with real-time feedback and comprehensive tracking of student progress.

Through continuous refinement and feedback-based iterations, LearningMaths aims to stay attuned to the evolving needs of students and educators, enhancing learning outcomes and educational experiences in Mizoram.

Discussion: The development of the LearningMaths app represented a significant stride towards integrating technology into educational practices, particularly in regions like Mizoram where such digital resources were not as prevalent. The decision to develop an educational app specifically designed for secondary school students in Mizoram studying in class X aligned with research revealing an increase in performance after pupils were exposed to contextualized and localized modules (Bendijo et al., 2022).

Focusing exclusively on Android for LearningMaths was both a strategic and practical decision. Recent data showed that Android held a 70.69% share of the global smartphone market, compared to iPhone's (iOS) 28.58% share (Sherif, 2024). Additionally, using Android Studio and Java for development took advantage of well-supported, open-source technologies. The extensive array of Java libraries, frameworks, and online forums facilitated easier troubleshooting, advice-seeking, and staying updated with the latest best practices in Android development (Anand, 2023).

Furthermore, the use of interactive elements and systematic learning modules within LearningMaths supported findings from Lukita et al. (2017), who argued that interactive learning could potentially improve the learning experience. The app's integration of quizzes, formula access, and self-assessment tests aligned with these insights, offering a more engaging and responsive learning environment than traditional methods.

5.2.7 Major findings and discussions regarding the finding of effectiveness of learning app on mathematics among secondary school students

The major findings of the current research revolved around the efficacy of the LearningMaths app in enhancing mathematics competency among secondary school students in Mizoram. A pre-test and post-test design was employed, with a specific mathematics achievement test administered to both control and experimental groups. The post-test scores were then analyzed to determine the app's effectiveness.

- The normality of the post-test scores was assessed for both groups. The Shapiro-Wilk test results indicated that the post-test scores of the control group did not deviate significantly from a normal distribution ($p=0.157$), suggesting that the distribution of scores was normal. In contrast, the experimental group's scores deviated from normality ($p=0.003$), indicating a non-normal distribution.

- The mean post-test score for the experimental group (12.84) was higher than that of the control group (11.42).
- The calculated t-value (2.001) exceeded the critical value at the 0.05 level (1.99) but was below the critical value at the 0.01 level (2.64). Indicating that the test results were not significant at the 0.01 level but showed significance at the 0.05 level.

Therefore, it can be concluded that integrating interactive and structured digital learning tools, such as the LearningMaths app, may have a positive effect on secondary school students compared to those who did not use the app.

Discussion: The findings of the study suggested that while the LearningMaths app may have contributed to improvements in mathematics competency among students, the effect was not significant enough to be considered highly reliable. This could have been due to various factors such as the duration of app usage, individual differences in learning preferences, or limitations in the app's content or design. The findings supported the hypothesis that digital educational tools, like the LearningMaths app, could significantly enhance learning outcomes in mathematics. This was consistent with previous research showing that learning through ICT was more effective for mathematics education at the secondary level compared to conventional teaching (Senthamaraikannan, 2019; Safdar et al., 2011).

Keong et al. (2005) also concluded that ICT could make the teaching process more effective and enhance students' understanding of basic concepts. Furthermore, Li and Ma (2010) demonstrated statistically significant positive effects of computer technology (CT) on mathematics achievement, indicating that students using CT often experienced improved motivation and engagement, which are crucial for academic success.

Studies by Bayaa and Daher (2009) also found that students were positively impressed by the potential and capabilities of mobile phones used in the mathematics learning process. Similarly, a study on teaching and learning mathematics through technology in Mizoram concluded that students were excited about the methodology and wanted more such training in the future. It was recommended that teachers should try to motivate students by using software or computer-based methods as much as possible (Lalduhawma, 2018). The potential of ICT in teaching mathematics was vast. It supported mathematics teachers in improving lesson design, and teaching strategies, and staying updated with both content and pedagogical knowledge. Moreover, it facilitated the development of other relevant skills, contributing to a more dynamic and effective teaching and learning environment (Joshi, 2017).

5.2.8 Major findings and discussions regarding Comparisons of the effectiveness of learning app on mathematics among secondary school students in terms of gender

A comparison of the effectiveness of learning app on mathematics among secondary school students in terms of gender revealed that-

- There was a slight disparity in mean scores between males and females. However, these differences lack statistical significance.
- The calculated t-value of 0.532, with a significance level not meeting the level of significance at 0.01 or 0.05, indicated that the null hypothesis "There is no significant difference in the effectiveness of the learning app on mathematics between male and female secondary school students" was retained.

Thus, it can be concluded that there was no significant difference in the post-test mathematics scores between male and female students. Both groups benefited similarly from the use of the learning app.

Discussion: The analysis suggested that both male and female students experienced similar improvements in their post-test mathematics scores as a result of using the learning app. Despite slight disparities in mean scores between males and females, these differences lacked statistical significance. This finding supported the notion that digital educational tools, such as the LearningMaths app, could be universally applied across different gender groups without the need for gender-specific adjustments.

The results aligned with previous research demonstrating that educational technologies could enhance student performance without significant gender disparities. For instance, a study by Palomares-Ruiz et al. (2020) indicated that higher motivation in the experimental group was evident in their learning and their better marks compared to the control group. The improvement for women (1.708) was slightly higher than that of men (1.584); however, this difference was not statistically significant, indicating that both genders benefited similarly from educational technology. Similarly, Kay (2020) found that student learning performance increased significantly after using mathematics apps for tasks requiring remembering, understanding, application, and analysis. The study showed that factors such as student gender, ability, attitudes, and age had no significant impact on learning performance.

5.3 Suggestions for the improvement of Mathematics learning in Mizoram

Improving mathematics education in regions like Mizoram necessitates a comprehensive strategy that takes into account the distinct socio-cultural, economic, and educational landscapes of the region. Here are some strategies, supported by research and examples from similar contexts, that could be adapted and implemented in Mizoram:

5.3.1 Curriculum Localization and Contextualization

Localization and contextualization entail a detailed analysis of the surrounding conditions and factors relevant to a subject matter. This process includes tailoring products or services to meet the specific preferences and cultural norms of a targeted audience. Studies indicated that performance tends to improve following the exposure of students to modules that are contextualized and localized (Bendijo et al., 2022; Fabrigas and Taban, 2023; Mam et.al., 2017). Context on students' lives made the class lively and engaging where the students construct their own meaning (Reyes et. al., 2019).

Suggestion

- To design mathematics problems and examples that relate to local industries, such as agriculture, forest-based economies, and local market transactions.

- To incorporate local cultural and historical references into mathematics problems and examples.

5.3.2 Professional Development for Teachers

According to Loucks-Horsley et al. (2009), effective professional development can lead to improved teaching practices. Professional development represents the sole strategy used by educational systems to enhance teacher performance. It also serves as the primary method through which educators can acquire new skills and knowledge, enabling them to improve their teaching effectiveness and increase student achievement (Baporikar, 2015).

Suggestion

- To set up regular workshops and training sessions in collaboration with educational institutions like Mizoram University.

- To use these sessions to introduce innovative teaching methods such as inquiry-based learning and collaborative learning.

5.3.3 Use of Technology in Education

The present study revealed that there was a positive impact of technology integration in mathematics learning among secondary school students of Mizoram. Similarly, Poçan et al. (2023) have found that mobile technology used in informal educational settings enhances learning outcomes. Research by Cheung and Slavin (2013) also supported the notion that effective integration of technology can improve mathematics learning. Furthermore, Young et al. (2018) recommend that the successful incorporation of technology in math classrooms should take into account factors such as the student's grade level, the duration of technology use, and its role in instruction.

Suggestion

- To develop and promote educational applications tailored to cater to the educational requirements of Mizo students.

- To employ platforms such as Khan Academy, Geogebra, and similar apps that offer interactive and personalized math learning opportunities.

- To ensure that schools in rural and isolated locations are equipped with the essential infrastructure to facilitate the use of these technologies.

5.3.4 Student-Centered Learning Approaches

Garner (2015) found that the student-centred learning methods led to an increase in student understanding as evidenced by various assessment measures. Also, it was made clear that students enjoyed these problem-based tasks and appreciated the collaboration made available through this method of learning. Student-centred teaching methods were more effective on math achievement and attitude and anxiety toward mathematics than the traditional methods (Emanet and Kezer 2021). Rehman et.al., (2023) concluded that project-based learning activities boosted the level of collaboration and problem-solving skills among students.

Suggestion

- To incorporate project-based learning, where students work on longer-term projects that integrate mathematics with other subjects and real-world problems.

- This could include projects on budgeting for family or community events, or designing simple structures.

5.3.5 Bilingual Education Approaches

Cummins (2000) advocated for the cognitive benefits of bilingual education. Saldate et.al., (1985) in their study concluded that students in the bilingual program outperformed their control counterparts in reading and mathematics achievement. The mother tongue should be employed in the teaching of mathematics at the primary school level to internalize mathematics language and make the pupils mathematics-friendly at their tender age (Oginni and Owolabi 2013). Siyang (2018) concluded that "the use of the mother tongue as a medium of instruction is more effective than the English language."

Suggestion

- To utilize bilingual education methods to teach mathematics in both the local language (Mizo) and English.

- To develop resources and teaching materials from the primary school level in Mizo that can help bridge the language gap in mathematics learning.

- To train teachers to deliver math lessons effectively in both languages.

5.4 Educational Implications of the Study

The findings of the research presented several educational implications as follows:

- **Digital Literacy Programs:** With a significant portion of students using their smartphones for social interaction and entertainment purposes while only a smaller percentage of students used their smartphones for educational purposes, there was a need for digital literacy programs to teach students how to effectively and responsibly use their devices for educational purposes. These programs could have focused on enhancing students' ability to search for information, access learning materials, and interact with educational content online.
- **Balanced Integration of Technology:** Given that the majority (77.43%) of students fell into the average range of smartphone usage, educational institutions could have leveraged this familiarity with technology to integrate digital tools and resources into the curriculum. This might have involved developing mobile-friendly educational resources, such as interactive e-books, educational games, and multimedia content that could be accessed via smartphones. This could have enhanced learning experiences while maintaining healthy usage habits.
- **Balanced Interventions for Both Genders:** Since the study revealed no significant difference in smartphone usage between male and female students, educational interventions aimed at responsible smartphone use should have targeted both genders equally. Programs focusing on digital literacy and policy development on smartphone use could have been designed to benefit all students.
- **Policy Implications for Bridging the Gap:** The significant difference in smartphone usage levels of students across different school localities and management highlighted the need for policies aimed at bridging the digital divide by ensuring that socio-economically backward and rural students had equal access to smartphones and other digital technologies. This could have involved subsidizing smartphone purchases for low-income families, investing in rural internet infrastructure, and integrating digital literacy into school curriculums. Such measures could have helped level the playing field and ensured that all students benefited from digital learning opportunities.

- **Use of Technology in Education**: The successful development and implementation of the "LearningMaths" app highlighted the potential of using technology to enhance educational outcomes. It demonstrated how digital tools could be integrated into the education system to provide innovative learning solutions. The positive impact of the LearningMaths app on secondary students' mathematics performance suggested that schools in Mizoram and potentially other similar contexts should have considered integrating interactive digital tools into their mathematics curricula. The non-normal distribution of scores in the experimental group suggested that the app's impact might have varied widely among students. This variability should have been considered when implementing such tools, ensuring that all students benefited from digital learning resources.
- **Gender Equity in Technology Integration**: The lack of significant differences in the effectiveness of the learning app on mathematics between male and female secondary school students suggested that such educational technology interventions could promote gender equity in learning outcomes. These results had practical implications for educators and policymakers. Given that the learning app was beneficial to all students, regardless of gender, schools could integrate this technology into their curriculum with confidence, knowing it did not perpetuate gender biases.

5.5 Suggestions for Further Research

The researcher suggested the following for further research:

1. Effect of Smartphone usage on the academic performance of students at different levels of study.

2. A longitudinal investigation into the evolution of smartphone usage patterns among secondary school students in Mizoram.

3. An investigation into the role of socio-economic factors in smartphone usage among students.

4. A comparative study of smartphone usage among secondary school students in Mizoram and Meghalaya. (or any other northeast state)

5. An analysis of the impact of the whole curriculum coverage in educational apps on student outcomes in Mathematics education.

6. Longitudinal study on the impact of Educational Technologies on academic performance across different subject areas.

5.6 Conclusion

The research titled "Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram" explored the complex interaction between smartphone usage and the efficacy of mobile learning applications in enhancing mathematical proficiency among secondary school students in Mizoram. This study was pivotal in understanding how modern technology, specifically smartphones, could be harnessed to improve educational outcomes in a region that faced unique socio-economic and geographical challenges.

The study's findings revealed that while smartphones were primarily used for social interaction and entertainment, there was significant potential to harness these devices for educational purposes. Most students in Mizoram used smartphones moderately, with most falling into the average categories of usage, suggesting they could balance digital activities without serious negative impacts. Despite slight gender differences in usage levels, with females showing slightly higher average usage, these differences were not statistically significant, indicating that gender did not play a major role in how students used their smartphones for educational purposes. This challenged some preconceived notions about gender-specific digital behaviour and pointed towards the possibility of uniform educational strategies that did not need to be gender-specific.

Furthermore, a performance gap was identified between urban and rural students' smartphone usage, with urban students more likely to have used smartphones at higher levels. This divide was mirrored in national trends and highlighted the broader issue of digital inequality that could affect access to educational resources. Similarly, students from private schools tended to use smartphones more frequently than those from government schools, suggesting disparities in digital access and educational opportunities based on the type of school management.

The introduction of the "LearningMaths" app represented a significant stride towards integrating technology into education in Mizoram. The app, tailored to the local curriculum and available in the Mizo language, provided structured learning modules and interactive quizzes and demonstrated positive outcomes in enhancing mathematics competency among students. The successful implementation and positive reception of the LearningMaths app suggested that similar digital tools could have been developed for other subjects and learning levels to further support student learning across Mizoram. The effectiveness of this app did not differ significantly between male and female students, which supported the use of digital tools across gender lines in educational settings.

This body of research not only informed about current usage patterns and educational practices but also guided future initiatives aimed at leveraging technology to enhance educational outcomes. By recognizing the unique socio-cultural and economic landscape of Mizoram, the study proposed a comprehensive approach to educational enhancement that aligned with both national educational policies and local needs.

Overall, the research underscores the potential of integrating technology into education in Mizoram and India. By addressing digital divides, promoting gender-neutral strategies, and developing localized educational tools, the findings can help guide efforts to enhance educational outcomes and create a more inclusive and effective learning environment in India.

SUMMARY

SUMMARY

Introduction

In India, secondary education plays a pivotal role in bridging the gap between primary and higher education. After the independence of India, several reforms and commissions aimed to enhance this phase. The National Education Policy (NEP) 2020 introduces changes to align with international standards, focusing on subject choice and reducing rote learning. Mathematics at the secondary level of education, stressed by the 1964-1966 Commission and the National Curriculum Framework (NCF) 2005, aims to make mathematics learning engaging by promoting practical skills and abstract reasoning, encouraging students to enjoy, discuss, and solve meaningful problems, thus improving overall engagement and understanding.

Mathematics education benefits from a variety of learning resources, including textbooks, digital tools, and interactive platforms. Digital resources, driven by ICT, enhance learning by providing structured lessons, interactive exercises, and adaptive technologies. These tools support individualized learning, promote active engagement, and facilitate better educational outcomes. The Indian government has recognized the importance of ICT in education through various initiatives, such as the ICT@School Scheme and the National Education Policy 2020, which aim to modernize and improve the quality of secondary education nationwide.

The increasing use of smartphones, a key ICT tool, is driving a surge in educational app development. These apps improve learning by providing flexible and accessible education, bridging gaps between students, teachers, and parents, and offering interactive features, making them valuable digital resources for studying mathematics. Despite the vast array of educational apps available, there remains a gap in resources aligned with specific regional curricula like Mizoram.

Rationale of the study

The massive growth in digital literacy and its impact on different areas of the world is a known fact. India has also become a major beneficiary and the increase in online education is testimony to this fact. The growing use of smartphones among secondary school students has recently drawn significant attention. It might not be completely incorrect to assume that the majority of secondary school students are familiar with using smartphones. In fact, the majority has become reliant on smartphones as a result of the COVID-19 pandemic which prevented opening schools for more than a year and necessitated emergency digital-based education throughout the world. Understanding the length of time students spend with their smartphones as well as the merits and demerits of smartphone usage, are key considerations for teachers, policymakers, administrators, and anyone else involved in the education sector.

The National Education Policy 2020 mentioned that “a rich variety of educational software will be developed and made available for students and teachers at all levels to improve teaching and learning” (Ministry of Human Resources Development, 2020). Moreover, researchers and policymakers must understand the effectiveness of this software in the educational process. In this context, conducting a research study to find out the effectiveness of technology integration in education will be helpful for the successful implementation of the National Education Policy 2020.

However, despite this overwhelming digital advancement, many areas in Mizoram, mostly in the remote and rural areas, are still unable to benefit from and experience all that digital advancement has to offer due to a lack of or poor internet connection, which prevents students from using the internet as effectively as they could in areas with a good internet connection. The COVID-19 pandemic made many classes and study materials only accessible through online classes, which made the problem worse. As a result, creating an offline application will be crucial for learning in both these challenging situations and in those where an internet connection is not an issue because offline applications are so accessible.

Mathematics education is of another great importance. All sciences are built on the foundation of mathematics, so anyone who wants to pursue technical education must first comprehend this subject thoroughly. The relevance of mathematics for students' futures is further increased by the fact that nations around the world are now competing with one another, making technological advancement of considerable consequence. It may be accurate to state that among secondary school students, mathematics is the subject they fear the most. Therefore, researchers must create a new approach to teaching and learning mathematics so that the students may quickly understand the subject and enjoy mathematics rather than fear it.

Since it is clear that smartphones are here to stay, preventing students from using them would be a useless feat. What is more important would be to channel this activity into a worthwhile one. Therefore, it becomes a major concern to not only understand the level of usage of smartphones by secondary school students but also devise some way to manipulate students' affinity with smartphones in a way that would benefit their ability to understand mathematics. With these thoughts in mind, the researcher has decided to take up a research work that would successfully combine the two elements i.e., smartphone usage and mathematics learning and come up with results that would be of practical use for students and even other researchers and policymakers.

Research Questions

1. What is the major purpose for smartphone usage among secondary school students of Mizoram?
2. What is the level of smartphone usage among secondary school students of Mizoram?
3. Is there any difference on the level of smartphone usage between male and female secondary school students of Mizoram?
4. Is there any difference on the level of smartphone usage between rural and urban secondary school students of Mizoram?
5. Is there any difference on the level of smartphone usage between private and government secondary school students of Mizoram?
6. Is it possible to develop a learning app on mathematics for secondary school students of Mizoram?
7. What is the effectiveness of learning app on mathematics among secondary school students?
8. Will there be a difference in the effectiveness of learning app on mathematics between male and female secondary school students?

Statement of the Problem

The problem of the proposed study is entitled 'Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram'.

Objectives of the Study

1 To find out the major purpose for smartphone usage among secondary school students of Mizoram.
2 To find out the level of smartphone usage among secondary school students of Mizoram.
3 To compare the level of smartphone usage among secondary school students of Mizoram based on gender.
4 To compare the level of smartphone usage among secondary school students of Mizoram based on locality.
5 To compare the level of smartphone usage among secondary school students of Mizoram based on management of school.
6 To develop a learning app on mathematics for secondary school students of Mizoram.
7 To find out the effectiveness of learning app on mathematics among secondary school students.
8 To compare the effectiveness of learning app on mathematics among secondary school students in terms of gender.
9 To suggest measures for the improvement of Mathematics learning in Mizoram.

Null Hypotheses of the Study

1. There is no significant difference in the level of smartphone usage between male and female secondary school students of Mizoram.
2. There is no significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram.
3. There is no significant difference in the level of smartphone usage between private and government secondary school students of Mizoram.

4. There is no significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app.
5. There is no significant difference in the effectiveness of learning app on mathematics between male and female secondary school students.

Review of Literature

A review of literature related to smartphone usage among students, mathematics learning at the secondary level of education and mathematics learning using ICT was done by the scholar to know more about the status of research done and also to understand the findings of other researchers on the topic. For a period of 16 years spanning from 2005 to 2021, a total of 66 related research works were traced. From a review of 66 studies, with 2 in Mizoram, 27 in the rest of India, and 37 outside India, the most researched area was smartphone usage among students (24 studies), followed by mathematics learning at the secondary level (23 studies), and mathematics learning using digital resources (19 studies).

Research Approach

The present study used descriptive research design to investigate the major purpose of smartphone usage and the level of smartphone usage among secondary school students in Mizoram as it requires survey and test findings. To find out the effectiveness of learning app on mathematics among secondary school students, the researcher used a quasi-experimental research design. The approach is of mixed type as both quantitative as well as qualitative methods are employed for data analysis.

Population and Sample

The population of the present study comprised all the secondary school students of both Govt. and Non-govt. schools in Mizoram.

There were two kinds of samples for the present study to realize different objectives:

i. Sample for administration of questionnaire: This sample was collected to assess the extent and primary purposes of smartphone usage among secondary school students in Mizoram. A sample of 700 secondary school students was randomly selected from the population. Sampling was done based on a multistage simple random sampling method. The study covered all 11 districts, with four districts chosen for sampling. Schools within the chosen districts were divided into government and private categories, with students randomly selected from each type across the districts.

ii. Sample for quasi-experiment: This sample was collected to assess the effectiveness of the mathematics learning app for secondary school students in Mizoram. For this purpose, all secondary schools with a Class X enrolment higher than 90 during the academic year 2022-2023 in Mizoram were identified. Among these schools, one school was randomly selected to ensure an unbiased representation. From the chosen school, 90 students were randomly selected as the sample and later divided into control and experimental groups.

Tools for Data Collection

1. Smartphone Usage Scale (SUS), developed and standardized by the researcher to find out the level and major purpose of smartphone usage among secondary school students.
2. Mathematics Achievement test for class X students developed by the researcher to measure the effectiveness of the mathematics learning app.
3. Android learning app called Learning Maths for studying Mathematics on a smartphone based on the MBSE class X syllabus developed by the researcher to find out the effectiveness of the mathematics learning app.

Collection of Primary Data

1. To find out the major purpose and level of smartphone usage, the selected sample schools were visited by the researcher, after discussing the purpose of the study with the school authority or headmaster, written permission was obtained. Following Subsequently, a research schedule was established. On the fixed date, the researcher personally collected the data by distributing questionnaires to the selected students.
2. To find out the effectiveness of the learning app on mathematics among secondary school students, the researcher personally visited a selected sample school. After explaining and discussing the objectives and methodology of the study to the school headmaster, written approval was acquired and a schedule for the experimental study was set.

A pre-test on mathematics competency was conducted on a randomly selected sample of Class X students using the Mathematics Achievement test developed by the researcher for the pre-test. After their scores had been recorded, they were divided into two equivalent groups i.e., control and experimental groups.

After 91 working days from the introduction of the intervention (Learning app) to the experimental group and completion of all the learning modules, a post-test was conducted on the two groups using a mathematics achievement test for post-test developed by the researcher. The data obtained on the post-test was used for further analysis and interpretation to see the effectiveness of the learning app on students.

Data Analysis

In the data analysis phase, the researcher employed both quantitative and qualitative methods to analyse the collected data comprehensively.

Quantitative analysis involves the use of descriptive and inferential statistics to examine numerical data quantitatively such as percentages, means, normality tests, t-tests and correlation. Microsoft Excel and Statistical Package for the Social Sciences (SPSS) were the primary tools utilized for conducting statistical tests and analyses.

Qualitative data were analysed thematically to identify recurring themes, patterns, and insights that emerged from participants' responses.

Major Findings and discussions of the study

1. Major findings and discussions regarding the finding of major purpose for smartphone usage among secondary school students of Mizoram

This study revealed that-

– 90.14% of secondary school students in Mizoram used smartphones for social media platforms such as Facebook, WhatsApp, Instagram, and TikTok.
– 89.43% of secondary school students in Mizoram used smartphones for entertainment purposes like listening to music and watching videos/movies.
– 73.14% of secondary school students in Mizoram used smartphones for traditional communication methods, such as making phone calls and chatting.

- 72.43% of secondary school students in Mizoram used smartphones to search for information on Google.
- 54.86% of secondary school students in Mizoram used smartphones for playing games, both online and offline.
- 49.71% of secondary school students in Mizoram used smartphones for photography and video recording.
- 40.71% of secondary school students in Mizoram used smartphones for reading news and entertainment.
- 39% of secondary school students in Mizoram used smartphones to access learning materials.
- 19.29% of secondary school students in Mizoram used smartphones for interaction with teachers.
- 1.14% of secondary school students in Mizoram used smartphones for other purposes like editing, business-related activities, and using dictionaries.

The majority (75%) of the secondary school students in Mizoram used their smartphones for social interaction and entertainment purposes while only a smaller percentage (25%) of students use their smartphones for educational purposes.

Discussion: Findings on smartphone usage among secondary school students in Mizoram reveal a dominant trend towards social interaction and entertainment over educational use. This aligns with broader research indicating adolescents prefer social media, entertainment, and gaming over academic activities (Harfield et al., 2014; Cha and Seo, 2018; Fook et al., 2021). A high percentage of students use smartphones for social media (90.14%) and entertainment (89.43%), reflecting global trends where platforms like Facebook, WhatsApp, and TikTok are prevalent (Mahalakshmi, 2013; Jesse, 2015; Savio, 2016; Soegoto, 2019). Additionally, 54.86% use smartphones for gaming, consistent with findings that gaming is a major recreational activity among youth (Liu et al., 2016). However, lower percentages of students use smartphones for educational purposes (39% for accessing learning materials and 19.29% for interacting with teachers), indicating a potential gap in integrating technology into education. This underscores the importance of understanding barriers to educational technology adoption and designing interventions to promote its effective use in academic settings (Ertmer, 1999). Identifying ways to optimize educational technology use among students is crucial.

2. Major findings and discussions regarding the finding of the level of smartphone usage among secondary school students of Mizoram

This study revealed that-

- Grade A, representing the "Extremely High" smartphone usage level, has a small proportion (2.43%) of students. These students have raw scores significantly above the mean, indicating heavy dependence or usage.
- Grade B, representing the "High" smartphone usage level, has a moderate group (9%) of students, with raw scores well above average, suggesting frequent use.
- Grade C, representing the "Above Average" smartphone usage level, has a significant portion (18.72%) of students with raw scores more than the average student, but not excessively.
- Grade D, representing the "Average" smartphone usage level, has the largest group (38.57%) of students, indicating a balanced or typical use among these students.
- Grade E, representing "Below Average" smartphone usage level, has a considerable number (20.14%) of students who used their smartphones less than average, which might indicate moderate or restricted use.
- Grade F, representing the "Low" smartphone usage level, has a smaller group (9.43%) of students, suggesting limited interaction with their devices.
- Grade G, representing the "Extremely Low" smartphone usage level, has a very small fraction (1.71%) of students, which could indicate minimal dependency or access to smartphones.
- Overall, the majority (77.43%) of students fall into Grades C, D, and E, representing "Above Average," "Average," and "Below Average" usage levels.

Thus, it can be concluded that the overall smartphone usage among secondary school students in Mizoram is average, indicating typical smartphone use with lesser risks for negative consequences.

Discussion: The study concluded that the majority (77.43%) of secondary school students in Mizoram had an average level of smartphone usage, with the largest group in Grade D, followed by Grades C and E. A smaller percentage of students exhibited very high or very low usage. This indicates that while smartphone usage was common, extreme behaviours were less prevalent. Grades A and B, representing high and very high usage, included only 11.43% of students, aligning with similar studies such as Haug et al. (2015), which found 16.9% of students experienced smartphone addiction. Comparisons with global research showed varying levels of smartphone addiction risks: Heo and Lee (2018) found 24.7% of high school students at risk, Cha and Seo (2018) reported 30.9%, and Lee et al. (2021) in Malaysia found 57.6% at high risk. These differences might result from variations in geographic regions or differences in the timeframes of the studies. The balanced smartphone usage among Mizoram students suggested a healthy integration of technology into their lives, avoiding the pitfalls of excessive use. Understanding these patterns is crucial for educators and policymakers to promote healthy smartphone usage habits.

3. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on gender

A comparison of the level of smartphone usage among secondary school students of Mizoram based on gender revealed that-

- The mean scores for male and female students were relatively close, with females scoring slightly higher on average (78.19 vs. 77.81).
- The calculated t-value of 0.403 with 698 degrees of freedom indicated a statistically non-significant difference in mean scores between male and female students at both the 0.01(2.58) and 0.05(1.96) significance levels.

Thus, it can be concluded that there is no significant difference between male and female secondary school students of Mizoram in the level of their smartphone usage. Suggesting that gender does not play a major role in influencing the extent of smartphone use among the students.

Discussion: The absence of statistically significant differences in the mean scores of smartphone usage between male and female secondary school students in Mizoram indicates that gender may not play a major role in influencing smartphone usage patterns in this context. This implies that potential concerns or benefits of smartphone usage might affect both genders equally. Al-Barashdi et al. (2015) found mixed results in studies on gender differences in smartphone use, with some indicating a significant relationship and others not. Nayak (2018) reported that female students used smartphones more than males, suggesting gender-specific preferences or needs such as app types, social media engagement, or communication habits. Conversely, studies by Savio (2016), Negi (2019), and Rekha (2019) found that male students used smartphones more, often due to gaming, technical interest, or social interactions on digital platforms. These contrasting findings indicate that gender differences in smartphone usage are not uniform and may be influenced by factors like cultural norms, regional differences, and specific demographic characteristics.

4. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on locality

A comparison of the level of smartphone usage among secondary school students of Mizoram based on locality revealed that-

- The mean score for urban students (78.91) is higher than that for rural students (76.92). Additionally, the standard deviation, which measures variability in scores, is lower in urban students (12.102) compared to rural students (13.192).
- The calculated t-value of 2.079 with 698 degrees of freedom indicated a statistically significant difference in the means of rural and urban student scores at the 0.05 significance level but not at the 0.01 level.

The analysis indicated a slight difference in smartphone usage between urban and rural students, though the effect size was not large enough to be substantial. Therefore, it was reasonable to conclude that the level of smartphone usage was higher in students from urban as compared to students from rural areas.

Discussion: The performance gap between rural and urban students in smartphone usage reveals that urban students generally exhibit higher usage across most categories. This aligns with Bhanderi et al. (2021) in Himachal Pradesh, who found that urban students had greater access to and utilized smartphones more extensively than their rural counterparts, highlighting a broader digital divide in India. The OXFAM India Digital Divide: Inequality Report 2022 indicates that “only

31% of the rural population used the Internet compared to 67% of the urban population”, emphasizing the uneven distribution of digital infrastructure. This divide affects access to digital education and economic opportunities, with disparities also seen between under-resourced and affluent urban areas (Laskar, 2023). Lower smartphone and internet usage among rural students is attributed to inadequate digital infrastructure, lower socioeconomic status, and limited availability of affordable devices and internet services. However, the digital divide is not uniform across all states. Rekha (2019) found similar mobile phone usage levels among students in rural and urban Haryana, suggesting regional variations in the digital divide influenced by state-level policies, local infrastructure, and community initiatives. Some states may have implemented effective measures to ensure equitable digital access, reducing disparities observed at the national level.

5. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on management of school

A comparison of the level of smartphone usage among secondary school students of Mizoram based on management of school revealed that-

– The mean score for students in private schools was 79.62, with a standard deviation of 12.048, indicating less variability in scores. Students in government schools had a lower mean score of 76.39 and a higher standard deviation of 13.020, suggesting greater variability in their academic performances.
– A t-test comparing the mean scores of students from private and government schools yielded a calculated t-value of 3.408. With 698 degrees of freedom, this difference is statistically significant at both the 0.01 and 0.05 levels.

Thus, it can be concluded that there is a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram, with private school students exhibiting significantly higher usage than their government school counterparts.

Discussion: The study highlighted significant disparities in smartphone usage between private and government school students in Mizoram, favouring private school students. This disparity is largely due to socioeconomic differences, with private school students often coming from more affluent backgrounds that facilitate greater access to digital technologies. Government schools, serving economically disadvantaged students, struggle to provide consistent access to these resources. This aligns with broader research, such as Tewathia et al. (2020), which found significant variations in ICT ownership and usage across socioeconomic groups in India. Sharma and Banerjee (2022) also noted substantial computer and internet usage gaps and English language skills linked to social and economic marginalities. These findings indicate that India's socioeconomic divide is a major contributor to its digital divide, as Laskar (2023) pointed out. The implications are significant: private school students benefit from enhanced educational experiences due to higher smartphone ownership and usage, accessing a wealth of online resources and educational tools. Conversely, government school students miss out on these opportunities, underlining the need for targeted interventions to bridge this digital divide.

6. Major findings and discussions regarding the objective: To develop a learning app on mathematics for secondary school students of Mizoram

This objective was successfully realized and a learning app on mathematics for secondary school students was developed by the researcher with the hope that this application presents an opportunity to enhance educational outcomes through technology.

- The app, named "LearningMaths," was developed specifically for Class X students in Mizoram, aligning with the Mizoram Board of School Education curriculum.
- Developed exclusively for the Android operating system, the app benefited from the platform's extensive reach and developer-friendly environment.
- Utilizing Android Studio as the primary development platform, the researcher opted for Java as the primary programming language, given its versatility and the researcher's familiarity.
- Emphasizing user-centric design, the app featured structured learning modules, interactive quizzes, formula references, and language support in Mizo.

– LearningMaths contained only eight learning modules, which covered the first eight chapters of the textbook. Each module adheres to a consistent structural design.
– Thorough development and testing phases ensured the app's compatibility across various devices, providing a seamless learning experience.
– The app included self-assessment tests with real-time feedback and comprehensive tracking of student progress.

Through continuous refinement and feedback-based iterations, LearningMaths aims to stay attuned to the evolving needs of students and educators, enhancing learning outcomes and educational experiences in Mizoram.

Discussion: The development of the LearningMaths app marked a significant advancement in incorporating technology into educational practices in regions like Mizoram, where such digital resources were less common. Targeted at secondary school students in class X, the app was designed based on research indicating improved performance when students engaged with contextualized and localized modules (Bendijo et al., 2022). The focus on Android was a strategic choice, as Android held a dominant 70.69% share of the global smartphone market compared to iPhone's (iOS) 28.58% (Sherif, 2024). Utilizing Android Studio and Java leveraged well-supported, open-source technologies, facilitating easier troubleshooting and access to a vast array of libraries, frameworks, and online resources (Anand, 2023). The app's interactive elements and structured learning modules supported findings by Lukita et al. (2017), suggesting that interactive learning enhances the educational experience. Features like quizzes, formula access, and self-assessment tests made the learning environment more engaging and responsive compared to traditional methods, aligning to improve mathematics competency among students in Mizoram.

7. Major findings and discussions regarding the finding of effectiveness of learning app on mathematics among secondary school students

The major findings of the current research revolved around the efficacy of the LearningMaths app in enhancing mathematics competency among secondary school students in Mizoram. A pre-test and post-test design was employed, with a specific mathematics achievement test administered to both control and experimental groups. The post-test scores were then analysed to determine the app's effectiveness.

- The normality of the post-test scores was assessed for both groups using the Shapiro-Wilk test. Results indicated that the control group did not deviate significantly from a normal distribution (p=0.157), suggesting that the distribution of scores was normal. In contrast, the experimental group's scores deviated from normality (p=0.003), indicating a non-normal distribution.
- The mean post-test score for the experimental group was 12.84, higher than the mean post-test score of 11.42 for the control group.
- The calculated t-value (2.001) exceeded the critical value at the 0.05 level (1.99) but was below the critical value at the 0.01 level (2.64). Indicating that the test results were not significant at the 0.01 level but showed significance at the 0.05 level.

Thus, it can be concluded that incorporating interactive and structured digital learning tools, like the LearningMaths app might have a positive impact on secondary school students when compared to students who did not use the app.

Discussion: The findings suggested that while the LearningMaths app may have improved students' mathematics competency, the effect was not highly significant. Various factors such as the duration of app usage, individual learning preferences, or limitations in the app's content or design might have influenced the results. Despite this, the findings aligned with previous research indicating that digital educational tools could enhance mathematics learning outcomes. Studies by Senthamaraikannan (2019) and Safdar et al. (2011) showed ICT's effectiveness in secondary-level mathematics education compared to conventional methods. Keong et al. (2005) found ICT made teaching more effective, while Li and Ma (2010) demonstrated significant positive effects of computer technology on mathematics achievement, with improved student motivation and engagement. Bayaa and Daher (2009) noted students' positive reception of mobile phones in learning, and Lalduhawma (2018) found enthusiasm for technology-based math education in Mizoram. Joshi (2017) highlighted ICT's potential to enhance lesson design, teaching strategies, and teachers' content and pedagogical knowledge, creating a more dynamic and effective learning environment. The overall consensus is that ICT can significantly contribute to better teaching and learning experiences in mathematics.

8. Major findings and discussions regarding Comparisons of the effectiveness of learning app on mathematics among secondary school students in terms of gender

A comparison of the effectiveness of learning app on mathematics among secondary school students in Mizoram in terms of gender revealed that-

- There was a slight disparity in mean scores between males and females. However, these differences lack statistical significance.
- The calculated t-value of 0.532, with a significance level not meeting the level of significance at 0.01 or 0.05, indicated that the null hypothesis "There is no significant difference in the effectiveness of the learning app on mathematics between male and female secondary school students" was retained.

Thus, it can be concluded that there was no significant difference in the post-test mathematics scores between male and female students. Both groups benefited similarly from the use of the learning app.

Discussion: The analysis revealed that both male and female students showed comparable improvements in post-test mathematics scores after using the LearningMaths app. Despite minor differences in mean scores, these were not statistically significant, indicating that the app is equally effective for both genders without needing gender-specific adjustments. This aligns with previous research, such as Palomares-Ruiz et al. (2020), which found higher motivation and better marks in an experimental group using educational technology, with a slightly higher, yet not significant, improvement for women (1.708) compared to men (1.584). Similarly, Kay (2020) demonstrated significant increases in student learning performance using mathematics apps for various cognitive tasks, with no significant impact from factors like gender, ability, attitudes, or age. These findings collectively support the efficacy of digital educational tools in enhancing student performance across diverse gender groups.

Suggestions for the improvement of Mathematics learning in Mizoram

Improving mathematics education in regions like Mizoram necessitates a comprehensive strategy that takes into account the distinct socio-cultural, economic, and educational landscapes of the region. Here are some strategies, supported by research and examples from similar contexts, that could be adapted and implemented in Mizoram:

1. Curriculum Localization and Contextualization*:* Localization and contextualization entail a detailed analysis of the surrounding conditions and factors relevant to a subject matter. This process includes tailoring products or services to meet the specific preferences and cultural norms of a targeted audience. Studies indicated that performance tends to improve following the exposure of students to modules that are contextualized and localized (Bendijo et al., 2022; Fabrigas and Taban, 2023; Mam et.al., 2017). Reyes et. al., (2019) concluded that context in students' lives made the class lively and engaging where the students construct their own meaning.

Suggestion:

- To design mathematics problems and examples that relate to local industries, such as agriculture, forest-based economies, and local market transactions.

- To incorporate local cultural and historical references into mathematics problems and examples.

2. Professional Development for Teachers*:* According to Loucks-Horsley et al. (2009), effective professional development can lead to improved teaching practices. Professional development represents the sole strategy used by educational systems to enhance teacher performance. It also serves as the primary method through which educators can acquire new skills and knowledge, enabling them to improve their teaching effectiveness and increase student achievement (Baporikar, 2015).

Suggestion:

- To set up regular workshops and training sessions in collaboration with educational institutions like Mizoram University.

- To use these sessions to introduce innovative teaching methods such as inquiry-based learning and collaborative learning.

3. Use of Technology in Education*:* The present study revealed that there was a positive impact of technology integration in mathematics learning among secondary school students of Mizoram. Similarly, Poçan et al. (2023) have found that mobile technology used in informal educational settings enhances learning outcomes. Research by Cheung and Slavin (2013) also supported the notion that effective integration of technology can improve mathematics learning. Furthermore, Young et al. (2018) recommend that the successful incorporation of technology in math classrooms should take into account factors such as the student's grade level, the duration of technology use, and its role in instruction.

Suggestion:

- To develop and promote educational applications tailored to cater to the educational requirements of Mizo students.
- To employ platforms such as Khan Academy, Geogebra, and similar apps that offer interactive and personalized math learning opportunities.
- To ensure that schools in rural and isolated locations are equipped with the essential infrastructure to facilitate the use of these technologies.

4. Student-Centered Learning Approaches*:* Garner (2015) found that the student-centred learning methods led to an increase in student understanding as evidenced by various assessment measures. Also, it was made clear that students enjoyed these problem-based tasks and appreciated the collaboration made available through this method of learning. Student-centred teaching methods were more effective on math achievement and attitude and anxiety toward mathematics than the traditional methods (Emanet and Kezer 2021). Rehman et.al., (2023) concluded that project-based learning activities boosted the level of collaboration and problem-solving skills among students.

Suggestion:

- To incorporate project-based learning, where students work on longer-term projects that integrate mathematics with other subjects and real-world problems.
- This could include projects on budgeting for family or community events, or designing simple structures.

***5. Bilingual Education Approaches**:* Cummins (2000) advocated for the cognitive benefits of bilingual education. Saldate et.al., (1985) in their study concluded that students in the bilingual program outperformed their control counterparts in reading and mathematics achievement. The mother tongue should be employed in the teaching of mathematics at the primary school level to internalize mathematics language and make the pupils mathematics-friendly at their tender age (Oginni and Owolabi 2013). Siyang (2018) concluded that the use of the mother tongue as a medium of instruction is more effective than the English language.

Suggestion:

- To utilize bilingual education methods to teach mathematics in both the local language (Mizo) and English.

- To develop resources and teaching materials from the primary school level in Mizo that can help bridge the language gap in mathematics learning.

- To train teachers to deliver math lessons effectively in both languages.

Educational Implications of the Study

The findings of the research presented several educational implications as follows:

– ***Digital Literacy Programs:*** With a significant portion of students using their smartphones for social interaction and entertainment purposes while only a smaller percentage of students used their smartphones for educational purposes, there was a need for digital literacy programs to teach students how to effectively and responsibly use their devices for educational purposes.

– ***Balanced Integration of Technology:*** Given that the majority (77.43%) of students fell into the average range of smartphone usage, educational institutions could have leveraged this familiarity with technology to integrate digital tools and resources into the curriculum. This could have enhanced learning experiences while maintaining healthy usage habits.

– ***Balanced Interventions for Both Genders*****:** Since the study revealed no significant difference in smartphone usage between male and female students, educational interventions aimed at responsible smartphone use should have targeted both genders equally. Programs focusing on digital literacy and policy development on smartphone use could have been designed to benefit all students.

- ***Policy Implications for Bridging the Gap:*** The significant difference in smartphone usage levels of students across different school localities and management highlighted the need for policies aimed at bridging the digital divide by ensuring that socio-economically backward and rural students had equal access to smartphones and other digital technologies. Such measures could have helped level the playing field and ensured that all students benefited from digital learning opportunities.
- ***Use of Technology in Education****:* The successful development and implementation of the "LearningMaths" app highlighted the potential of using technology to enhance educational outcomes. It demonstrated how digital tools could be integrated into the education system to provide innovative learning solutions. The positive impact of the LearningMaths app on secondary students' mathematics performance suggested that schools in Mizoram and potentially other similar contexts should have considered integrating interactive digital tools into their mathematics curricula. The non-normal distribution of scores in the experimental group suggested that the app's impact might have varied widely among students. This variability should have been considered when implementing such tools, ensuring all students benefited from digital learning resources.
- ***Gender Equity in Technology Integration***: The lack of significant differences in the effectiveness of the learning app on mathematics between male and female secondary school students suggested that such educational technology interventions could promote gender equity in learning outcomes. These results had practical implications for educators and policymakers. Given that the learning app was beneficial to all students, regardless of gender, schools could integrate this technology into their curriculum with confidence, knowing it did not perpetuate gender biases.

Suggestions for Further Research

The researcher suggested the following for further research:

1. Effect of Smartphone usage on the academic performance of students at different levels of study.
2. A longitudinal study to trace changes in smartphone usage among secondary school students in Mizoram.
3. An investigation into the role of socio-economic factors in smartphone usage among students.
4. A comparative study of smartphone usage among secondary school students in Mizoram and Meghalaya. (or any other northeast state)
5. An analysis of the impact of the whole curriculum coverage in educational apps on student outcomes in Mathematics education.
6. Longitudinal study on the impact of Educational Technologies on academic performance across different subject areas.

Conclusion

The research titled "Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram" explored the complex interaction between smartphone usage and the efficacy of mobile learning applications in enhancing mathematical proficiency among secondary school students in Mizoram. Findings indicated that while smartphones were mainly used for social interaction and entertainment, they held significant potential for educational use. Most students balanced their smartphone usage without adverse effects, with no significant gender differences in usage patterns.

However, a digital divide was evident between urban and rural students, and between private and government school students, with urban and private school students using smartphones more frequently. These highlighted broader issues of digital inequality affecting educational access.

The "LearningMaths" app, designed to align with the local curriculum and available in the Mizo language, showed positive outcomes in enhancing mathematics competency among students. Its success indicated that similar digital tools could be developed for other subjects and levels. The app's effectiveness was consistent across genders, supporting the use of gender-neutral digital tools in education.

The research underscored the importance of integrating technology into education to address regional socio-economic challenges. It emphasized the need for localized educational tools, promoting gender-neutral strategies, and addressing digital divides to enhance educational outcomes in Mizoram and India. By aligning with national educational policies and addressing local needs, the study offered a comprehensive approach to improving education through technology.

APPENDICES

APPENDICES

1. Appendix-I: Smartphone Usage Scale

SMARTPHONE USAGE SCALE

Please fill up the following information: **Date: ___/___/______**

Name: ___________________________ **School: __________________________**

Gender: Male/Female **Locality (Khua/Veng): _____________**

I mainly use my smartphone (You can tick more than one)

- ☐ **for social media (Facebook, WhatsApp, Instagram, TikTok).**
- ☐ **for playing games (Online and offline).**
- ☐ **for listening to music and watching videos/movies.**
- ☐ **for searching information on Google.**
- ☐ **for photography and video recording.**
- ☐ **for reading news and entertainment.**
- ☐ **for interaction with teacher.**
- ☐ **to access learning materials.**
- ☐ **for making phone calls and chatting.**
- ☐ **Other: ___________________**

Instructions:

Below is a list of statements aimed to measure the extent of your smartphone usage. Please put a tick mark (✓) on any one of the five boxes given on the right side of each statement. Please respond to every item. There is no time limit but you have to respond as quickly as possible. Your frank and sincere answers will be very much appreciated. Your responses will be kept confidential.

Sl. No.	Statements	Responses				
		Always (Ziah)	Frequently (Zing/thin)	Sometimes (A changin)	Rarely **(**Khat**)**	Never (Ngailo)
Extent of Smartphone usage for Studies						
1	I use my smartphone to record important assignments. (Assignment pawimawh chhinchhiah nan Smartphone ka hmang.)					
2	*I like to learn from my textbook than from my smartphone. (Smartphone hmanga zirlai zir ai chuan ka lehkhabu ami zir ka duh zawk.)					
3	*I find it hard to get answers for my studies through smartphone. (Ka zirlaia zawhna chhana smartphone hmanga zawn hmuh hi a harsa ka ti.)					
4	*Teacher explanation is effective than learning through smartphone. (Zirtirtu hrilhfiahna hi smartphone hmanga zir ai chuan a sawt zawk.)					
5	*I find it hard to understand concept and ideas through my smartphone. (Smartphone atang chuan thil nihdan tlangpui hriat fiah thiam a har ka ti.)					
6	I like to search for queries about my studies from my smartphone rather than ask my teachers. (Ka zirlaia ka hriatthiamloh zirtirtu te zawh ai					

Sl. No.	Statements	Responses				
		Always (Ziah)	Frequently (Zing/thin)	Sometimes (A changin)	Rarely (Khat)	Never (Ngailo)
	chuan smartphone hmanga a chhanna zawn ka duh zawk.)					
7	* Learning in a classroom is more enjoyable than learning through smartphone. (Smartphone hmanga lehkha zir ai chuan classroom a zir hi a nuam in a hlimawm zawk.)					
	Extent of Smartphone use in Personal life					
8	I miss planned work due to smartphone use. (Smartphone hman vangin ka tihtur ruahmansa ka thulh phah.)					
9	I use my smartphone to relieve stress. (Rilru hrehawm tihnep nan smartphone ka hmang.)					
10	*I leave my smartphone at home while I'm going out. (Ka chhuah dawnin inah ka smartphone ka dah.)					
11	*I use my smartphone only in my spare time. (Ka hunawl ah chiah smartphone ka hmang.)					
12	I bring my smartphone to the toilet. (Toilet ah smartphone ka keng lut.)					
13	I check Social Networking Service sites like WhatsApp or Facebook right after waking up. (Zinga ka thawh veleh heng Social Networking sites Whatsapp leh					

Sl. No.	Statements	Responses				
		Always (Ziah)	Frequently (Zing/thin)	Sometimes (A changin)	Rarely **(**Khat**)**	Never (Ngailo)
	Facebook te hi ka en/khawih.)					
14	I sleep less because of smartphone usage. (Smartphone hman avangin ka mut tlem phah.)					
15	I check my smartphone even when there is no notification. (Notification a awmloh lai pawhin ka smartphone ka endik.)					
16	I use my smartphone longer than intended. (Ka tum aia rei smartphone ka hmang.)					
Smartphone use in relationship with others						
17	People tell me that I use my smartphone too much. (Miin smartphone ka hman nasat thu min hrilh.)					
18	I get irritated when bothered while using my smartphone. (Smartphone hman laia min tihbuai hian ka thinur.)					
19	I start a conversation with unknown person using my smartphone. (Smartphone hmangin hmelhriatloh pawh ka be hmasa.)					
20	*I like to play games outside with my friends than playing games on my smartphone. (Smartphone a games khelh ai chuan pawna thiante					

Sl. No.	Statements	Responses				
		Always (Ziah)	Frequently (Zing/thin)	Sometimes (A changin)	Rarely **(**Khat**)**	Never (Ngailo)
	nena infiam ka duh zawk.)					
21	*I like to hang out with my friends than chatting through my smartphone. (Smartphone kal tlanga mi biak ai chuan ka thiante nena inkawm ka duh zawk.)					
22	*I refrain myself from using smartphone while I'm with my friends or family. (Ka thiante leh chhungte bula ka awm chuan smartphone hman ka insum.)					
23	I consider my smartphone buddies as my real friends. (Smartphone kaltlanga ka thiante hi ka thian tak takah ka ngai)					
24	I feel that my relationships with my smartphone buddies are more intimate than my relationships with my real-life friends. (Ka thian te tak tak nena kan in laichinna aiin smartphone kaltlanga ka thian te nena kan inlaichinna hi a inhnaih zawka hriatna ka nei.)					
25	Not being able to use my smartphone would be as painful as losing a friend. (Smartphone hman theihloh chu thiante hloh tlukin a hrehawm.)					

Sl. No.	Statements	Responses				
		Always (Ziah)	Frequently (Zing/thin)	Sometimes (A changin)	Rarely (Khat)	Never (Ngailo)
26	Smartphone enables me to interact with friends without wasting time to pay visits with each other. (Hun khawhral loa thiante nen chanchin kan in hriat tawn theih nan smartphone ka hmang.)					
27	*During conversation, I give priority to the people around me than checking my smartphone notification. (Midang nen kan inbiak lain ka phone notification en ai chuan mi ka biak lai ka ngai pawimawh zawk.)					
28	*I have more real-life friends than smartphone buddies. (Smartphone kaltlanga thian aiin thian tak tak ka ngah zawk.)					
29	Because of the smartphone, I have friends whom I have not met who are willing to help me in times of need. (Smartphone avangin thian tha ka la hmuh ngailoh, tanpui ka ngaihna a min pui duh tu ka nei)					

2. Appendix-II: Mathematics Achievement Test

MATHEMATICS ACHIEVEMENT TEST(PRE-TEST)

CLASS X

Full Mark – 25

Time – 45 minutes

General Instructions:

i) All questions are compulsory.

ii) Figures in the margin indicates marks.

iii) Use of calculator is not allowed.

1. Choose the correct answer: $9 \times 1 = 9$

a) The extra amount charged by the seller for deferred payment is called–

i) Cash Price ii) Interest

iii) Sum borrowed iv) Instalments

b) A speed of 9 km/hr equals –

i) 1.5 m/s ii) 2 m/s

iii) 2.5 m/s iv) 3 m/s

c) The multiplicative inverse of $\frac{x+1}{x-2}$ is -

i) $\frac{x-2}{x+1}$ ii) $\frac{x+1}{x-2}$

iii) $\frac{x-1}{x+2}$ iv) $\frac{x+2}{x-1}$

d) Which of the following is a quadratic equation –

i) x + 2 = 0 ii) $\frac{1}{x} + 2 = 0$

iii) 2x + 2 = 0 iv) $x^2 + 2 = 0$

e) The 11^{th} term of the Arithmetic Progression 4, 7, 12, … is –

i) 26 ii) 28

iii) 30 iv) 34

f) A stair is in the form of an A.P. and each step is 5 inches in height, the distance between the 14^{th} step and the 19^{th} step is –

i) 15 inches ii) 20 inches

iii) 25 inches iv) 30 inches

g) If $A \subseteq B$ then $A - B$ is equal to–

i) $B - A$ ii) A

iii) B iv) φ

h) If $X = \{x : x$ is an odd integers$\}$ and $Y = \{ x : x$ is an even integers$\}$, then $X \cap Y$ is –

i) {} ii) {0}

iii) {1} iv) {2}

i) In a group of people, 15 like Messi, 21 like Ronaldo and 6 like both. The number of people who like either Messi or Ronaldo is –

i) 21 ii) 30

iii) 36 iv) 42

2. Answer the following questions: $3 \times 2 = 6$

a) An article costs ₹ 12,000. It is purchased in three annual instalments of ₹ 5000 each. What is the total interest charged and its percentage?

b) Liana finish 100 m race in 12 sec. Find the distance covered by him in 1 minute.

c) Find the sum of the first 30 terms of the A.P: -24, -22, - 20…

3. Find the HCF and LCM of the following polynomials: -3

$f(x) = 40(2x^3 - 5x^2 - 3x)$

$g(x) = 35(x^4 - 27x)$

4. Rina's mother is 26 years older than him. The product of their ages (in years) 3 years from now will be 360. What is Rina's present age -3

5. The ratio of the incomes of Sanga and Mawia is 9:7 and the ratio of their expenditures is 4:3. If each of them manages to save ₹3000 per month, find their monthly incomes and expenditures, also verify the results. -4

MATHEMATICS ACHIEVEMENT TEST(POST-TEST)

CLASS X

Full Mark – 25

Time – 45 minutes

General Instructions:

i) All questions are compulsory.

ii) Figures in the margin indicates marks.

iii) Use of calculator is not allowed.

1. Choose the correct answer: $9 \times 1 = 9$

a) The sum which is paid by the customer at regular intervals towards the remaining balance of the selling price of the article is called–

i) Cash Price | ii) Interest

iii) Sum borrowed | iv) Instalments

b) If Speed = *p*, Distance = *q* and Time = *r*, then *r* is equal to –

i) $\frac{p}{q}$ | ii) $\frac{q}{p}$

iii) pq | iv) None of these

c) If the HCF of two polynomials *A* and *B* is *C*, then their LCM is -

i) $\frac{AB}{C}$ | ii) $\frac{AC}{B}$

iii) $\frac{BC}{A}$ | iv) None of these

d) If a quadratic equation $ax^2 + bx + c = 0$, has real and equal roots, then the value of b^2 is –

i) ac | ii) 2ac

iii) 4ac | iv) 8ac

e) The sum of the first 50 natural numbers is –

i) 1275 | ii) 1345

iii) 1527 | iv) 1725

f) Sanga puts money in his son’s money box. He started initially with ₹ 100 and increased ₹ 150 every year. What would be the amount on the tenth birthday? –

i) ₹ 1400 | ii) ₹ 1450

iii) ₹ 1500 | iv) ₹ 1550

g) A set with no element is known as –

i) Subset | ii) Singleton set

iii) Power set | iv) Empty set

h) The number of subsets of A = {0,5,10} is –

i) 3 | ii) 6

iii) 8 | iv) 12

i) In a group of 65 students, 40 students use learning apps, and 10 students use both learning apps and guidebooks. How many students use the guidebook? –

i) 30 | ii) 35

iii) 42 | iv) 50

2. Answer the following questions: $3 \times 2 = 6$

a) An iPhone is available for ₹ 25000 cash or ₹10000 cash down payment along with two equal annual instalments of ₹8000 each. What is the total interest charged?

b) Piana and Biaka can do their homework in 6 minutes. Piana alone can do it in 10 minutes. What time will Biaka required to do it alone?

c) If $\frac{6}{5}$, A, 8 are in A.P. What is the value of A?

3. What should be added to $\frac{(x-1)}{(x-2)}$ to obtain $\frac{(2x^2-4)}{(x^2-4)}$? - 3

4. 12 pens are distributed equally among a certain number of students. Had there been one more student, each would have received one pen less. Find the number of students. - 3

5. At a certain time in Aizawl Zoo, the number of heads and the number of legs of deer and human visitors were counted and it was found that there were 39 heads and 132 legs. Find the number of deer and human visitors in the zoo. - 4

SCORING KEY: MATHEMATICS ACHIEVEMENT TEST(PRE-TEST)

1. Choose the correct answer: $9 \times 1 = 9$

a) The extra amount charged by the seller for deferred payment is called–

i) Cash Price | **ii) Interest**

iii) Sum borrowed | iv) Instalments

Solution: Interest

b) A speed of 9 km/hr equals –

i) 1.5 m/s | ii) 2 m/s

iii) 2.5 m/s | iv) 3 m/s

Solution: 9 km/hr = $\frac{5}{18} \times 9$ m/s = 2.5 m/s

c) The multiplicative inverse of $\frac{x+1}{x-2}$ is-

i) $\boldsymbol{\frac{x-2}{x+1}}$ | ii) $\frac{x+1}{x-2}$

iii) $\frac{x-1}{x+2}$ | iv) $\frac{x+2}{x-1}$

Solution: $\frac{x-2}{x+1}$

d) Which of the following is a quadratic equation –

i) $x + 2 = 0$ | ii) $\frac{1}{x} + 2 = 0$

iii) $2x + 2 = 0$ | **iv)** $\boldsymbol{x^2 + 2 = 0}$

Solution: $x^2 + 2 = 0$

e) The 11th term of the Arithmetic Progression 4, 7, 12, … is –

i) 26 | ii) 28

iii) 30 | **iv) 34**

Solution: Here, $a = 4$, $d = a_2 - a_1 = 7 - 4 = 3$

$a_n = a + (n-1)d$ => $a_{11} = 4 + (11 - 1)3 = 4 + 10 \times 3 = 34$

f) A stair is in the form of an A.P. and each step is 5 inches in height, the distance between the 14th step and the 19th step is –

i) 15 inches | ii) 20 inches

iii) 25 inches | iv) 30 inches

Solution: $d = 5$

$a_{19} - a_{14} = (a + 18d) - (a + 13d) = a + 18d - a - 13d = 5d = 5 \times 5 = 25$

g) If A ⊆ B then A – B is equal to–

i) B – A | ii) A
iii) B | **iv) φ**

Solution: φ

h) If X = {x : x is an odd integers} and Y = { x : x is an even integers}, then X∩Y is –

i) {} | ii) {0}
iii) {1} | iv) {2}

Solution: A = {1,3,5,…}, B = { 2,4,6,….}, A∩B = {}

i) In a group of people, 15 like Messi, 21 like Ronaldo and 6 like both. The number of people who like either Messi or Ronaldo is –

i) 21 | **ii) 30**
iii) 36 | iv) 42

Solution: n(M) =15, n(R) =21, n(M∩R) = 6

n(MUR) = n(M) + n(R) - n(M∩R) = 15 +21 - 6 = 30

2. Answer the following questions: $3 \times 2 = 6$

a) An article costs ₹ 12,000. It is purchased in three annual instalments of ₹ 5000 each. What is the total interest charged and its percentage?

Solution: Sum borrowed = 12000

Total interest charged = time × instalment – Sum borrowed

= 3 × 5000 – 12000

= 15000 – 12000 = 3000

Percentage = $\frac{3000\ X\ 100}{12000}$ = 25 %

b) Liana finish 100 m race in 12 sec. Find the distance covered by him in 1 minute.

Solution: Distance covered by Liana = 100 m

Time taken = 12 sec.

Liana's Speed = $\frac{100}{12}$ = 8.33 m/sec.

Now, Distance covered by him in 1 min (60 sec) = Speed × Time

= 8.33 m/sec × 60 sec = 499.8 m

c) Find the sum of the first 30 terms of the A.P: -24, -22, - 20…

Solution: $a = -24$, $d = -22 - (-24) = 2$, $n = 35$

We know that, $S_n = \frac{n}{2}[2a + (n - 1)d]$

$S_{30} = \frac{20}{2}[2(-24) + (30 - 1)2] = 10(-48 + 58) = 10 \times 10$

$= 100$

So, the sum of the first 30 terms of the AP is 100.

3. Find the HCF and LCM of the following polynomials: -3

f(x) $= 40(2x^3 - 5x^2 - 3x)$

g(x) $= 35(x^4 - 27x)$

Solution: $f(x) = 40(2x^3 - 5x^2 - 3x) = 2^3 \times 5 \times x(2x^2 - 5x - 3)$

$= 2^3 \times 5 \times x(2x^2 - 6x + x - 3) = 2^3 \times 5 \times x[2x(x - 3) + 1(x - 3)]$

$= 2^3 \times 5 \times x(2x + 1)(x - 3)$

$g(x) = 35(x^4 - 27x) = 5 \times 7 \times x(x^3 - 27)$

$= 5 \times 7 \times x(x^3 - 3^3) = 5 \times 7 \times x(x - 3)(x^2 + 3x + 9)$

Therefore, HCF of *f(x)* and *g(x)* is $5x(x - 3)$.

And, LCM of *f(x)* and *g(x)* is $280x(x - 3)(2x + 1)(x^2 + 3x + 9)$

4. Rina is twice as old as Liana. Two years hence, the product of their ages (in years) will be 60. What is Rina's present age -3

Solution: Let x be the present age of Liana.

Rina's age = 2x

Two years hence, Lianas age = (x + 2), Rina's age = (2x + 2)

So, $(x + 2)(2x + 2) = 60$

$\Rightarrow 2x^2 + 2x + 4x + 4 = 60 \Rightarrow 2x^2 + 6x + 4 - 60 = 0$

$\Rightarrow 2x^2 + 6x - 56 = 0 \Rightarrow x^2 + 3x - 28 = 0$

$\Rightarrow x^2 + 7x - 4x - 28 = 0 \Rightarrow x(x + 7) - 4(x + 7) = 0$

$\Rightarrow (x + 7)(x - 4) = 0$

Either, $(x + 7) = 0$ or $(x - 4) = 0$

$x = -7$ or $x = 4$

Omitting the negative value i.e. year is not negative.

Rina's age = $2 \times 4 = 8$ years.

5. The ratio of the incomes of Sanga and Mawia is 9:7 and the ratio of their expenditures is 4:3. If each of them manages to save ₹3000 per month, find their monthly incomes and expenditures, also verify the results. -4

Solution: Let us denote the incomes of the two persons by ₹9x and ₹7x and their expenditures by ₹4y and ₹3y respectively.

We have, $9x - 4y = 3000$ - (i)

$7x - 3y = 3000$ - (ii)

On multiplying equation (i) by 3 and equation (ii) by 4, we get,

$27x - 12y = 9000$ - (iii)

$28x - 12y = 12000$ - (iv)

On subtracting equation (iii) from equation (iv), we get

$(28x - 12y) - (27x - 12y) = 12000 - 9000$

=> $x = 3000$

Substituting x = 3000 in equation (i), we get

$9(3000) - 4y = 3000$

=> $-4y = 3000 - 27000$ => $y = -\frac{-24000}{-4}$

=> $y = 6000$

Therefore, the monthly incomes of Sanga and Mawia are ₹27000 and ₹21000 respectively.

Verification:

27000:21000 = 9:7

Also, the ratio of their expenditures

= 27000 – 3000 : 21000 – 3000 = 24000:18000

= 4:3

SCORING KEY: MATHEMATICS ACHIEVEMENT TEST(POST-TEST)

1. Choose the correct answer: $9 \times 1 = 9$

a) The sum which is paid by the customer at regular intervals towards the remaining balance of the selling price of the article is called–

i) Cash Price ii) Interest

iii) Sum borrowed **iv) Instalments**

Solution: Instalments

b) If Speed = *p*, Distance = *q* and Time = *r*, then *r* is equal to –

i) $\frac{p}{q}$ **ii)** $\boldsymbol{\frac{q}{p}}$

iii) pq iv) None of these

Solution: Time = $\frac{Distance}{Speed} = \frac{q}{p}$

c) If the HCF of two polynomials *A* and *B* is *C*, then their LCM is -

i) $\boldsymbol{\frac{AB}{C}}$ ii) $\frac{AC}{B}$

iii) $\frac{BC}{A}$ iv) None of these

Solution: LCM of A and B = $\frac{A\ X\ B}{HCF} = \frac{AB}{C}$

d) If a quadratic equation $ax^2 + bx + c = 0$, has real and equal roots, then the value of b^2 is –

i) ac ii) 2ac

iii) 4ac iv) 8ac

Solution: For real and Equal root, $b^2 - 4ac = 0$, => $b^2 = 4ac$

e) The sum of the first 50 natural numbers is –

i) 1275 ii) 1345

iii) 1527 iv) 1725

Solution: A.P. = 1,2,3….50. (First fifty natural number)

Here, a = 1, d= 1, n= 50, $S_n = \frac{n}{2}[2a + (n-1)d]$

=> $S_{50} = \frac{50}{2}[2X1 + (50-1)1]$ = 25 X [2 + 49] = 25 X 51 = 1275

f) Sanga puts money in his son's money box. He started initially with ₹ 100 and increased ₹ 150 every year. What would be the amount on the tenth birthday? –

i) ₹ 1400 **ii) ₹ 1450**

iii) ₹ 1500 iv) ₹ 1550

Solution: Here, a = 100, d = 150, n = 10 ; $a_n = a + (n-1)d$

⇨ a_{10} = 100 + (10-1)150 = 100 + 9 X 150 = 100 + 1350 = 1450

g) A set with no element is known as –

i) Subset ii) Singleton set

iii) Power set **iv) Empty set**

Solution: Empty set

h) The number of subsets of A = {0,5,10} is –

i) 3 ii) 6

iii) 8 iv) 12

Solution: Subset of A are {},{0},{5},{10},{0,5},{0,10},{5,10},{0,5,10} = 8

i) In a group of 65 students, 40 students use learning apps, and 10 students use both learning apps and guidebooks. How many students use the guidebook? –

i) 30 **ii) 35**

iii) 42 iv) 50

Solution : Let A = set of students who use learning app, B = set of students who use guidebook

n(AUB) = 65, n(A) = 40, n(AnB) = 10, n(B) = ?

n(A) + n(B) – n(AnB) = n(AUB); n(B) = n(AUB) + n (AnB) – n(A)

n(B) = 65+10 -40 = 35

2. Answer the following questions: $3 \times 2 = 6$

a) An iPhone is available for ₹ 25000 cash or ₹10000 cash down payment along with two equal annual instalments of ₹8000 each. What is the total interest charged?

Solution: Here, Cost price = ₹ 25000, Cash down payment = ₹10000, Instalments = ₹8000,

No of instalments = 2

Total interest charged = No. of Instalments X Instalments + Cash down payment – Cost price

⇨ Total interest charged = 2 X 8000 + 10000 – 25000

= 16000 – 15000

$= 1000$

b) Piana and Biaka can do their homework in 6 minutes. Piana alone can do it in 10 minutes. What time will Biaka required to do it alone?

Solution: Piana and Biaka's 1 minute work = $\frac{1}{6}$

Piana's 1 minute work = $\frac{1}{10}$

Biaka's 1 minute work = Piana and Biaka's 1 minute work – Piana's 1 minute work

$= \frac{1}{6} - \frac{1}{10} = \frac{5-3}{30} = \frac{2}{30} = \frac{1}{15}$

Thus, Biaka can do the same work in 15 minutes.

c) If $\frac{6}{5}$, A, 8 are in A.P. What is the value of A?

Solution: Here, $a_1 = \frac{6}{5}$, $a_2 = A$, $a_3 = 8$

Now, $d = a_2 - a_1 = a_3 - a_2$

⇨ $A - \frac{6}{5} = 8 - A$

⇨ $A+A = 8 + \frac{6}{5}$

⇨ $2A = \frac{40+6}{5}$

⇨ $A = \frac{46}{5X2}$

⇨ $A = \frac{23}{5}$

3. What should be added to $\frac{(x-1)}{(x-2)}$ to obtain $\frac{(2x^2-4)}{(x^2-4)}$? - 3

Solution: Let f(x) be the required expression.

Then, $\frac{(x-1)}{(x-2)} + f(x) = \frac{(2x^2-4)}{(x^2-4)}$

⇨ $f(x) = \frac{(2x^2-4)}{(x+2)(x-2)} - \frac{(x-1)}{(x-2)}$

⇨ $f(x) = \frac{(2x^2-4) - (x+2)(x-1)}{(x+2)(x-2)}$

⇨ $f(x) = \frac{2x^2-4 - (x^2+2x-x-2)}{(x+2)(x-2)}$

⇨ $f(x) = \frac{2x^2-4 - x^2-2x+x+2)}{(x+2)(x-2)}$

⇨ f(x) = $\frac{(x^2-2x+x-2)}{(x+2)(x-2)}$

⇨ f(x) = $\frac{x(x-2)+1(x-2)}{(x+2)(x-2)}$

⇨ f(x) = $\frac{(x-2)(x+1)}{(x+2)(x-2)}$

⇨ f(x) = $\frac{(x+1)}{(x+2)}$

Therefore, the required expression is $\frac{(x+1)}{(x+2)}$

4. 12 pens are distributed equally among a certain number of students. Had there been one more student, each would have received one pen less. Find the number of students. - 3

Solution: Let the number of students be *x*.

Total number of pens = 12

Number of pens per student = $\frac{12}{x}$

Now, if there are 1 more student, then number of students = $x + 1$

Number of pens for increased number of students = $\frac{12}{x+1}$

By question, $\frac{12}{x} - \frac{12}{x+1} = 1$

⇨ $\frac{12(x+1)-12x}{x(x+1)} = 1$

⇨ $12x + 12 - 12x = x(x+1)$

⇨ $12 = x^2 + x$

⇨ $x^2 + x - 12 = 0$

⇨ $x^2 + 4x - 3x - 12 = 0$

⇨ $x(x+4) - 3(x+4) = 0$

⇨ $(x+4)(x-3) = 0$

Either, $x = -4$ or $x = 3$

Therefore, $x = 3$ ($x = -4$ is not possible because number of students cannot be negative)

So, the number of students is 3.

5. At a certain time in Aizawl Zoo, the number of heads and the number of legs of deer and human visitors were counted and it was found that there were 39 heads and 132 legs. Find the number of deer and human visitors in the zoo. - 4

Solution: Let the number of deer be x and the number of humans be y.

From question,

$x + y = 39$ -(i) (deer and human has 1 head each)

$4x + 2y = 132$ -(ii) (deer has 4 leg and human has 2 leg)

Multiplying equation (i) by 4 and equation (ii) by 1, we get,

$4x + 4y = 156$ -(iii)

$4x + 2y = 132$ -(iv)

Subtracting equation (iv) from equation (iii) we get,

$2y = 24$

$\Rightarrow y = 12$

Putting y = 12 in equation (i), we get,

$x + 12 = 39$

$\Rightarrow x = 39 - 12$

$\Rightarrow x = 27$

So, there are 27 deer and 12 human visitors in the zoo at that time.

3. Appendix-III: LearningMaths Guide(In Mizo)

LEARNINGMATHS HMAN DAN TUR

Phone a install hnua LearningMaths icon hmeh in a hnuai ami Figure 1 hi alo lang ang.

Figure 1.

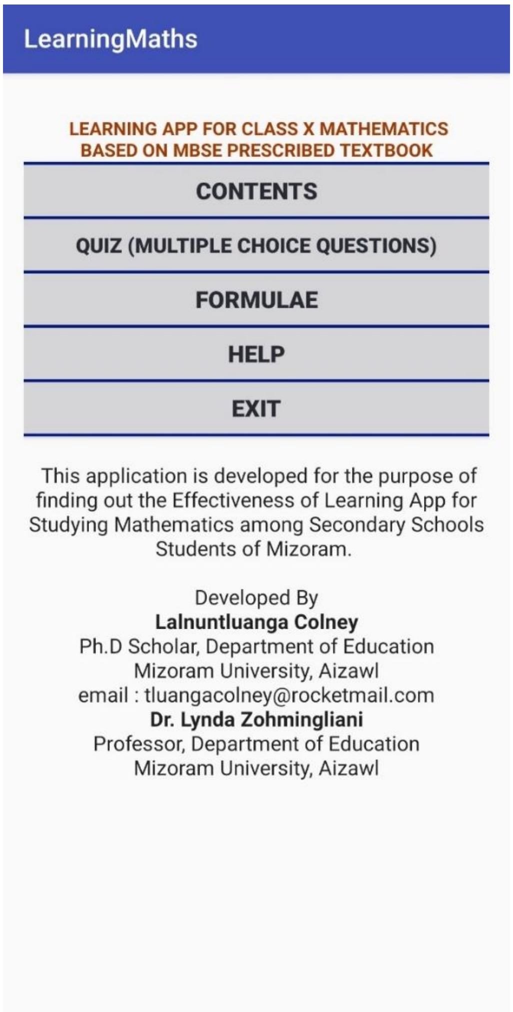


Figure 2.

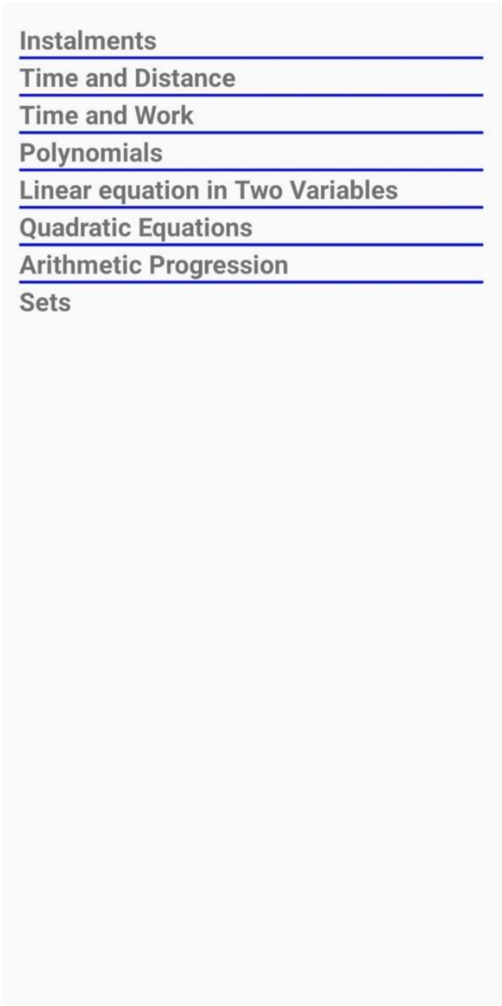


Figure 1 ami contents hmeh hnuah Figure 2 hi alo lang anga, hetah hian chapter hrang hrang te a indawta dah khawm a ni, chapter 8- Sets thleng hian siam zawh tawh a ni.

Figure 1 ami Quiz(Multiple choice question) hi hmeh chuan Figure 3 hi alo lang ang, quiz hi objective type test a ni a, board exam a multiple choice question chhuak thei(probable question) 150 dah luh a ni. Zawhna lo langah a chhanna dik ni a i hriat i hmeh hnuah NEXT tih alo lang anga, chhan dik chuan score a in belh zel anga chhan dikloh chuan chance a tla hniam ve zel ang. Vawi khat test ah chance vawi 5 zel a awm a chance hi 0 a nih hma chu a test chhunzawm theih a ni. Question pakhat chhan nan minute 2 chhung hun a awma, hemi chhunga chhan hman loh chuan test a tawp ang.

Formulae i hmeh chuan Figure 4 hi lo lang in hetah hian Class X zirlaibu a formula hrang hrang chapter indawt dana dah khawm a ni. Chapter tin te thiam tur chuan kan formula hman tur te hi by-heart vek phawt tur a ni.

Figure 3.

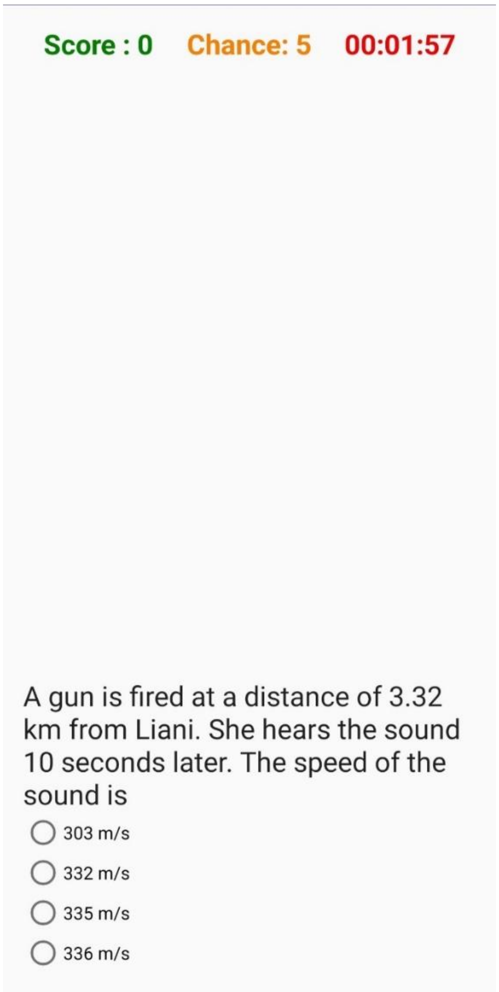


Figure 4.

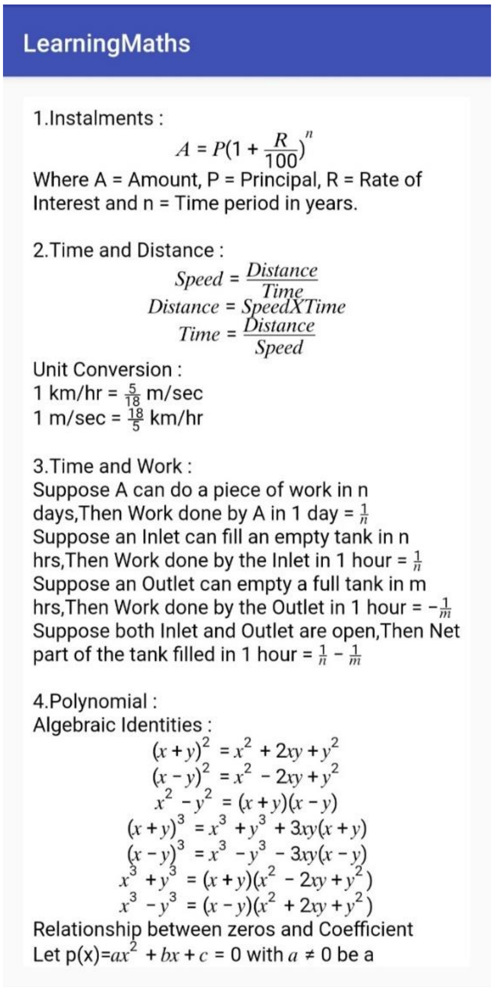


Figure 2 ami chapter tin te hi a kalphung a in ang veka, Instalment hi hmeh chuan Figure 5 hi alo lang anga hetah hian a dang hmeh chhuah na tur 5 bakah instalment chapter zirna video hrang hrang youtube ami chu awlsam taka en mai theih tura dah lan a ni.

Figure 5 ami Key points hi hmeh chuan figure 6 hi lo langin hetah hian instalments chawh dawna hriat tur pawimawh te alo langa, hmeh nawn leh chuan a bo leh dawn a ni.

Figure 5.

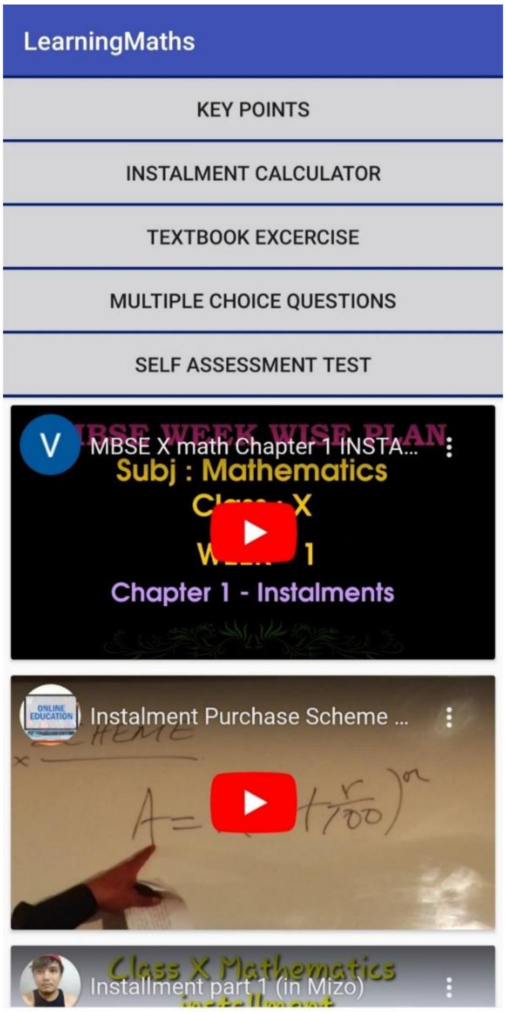


Figure 6.

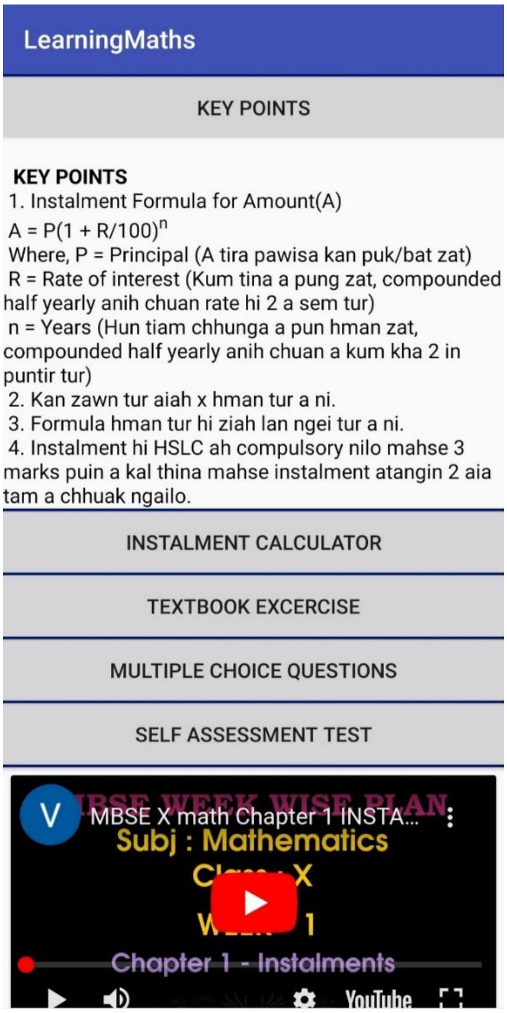


Figure 5 ami Instalment Calculator hi hmeh chuan Figure 7 hi lo langin hetah hian field hrang hrang dah khah tur a awma kan zawhna ami value kan neih sa kan dah khah hnuah Solution hmehin a chhanna a lo lang ang. Hetah hian textbooka question awmsa mai bakah texbook pawn ami thlengin chawh theih a ni. Instalment calculator hmang thiam tur chuan instalment chaptera term hrang hrang te hriat fiah hmasak phawt a ngai a ni.

Textbook Excercise hi hmeh chuan Figure 8 a lo lang ang hian textbook chhunga zawhna awmsa thenkhat a lo lang anga, zawhna lo lang hmeh hnuah a chhanna a lo lang ang. Zirlai ten an mahnia an chawh chhuah ve theihna atan textbooka zawhna thenkhat dah tel veloh a ni.

Figure 7.

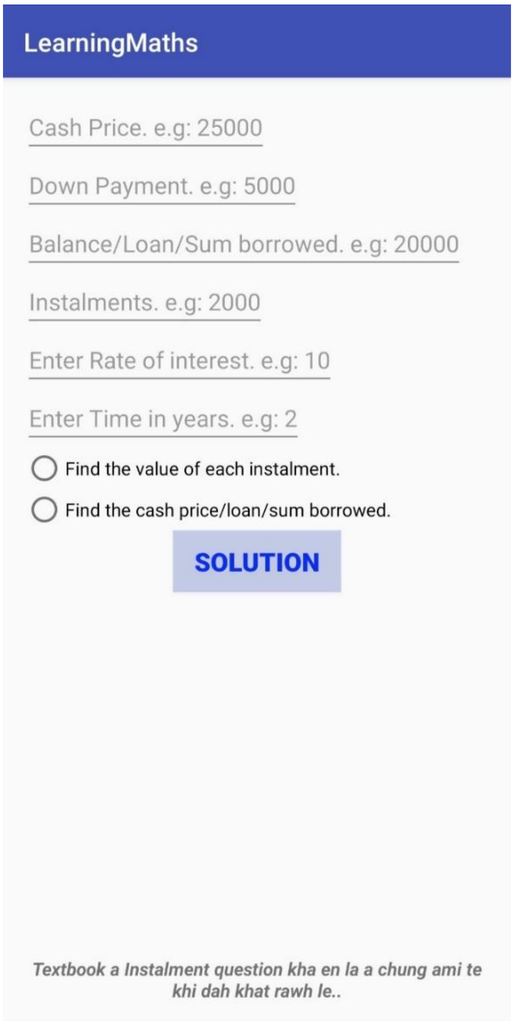


Figure 8.

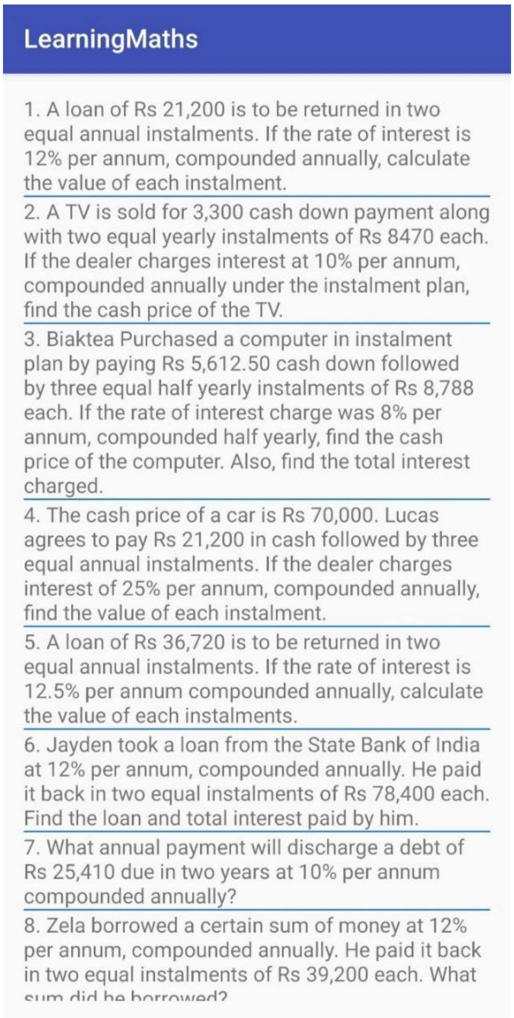
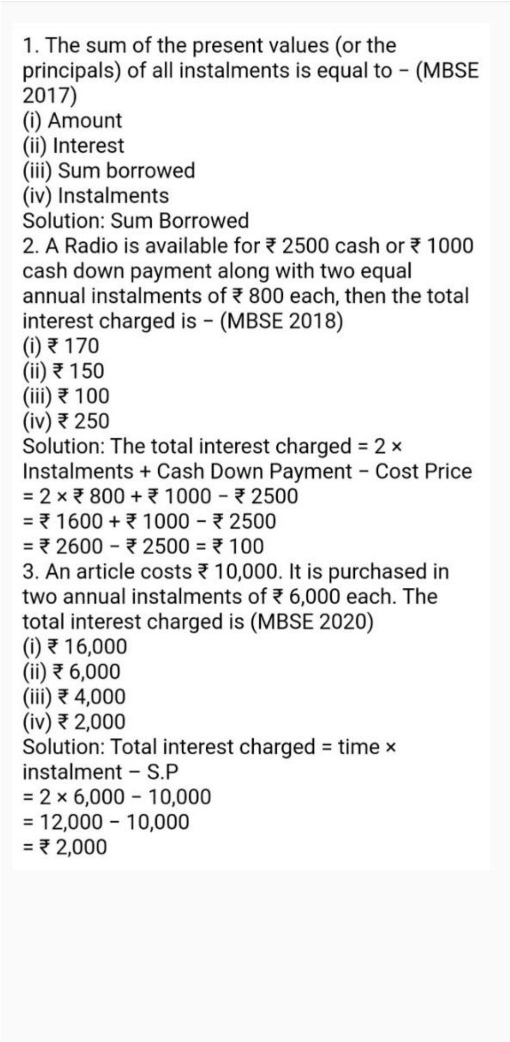


Figure 5 ami Multiple Choice Questions hi hmeh chuan Figure 9 hi a lo lang anga, hetah hian Instalment chapter chhhunga multiple choice question awm thei te leh a solution dah lan nghal a ni.

Self Assessment Test hmeh chuan Figure 10 hi a lo lang anga hetah hian objective type a test na tur question leh chhanna tur a lo lang anga chhanna hmeh hnuah NEXT tih alo lang ang, zawhna pakhat chhanna chawh chhuahna hun atan minute 4 zel a awm a ni. Zawhna 10 chhan hnuah Figure 11. hi a lo lang anga mark score dan a zirin star hmuh zat a danglama 4 star hmu pha chin tan Hming, Roll No. leh Section dahkhahna tur a lo lang anga dahkhah kim hnuah submit result tih hmetin result hi submit tur a ni. Result submit te hi researcher hnenah direct in a lut nghal zel a ni. 4 star hmu pha tur hian zawhna 70% tal chhan dik a ngai a, 4 star hmuh tlin hma chu result submit na tur hi a lo lang thei dawnlo a ni.

Figure 9.



1. The sum of the present values (or the principals) of all instalments is equal to – (MBSE 2017)
(i) Amount
(ii) Interest
(iii) Sum borrowed
(iv) Instalments
Solution: Sum Borrowed
2. A Radio is available for ₹ 2500 cash or ₹ 1000 cash down payment along with two equal annual instalments of ₹ 800 each, then the total interest charged is – (MBSE 2018)
(i) ₹ 170
(ii) ₹ 150
(iii) ₹ 100
(iv) ₹ 250
Solution: The total interest charged = 2 × Instalments + Cash Down Payment – Cost Price
= 2 × ₹ 800 + ₹ 1000 – ₹ 2500
= ₹ 1600 + ₹ 1000 – ₹ 2500
= ₹ 2600 – ₹ 2500 = ₹ 100
3. An article costs ₹ 10,000. It is purchased in two annual instalments of ₹ 6,000 each. The total interest charged is (MBSE 2020)
(i) ₹ 16,000
(ii) ₹ 6,000
(iii) ₹ 4,000
(iv) ₹ 2,000
Solution: Total interest charged = time × instalment – S.P
= 2 × 6,000 – 10,000
= 12,000 – 10,000
= ₹ 2,000

Figure 10.

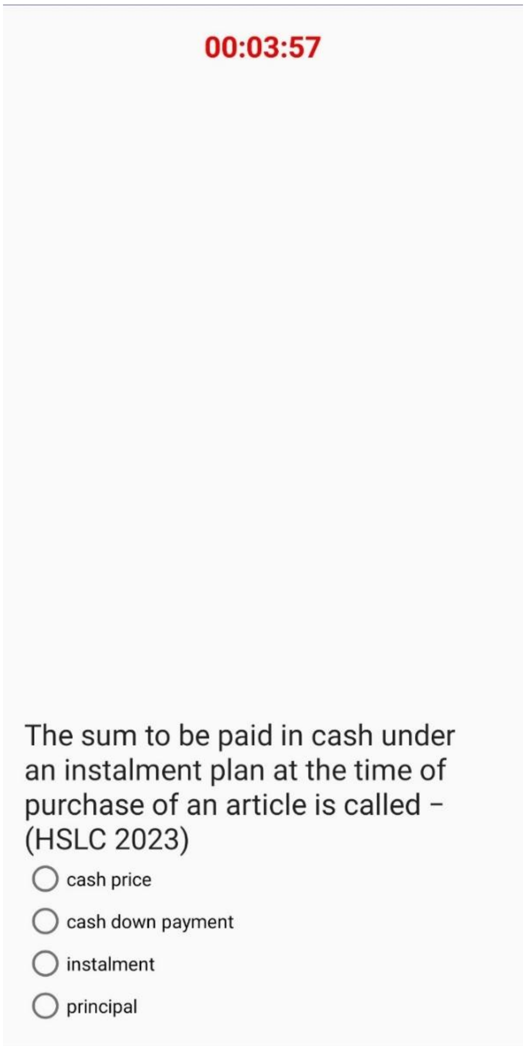
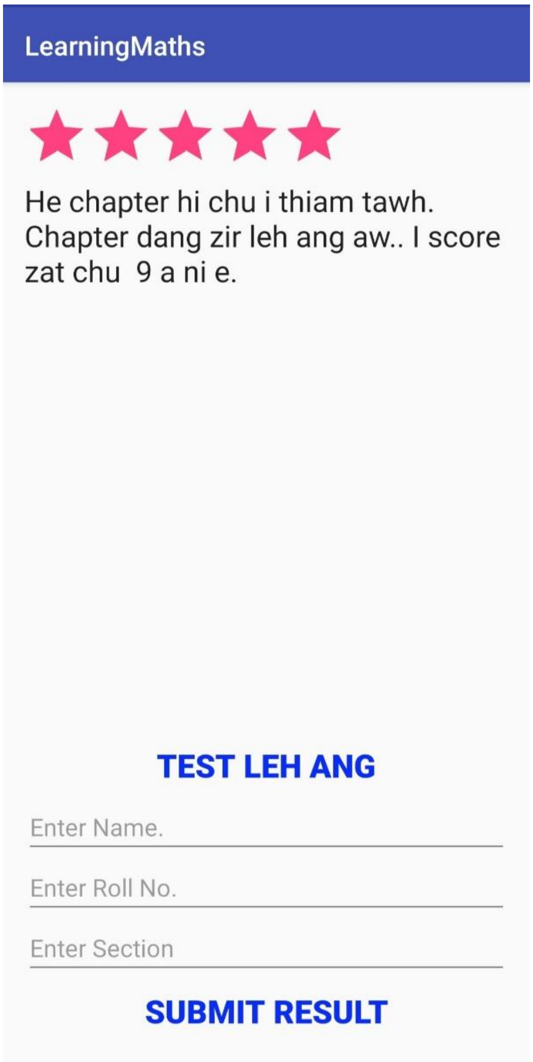


Figure 11.



Instalment module a chung kan en tak ang khian Time and Distance, Time and Work, Polynomials, Linear Equations in Two Variables, Quadratic Equations, Arithmetic Progression leh Sets module zir phawt tur a ni ang.

4. Appendix-IV: Self-Assessment Submission Data

Date	Name	Roll No	Section	Topic	Marks
08/06/2023 20:40:16	Babie Remruatfeli	2	A	Instalment	8
10/06/2023 17:17:18	Biakrinpuii	3	A	Instalment	7
12/06/2023 18:23:15	B.Malsawmzuali	4	A	Instalment	9
11/06/2023 17:33:39	Chingremmawii	6	A	Instalment	9
09/06/2023 18:23:24	C.Lalawmpuii	7	A	Instalment	7
13/06/2023 21:08:35	C.Malsawmsangi	9	A	Instalment	8
15/06/2023 13:41:03	Esther Lalramhluni	12	A	Instalment	9
11/06/2023 16:11:18	F.Vanlalrinngheti	15	A	Instalment	7
16/06/2023 16:40:12	Jessica B.Lalremmawii	17	A	Instalment	8
10/06/2023 18:19:09	Juliet Lalmuanpuii	18	A	Instalment	9
09/06/2023 17:50:13	Lalfakawmi	22	A	Instalment	8
12/06/2023 20:11:28	Lalramliani	23	A	Instalment	8
14/06/2023 16:11:43	Lalrinngheti	25	A	Instalment	8
09/06/2023 21:55:09	Lalthlengkimi	28	A	Instalment	9
11/06/2023 13:11:10	Malsawmzuali	31	A	Instalment	7
13/06/2023 17:56:12	Ruthi Lalneihhlimi	33	A	Instalment	9
08/06/2023 17:40:21	V.Lalhruaitluangi	34	A	Instalment	8
09/06/2023 19:23:36	Vanlalawmpuii	35	A	Instalment	9
14/06/2023 16:12:11	C.Lallawmkima	38	A	Instalment	7
15/06/2023 11:53:19	Christian Lalramdinthara	39	A	Instalment	8
14/06/2023 18:45:17	Lalnunfela	40	A	Instalment	8
12/06/2023 17:40:16	George Lalthansanga	41	A	Instalment	10
13/06/2023 18:03:45	Gideon Malsawmtluanga	42	A	Instalment	10
10/06/2023 10:56:31	H.Lalrinpuia	43	A	Instalment	9
15/06/2023 11:14:41	Javier Saidingpuia	44	A	Instalment	8
09/06/2023 20:30:32	K.Lalruatpuia	45	A	Instalment	7
16/06/2023 17:13:49	Lalnunfela	48	A	Instalment	7
14/06/2023 18:32:09	Vanlalhriatpuii	115	B	Instalment	8
14/06/2023 17:55:23	Vanlalrindiki	117	B	Instalment	9
16/06/2023 16:45:07	Zoneihmawii	122	B	Instalment	7
09/06/2023 20:07:13	Zoremsangi	123	B	Instalment	8
12/06/2023 19:55:12	C.Lalrinzuala	127	B	Instalment	9
13/06/2023 19:29:41	Lalruatfela	135	B	Instalment	9
14/06/2023 17:55:18	Malsawmdawngkima	137	B	Instalment	8
16/06/2023 16:43:47	Lalvenhima	146	B	Instalment	8
10/06/2023 12:05:12	MS Tluangzeli	147	B	Instalment	7
13/06/2023 19:06:15	C.Zomuansangi	202	C	Instalment	9
14/06/2023 18:45:09	Lalrosangpuii	207	C	Instalment	8
14/06/2023 17:09:34	Lalchhanhimi	20	A	Instalment	7
12/06/2023 19:25:44	Rebecca VL Hmachhuani	215	C	Instalment	9
14/06/2023 17:22:19	Vanlalhriati	221	C	Instalment	8
14/06/2023 19:09:29	Josia Lalenkawla	227	C	Instalment	7
10/06/2023 14:21:05	K.Lalthazuala	228	C	Instalment	7
14/06/2023 17:38:20	Mesak Lalromawia	237	C	Instalment	9
12/06/2023 17:25:31	Vanlalduhsaka	241	C	Instalment	8
30/06/2023 21:40:16	Babie Remruatfeli	2	A	Time and Distance	8

01/07/2023 15:16:58	Biakrinpuii	3	A	Time and Distance	7
05/07/2023 17:23:45	B.Malsawmzuali	4	A	Time and Distance	8
01/07/2023 17:23:13	Chingremmawii	6	A	Time and Distance	8
02/07/2023 15:43:21	C.Lalawmpuii	7	A	Time and Distance	9
30/06/2023 18:07:55	C.Malsawmsangi	9	A	Time and Distance	7
03/07/2023 19:46:01	Esther Lalramhluni	12	A	Time and Distance	8
04/07/2023 17:51:28	F.Vanlalrinngheti	15	A	Time and Distance	8
01/07/2023 17:21:11	Jessica B.Lalremmawii	17	A	Time and Distance	8
29/06/2023 17:45:29	Juliet Lalmuanpuii	18	A	Time and Distance	9
03/07/2023 17:20:23	Lalchhanhimi	20	A	Time and Distance	9
29/06/2023 10:11:28	Lalfakawmi	22	A	Time and Distance	7
28/06/2023 19:21:23	Lalramliani	23	A	Time and Distance	7
29/06/2023 21:23:06	Lalrinngheti	25	A	Time and Distance	8
02/07/2023 19:21:12	Lalthlengkimi	28	A	Time and Distance	9
02/07/2023 14:31:56	Malsawmzuali	31	A	Time and Distance	9
28/06/2023 19:20:51	Ruthi Lalneihhlimi	33	A	Time and Distance	8
03/07/2023 20:12:06	V.Lalhruaitluangi	34	A	Time and Distance	7
01/07/2023 11:32:31	Vanlalawmpuii	35	A	Time and Distance	8
02/07/2023 14:13:29	C.Lallawmkima	38	A	Time and Distance	9
30/06/2023 19:22:34	Christian Lalramdinthara	39	A	Time and Distance	7
01/07/2023 18:41:32	Lalnunfela	40	A	Time and Distance	8
28/06/2023 19:12:23	George Lalthansanga	41	A	Time and Distance	9
28/06/2023 18:26:13	Gideon Malsawmtluanga	42	A	Time and Distance	10
15/06/2023 11:14:41	H.Lalrinpuia	43	A	Time and Distance	7
02/07/2023 15:34:09	Javier Saidingpuia	44	A	Time and Distance	8
03/07/2023 18:11:34	K.Lalruatpuia	45	A	Time and Distance	9
30/06/2023 14:55:41	Lalnunfela	48	A	Time and Distance	9
02/07/2023 16:03:54	Vanlalhriatpuii	115	B	Time and Distance	8
03/07/2023 17:54:18	Vanlalrindiki	117	B	Time and Distance	7
29/06/2023 19:33:54	Zoneihmawii	122	B	Time and Distance	8
02/07/2023 17:15:02	Zoremsangi	123	B	Time and Distance	7
03/07/2023 14:59:08	C.Lalrinzuala	127	B	Time and Distance	8
04/07/2023 16:25:54	Lalruatfela	135	B	Time and Distance	8
03/07/2023 18:53:41	Malsawmdawngkima	137	B	Time and Distance	9
29/06/2023 19:52:02	Lalvenhima	146	B	Time and Distance	9
30/06/2023 11:41:22	MS Tluangzeli	147	B	Time and Distance	7
28/06/2023 18:15:47	C.Zomuansangi	202	C	Time and Distance	8
01/07/2023 16:35:19	Lalrosangpuii	207	C	Time and Distance	9
01/06/2023 17:51:17	Rebecca VL Hmachhuani	215	C	Time and Distance	7
30/06/2023 12:14:10	Vanlalhriati	221	C	Time and Distance	8
03/07/2023 15:59:08	Josia Lalenkawla	227	C	Time and Distance	8
02/07/2023 15:54:13	K.Lalthazuala	228	C	Time and Distance	7
30/06/2023 19:31:57	Mesak Lalromawia	237	C	Time and Distance	9
01/07/2023 18:56:03	Vanlalduhsaka	241	C	Time and Distance	8
01/08/2023 19:30:36	Babie Remruatfeli	2	A	Time and Work	7
15/07/2023 20:03:22	Biakrinpuii	3	A	Time and Work	8
30/07/2023 18:13:12	B.Malsawmzuali	4	A	Time and Work	8

01/08/2023 18:33:29	Chingremmawii	6	A	Time and Work	9
02/08/2023 19:12:01	C.Lalawmpuii	7	A	Time and Work	8
30/07/2023 18:58:56	C.Malsawmsangi	9	A	Time and Work	7
31/07/2023 16:32:20	Esther Lalramhluni	12	A	Time and Work	8
03/08/2023 19:00:47	F.Vanlalrinngheti	15	A	Time and Work	9
01/08/2023 20:20:19	Jessica B.Lalremmawii	17	A	Time and Work	8
01/08/2023 17:45:57	Juliet Lalmuanpuii	18	A	Time and Work	7
31/07/2023 18:36:41	Lalchhanhimi	20	A	Time and Work	8
01/08/2023 16:14:39	Lalfakawmi	22	A	Time and Work	8
31/07/2023 20:37:29	Lalramliani	23	A	Time and Work	7
30/07/2023 17:09:12	Lalrinngheti	25	A	Time and Work	8
03/08/2023 17:35:57	Lalthlengkimi	28	A	Time and Work	9
02/08/2023 18:03:17	Malsawmzuali	31	A	Time and Work	9
01/08/2023 20:55:18	Ruthi Lalneihhlimi	33	A	Time and Work	8
31/07/2023 18:23:13	V.Lalhruaitluangi	34	A	Time and Work	7
31/07/2023 18:09:04	Vanlalawmpuii	35	A	Time and Work	8
02/08/2023 19:17:54	C.Lallawmkima	38	A	Time and Work	8
03/08/2023 16:49:04	Christian Lalramdinthara	39	A	Time and Work	9
01/08/2023 20:01:52	Lalnunfela	40	A	Time and Work	9
02/08/2023 17:24:07	George Lalthansanga	41	A	Time and Work	9
31/07/2023 16:53:23	Gideon Malsawmtluanga	42	A	Time and Work	9
30/07/2023 18:56:34	H.Lalrinpuia	43	A	Time and Work	7
01/08/2023 20:41:25	Javier Saidingpuia	44	A	Time and Work	7
02/08/2023 17:32:06	K.Lalruatpuia	45	A	Time and Work	8
01/08/2023 18:24:00	Lalnunfela	48	A	Time and Work	9
02/08/2023 16:26:30	Vanlalhriatpuii	115	B	Time and Work	8
01/08/2023 18:34:01	Vanlalrindiki	117	B	Time and Work	7
31/07/2023 17:05:50	Zoneihmawii	122	B	Time and Work	8
02/08/2023 20:00:36	Zoremsangi	123	B	Time and Work	9
01/08/2023 17:26:09	C.Lalrinzuala	127	B	Time and Work	8
01/08/2023 17:54:56	Lalruatfela	135	B	Time and Work	7
31/07/2023 16:13:07	Malsawmdawngkima	137	B	Time and Work	8
31/07/2023 17:42:28	Lalvenhima	146	B	Time and Work	7
02/08/2023 20:25:48	MS Tluangzeli	147	B	Time and Work	9
02/08/2023 17:49:44	C.Zomuansangi	202	C	Time and Work	8
30/07/2023 20:31:00	Lalrosangpuii	207	C	Time and Work	7
31/07/2023 17:10:12	Rebecca VL Hmachhuani	215	C	Time and Work	9
02/08/2023 20:39:45	Vanlalhriati	221	C	Time and Work	8
02/08/2023 18:04:28	Josia Lalenkawla	227	C	Time and Work	7
31/07/2023 20:18:59	K.Lalthazuala	228	C	Time and Work	8
31/07/2023 17:17:40	Mesak Lalromawia	237	C	Time and Work	9
01/08/2023 19:08:36	Vanlalduhsaka	241	C	Time and Work	7
18/08/2023 20:38:55	Babie Remruatfeli	2	A	Polynomials	7
21/08/2023 15:52:21	Biakrinpuii	3	A	Polynomials	8
19/08/2023 17:31:39	B.Malsawmzuali	4	A	Polynomials	8
22/08/2023 17:09:48	Chingremmawii	6	A	Polynomials	9
22/08/2023 20:25:31	C.Lalawmpuii	7	A	Polynomials	8

21/08/2023 17:43:38	C.Malsawmsangi	9	A	Polynomials	7
24/08/2023 19:35:09	Esther Lalramhluni	12	A	Polynomials	7
19/08/2023 18:09:30	F.Vanlalrinngheti	15	A	Polynomials	7
18/08/2023 15:42:08	Jessica B.Lalremmawii	17	A	Polynomials	8
22/08/2023 16:10:06	Juliet Lalmuanpuii	18	A	Polynomials	8
23/08/2023 19:22:20	Lalchhanhimi	20	A	Polynomials	9
19/08/2023 20:52:21	Lalfakawmi	22	A	Polynomials	9
22/08/2023 20:12:19	Lalramliani	23	A	Polynomials	8
16/08/2023 20:21:08	Lalrinngheti	25	A	Polynomials	7
24/08/2023 17:36:55	Lalthlengkimi	28	A	Polynomials	8
18/08/2023 17:54:26	Malsawmzuali	31	A	Polynomials	9
18/08/2023 16:21:31	Ruthi Lalneihhlimi	33	A	Polynomials	8
24/08/2023 19:09:22	V.Lalhruaitluangi	34	A	Polynomials	7
23/08/2023 16:34:58	Vanlalawmpuii	35	A	Polynomials	8
18/08/2023 19:16:20	C.Lallawmkima	38	A	Polynomials	9
17/08/2023 16:45:02	Christian Lalramdinthara	39	A	Polynomials	8
24/08/2023 16:03:33	Lalnunfela	40	A	Polynomials	7
24/08/2023 15:32:38	George Lalthansanga	41	A	Polynomials	8
20/08/2023 19:52:44	Gideon Malsawmtluanga	42	A	Polynomials	9
19/08/2023 15:36:34	H.Lalrinpuia	43	A	Polynomials	9
22/08/2023 19:12:24	Javier Saidingpuia	44	A	Polynomials	9
20/08/2023 19:29:24	K.Lalruatpuia	45	A	Polynomials	8
18/08/2023 19:59:29	Lalnunfela	48	A	Polynomials	8
20/08/2023 18:34:13	Vanlalhriatpuii	115	B	Polynomials	8
18/08/2023 19:55:53	Vanlalrindiki	117	B	Polynomials	7
21/08/2023 19:57:08	Zoneihmawii	122	B	Polynomials	8
17/08/2023 17:12:08	Zoremsangi	123	B	Polynomials	8
16/08/2023 15:26:13	C.Lalrinzuala	127	B	Polynomials	9
22/08/2023 17:42:07	Lalruatfela	135	B	Polynomials	8
21/08/2023 19:34:54	Malsawmdawngkima	137	B	Polynomials	9
18/08/2023 18:36:26	Lalvenhima	146	B	Polynomials	8
23/08/2023 15:48:50	MS Tluangzeli	147	B	Polynomials	8
19/08/2023 17:52:10	C.Zomuansangi	202	C	Polynomials	8
19/08/2023 17:30:37	Lalrosangpuii	207	C	Polynomials	7
17/08/2023 20:09:06	Rebecca VL Hmachhuani	215	C	Polynomials	7
18/08/2023 17:27:50	Vanlalhriati	221	C	Polynomials	7
21/08/2023 15:16:56	Josia Lalenkawla	227	C	Polynomials	8
18/08/2023 20:06:36	K.Lalthazuala	228	C	Polynomials	8
21/08/2023 19:03:20	Mesak Lalromawia	237	C	Polynomials	9
20/08/2023 19:54:02	Vanlalduhsaka	241	C	Polynomials	8
09/09/2023 15:23:45	Babie Remruatfeli	2	A	Linear equations in Two Variables	9
10/09/2023 16:12:34	Biakrinpuii	3	A	Linear equations in Two Variables	8
11/09/2023 17:55:12	B.Malsawmzuali	4	A	Linear equations in Two Variables	7
12/09/2023 19:04:21	Chingremmawii	6	A	Linear equations in Two Variables	7
13/09/2023 18:47:39	C.Lalawmpuii	7	A	Linear equations in Two Variables	8
14/09/2023 15:33:56	C.Malsawmsangi	9	A	Linear equations in Two Variables	9
09/09/2023 17:29:08	Esther Lalramhluni	12	A	Linear equations in Two Variables	8

10/09/2023 15:49:27	F.Vanlalrinngheti	15	A	Linear equations in Two Variables	8
11/09/2023 18:21:30	Jessica B.Lalremmawii	17	A	Linear equations in Two Variables	9
12/09/2023 19:56:18	Juliet Lalmuanpuii	18	A	Linear equations in Two Variables	8
13/09/2023 16:42:14	Lalchhanhimi	20	A	Linear equations in Two Variables	7
14/09/2023 17:38:07	Lalfakawmi	22	A	Linear equations in Two Variables	8
09/09/2023 19:15:50	Lalramliani	23	A	Linear equations in Two Variables	9
10/09/2023 18:36:42	Lalrinngheti	25	A	Linear equations in Two Variables	8
11/09/2023 15:27:18	Lalthlengkimi	28	A	Linear equations in Two Variables	7
12/09/2023 17:59:09	Malsawmzuali	31	A	Linear equations in Two Variables	8
13/09/2023 19:43:05	Ruthi Lalneihhlimi	33	A	Linear equations in Two Variables	9
14/09/2023 16:11:22	V.Lalhruaitluangi	34	A	Linear equations in Two Variables	7
09/09/2023 18:02:30	Vanlalawmpuii	35	A	Linear equations in Two Variables	8
10/09/2023 19:31:13	C.Lallawmkima	38	A	Linear equations in Two Variables	7
11/09/2023 16:54:47	Christian Lalramdinthara	39	A	Linear equations in Two Variables	9
12/09/2023 15:18:53	Lalnunfela	40	A	Linear equations in Two Variables	8
13/09/2023 17:45:36	George Lalthansanga	41	A	Linear equations in Two Variables	9
14/09/2023 18:28:17	Gideon Malsawmtluanga	42	A	Linear equations in Two Variables	8
09/09/2023 15:55:11	H.Lalrinpuia	43	A	Linear equations in Two Variables	7
10/09/2023 17:10:42	Javier Saidingpuia	44	A	Linear equations in Two Variables	7
11/09/2023 19:07:23	K.Lalruatpuia	45	A	Linear equations in Two Variables	8
12/09/2023 16:29:41	Lalnunfela	48	A	Linear equations in Two Variables	9
13/09/2023 18:52:10	Vanlalhriatpuii	115	B	Linear equations in Two Variables	8
14/09/2023 19:21:09	Vanlalrindiki	117	B	Linear equations in Two Variables	7
09/09/2023 17:46:33	Zoneihmawii	122	B	Linear equations in Two Variables	9
10/09/2023 15:37:26	Zoremsangi	123	B	Linear equations in Two Variables	8
11/09/2023 18:19:14	C.Lalrinzuala	127	B	Linear equations in Two Variables	7
12/09/2023 19:35:50	Lalruatfela	135	B	Linear equations in Two Variables	7
13/09/2023 16:57:29	Malsawmdawngkima	137	B	Linear equations in Two Variables	9
14/09/2023 17:11:48	Lalvenhima	146	B	Linear equations in Two Variables	7
09/09/2023 19:42:08	MS Tluangzeli	147	B	Linear equations in Two Variables	7
10/09/2023 18:14:55	C.Zomuansangi	202	C	Linear equations in Two Variables	8
11/09/2023 15:41:30	Lalrosangpuii	207	C	Linear equations in Two Variables	9
12/09/2023 17:23:17	Rebecca VL Hmachhuani	215	C	Linear equations in Two Variables	7
13/09/2023 19:50:06	Vanlalhriati	221	C	Linear equations in Two Variables	8
14/09/2023 16:38:24	Josia Lalenkawla	227	C	Linear equations in Two Variables	8
09/09/2023 15:12:13	K.Lalthazuala	228	C	Linear equations in Two Variables	7
10/09/2023 17:59:29	Mesak Lalromawia	237	C	Linear equations in Two Variables	9
11/09/2023 19:04:31	Vanlalduhsaka	241	C	Linear equations in Two Variables	7
02/10/2023 15:23:45	Babie Remruatfeli	2	A	Quadratic Equations	8
02/10/2023 17:56:12	Biakrinpuii	3	A	Quadratic Equations	7
03/10/2023 16:34:50	B.Malsawmzuali	4	A	Quadratic Equations	8
04/10/2023 18:09:23	Chingremmawii	6	A	Quadratic Equations	9
05/10/2023 19:43:37	C.Lalawmpuii	7	A	Quadratic Equations	8
06/10/2023 16:55:11	C.Malsawmsangi	9	A	Quadratic Equations	7
07/10/2023 15:40:22	Esther Lalramhluni	12	A	Quadratic Equations	7
07/10/2023 17:12:09	F.Vanlalrinngheti	15	A	Quadratic Equations	9
08/10/2023 19:03:08	Jessica B.Lalremmawii	17	A	Quadratic Equations	8

02/10/2023 16:22:37	Juliet Lalmuanpuii	18	A	Quadratic Equations	7
03/10/2023 18:44:29	Lalchhanhimi	20	A	Quadratic Equations	7
04/10/2023 20:11:45	Lalfakawmi	22	A	Quadratic Equations	8
05/10/2023 19:22:51	Lalramliani	23	A	Quadratic Equations	9
06/10/2023 20:00:12	Lalrinngheti	25	A	Quadratic Equations	7
07/10/2023 16:50:44	Lalthlengkimi	28	A	Quadratic Equations	8
08/10/2023 18:35:12	Malsawmzuali	31	A	Quadratic Equations	8
03/10/2023 19:02:18	Ruthi Lalneihhlimi	33	A	Quadratic Equations	7
04/10/2023 17:31:59	V.Lalhruaitluangi	34	A	Quadratic Equations	9
05/10/2023 15:54:33	Vanlalawmpuii	35	A	Quadratic Equations	8
06/10/2023 19:20:55	C.Lallawmkima	38	A	Quadratic Equations	7
07/10/2023 18:12:43	Christian Lalramdinthara	39	A	Quadratic Equations	8
08/10/2023 20:23:18	Lalnunfela	40	A	Quadratic Equations	9
02/10/2023 18:45:27	George Lalthansanga	41	A	Quadratic Equations	8
03/10/2023 20:17:11	Gideon Malsawmtluanga	42	A	Quadratic Equations	7
04/10/2023 15:48:56	H.Lalrinpuia	43	A	Quadratic Equations	9
05/10/2023 16:32:40	Javier Saidingpuia	44	A	Quadratic Equations	8
06/10/2023 17:24:37	K.Lalruatpuia	45	A	Quadratic Equations	7
07/10/2023 19:33:25	Lalnunfela	48	A	Quadratic Equations	8
08/10/2023 16:42:03	Vanlalhriatpuii	115	B	Quadratic Equations	9
03/10/2023 15:30:14	Vanlalrindiki	117	B	Quadratic Equations	7
04/10/2023 19:08:46	Zoneihmawii	122	B	Quadratic Equations	8
05/10/2023 18:50:12	Zoremsangi	123	B	Quadratic Equations	7
06/10/2023 16:40:55	C.Lalrinzuala	127	B	Quadratic Equations	9
07/10/2023 17:23:40	Lalruatfela	135	B	Quadratic Equations	8
08/10/2023 20:09:27	Malsawmdawngkima	137	B	Quadratic Equations	7
02/10/2023 20:05:38	Lalvenhima	146	B	Quadratic Equations	8
03/10/2023 16:17:49	MS Tluangzeli	147	B	Quadratic Equations	9
04/10/2023 18:22:34	C.Zomuansangi	202	C	Quadratic Equations	8
05/10/2023 19:58:25	Lalrosangpuii	207	C	Quadratic Equations	7
06/10/2023 15:57:11	Rebecca VL Hmachhuani	215	C	Quadratic Equations	8
07/10/2023 20:00:14	Vanlalhriati	221	C	Quadratic Equations	9
08/10/2023 19:44:01	Josia Lalenkawla	227	C	Quadratic Equations	8
02/10/2023 17:16:50	K.Lalthazuala	228	C	Quadratic Equations	7
03/10/2023 20:45:39	Mesak Lalromawia	237	C	Quadratic Equations	9
04/10/2023 16:32:20	Vanlalduhsaka	241	C	Quadratic Equations	8
27/10/2023 15:32:17	Babie Remruatfeli	2	A	Arithmetic Progression	7
29/10/2023 16:23:45	Biakrinpuii	3	A	Arithmetic Progression	8
24/10/2023 18:07:12	B.Malsawmzuali	4	A	Arithmetic Progression	9
28/10/2023 19:15:09	Chingremmawii	6	A	Arithmetic Progression	8
30/10/2023 17:45:38	C.Lalawmpuii	7	A	Arithmetic Progression	7
26/10/2023 16:54:23	C.Malsawmsangi	9	A	Arithmetic Progression	8
25/10/2023 19:03:50	Esther Lalramhluni	12	A	Arithmetic Progression	7
27/10/2023 18:29:41	F.Vanlalrinngheti	15	A	Arithmetic Progression	9
29/10/2023 20:08:16	Jessica B.Lalremmawii	17	A	Arithmetic Progression	8
24/10/2023 19:34:22	Juliet Lalmuanpuii	18	A	Arithmetic Progression	7
28/10/2023 20:20:17	Lalchhanhimi	20	A	Arithmetic Progression	8

30/10/2023 15:49:27	Lalfakawmi	22	A	Arithmetic Progression	8
25/10/2023 17:12:43	Lalramliani	23	A	Arithmetic Progression	7
26/10/2023 19:55:38	Lalrinngheti	25	A	Arithmetic Progression	9
29/10/2023 15:47:12	Lalthlengkimi	28	A	Arithmetic Progression	7
27/10/2023 20:01:55	Malsawmzuali	31	A	Arithmetic Progression	7
24/10/2023 16:46:30	Ruthi Lalneihhlimi	33	A	Arithmetic Progression	7
28/10/2023 18:52:41	V.Lalhruaitluangi	34	A	Arithmetic Progression	8
30/10/2023 19:25:14	Vanlalawmpuii	35	A	Arithmetic Progression	7
26/10/2023 20:09:33	C.Lallawmkima	38	A	Arithmetic Progression	8
25/10/2023 18:16:27	Christian Lalramdinthara	39	A	Arithmetic Progression	8
29/10/2023 17:36:50	Lalnunfela	40	A	Arithmetic Progression	9
24/10/2023 15:20:44	George Lalthansanga	41	A	Arithmetic Progression	8
28/10/2023 15:59:12	Gideon Malsawmtluanga	42	A	Arithmetic Progression	9
30/10/2023 16:34:19	H.Lalrinpuia	43	A	Arithmetic Progression	8
25/10/2023 19:12:05	Javier Saidingpuia	44	A	Arithmetic Progression	7
26/10/2023 17:50:21	K.Lalruatpuia	45	A	Arithmetic Progression	8
27/10/2023 16:05:47	Lalnunfela	48	A	Arithmetic Progression	7
28/10/2023 16:58:31	Vanlalhriatpuii	115	B	Arithmetic Progression	8
29/10/2023 19:45:07	Vanlalrindiki	117	B	Arithmetic Progression	7
24/10/2023 17:30:12	Zoneihmawii	122	B	Arithmetic Progression	8
30/10/2023 18:42:19	Zoremsangi	123	B	Arithmetic Progression	7
27/10/2023 19:03:25	C.Lalrinzuala	127	B	Arithmetic Progression	8
26/10/2023 18:36:54	Lalruatfela	135	B	Arithmetic Progression	9
25/10/2023 20:11:43	Malsawmdawngkima	137	B	Arithmetic Progression	8
28/10/2023 17:23:09	Lalvenhima	146	B	Arithmetic Progression	7
29/10/2023 18:57:16	MS Tluangzeli	147	B	Arithmetic Progression	7
24/10/2023 19:45:07	C.Zomuansangi	202	C	Arithmetic Progression	8
30/10/2023 20:12:33	Lalrosangpuii	207	C	Arithmetic Progression	7
27/10/2023 15:57:22	Rebecca VL Hmachhuani	215	C	Arithmetic Progression	7
26/10/2023 15:48:13	Vanlalhriati	221	C	Arithmetic Progression	8
29/10/2023 16:36:29	Josia Lalenkawla	227	C	Arithmetic Progression	7
28/10/2023 20:45:00	K.Lalthazuala	228	C	Arithmetic Progression	8
30/10/2023 19:58:11	Mesak Lalromawia	237	C	Arithmetic Progression	7
25/10/2023 16:27:34	Vanlalduhsaka	241	C	Arithmetic Progression	7
04/12/2023 17:23:45	Babie Remruatfeli	2	A	Sets	8
03/12/2023 19:34:22	Biakrinpuii	3	A	Sets	9
06/12/2023 15:47:31	B.Malsawmzuali	4	A	Sets	8
05/12/2023 20:12:50	Chingremmawii	6	A	Sets	9
02/12/2023 18:29:13	C.Lalawmpuii	7	A	Sets	9
06/12/2023 16:05:22	C.Malsawmsangi	9	A	Sets	8
04/12/2023 15:15:40	Esther Lalramhluni	12	A	Sets	8
05/12/2023 19:09:28	F.Vanlalrinngheti	15	A	Sets	9
03/12/2023 17:44:55	Jessica B.Lalremmawii	17	A	Sets	7
06/12/2023 18:39:21	Juliet Lalmuanpuii	18	A	Sets	8
02/12/2023 20:21:13	Lalchhanhimi	20	A	Sets	9
05/12/2023 18:51:47	Lalfakawmi	22	A	Sets	8
04/12/2023 16:30:08	Lalramliani	23	A	Sets	9

06/12/2023 19:23:09	Lalrinngheti	25	A	Sets	8
02/12/2023 15:52:37	Lalthlengkimi	28	A	Sets	8
05/12/2023 17:19:04	Malsawmzuali	31	A	Sets	9
03/12/2023 19:05:44	Ruthi Lalneihhlimi	33	A	Sets	8
06/12/2023 15:58:29	V.Lalhruaitluangi	34	A	Sets	9
04/12/2023 18:11:55	Vanlalawmpuii	35	A	Sets	8
05/12/2023 16:44:51	C.Lallawmkima	38	A	Sets	9
02/12/2023 19:57:26	Christian Lalramdinthara	39	A	Sets	7
06/12/2023 17:35:12	Lalnunfela	40	A	Sets	8
04/12/2023 19:20:48	George Lalthansanga	41	A	Sets	10
03/12/2023 18:43:20	Gideon Malsawmtluanga	42	A	Sets	10
05/12/2023 20:10:17	H.Lalrinpuia	43	A	Sets	8
06/12/2023 20:23:45	Javier Saidingpuia	44	A	Sets	7
02/12/2023 16:05:50	K.Lalruatpuia	45	A	Sets	8
06/12/2023 15:34:11	Lalnunfela	48	A	Sets	9
03/12/2023 20:17:56	Vanlalhriatpuii	115	B	Sets	9
05/12/2023 15:47:21	Vanlalrindiki	117	B	Sets	8
04/12/2023 19:57:33	Zoneihmawii	122	B	Sets	8
06/12/2023 19:02:05	Zoremsangi	123	B	Sets	9
02/12/2023 18:14:39	C.Lalrinzuala	127	B	Sets	7
05/12/2023 16:22:09	Lalruatfela	135	B	Sets	8
04/12/2023 17:42:44	Malsawmdawngkima	137	B	Sets	9
06/12/2023 20:11:27	Lalvenhima	146	B	Sets	9
03/12/2023 16:30:17	MS Tluangzeli	147	B	Sets	8
02/12/2023 17:55:56	C.Zomuansangi	202	C	Sets	8
06/12/2023 18:51:50	Lalrosangpuii	207	C	Sets	9
03/12/2023 15:22:33	Rebecca VL Hmachhuani	215	C	Sets	8
04/12/2023 15:37:29	Vanlalhriati	221	C	Sets	7
06/12/2023 17:29:12	Josia Lalenkawla	227	C	Sets	9
02/12/2023 19:03:41	K.Lalthazuala	228	C	Sets	8
05/12/2023 20:44:30	Mesak Lalromawia	237	C	Sets	9
06/12/2023 16:50:09	Vanlalduhsaka	241	C	Sets	9

5. Appendix-V: LearningMaths Source Code

1. MainActivity.Java

```java
package tluangacolney.learningmaths;


import android.content.Intent;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.view.View;
import android.widget.Button;
public class MainActivity extends AppCompatActivity
{

    Button btn5,btn1,btn4,btn2,btn;

    @Override
    protected void onCreate(Bundle savedInstanceState)
    {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_main);

        btn5 = (Button) findViewById(R.id.button5);
        btn5.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                finish();
                System.exit(0);
            }
        });
        btn1 = (Button) findViewById(R.id.button1);
        btn1.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(MainActivity.this,ContentActivity.class));
            }
        });
        btn4 = (Button) findViewById(R.id.button4);
        btn4.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(MainActivity.this,HelpActivity.class));
            }
        });
        btn2 = (Button) findViewById(R.id.button2);
        btn2.setOnClickListener(new View.OnClickListener()
        {
```

```
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(MainActivity.this,FormulaActivity.class));
            }
        });
        btn = (Button) findViewById(R.id.button);
        btn.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(MainActivity.this,TestActivity.class));
            }
        });
    }
}
```

2. ContentActivity.Java

```
package tluangacolney.learningmaths;

import android.content.Intent;
import android.os.Bundle;
import android.app.Activity;
import android.widget.AdapterView;
import android.widget.ArrayAdapter;
import android.widget.ListView;
import android.view.View;

public class ContentActivity extends Activity {

    static final String[] chaptr = new String[] { "Instalments",
            "Time and Distance",
            "Time and Work",
            "Polynomials",
            "Linear equation in Two Variables",
            "Quadratic Equations",
            "Arithmetic Progression",
            "Sets",
             };

    @Override
    public void onCreate(Bundle savedInstanceState) {

        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_content);

        ArrayAdapter<String>adapter = new
ArrayAdapter<String>(this,R.layout.chapter,chaptr);
        ListView list = (ListView)findViewById(R.id.listView);
        list.setAdapter(adapter);
        list.setOnItemClickListener(new AdapterView.OnItemClickListener()
```

```
{
            @Override
            public void onItemClick(AdapterView<?> parent, View view, int
position, long id) {
                switch (position) {
                    case 0:
                        Intent newActivity = new
Intent(ContentActivity.this, Unit1.class);
                        startActivity(newActivity);
                        break;
                    case 1:
                        Intent newActivity1 = new
Intent(ContentActivity.this, TandDMain.class);
                        startActivity(newActivity1);
                        break;
                    case 2:
                        Intent newActivity2 = new
Intent(ContentActivity.this, TandWMain.class);
                        startActivity(newActivity2);
                        break;
                    case 3:
                        Intent newActivity3 = new
Intent(ContentActivity.this, AlgebraMain.class);
                        startActivity(newActivity3);
                        break;
                    case 4:
                        Intent newActivity4 = new
Intent(ContentActivity.this, LinearEquation.class);
                        startActivity(newActivity4);
                        break;
                    case 5:
                        Intent newActivity5 = new
Intent(ContentActivity.this, QuadraticEquation.class);
                        startActivity(newActivity5);
                        break;
                    case 6:
                        Intent newActivity6 = new
Intent(ContentActivity.this, APMain.class);
                        startActivity(newActivity6);
                        break;
                    case 7:
                        Intent newActivity7 = new
Intent(ContentActivity.this, SetsMain.class);
                        startActivity(newActivity7);
                        break;
                }
            }
            @SuppressWarnings("unused")
            public void onclick(View v) {
            };
        });
    }
}
```

3. InstalmentActivity.Java

```
package tluangacolney.learningmaths;

import android.content.Intent;
import android.os.Bundle;
import android.support.v7.app.AppCompatActivity;
import android.support.v7.widget.LinearLayoutManager;
import android.support.v7.widget.RecyclerView;
import android.view.View;
import android.widget.Button;
import android.widget.TextView;

import java.util.ArrayList;

public class Unit1 extends AppCompatActivity {
    Button btn1,btn2,btn3,btn4,btn5;
    TextView t5;

    RecyclerView recyclerView;
    ArrayList<youTubeVideos> arrayList;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_unit1);
        t5 = (TextView) findViewById(R.id.textView5);

        t5.setVisibility(View.GONE);

        btn1 = (Button) findViewById(R.id.button6);
        btn1.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(tluangacolney.learningmaths.Unit1.this, InstalmentActivity.class));
            }
        });

        btn2 = (Button) findViewById(R.id.button8);
        btn2.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(tluangacolney.learningmaths.Unit1.this,
InstalmentExcersisee.class));
            }
        });
        btn3 = (Button) findViewById(R.id.button21);
        btn3.setOnClickListener(new View.OnClickListener()
        {
```

```
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(tluangacolney.learningmaths.Unit1.this, MCQInstalments.class));
            }
        });
        btn4 = (Button) findViewById(R.id.button23);
        btn4.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                startActivity(new
Intent(tluangacolney.learningmaths.Unit1.this, SelfAssessmentInst.class));
            }
        });
        btn5 = (Button) findViewById(R.id.button32);
        btn5.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                t5.setVisibility((t5.getVisibility() == View.VISIBLE)
                        ? View.GONE : View.VISIBLE);
            }
        });

        recyclerView = findViewById(R.id.recyclerView1);
        recyclerView.setHasFixedSize(true);
        recyclerView.setLayoutManager( new LinearLayoutManager(this));
        arrayList = new ArrayList<youTubeVideos>();

        youTubeVideos youTubeVideos= new
youTubeVideos("https://youtube.com/embed/yBxAbkJRWxk");arrayList.add(youTu
beVideos);
        youTubeVideos= new
youTubeVideos("https://youtube.com/embed/CLI_7znefFE");arrayList.add(youTu
beVideos);
        youTubeVideos= new
youTubeVideos("https://youtube.com/embed/UjyxYkA8sBY");arrayList.add(youTu
beVideos);
        youTubeVideos= new
youTubeVideos("https://youtube.com/embed/PyLl1n5OZu0");arrayList.add(youTu
beVideos);
        VideoAdapter videoAdapter = new VideoAdapter(arrayList, this);
        recyclerView.setAdapter(videoAdapter);

    }
}
```

4. InstalmentCalculator.Java

```
package tluangacolney.learningmaths;

import android.content.DialogInterface;
import android.content.Intent;
import android.support.v7.app.AlertDialog;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.text.Editable;
import android.text.InputFilter;
import android.text.Spanned;
import android.text.TextWatcher;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.LinearLayout;
import android.widget.RadioButton;
import android.widget.RadioGroup;
import android.content.Context;

public class InstalmentActivity extends AppCompatActivity {
    EditText edtcp,edtdp,edtbl,edtrt,edttm,edtin;
    LinearLayout lr2;
    RadioButton r1,r2;
    RadioGroup rg;
    Button soln;
    double dwnpm,blns,inslmn,inrate,intime;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_instalment);

        edtcp = (EditText)findViewById(R.id.editcp);
        edtdp = (EditText)findViewById(R.id.editdp);
        edtbl = (EditText)findViewById(R.id.editbl);
        edtin = (EditText)findViewById(R.id.editins);
        edtrt = (EditText)findViewById(R.id.editrate);
        edtrt.setFilters(new InputFilter[]{new
InputFilterMinMaxr("1","100")});
        edttm = (EditText)findViewById(R.id.edittime);
        edttm.setFilters(new InputFilter[]{new
InputFilterMinMax("1","3")});
        lr2 = (LinearLayout)findViewById(R.id.linearinst2);
        r1 =(RadioButton) findViewById(R.id.find0);
        r2 =(RadioButton) findViewById(R.id.find1);
        rg = (RadioGroup) findViewById(R.id.rginst);
        soln = (Button) findViewById(R.id.instsolve);


        edtbl.addTextChangedListener(new TextWatcher() {
            @Override
            public void beforeTextChanged(CharSequence s, int start, int
count, int after) {

            }
```

```
            @Override
            public void onTextChanged(CharSequence s, int start, int
before, int count) {
                if(s.toString().equals(""))
                {
                    edtin.setVisibility(View.VISIBLE);
                    r2.setVisibility(View.VISIBLE);
                }
                else
                {
                    edtin.setVisibility(View.GONE);
                    r2.setVisibility(View.GONE);
                    r1.setChecked(true);
                }
            }

            @Override
            public void afterTextChanged(Editable s) {


            }
        });
        edtin.addTextChangedListener(new TextWatcher() {
            @Override
            public void beforeTextChanged(CharSequence s, int start, int
count, int after) {

            }

            @Override
            public void onTextChanged(CharSequence s, int start, int
before, int count) {
                if(s.toString().equals(""))
                {
                    edtbl.setVisibility(View.VISIBLE);
                    r1.setVisibility(View.VISIBLE);
                }
                else
                {
                    edtbl.setVisibility(View.GONE);
                    r1.setVisibility(View.GONE);
                    r2.setChecked(true);
                }
            }

            @Override
            public void afterTextChanged(Editable s) {

            }
        });
        edtdp.addTextChangedListener(new TextWatcher() {
            @Override
            public void beforeTextChanged(CharSequence s, int start, int
count, int after) {
```

```
            }

            @Override
            public void onTextChanged(CharSequence s, int start, int
before, int count) {

                if(s.length()!=0 && edtcp.getText().length()!=0)
                {

edtbl.setText(""+(Double.parseDouble(edtcp.getText().toString()) -
Double.parseDouble(s.toString())));
                    edtbl.setEnabled(false);
                }
                else if(edtcp.getText().length()==0)
                {
                    edtbl.getText().clear();
                    edtbl.setEnabled(true);
                }
            }

            @Override
            public void afterTextChanged(Editable s) {

            }
        });
        edtcp.addTextChangedListener(new TextWatcher() {
            @Override
            public void beforeTextChanged(CharSequence s, int start, int
count, int after) {

            }

            @Override
            public void onTextChanged(CharSequence s, int start, int
before, int count) {

                if(s.length()!=0 && edtdp.getText().length()!=0)
                {
                    edtbl.setText(""+(Double.parseDouble(s.toString())-
Double.parseDouble(edtdp.getText().toString())));
                    edtbl.setEnabled(false);
                }
                else if(s.length()!=0 && edtdp.getText().length()==0)
                {
                    edtbl.setText(""+(Double.parseDouble(s.toString())));
                    edtbl.setEnabled(false);
                }
                else
                {
                    edtbl.getText().clear();
                    edtbl.setEnabled(true);
                }
            }

            @Override
            public void afterTextChanged(Editable s) {
```

```
        }
    });

    final Context context = this;
    soln.setOnClickListener(new View.OnClickListener() {
        @Override
        public void onClick(View v) {

            try {dwnpm =
Double.parseDouble(edtdp.getText().toString());}
            catch(final NumberFormatException e) {dwnpm = 0.0;}
            try {blns =
Double.parseDouble(edtbl.getText().toString());}
            catch(final NumberFormatException e) {blns = 0.0;}
            try {inslmn =
Double.parseDouble(edtin.getText().toString());}
            catch(final NumberFormatException e) {inslmn = 0.0;}
            try {inrate =
Double.parseDouble(edtrt.getText().toString());}
            catch(final NumberFormatException e) {inrate = 0.0;}
            try {intime =
Double.parseDouble(edttm.getText().toString());}
            catch(final NumberFormatException e) {intime = 0.0;}

            if((edtbl.getText().toString().equals("") &&
edtin.getText().toString().equals(""))

||edtrt.getText().toString().equals("")||edttm.getText().toString().equals
("") )
            {

                AlertDialog.Builder ald = new
AlertDialog.Builder(context);
                ald.setTitle("Lawks aw..");
                ald.setMessage("I la dah khat kimlo. Solution i hmeh
hma in dah khat kim phawt rawh..");
                ald.setNegativeButton("Aw..", new
DialogInterface.OnClickListener()
                {
                    public void onClick(DialogInterface dialog,int id)
                {
                    dialog.cancel();
                }
                });
                AlertDialog alertdialog = ald.create();
                alertdialog.show();
            }
            else
            {
                if(r1.isChecked())
                {
                    Intent intent = new
Intent(InstalmentActivity.this, InstalmentResult1.class);
                    // passing the double value
                    Bundle c = new Bundle();
```

```
                        c.putDouble("Balance", blns);
                        intent.putExtras(c);
                        Bundle d = new Bundle();
                        d.putDouble("Rate", inrate);
                        intent.putExtras(d);
                        Bundle e = new Bundle();
                        e.putDouble("Time", intime);
                        intent.putExtras(e);
                        startActivity(intent);
                        //finish();
                        edtcp.getText().clear();
                        edtdp.getText().clear();
                        edtbl.getText().clear();
                        edtin.getText().clear();
                        edtrt.getText().clear();
                        edttm.getText().clear();

                    }
                    else
                    {
                        Intent intent = new
Intent(InstalmentActivity.this, InstalmentResult2.class);
                        // passing the int value
                        Bundle b = new Bundle();
                        b.putDouble("Dwnpaymn", dwnpm);
                        intent.putExtras(b);
                        Bundle c = new Bundle();
                        c.putDouble("Instalment", inslmn);
                        intent.putExtras(c);
                        Bundle d = new Bundle();
                        d.putDouble("Rate", inrate);
                        intent.putExtras(d);
                        Bundle e = new Bundle();
                        e.putDouble("Time", intime);
                        intent.putExtras(e);
                        startActivity(intent);
                        //finish();
                        edtcp.getText().clear();
                        edtdp.getText().clear();
                        edtbl.getText().clear();
                        edtin.getText().clear();
                        edtrt.getText().clear();
                        edttm.getText().clear();
                    }
                }

            }

        });

    }

    public class InputFilterMinMax implements InputFilter {

        private int min, max;
```

```
        public InputFilterMinMax(int min, int max) {
            this.min = min;
            this.max = max;
        }

        public InputFilterMinMax(String min, String max) {
            this.min = Integer.parseInt(min);
            this.max = Integer.parseInt(max);
        }

        @Override
        public CharSequence filter(CharSequence source, int start, int
end, Spanned dest, int dstart, int dend) {
            try {
                int input = Integer.parseInt(dest.toString() +
source.toString());
                if (isInRange(min, max, input))
                    return null;
            } catch (NumberFormatException nfe) {
            }
            return "";
        }

        private boolean isInRange(int a, int b, int c) {
            return b > a ? c >= a && c <= b : c >= b && c <= a;
        }
    }

    public class InputFilterMinMaxr implements InputFilter {

        private double min, max;

        public InputFilterMinMaxr(double min, double max) {
            this.min = min;
            this.max = max;
        }

        public InputFilterMinMaxr(String min, String max) {
            this.min = Double.parseDouble(min);
            this.max = Double.parseDouble(max);
    }

        @Override
        public CharSequence filter(CharSequence source, int start, int
end, Spanned dest, int dstart, int dend) {
            try {
                double input = Double.parseDouble(dest.toString() +
source.toString());
                if (isInRange(min, max, input))
                    return null;
            } catch (NumberFormatException nfe) {
            }
            return "";
        }

        private boolean isInRange(double a, double b, double c) {
```

```
            return b > a ? c >= a && c <= b : c >= b && c <= a;
        }
    }
}
```

5. InstalmentCalculatorResult1.Java

```
package tluangacolney.learningmaths;

import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.webkit.WebSettings;
import android.webkit.WebView;
import android.webkit.WebViewClient;

public class InstalmentResult1 extends AppCompatActivity {
    double
plus100,plusagn,r1,r2,r3,x1,x2,x3,tx,ex,inte2,inte1,inte3,plussq,plusmul,s
plus;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_instalment_result1);
        Bundle c = getIntent().getExtras();
        double blns= c.getDouble("Balance");
        Bundle d = getIntent().getExtras();
        double inrate= d.getDouble("Rate");
        Bundle e = getIntent().getExtras();
        double intime= e.getDouble("Time");
        plus100 = inrate +100;
        plusagn = plus100 + 100;
        plussq =plus100*plus100;
        plusmul = plus100*100;
        splus = plussq+plusmul+10000;
        r1=(blns*plus100)/100;
        r2 =blns*(plus100/100)*(plus100/plusagn);
        r3 = blns*(plus100/100)*(plussq/splus);
        x1 = Math.round(r1*100)/100.0d;
        x2= Math.round(r2*100)/100.0d;
        x3= Math.round(r3*100)/100.0d;
        tx = Math.round(2*r2*100)/100.0d;
        ex =Math.round(3*r3*100)/100.0d;
        inte1 = Math.round((x1-blns)*100)/100.0d;
        inte2 =Math.round((tx-blns)*100)/100.0d;
        inte3 = Math.round((ex -blns)*100)/100.0d;
        WebView webView = (WebView)findViewById(R.id.webinstresult1);
        webView.setWebViewClient(new WebViewClient());
        WebSettings webSettings = webView.getSettings();
        webSettings.setJavaScriptEnabled(true);
        String js1 = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
```

```
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s1 = 'SOLUTION :"
                + "<br/>Let the value of instalment be $x$ and $P_1$ be
the " +
                "Principals for the instalments. "
                + "<br/>We have, "
                + "<br/>Sum to be paid = Rs " + blns
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                + " x = $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => x = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = x(100/{"+ plus100 + "})^1$"

                + "<br/>Thus, We have"
                + "<br/>$P_1 =$" + blns
                + "<br/>=> $x(100/{"+ plus100 +"})^1 = $ " +blns
                + "<br/>=> $x = " +blns+ "X"+ plus100 +"/100$"
                + "<br/>=> x = " +x1
                + "<br/>Hence, The value of each instalment is Rs " +x1
                + "<br/>So, Interest to be paid = " +x1+" - "+blns+ " = Rs
"+inte1
                + "';M.parseMath(s1);document.write(s1);</script>
</body>";
        String js2 = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s2 = 'SOLUTION :"
                + "<br/>Let the value of each instalment be $x$ and $P_1$
and $P_2$ be the " +
                "Principals for each instalments respectively. "
                + "<br/>We have, "
                + "<br/>Sum to be paid = Rs " + blns
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                + " x = $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => x = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = x(100/{"+ plus100 + "})^1$"
                + "<br/>and, <br/>x = $P_2(1+{"+ inrate + "}/100)^2$"
                + "<br/>=> x = $P_2({"+ plus100 + "}/100)^2$"
                + "<br/>=> $P_2 = x(100/{"+ plus100 + "})^2$"
                + "<br/>Thus, We have"
                + "<br/>$P_1 + P_2 =$" + blns
                + "<br/>=> $x(100/{"+ plus100 +"})^1 +x(100/{"+ plus100 +
"})^2 = $ " +blns
                + "<br/>=> $100/"+ plus100 +" x(1 +100/"+ plus100 + ") = $
" +blns
```

```
                + "<br/>=> $100/"+ plus100 +" x("+ plusagn +"/"+ plus100 +
") = $ " +blns
                + "<br/>=> $x = " +blns+ "X"+ plus100 +"/100 X "+ plus100
+"/"+ plusagn+"$"
                + "<br/>=> x = " +x2
                + "<br/>Hence, The value of each instalment is Rs " +x2
                + "<br/>So, Interest to be paid = " +tx+" - "+blns+ " = Rs
"+inte2
                + "';M.parseMath(s2);document.write(s2);</script>
</body>";
        String js3 = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s3 = 'SOLUTION :"
                + "<br/>Let the value of each instalment be $x$ and
$P_1$,$P_2$ and $P_3$ be the " +
                "Principals for each instalments respectively. "
                + "<br/>We have, "
                + "<br/>Sum to be paid = Rs " + blns
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                + " x = $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => x = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = x(100/{"+ plus100 + "})^1$"
                + "<br/>and, <br/>x = $P_2(1+{"+ inrate + "}/100)^2$"
                + "<br/>=> x = $P_2({"+ plus100 + "}/100)^2$"
                + "<br/>=> $P_2 = x(100/{"+ plus100 + "})^2$"
                + "<br/>and, <br/>x = $P_3(1+{"+ inrate + "}/100)^3$"
                + "<br/>=> x = $P_3({"+ plus100 + "}/100)^3$"
                + "<br/>=> $P_3 = x(100/{"+ plus100 + "})^3$"
                + "<br/>Thus, We have"
                + "<br/>$P_1 + P_2 + P_3 =$" + blns
                + "<br/>=> $x(100/{"+ plus100 +"})^1 +x(100/{"+ plus100 +
"})^2 + x(100/{"+ plus100 + "})^3= $ " +blns
                + "<br/>=> $100/"+ plus100 +" x[1 +100/"+ plus100 + "+
(100/"+ plus100+")^2] = $ " +blns
                + "<br/>=> $100/"+ plus100 +" x({"+ plussq +"+"+plusmul+
"+"+10000+"}/"+ plussq + ") = $ " +blns
                + "<br/>=> $100/"+ plus100 +" x("+ splus +"/"+ plussq + ")
= $ " +blns
                + "<br/>=> $x = " +blns+ "X"+ plus100 +"/100 X "+ plussq
+"/"+ splus+"$"
                + "<br/>=> x = " +x3
                + "<br/>Hence, The value of each instalment is Rs " +x3
                + "<br/>So, Interest to be paid = " +ex+" - "+blns+ " = Rs
"+inte3
                + "';M.parseMath(s3);document.write(s3);</script>
</body>";
        if(intime==1)
```

```
        {
            webView.loadDataWithBaseURL( "" ,js1,  "text/html",  "UTF-8",
null);
        }
        else if(intime==2)
        {
            webView.loadDataWithBaseURL("", js2, "text/html", "UTF-8",
null);
        }
        else
        {
            webView.loadDataWithBaseURL( "" ,js3,  "text/html",  "UTF-8",
null);
        }

    }
}
```

6. InstalmentCalculatorResult2.Java

```
package tluangacolney.learningmaths;

import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.webkit.WebSettings;
import android.webkit.WebView;
import android.webkit.WebViewClient;

public class InstalmentResult2 extends AppCompatActivity {

    double  plus100,r1,r2,r3,x1,x2,x3,tx,ex,inte2,inte1,inte3,ox,s2,s3;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_instalment_result2);
        Bundle b = getIntent().getExtras();
        double dwnpm= b.getDouble("Dwnpaymn");
        Bundle c = getIntent().getExtras();
        double intmn= c.getDouble("Instalment");
        Bundle d = getIntent().getExtras();
        double inrate= d.getDouble("Rate");
        Bundle e = getIntent().getExtras();
        double intime= e.getDouble("Time");
        plus100 = inrate +100;
        r1=(intmn*100)/plus100;
        r2=intmn*(100/plus100)*(100/plus100);
        r3=intmn*(100/plus100)*(100/plus100)*(100/plus100);
        x1 = Math.round(r1*100)/100.0d;
        x2= Math.round(r2*100)/100.0d;
        x3= Math.round(r3*100)/100.0d;
        ox = x1 + dwnpm;
        tx = x1 +x2+ dwnpm;
        ex =x1 + x2 + x3 + dwnpm;
        s2=x1+x2;
        s3 = x1+x2+x3;
```

```
        inte1 = Math.round((intmn - x1)*100)/100.0d;
        inte2 =Math.round((2*intmn -s2)*100)/100.0d;
        inte3 = Math.round((3*intmn - s3)*100)/100.0d;
        WebView webView = (WebView)findViewById(R.id.webinstresult2);
        webView.setWebViewClient(new WebViewClient());
        WebSettings webSettings = webView.getSettings();
        webSettings.setJavaScriptEnabled(true);
        String js1 = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s1 = 'SOLUTION :"
                + "<br/>Let $P_1$ be the " +
                "principal for the the instalments. "
                + "<br/>We have, "
                + "<br/>Value of Instalment = Rs " + intmn
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                +  intmn +"= $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => "+  intmn +" = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = "+  intmn +"X 100/"+ plus100 + "$"
                + "<br/> => $P_1 = $"+  x1
                + "<br/>Hence, The Cash Price/Loan/Sum borrowed is = $Down
Payment + P_1 $ = Rs " +ox
                + "<br/>So, Interest charged = " +intmn+" - "+x1+ " = Rs
"+inte1
                + "';M.parseMath(s1);document.write(s1);</script>
</body>";
        String js2 = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s2 = 'SOLUTION :"
                + "<br/>Let $P_1$ and $P_2$ be the " +
                "principal for the first and second instalment
respectively "
                + "<br/>We have, "
                + "<br/>Value of each Instalments = Rs " + intmn
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                +  intmn +"= $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => "+  intmn +" = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = "+  intmn +"X 100/"+ plus100 + "$"
                + "<br/> => $P_1 = $"+  x1
```

```
                +"<br/>and, "+  intmn +"= $P_2(1+{"+ inrate + "}/100)^2$"
                + "<br/> => "+  intmn +" = $P_2({"+ plus100 + "}/100)^2$"
                + "<br/> => $P_2 = "+  intmn +"X 100/"+ plus100 + "X 
100/"+ plus100 + "$"
                + "<br/> => $P_2 = $"+  x2
                + "<br/>Hence, The Cash Price/Loan/Sum borrowed is = $Down 
Payment + P_1 + P_2$ = Rs " +tx
                + "<br/>So, Interest charged = " +2*intmn+" - "+s2+ " = Rs 
"+inte2
                + "';M.parseMath(s2);document.write(s2);</script>
</body>";
        String js3 = "<html><head>"
                + "<link rel='stylesheet' 
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s3 = 'SOLUTION :"
                + "<br/>Let $P_1$,$P_2$ and $P_3$ be the " +
                "principal for the first, second and third instalment 
respectively "
                + "<br/>We have, "
                + "<br/>Value of each Instalments = Rs " + intmn
                + "<br/> Rate of Interest = " + inrate +"% per annum"

                +"<br/>We know that, $$ A = P{(1+ R/100)}^n$$ "
                +  intmn +"= $P_1(1+{"+ inrate + "}/100)^1$"
                + "<br/> => "+  intmn +" = $P_1({"+ plus100 + "}/100)^1$"
                + "<br/> => $P_1 = "+  intmn +"X 100/"+ plus100 + "$"
                + "<br/> => $P_1 = $"+  x1
                +"<br/>and, "+  intmn +"= $P_2(1+{"+ inrate + "}/100)^2$"
                + "<br/> => "+  intmn +" = $P_2({"+ plus100 + "}/100)^2$"
                + "<br/> => $P_2 = "+  intmn +"X 100/"+ plus100 + "X 
100/"+ plus100 + "$"
                + "<br/> => $P_2 = $"+  x2
                +"<br/>and, "+  intmn +"= $P_3(1+{"+ inrate + "}/100)^3$"
                + "<br/> => "+  intmn +" = $P_3({"+ plus100 + "}/100)^3$"
                + "<br/> => $P_3 = "+  intmn +"X 100/"+ plus100 + "X 
100/"+ plus100 +"X 100/"+ plus100 + "$"
                + "<br/> => $P_3 = $"+  x3
                + "<br/>Hence, The Cash Price/Loan/Sum borrowed is = $Down 
Payment + P_1 + P_2 + P_3$ = Rs " +ex
                + "<br/>So, Interest charged = " +3*intmn+" - "+s3+ " = Rs 
"+inte3
                + "';M.parseMath(s3);document.write(s3);</script>
</body>";
        if(intime==1)
        {
            webView.loadDataWithBaseURL( "" ,js1,  "text/html",  "UTF-8", 
null);
        }
        else if(intime==2)
        {
```

```
            webView.loadDataWithBaseURL("", js2, "text/html", "UTF-8",
null);
        }
        else
        {
            webView.loadDataWithBaseURL( "" ,js3,  "text/html",  "UTF-8",
null);
        }
    }
}
```

7. InstalmentExcercise.Java

```
package tluangacolney.learningmaths;

import android.content.Intent;
import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.view.View;
import android.widget.AdapterView;
import android.widget.ArrayAdapter;
import android.widget.ListView;

public class InstalmentExcersisee extends AppCompatActivity {
    static final String[] chaptr = new String[] {
            "1. A loan of Rs 21,200 is to be returned in two equal annual
instalments. If the rate of interest is 12% per annum, compounded
annually, calculate the value of each instalment.",
            "2. A TV is sold for 3,300 cash down payment along with two
equal yearly instalments of Rs 8470 each. If the dealer charges interest
at 10% per annum, compounded annually under the instalment plan, find the
cash price of the TV.",
            "3. Biaktea Purchased a computer in instalment plan by paying
Rs 5,612.50 cash down followed by three equal half yearly instalments of
Rs 8,788 each. If the rate of interest charge was 8% per annum, compounded
half yearly, find the cash price of the computer. Also, find the total
interest charged.",
            "4. The cash price of a car is Rs 70,000. Lucas agrees to pay
Rs 21,200 in cash followed by three equal annual instalments. If the
dealer charges interest of 25% per annum, compounded annually, find the
value of each instalment.",
            "5. A loan of Rs 36,720 is to be returned in two equal annual
instalments. If the rate of interest is 12.5% per annum compounded
annually, calculate the value of each instalments.",
            "6. Jayden took a loan from the State Bank of India at 12% per
annum, compounded annually. He paid it back in two equal instalments of Rs
78,400 each. Find the loan and total interest paid by him.",
            "7. What annual payment will discharge a debt of Rs 25,410 due
in two years at 10% per annum compounded annually?",
            "8. Zela borrowed a certain sum of money at 12% per annum,
compounded annually. He paid it back in two equal instalments of Rs 39,200
each. What sum did he borrowed?",

    };
```

```
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_instalment_excersisee);

        ArrayAdapter<String> adapter = new
ArrayAdapter<String>(this,R.layout.question,chaptr);
        ListView list = (ListView)findViewById(R.id.listtandd);
        list.setAdapter(adapter);
        list.setOnItemClickListener(new AdapterView.OnItemClickListener()
{
            @Override
            public void onItemClick(AdapterView<?> parent, View view, int
position, long id) {
                switch (position) {
                    case 0:
                        Intent newActivity1 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle b = new Bundle();
                        b.putInt("switchna", 1);
                        newActivity1.putExtras(b);
                        startActivity(newActivity1);
                        break;
                    case 1:
                        Intent newActivity2 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle c = new Bundle();
                        c.putInt("switchna", 2);
                        newActivity2.putExtras(c);
                        startActivity(newActivity2);
                        break;
                    case 2:
                        Intent newActivity3 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle d = new Bundle();
                        d.putInt("switchna", 3);
                        newActivity3.putExtras(d);
                        startActivity(newActivity3);
                        break;
                    case 3:
                        Intent newActivity4 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle e = new Bundle();
                        e.putInt("switchna", 4);
                        newActivity4.putExtras(e);
                        startActivity(newActivity4);
                        break;
                    case 4:
                        Intent newActivity5 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle f = new Bundle();
                        f.putInt("switchna", 5);
                        newActivity5.putExtras(f);
                        startActivity(newActivity5);
                        break;
                    case 5:
```

```
                        Intent newActivity6 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle g = new Bundle();
                        g.putInt("switchna", 6);
                        newActivity6.putExtras(g);
                        startActivity(newActivity6);
                        break;
                    case 6:
                        Intent newActivity7 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle h = new Bundle();
                        h.putInt("switchna", 7);
                        newActivity7.putExtras(h);
                        startActivity(newActivity7);
                        break;
                    case 7:
                        Intent newActivity8 = new
Intent(InstalmentExcersisee.this, InstResult.class);
                        Bundle i = new Bundle();
                        i.putInt("switchna", 8);
                        newActivity8.putExtras(i);
                        startActivity(newActivity8);
                        break;

                }
            }
            @SuppressWarnings("unused")
            public void onclick(View v) {
            };
        });
    }
}
```

8. InstalmentMCQ.Java

```
package tluangacolney.learningmaths;

import android.os.Bundle;

import android.support.v7.app.AppCompatActivity;
import android.webkit.WebSettings;
import android.webkit.WebView;
import android.webkit.WebViewClient;

public class MCQInstalments extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_m_c_q_instalments);

        WebView webView = (WebView)findViewById(R.id.webView);
        webView.setWebViewClient(new WebViewClient());
        WebSettings webSettings = webView.getSettings();
        webSettings.setJavaScriptEnabled(true);
```

```
        String js = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s = '1. The sum of the present values (or
the principals) of all instalments is equal to – (MBSE 2017)"
                + "<br/> (i) Amount <br/> (ii) Interest <br/> (iii) Sum
borrowed <br/> (iv) Instalments"
                + "<br/> Solution: Sum Borrowed"
                + "<br/> 2. A Radio is available for ₹ 2500 cash or ₹ 1000
cash down payment along with " +
                "two equal annual instalments of ₹ 800 each, then the
total interest charged is – (MBSE 2018)"
                + "<br/> (i) ₹ 170 <br/> (ii) ₹ 150 <br/> (iii) ₹ 100
<br/> (iv) ₹ 250"
                + "<br/> Solution: The total interest charged = 2 ×
Instalments + Cash Down Payment – Cost Price"
                + "<br/> = 2 × ₹ 800 + ₹ 1000 – ₹ 2500"
                + "<br/> = ₹ 1600 + ₹ 1000 – ₹ 2500"
                + "<br/> = ₹ 2600 – ₹ 2500 = ₹ 100"
                + "<br/> 3. An article costs ₹ 10,000. It is purchased in
two annual instalments of ₹ 6,000 " +
                "each. The total interest charged is (MBSE 2020)"
                + "<br/> (i) ₹ 16,000 <br/> (ii) ₹ 6,000 <br/> (iii) ₹
4,000 <br/> (iv) ₹ 2,000"
                + "<br/> Solution: Total interest charged = time ×
instalment – S.P"
                + "<br/> = 2 × 6,000 – 10,000"
                + "<br/> = 12,000 – 10,000"
                + "<br/> = ₹ 2,000"

                + "';M.parseMath(s);document.write(s);</script> </body>";
        webView.loadDataWithBaseURL( "" ,js,  "text/html",  "UTF-8",
null);

    }
}
```

9. InstalmentSAT.Java

```
package tluangacolney.learningmaths;


import java.util.List;
import java.util.concurrent.TimeUnit;

import android.annotation.SuppressLint;
import android.os.Bundle;
import android.app.Activity;
import android.content.Intent;
```

```java
import android.os.CountDownTimer;
import android.text.Html;
import android.util.Log;
import android.view.Menu;
import android.view.View;
import android.widget.Button;
import android.widget.RadioButton;
import android.widget.RadioGroup;
import android.widget.TextView;
import android.widget.Toast;

public class SelfAssessmentInst extends Activity {
    List<Question> quesList;
    int score=0;
    int qid=0;
    Question currentQ;
    RadioButton rda, rdb, rdc,rdd;
    Button butNext;
    TextView txtQuestion, times;
    RadioGroup rdgroup;
    CountDownTimer timer;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_self_assessment_inst);
        DbHelperInst db=new DbHelperInst(this);
        quesList=db.getAllQuestions();
        currentQ=quesList.get(qid);
        txtQuestion=(TextView)findViewById(R.id.testtext);
        rda=(RadioButton)findViewById(R.id.radio0);
        rdb=(RadioButton)findViewById(R.id.radio1);
        rdc=(RadioButton)findViewById(R.id.radio2);
        rdd=(RadioButton)findViewById(R.id.radio3);
        butNext=(Button)findViewById(R.id.next);
        rdgroup = (RadioGroup)findViewById(R.id.radioGroup1);
        rdgroup.clearCheck();
        butNext.setVisibility(View.GONE);
        setQuestionView();

        // the textview in which score will be displayed

        // the timer
        times = (TextView) findViewById(R.id.timers);


        // method which will set the things up for our game

        times.setText("00:00:60");

        // A timer of 60 seconds to play for, with an interval of 1 second
(1000 milliseconds)
        timer = new CounterClass(240000, 1000);
        timer.start();

        rdgroup.setOnCheckedChangeListener(new
RadioGroup.OnCheckedChangeListener() {
```

```java
            @SuppressLint("ResourceType")
            @Override
            public void onCheckedChanged(RadioGroup group, int checkedid)
            {
                RadioButton rd =
(RadioButton)group.findViewById(checkedid);
                if (null!= rd && checkedid>-1)
                {
                    butNext.setVisibility(View.VISIBLE);}
            }
        });

        butNext.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {

                timer.cancel();
                timer.start();

                RadioGroup grp=(RadioGroup)findViewById(R.id.radioGroup1);
                RadioButton
answer=(RadioButton)findViewById(grp.getCheckedRadioButtonId());
                if(currentQ.getANSWER().equals(answer.getText()))
                {
                    // if conditions matches increase the int (score) by 1
                    // and set the text of the score view
                    score++;
                }
                if (qid < 10)
                {
                    // if questions are not over then do this
                    currentQ = quesList.get(qid);
                    setQuestionView();

                }
                else
                {
                    timer.cancel();
                    // if over do this
                    Intent intent = new Intent(SelfAssessmentInst.this,
                            SAIResult.class);
                    Bundle b = new Bundle();
                    b.putInt("score", score); // Your score
                    intent.putExtras(b); // Put your score to your next
                    startActivity(intent);
                    finish();
                }

                rdgroup.clearCheck();
                butNext.setVisibility(View.GONE);

            }

        });

    }
```

```
    //@TargetApi(Build.VERSION_CODES.GINGERBREAD)
    //@SuppressLint("NewApi")
    public class CounterClass extends CountDownTimer {

        public CounterClass(long millisInFuture, long countDownInterval) {
            super(millisInFuture, countDownInterval);

        }

        @Override
        public void onFinish() {
            times.setText("Hun a zo");
            Intent intent = new Intent(SelfAssessmentInst.this,
                    SAIResult.class);
            Bundle b = new Bundle();
            b.putInt("score", score); // Your score
            intent.putExtras(b); // Put your score to your next
            startActivity(intent);
            finish();
        }

        @Override
        public void onTick(long millisUntilFinished) {


            long millis = millisUntilFinished;
            String hms = String.format(
                    "%02d:%02d:%02d",
                    TimeUnit.MILLISECONDS.toHours(millis),
                    TimeUnit.MILLISECONDS.toMinutes(millis)
                            -
TimeUnit.HOURS.toMinutes(TimeUnit.MILLISECONDS
                            .toHours(millis)),
                    TimeUnit.MILLISECONDS.toSeconds(millis)
                            -
TimeUnit.MINUTES.toSeconds(TimeUnit.MILLISECONDS
                            .toMinutes(millis)));
            System.out.println(hms);
            times.setText(hms);
        }
    }
    @Override
    public boolean onCreateOptionsMenu(Menu menu) {
        // Inflate the menu; this adds items to the action bar if it is
present.
        getMenuInflater().inflate(R.menu.activity_test, menu);
        return true;
    }
    private void setQuestionView()
    {
        txtQuestion.setText(Html.fromHtml(currentQ.getQUESTION()));
        rda.setText(currentQ.getOPTA());
        rdb.setText(currentQ.getOPTB());
        rdc.setText(currentQ.getOPTC());
        rdd.setText(currentQ.getOPTD());
```

```
        qid++;
    }
    @Override
    public void onBackPressed(){
        super.onBackPressed();
        timer.cancel();
    }
}
```

10. InstalmentSATresult.Java

```
package tluangacolney.learningmaths;

import android.app.ProgressDialog;
import android.content.Intent;
import android.os.Bundle;
import android.support.v7.app.AppCompatActivity;
import android.view.View;
import android.widget.Button;
import android.widget.EditText;
import android.widget.RatingBar;
import android.widget.TextView;
import android.widget.Toast;

import com.android.volley.AuthFailureError;
import com.android.volley.DefaultRetryPolicy;
import com.android.volley.NetworkError;
import com.android.volley.NoConnectionError;
import com.android.volley.ParseError;
import com.android.volley.Request;
import com.android.volley.RequestQueue;
import com.android.volley.Response;
import com.android.volley.RetryPolicy;
import com.android.volley.ServerError;
import com.android.volley.TimeoutError;
import com.android.volley.VolleyError;
import com.android.volley.toolbox.StringRequest;
import com.android.volley.toolbox.Volley;

import java.util.HashMap;
import java.util.Map;

public class SAIResult extends AppCompatActivity {

    EditText name,roll,sec;
Button btntg2;
int score;

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_s_a_i_result);
        name = (EditText)findViewById(R.id.name);
        roll = (EditText)findViewById(R.id.rollno);
        sec = (EditText)findViewById(R.id.section);
```

```
        RatingBar bar=(RatingBar)findViewById(R.id.ratingBar1);
        bar.setNumStars(5);
        bar.setStepSize(0.5f);
        //get text view
        TextView t=(TextView)findViewById(R.id.textResult);
        btntg2 = (Button) findViewById(R.id.btntag2);

        btntg2.setVisibility(View.GONE);
        name.setVisibility(View.GONE);
        roll.setVisibility(View.GONE);
        sec.setVisibility(View.GONE);
        //get score
        Bundle b = getIntent().getExtras();
        score= b.getInt("score");
        int rate = Math.round(score*50/85);
        //display score
        bar.setRating(rate);
        switch (rate)
        {
            case 0:t.setText(" Zir that leh i ngai nasa hle mai.. I score
zat chu " + " " + score + " " + "a ni e.");
                break;
            case 1:t.setText(" A lehpekah chuan tha deuhin i ti dawn nia!
I score zat chu " + " " + score + " " + "a ni e.");
                break;
            case 2: t.setText(" Hma sawn na tur tam tak ala awm ania.. I
score zat chu " + " " + score + " " + "a ni e.");
                break;
            case 3:t.setText(" Umm..a tha dawn e.. I score zat chu " + " "
+ score + " " + "a ni e.");
                break;
            case 4:t.setText("Tu emaw chu a in zir nasa hle mai. Chapter
dang zir leh ang aw.. I score zat chu " + " " + score + " " + "a ni e.");
                name.setVisibility(View.VISIBLE);
                roll.setVisibility(View.VISIBLE);
                sec.setVisibility(View.VISIBLE);
            btntg2.setVisibility(View.VISIBLE);
            break;
            case 5:t.setText("He chapter hi chu i thiam tawh. Chapter dang
zir leh ang aw.. I score zat chu " + " " + score + " " + "a ni e.");
                name.setVisibility(View.VISIBLE);
                roll.setVisibility(View.VISIBLE);
                sec.setVisibility(View.VISIBLE);
                btntg2.setVisibility(View.VISIBLE);
                break;
        }
        Button btntg = (Button) findViewById(R.id.btntag);
        btntg.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {
                finish();
                startActivity(new
Intent(SAIResult.this,SelfAssessmentInst.class));
```

```
            }
        });


        btntg2.setOnClickListener(new View.OnClickListener()
        {
            @Override
            public void onClick(View v)
            {

                if ( ( name.getText().toString().trim().equals("")))
                {
                    name.setError( "Name is required!" );
                }
                else if (( roll.getText().toString().trim().equals("")))
                {
                    roll.setError( "Roll No. is required!" );
                }
                else if (( sec.getText().toString().trim().equals("")))
                {
                    sec.setError( "Section is required!" );
                }
                else {
                    addItemToSheet();
                    finish();
                   // startActivity(new Intent(SAIResult.this,
ContentActivity.class));
                }
            }
        });
    }
    private void   addItemToSheet() {

        final String na = name.getText().toString();
        final String ro = roll.getText().toString();
        final String se = sec.getText().toString();
        final ProgressDialog loading =
ProgressDialog.show(this,"Submitting","Please wait");

        StringRequest stringRequest = new
StringRequest(Request.Method.POST,
"https://script.google.com/macros/s/AKfycbzDfaQzRh5UNwiE-
IJIeYUErYhLjE4BXLEWuBLpy4EC44AlW5118yhKA0rM2btDxpC9/exec",
                new Response.Listener<String>() {

                    @Override
                    public void onResponse(String response)

                    {
                        try {
                            loading.dismiss();

Toast.makeText(SAIResult.this,response,Toast.LENGTH_LONG).show();
                            Intent intent = new
Intent(getApplicationContext(),Unit1.class);
```

```
                                startActivity(intent);
                            }
                            catch (Exception e){}
                        }

                    },
                    new Response.ErrorListener() {
                        String message = null;
                        @Override
                        public void onErrorResponse(VolleyError volleyError) {
                            loading.dismiss();
                            if (volleyError instanceof NetworkError ||
volleyError instanceof AuthFailureError || volleyError instanceof
NoConnectionError || volleyError instanceof TimeoutError) {
                                message = "Cannot connect to Internet";
                            } else if (volleyError instanceof ServerError) {
                                message = "The server could not be found.
Please try again later";
                            }  else if (volleyError instanceof ParseError) {
                                message = "Parsing error! Please try again
later";
                            }
                        }
                    })
        {
            @Override
            protected Map<String, String> getParams() {
                Map<String, String> parmas = new HashMap<>();

                //here we pass params
                parmas.put("action","addItem");
                parmas.put("name",na);
                parmas.put("roll",ro);
                parmas.put("section",se);
                parmas.put("topic","Instalment");
                parmas.put("marks", String.valueOf(score));
                return parmas;
            }
        };
        int socketTimeOut = 50000;// u can change this .. here it is 50
seconds
        RetryPolicy retryPolicy = new DefaultRetryPolicy(socketTimeOut, 0,
DefaultRetryPolicy.DEFAULT_BACKOFF_MULT);
        stringRequest.setRetryPolicy(retryPolicy);
        RequestQueue mRequestQueue = Volley.newRequestQueue(this);
                mRequestQueue.add(stringRequest);

        }

    }
```

11. DBHelperInstalment.Java

```
package tluangacolney.learningmaths;


import android.content.ContentValues;
import android.content.Context;
import android.database.Cursor;
import android.database.sqlite.SQLiteDatabase;
import android.database.sqlite.SQLiteOpenHelper;

import java.util.ArrayList;
import java.util.List;

public class DbHelperInst extends SQLiteOpenHelper {
    private static final int DATABASE_VERSION = 1;
    // Database Name
    private static final String DATABASE_NAME = "instadata";
    // tasks table name
    private static final String TABLE_QUEST = "quest";
    // tasks Table Columns names
    private static final String KEY_ID = "id";
    private static final String KEY_QUES = "question";
    private static final String KEY_ANSWER = "answer"; //correct option
    private static final String KEY_OPTA= "opta"; //option a
    private static final String KEY_OPTB= "optb"; //option b
    private static final String KEY_OPTC= "optc"; //option c
    private static final String KEY_OPTD= "optd"; //option d
    private SQLiteDatabase dbase;
    public DbHelperInst(Context context) {
        super(context, DATABASE_NAME, null, DATABASE_VERSION);
    }
    @Override
    public void onCreate(SQLiteDatabase db) {
        dbase=db;
        String sql = "CREATE TABLE IF NOT EXISTS " + TABLE_QUEST + " ( "
                + KEY_ID + " INTEGER PRIMARY KEY AUTOINCREMENT, " +
KEY_QUES
                + " TEXT, " + KEY_ANSWER+ " TEXT, "+KEY_OPTA +" TEXT, "
                +KEY_OPTB +" TEXT,"+KEY_OPTC +" TEXT, "+KEY_OPTD+" TEXT)";
        db.execSQL(sql);
        addQuestions();
        //db.close();
    }
    private void addQuestions()
    {
        Question q1=new Question("Sum of present values of all instalments
is equal " +
                "to- (HSLC - 2017)",
                "Sum borrowed", "Amount", "interest","instalment", "Sum
borrowed");
        this.addQuestion(q1);
        Question q2=new Question("On compound interest,if the interest is
compounded half-yearly," +
                "then the time period becomes twice and rate is",
```

```
                "Same", "Doubled", "Halved","One-fourth", "Halved");
        this.addQuestion(q2);
        Question q3=new Question("Ruati borrowed Rs P at certain rate of 
compound interest and paid back in three " +
                "equal instalments of Rs Q each.Then total interest paid 
by her " +
                "is",
                "Rs (P-3Q)", "Rs (3Q-P)","Rs (3P-Q)","Rs (P+Q)","Rs (3Q-
P)");
        this.addQuestion(q3);
        Question q4=new Question("Kunga borrowed Rs 6625 at 25% 
p.a.,compounded annually. He paid it " +
                "back in two equal annual instalments of Rs 3920 each. The 
amount of interest charged " +
                "is",
                "Rs 470.40", "Rs 795", "Rs 1215","Rs 2705","Rs 1215");
        this.addQuestion(q4);
        Question q5=new Question("A Radio is available for Rs 2500 cash or 
Rs 1000 cash down payment along with two equal \n" +
                "annual instalments of Rs 800 each, then the total 
interest charged is – (HSLC 2018) ",
                "Rs 170","Rs 150","Rs 100","Rs 80","Rs 100");
        this.addQuestion(q5);
        Question q6=new Question("An article costs Rs 10,000. It is 
purchased in two annual instalments of Rs 6,000 each. The total \n" +
                "interest charged is- (HSLC 2020) " ,
                "Rs 16,000","Rs 6,000","Rs 4,000","Rs 2,000","Rs 2,000");
        this.addQuestion(q6);
        Question q7=new Question(" The sum to be paid in cash under an 
instalment plan at the time of purchase of an article is \n" +
                "called – (HSLC 2023) ",
                "cash price","cash down 
payment","instalment","principal","cash down payment");
        this.addQuestion(q7);
        Question q8=new Question(" A loan has to be paid in two equal 
annual instalments. If the rate of interest is 15% per annum,\n" +
                "compounded annually and each instalment is Rs 2,645, the 
total interest charged is- (HSLC 2023)",
                "Rs 990","Rs 1000","Rs 1200","Rs 1500","Rs 990");
        this.addQuestion(q8);
        Question q9=new Question("Mawia borrowed Rs 7,950 at 12% per annum 
compounded annually. If he pays it back in two equal \n" +
                "annual instalments, the value of each instalment is - 
(HSLC 2021)",
                "Rs 3,000","Rs 3,704","Rs 4,000","Rs 4,704","₹ 4,704");
        this.addQuestion(q9);
        Question q10=new Question("A motor cycle was sold by a shopkeeper 
for a cash down payment of Rs 34,000 along with two equal \n" +
                "annual instalments of Rs 12,000 each. If the rate of 
interest charged was 25% per annum compounded \n" +
                "annually, the cash price of the motor cycle is - (HSLC 
2018)",
                "Rs 61,280","Rs 55,280","Rs 51,280","Rs 50,280","Rs 
51,280");
        this.addQuestion(q10);
```

```java
    }
    @Override
    public void onUpgrade(SQLiteDatabase db, int oldV, int newV) {
        // Drop older table if existed
        db.execSQL("DROP TABLE IF EXISTS " + TABLE_QUEST);
        // Create tables again
        onCreate(db);
    }
    // Adding new question
    public void addQuestion(Question quest) {
        //SQLiteDatabase db = this.getWritableDatabase();
        ContentValues values = new ContentValues();
        values.put(KEY_QUES, quest.getQUESTION());
        values.put(KEY_ANSWER, quest.getANSWER());
        values.put(KEY_OPTA, quest.getOPTA());
        values.put(KEY_OPTB, quest.getOPTB());
        values.put(KEY_OPTC, quest.getOPTC());
        values.put(KEY_OPTD, quest.getOPTD());
        // Inserting Row
        dbase.insert(TABLE_QUEST, null, values);
    }
    public List<Question> getAllQuestions() {
        List<Question> quesList = new ArrayList<Question>();
        // Select All Query
        String selectQuery = "SELECT  * FROM " + TABLE_QUEST + " ORDER BY
RANDOM()";
        dbase=this.getReadableDatabase();
        Cursor cursor = dbase.rawQuery(selectQuery, null);
        // looping through all rows and adding to list
        if (cursor.moveToFirst()) {
            do {
                Question quest = new Question();
                quest.setID(cursor.getInt(0));
                quest.setQUESTION(cursor.getString(1));
                quest.setANSWER(cursor.getString(2));
                quest.setOPTA(cursor.getString(3));
                quest.setOPTB(cursor.getString(4));
                quest.setOPTC(cursor.getString(5));
                quest.setOPTD(cursor.getString(6));
                quesList.add(quest);
            } while (cursor.moveToNext());
        }
        // return quest list
        return quesList;
    }
    public int rowcount()
    {
        int row=0;
        String selectQuery = "SELECT  * FROM " + TABLE_QUEST;
        SQLiteDatabase db = this.getWritableDatabase();
        Cursor cursor = db.rawQuery(selectQuery, null);
        row=cursor.getCount();
        return row;
    }
}
```

12. MultipleChoiceQuestion(Quiz) Activity.Java

```java
package tluangacolney.learningmaths;


import java.util.List;
import java.util.concurrent.TimeUnit;

import android.annotation.SuppressLint;
import android.os.Bundle;
import android.app.Activity;
import android.content.Intent;
import android.os.CountDownTimer;
import android.text.Html;
import android.util.Log;
import android.view.Menu;
import android.view.View;
import android.widget.Button;
import android.widget.RadioButton;
import android.widget.RadioGroup;
import android.widget.TextView;
import android.widget.Toast;

public class TestActivity extends Activity {
    List<Question> quesList;
    int score=0;
    int qid=0;
    int lfe =5;
    Question currentQ;
    RadioButton rda, rdb, rdc,rdd;
    Button butNext;
    TextView txtQuestion, times, scored,life;
    RadioGroup rdgroup;
    CountDownTimer timer;
    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_test);
        DbHelper db=new DbHelper(this);
        quesList=db.getAllQuestions();
        currentQ=quesList.get(qid);
        txtQuestion=(TextView)findViewById(R.id.testtext);
        rda=(RadioButton)findViewById(R.id.radio0);
        rdb=(RadioButton)findViewById(R.id.radio1);
        rdc=(RadioButton)findViewById(R.id.radio2);
        rdd=(RadioButton)findViewById(R.id.radio3);
        butNext=(Button)findViewById(R.id.next);
        rdgroup = (RadioGroup)findViewById(R.id.radioGroup1);
        rdgroup.clearCheck();
        butNext.setVisibility(View.GONE);
        setQuestionView();

        // the textview in which score will be displayed
        scored = (TextView) findViewById(R.id.score);
        life = (TextView) findViewById(R.id.life);
```

```
        // the timer
        times = (TextView) findViewById(R.id.timers);


        // method which will set the things up for our game

        times.setText("00:00:60");

        // A timer of 60 seconds to play for, with an interval of 1 second
(1000 milliseconds)
        timer = new CounterClass(120000, 1000);
        timer.start();

       rdgroup.setOnCheckedChangeListener(new
RadioGroup.OnCheckedChangeListener() {
            @SuppressLint("ResourceType")
            @Override
            public void onCheckedChanged(RadioGroup group, int checkedid)
            {
                RadioButton rd =
(RadioButton)group.findViewById(checkedid);
                if (null!= rd && checkedid>-1)
                {
                    butNext.setVisibility(View.VISIBLE);}
            }
       });

        butNext.setOnClickListener(new View.OnClickListener() {
            @Override
            public void onClick(View v) {

                timer.cancel();
                timer.start();

                RadioGroup grp=(RadioGroup)findViewById(R.id.radioGroup1);
                RadioButton
answer=(RadioButton)findViewById(grp.getCheckedRadioButtonId());
                Log.d("yourans", currentQ.getANSWER()+"
"+answer.getText());
                if(currentQ.getANSWER().equals(answer.getText()))
                     {
                        // if conditions matches increase the int (score)
by 1
                        // and set the text of the score view
                        score++;
                         Log.d("score", "Your score"+score);
                        scored.setText("Score : " + score);
                    }
                else
                    {
                        lfe--;
                        life.setText("Chance : " + lfe);
                        Toast.makeText(getApplicationContext(),"Answer :
"+currentQ.getANSWER(),Toast.LENGTH_LONG).show();
                    }
                if (qid < 150)
```

```java
            {
                // if questions are not over then do this
                currentQ = quesList.get(qid);
                setQuestionView();
            }
            else
            {
                timer.cancel();
                // if over do this
                Intent intent = new Intent(TestActivity.this,
                        TestResultActivity.class);
                Bundle b = new Bundle();
                b.putInt("score", score); // Your score
                intent.putExtras(b); // Put your score to your next
                startActivity(intent);
                finish();

            }
            if (lfe==0)
            {
                timer.cancel();
                // if unlucky start activity and finish the game
                Intent intent = new Intent(TestActivity.this,
                        TestResultActivity.class);
                // passing the int value
                Bundle b = new Bundle();
                b.putInt("score", score); // Your score
                intent.putExtras(b); // Put your score to your next
                startActivity(intent);
                finish();
            }
            rdgroup.clearCheck();
            butNext.setVisibility(View.GONE);

        }

    });


}


//@TargetApi(Build.VERSION_CODES.GINGERBREAD)
//@SuppressLint("NewApi")
public class CounterClass extends CountDownTimer {

    public CounterClass(long millisInFuture, long countDownInterval) {
        super(millisInFuture, countDownInterval);

    }


    @Override
    public void onFinish() {
        times.setText("Hun a zo");
        Intent intent = new Intent(TestActivity.this,
```

```
                TestResultActivity.class);
        Bundle b = new Bundle();
        b.putInt("score", score); // Your score
        intent.putExtras(b); // Put your score to your next
        startActivity(intent);
        finish();
    }

    @Override
    public void onTick(long millisUntilFinished) {


        long millis = millisUntilFinished;
        String hms = String.format(
                "%02d:%02d:%02d",
                TimeUnit.MILLISECONDS.toHours(millis),
                TimeUnit.MILLISECONDS.toMinutes(millis)
                        -
TimeUnit.HOURS.toMinutes(TimeUnit.MILLISECONDS
                        .toHours(millis)),
                TimeUnit.MILLISECONDS.toSeconds(millis)
                        -
TimeUnit.MINUTES.toSeconds(TimeUnit.MILLISECONDS
                        .toMinutes(millis)));
        System.out.println(hms);
        times.setText(hms);
    }
}
@Override
public boolean onCreateOptionsMenu(Menu menu) {
    // Inflate the menu; this adds items to the action bar if it is
present.
    getMenuInflater().inflate(R.menu.activity_test, menu);
    return true;
}
private void setQuestionView()
{
    txtQuestion.setText(Html.fromHtml(currentQ.getQUESTION()));
    rda.setText(currentQ.getOPTA());
    rdb.setText(currentQ.getOPTB());
    rdc.setText(currentQ.getOPTC());
    rdd.setText(currentQ.getOPTD());
    qid++;
}
@Override
public void onBackPressed(){
    super.onBackPressed();
    timer.cancel();
}

}
```

13. MCQDBHelper.Java

```
package tluangacolney.learningmaths;


import android.content.ContentValues;
import android.content.Context;
import android.database.Cursor;
import android.database.sqlite.SQLiteDatabase;
import android.database.sqlite.SQLiteOpenHelper;

import java.util.ArrayList;
import java.util.List;
public class DbHelper extends SQLiteOpenHelper {
    private static final int DATABASE_VERSION = 1;
    // Database Name
    private static final String DATABASE_NAME = "mathstestna";
    // tasks table name
    private static final String TABLE_QUEST = "quest";
    // tasks Table Columns names
    private static final String KEY_ID = "id";
    private static final String KEY_QUES = "question";
    private static final String KEY_ANSWER = "answer"; //correct option
    private static final String KEY_OPTA= "opta"; //option a
    private static final String KEY_OPTB= "optb"; //option b
    private static final String KEY_OPTC= "optc"; //option c
    private static final String KEY_OPTD= "optd"; //option d
    private SQLiteDatabase dbase;
    public DbHelper(Context context) {
        super(context, DATABASE_NAME, null, DATABASE_VERSION);
    }
    @Override
    public void onCreate(SQLiteDatabase db) {
        dbase=db;
        String sql = "CREATE TABLE IF NOT EXISTS " + TABLE_QUEST + " ( "
                + KEY_ID + " INTEGER PRIMARY KEY AUTOINCREMENT, " +
KEY_QUES
                + " TEXT, " + KEY_ANSWER+ " TEXT, "+KEY_OPTA +" TEXT, "
                +KEY_OPTB +" TEXT,"+KEY_OPTC +" TEXT, "+KEY_OPTD+" TEXT)";
        db.execSQL(sql);
        addQuestions();
        //db.close();
    }
    private void addQuestions()
    {
        Question q1=new Question("Sum of present values of all instalments
is equal " +
                "to- (HSLC - 2017)", "Sum borrowed", "Amount",
"interest","instalment", "Sum borrowed");
        this.addQuestion(q1);
        Question q2=new Question("On compound interest,if the interest is
compounded half-yearly," +
                "then the time period becomes twice and rate is", "Same",
"Doubled", "Halved","One-fourth", "Halved");
        this.addQuestion(q2);
```

```
        Question q3=new Question("Ruati borrowed Rs P at certain rate of
compound interest and paid back in three " +
                "equal instalments of Rs Q each.Then total interest paid
by her " +
                "is","Rs(P-3Q)", "Rs(3Q-P)","Rs(3P-Q)","Rs(P+Q)","Rs(3Q-
P)");
        this.addQuestion(q3);
        Question q4=new Question("Kunga borrowed Rs 6625 at 25%
p.a.,compounded annually. He paid it " +
                "back in two equal annual instalments of Rs 3920 each. The
amount of interest charged " +
                "is",  "Rs 470.40", "Rs 795", "Rs 1215","Rs 2705","Rs
1215");
        this.addQuestion(q4);
        Question q5=new Question("The compound interest on Rs 25000 at 10%
per annum for 3 year " +
                "is","Rs 1000","Rs 1331","Rs 3275","Rs 8275","Rs 8275");
        this.addQuestion(q5);
        Question q6=new Question("If Speed = p, Distance = q and Time = r,
then r is equal " +
                "to","p/q","q/p","pq","None of these","q/p");
        this.addQuestion(q6);
        Question q7=new Question("Ruata crosses a path 600 m long in 5
minutes. His speed in km/hr " +
                "is","7.2","8.2","12","10","7.2");
        this.addQuestion(q7);
        Question q8=new Question("A speed of 54 km/hr equals to (HSLC -
2017)","16 m/s","15 m/s","5 m/s","1 m/s","15 m/s");
        this.addQuestion(q8);
        Question q9=new Question("How long does a train 200 metres long
running at the rate of 80 km/hr " +
                "take to cross an electricity pole?","2.5 seconds","5
seconds","8 seconds","9 seconds","9 seconds");
        this.addQuestion(q9);
        Question q10=new Question("A train running at the speed of 90
km/hr passes a pole on the " +
                "platform in 18 seconds. The length of the train in metres
is","500m","450m","625m","650m","450m");
        this.addQuestion(q10);
        Question q11=new Question("Seni goes to a certain village by her
Car at the speed of 15 km/hr " +
                "and comes back to the same point at the speed of 30
km/hr. Her average speed for the whole " +
                "journey is","45 km/hr","15 km/hr","22.5 km/hr","20
km/hr","20 km/hr");
        this.addQuestion(q11);
        Question q12=new Question("A gun is fired at a distance of 3.32 km
from Liani. She hears the sound " +
                "10 seconds later. The speed of the sound is","303
m/s","332 m/s","335 m/s","336 m/s","332 m/s");
        this.addQuestion(q12);
        Question q13=new Question("Walking at 3/4 of his usual pace,Thanga
reaches his factory 20 minutes " +
                "late. His usual time to reach is","1 hour","2 hour","3
hour","4 hour","1 hour");
        this.addQuestion(q13);
```

```
        Question q14=new Question("Mawii performs 1/5 of her journey by 
Bus,2/5 by Train and " +
                "the remaining 20 km on Motorcycle. Her total journey " +
                "is","50.4 km","55.6 km","30 km","50 km","50 km");
        this.addQuestion(q14);
        Question q15=new Question("Suppose 'A' can do a piece of work in 
'n' days. He can do 2/5 of " +
                "the same work in","5/2 days","5n/2 days","2n/5 
days","2/5n days","2n/5 days");
        this.addQuestion(q15);
        Question q16=new Question("Piana and Biaka can do a piece of work 
in 6 days, Piana alone can " +
                "do it in 10 days. What time will Biaka required to do it 
" +
                "alone?","30 days","25 days","15 days","16 days","15 
days");
        this.addQuestion(q16);
        Question q17=new Question("A and B can do a piece of work in 10 
days, B and C in 15 days, " +
                "C and A in 30 days.In how many days can they do it all 
working " +
                "together (HSLC - 2017)","10 days","11 days","15 days","8 
days","10 days");
        this.addQuestion(q17);
        Question q18=new Question("Suppose a tap fills a tank in 'n' 
hours. Then part of the tank " +
                "filled by the tap in 'm' hours is","m/n","n/m","mn","-
m/n","m/n");
        this.addQuestion(q18);
        Question q19=new Question("A tank which has leak in the bottom is 
filled in 20 hours. Had " +
                "there been no leak in the bottom, it would have been 
filled in 15 hours. The" +
                "leak can empty the tank in","15 hours","5 hours","75 
hours","60 hours","60 hours");
        this.addQuestion(q19);
        Question q20=new Question("Two pipes A and B can fill a cistern in 
15 minutes and 30 minutes " +
                "respectively. The cistern has an outlet C also. If all 
the three pipes are opened " +
                "together the cistern is filled in 20 minutes. The outlet 
pipe C can empty a full " +
                "cistern in","34 minutes","44 minutes","40 minutes","30 
minutes","40 minutes");
        this.addQuestion(q20);
        Question q21=new Question("If the product of the roots of the 
equation " +
                "x<sup><small>2</small></sup> - 3x + k = 10 is -2, the 
value of k " +
                "is","-2","8","-8","10","8");
        this.addQuestion(q21);
        Question q22=new Question("Sum of zeros of polynomial " +
                "6x<sup><small>2</small></sup> - 7x - 3 = 0 " +
                "is","-7/6","-1/2","6","None of these","None of these");
        this.addQuestion(q22);
        Question q23=new Question("If A and B are the roots of the
```

```
equation " +
                "x<sup><small>2</small></sup> + 2x - 24 = 0, " +
                "then the value of AB/(A+B) is","24","-12","12","-
24","12");
        this.addQuestion(q23);
        Question q24=new Question("The zeros of the polynomial " +
                "(x<sup><small>2</small></sup> - 2x - 99) are",
                "-9 and 11","9 and 11","-9 and -11","9 and -11","-9 and
11");
        this.addQuestion(q24);
        Question q25=new Question("If one zero of the polynomial " +
                "(x<sup><small>2</small></sup> + 3x + k) is 2, " +
                "then the value of k is","10","5","-5","-10","-10");
        this.addQuestion(q25);
        Question q26=new Question("If one zeros of the quadratic
polynomial " +
                "x<sup><small>2</small></sup> + (a+1)x + b are 2 and -3, "
+
                "then","a=5,b=-1","a=-7,b=-1","a=0,b=-6","a=2,b=-
6","a=0,b=-6");
        this.addQuestion(q26);
        Question q27=new Question("The additive inverse of (x+3)/(x-7) " +
                "is","(x+3)/(x-7)","(x-7)/(x+3)","-(x+3)/(x+7)","-
(x+3)/(x-7)","-(x+3)/(x-7)");
        this.addQuestion(q27);
        Question q28=new Question("The multiplicative inverse of (x-
1)/(x+5) " +
                "is (HSLC - 2017)","(x-1)/(x+5)","(x+5)/(x-1)","-(x-
1)/(x+5)","-(x+5)/(x-1)","(x+5)/(x-1)");
        this.addQuestion(q28);
        Question q29=new Question("The HCF of (x-
3)<sup><small>2</small></sup>" +
                "(x+4)<sup><small>2</small></sup> and (x-1)(x+4)(x-3) " +
                "is","(x+4)(x-3)","(x-1)(x-3)","(x+4)(x-1)","(x+4)(x-3)(x-
1)","(x+4)(x-3)");
        this.addQuestion(q29);
        Question q30=new Question("The LCM of f(x) =
(x+3)<sup><small>2</small></sup>" +
                "(x+1)<sup><small>2</small></sup>(x-2) and g(x)
=(x+1)(x+3)(x+4) " +
                "is","(x+1)(x+3)(x+4)","(x+1)(x-
2)(x+3)(x+4)","(x+1)(x+1)(x-2)(x+3)(x+4)",
                "(x+1)(x+1)(x-2)(x+3)(x+3)(x+4)","(x+1)(x+1)(x-
2)(x+3)(x+3)(x+4)");
        this.addQuestion(q30);
        Question q31=new Question("If (x-1) is the HCF of
(x<sup><small>2</small></sup> - 1) " +
                "and ax<sup><small>2</small></sup> - b(x-1),) " +
                "then","a = 2b","b = 2a","3a = 2b","2a = 3b","a = 2b");
        this.addQuestion(q31);
        Question q32=new Question("If the HCF of two polynomials A and B
is C, then their LCM " +
                "is","AB/C","AC/B","BC/A","None of these","AB/C");
        this.addQuestion(q32);
        Question q33=new Question("Graphically, the system of two linear
equations " +
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                "(6x-3y+11=0) and (2x-y+8=0) represents two lines which " +
                "are","intersecting at exactly one point","parallel","coincident",
                "intersecting at exactly two point","parallel");
        this.addQuestion(q33);
        Question q34=new Question("If a system of two linear equations is consistent, " +
                "then the lines will be" +
                "are","parallel","always coincident","intersecting or coincident",
                "always intersecting","intersecting or coincident");
        this.addQuestion(q34);
        Question q35=new Question("The system of two linear equations (x+2y+7=0) and (-3x-6y+4=0) " +
                "has","a unique solution","exactly two solutions","infinitely many solution",
                "no solution","no solution");
        this.addQuestion(q35);
        Question q36=new Question("If the graph lines of a system of two linear equations intersect " +
                "at a point, then the system of equations is said to " +
                "have","A unique solution","Infinitely many solution","No solution",
                "None of these","A unique solution");
        this.addQuestion(q36);
        Question q37=new Question("The system of equations x = a and y = b graphically represents lines " +
                "which are","intersecting at(a,b)","intersecting at(b,a)","coincident",
                "parallel","intersecting at(a,b)");
        this.addQuestion(q37);
        Question q38=new Question("For what value of k, do the equations (3x-y+9=0) and (6x-ky+18=0) " +
                "represent coincident lines","-1/2","1/2","2","-2","2");
        this.addQuestion(q38);
        Question q39=new Question("The system of equations (5x-15y=8) and (3x-9y=24/5) " +
                "has","a unique solution","two solution","Infinitely many solution","No solution","Infinitely many solution");
        this.addQuestion(q39);
        Question q40=new Question("If the lines given by (3x+2ky=2) and (2x+5y=-1) are parallel, then " +
                "the value of k is","15/4","2/5","-5/4","3/2","15/4");
        this.addQuestion(q40);
        Question q41=new Question("The value of 'a' for which the system of equations (ax-y=2) and (6x-2y=3) " +
                "will have infinitely many solutions is","12","-3","3","no value","no value");
        this.addQuestion(q41);
        Question q42=new Question("One equation of a system of dependent linear equations is " +
                "(-5x+7y=2). The second equation can be","-10x+14y+4=0","10x-14y=-4",
                "10x+14y+4=0","-10x+14y-4=0","10x-14y=-4");
        this.addQuestion(q42);
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        Question q43=new Question("A system of linear equations is which
has a unique solution " +
                "x=2,y=-3 is","x-4y-14=0 and 5x-y-13=0","2x+5y+11=0 and 4x
+10y+22=0",
                "2x-y-1=0 and 3x+2y=0","2x-3y+5=0 and x+y-1=0","x-4y-14=0
and 5x-y-13=0");
        this.addQuestion(q43);
        Question q44=new Question("If x=a,y=b is the solution of the
equations " +
                "x-y=2 and x+y=4, then the value of a and b are " +
                "respectively","5 and 3","3 and 1","3 and 5","-1 and -
3","3 and 1");
        this.addQuestion(q44);
        Question q45=new Question("(x+2)<sup><small>2</small></sup> = 2(x-
3) is " +
                "a","Linear equation","Quadratic equation","Cubic
equation","Biquadratic equation","Quadratic equation");
        this.addQuestion(q45);
        Question q46=new Question("If a quadratic equation
ax<sup><small>2</small></sup> + bx + c = 0," +
                "has real and equal roots, then each root is
","b/2a","2a/b","-b/a","-b/2a","-b/2a");
        this.addQuestion(q46);
        Question q47=new Question("The nature of the roots
3x<sup><small>2</small></sup> - 4x + 5 = 0," +
                "is ","Real and equal","Real and unequal","No real
roots","None of these","No real roots");
        this.addQuestion(q47);
        Question q48=new Question("The quadratic equation has real and
unequal roots " +
                "if","D>0","D=0","D<0","None of these","D>0");
        this.addQuestion(q48);
        Question q49=new Question("If a quadratic equation
ax<sup><small>2</small></sup> + bx + c = 0, " +
                "has real and equal roots, then the value of" +
                "b<sup><small>2</small></sup>
is","ac","2ac","3ac","4ac","4ac");
        this.addQuestion(q49);
        Question q50=new Question("Value of k for which the quadratic
equation" +
                " 2x<sup><small>2</small></sup> - kx + k = 0, has equal
roots" +
                "is ","0 and 8","4","8 only","0 only","0 and 8");
        this.addQuestion(q50);
        Question q51=new Question("The discriminant of the quadratic
equation " +
                " 4x<sup><small>2</small></sup> - 5x + 3 = 0 " +
                "is ","15","20","23","-23","-23");
        this.addQuestion(q51);
        Question q52=new Question("The equation
x<sup><small>2</small></sup> - 4x + p = 0 " +
                "has real and equal roots when the value of p
is","1","2","3","4","4");
        this.addQuestion(q52);
        Question q53=new Question("In an AP, if d=-
4,n=7,a<sub><small>n</small></sub>=4, " +
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                    "then a is","28","24","7","6","28");
        this.addQuestion(q53);
        Question q54=new Question("In an AP, if
a=9.6,d=4.6,a<sub><small>n</small></sub>=9.2, " +
                    "then n is","2","3","4","5","5");
        this.addQuestion(q54);
        Question q55=new Question("The 6th term from the end of an
AP:17,14,11.... -40 is (HSLC 2017)","25","-25","35","-35","-25");
        this.addQuestion(q55);
        Question q56=new Question("The 31st term of an AP whose first two
terms are -3 and 4" +
                    " is","27","207","213","-213","207");
        this.addQuestion(q56);
        Question q57=new Question("If 6/5,a,4 are in AP, the value of a" +
                    " is","13/5","13","1","26/5","13/5");
        this.addQuestion(q57);
        Question q58=new Question("If the common difference of an AP is 5,
then what is " +
                    "a<sub><small>19</small></sub> -
a<sub><small>14</small></sub> " +
                    "?","5","13","25","30","25");
        this.addQuestion(q58);
        Question q59=new Question("What is the common difference of an AP
is 5 in which " +
                    "a<sub><small>19</small></sub> -
a<sub><small>15</small></sub>=36" +
                    "?","9","-9","-4","4","9");
        this.addQuestion(q59);
        Question q60=new Question("The sum of first 100 natural number
is","4650","4750","5000","5050","5050");
        this.addQuestion(q60);
        Question q61=new Question("In an AP, if
a=1,a<sub><small>n</small></sub>=20," +
                    "S<sub><small>n</small></sub>=399, then n " +
                    "is","42","38","21","17","38");
        this.addQuestion(q61);
        Question q62=new Question("The sum of first 16 term of the
AP:10,6,2... " +
                    "is","320","-420","-320","-362","-320");
        this.addQuestion(q62);
        Question q63=new Question("If U={1,2,3,4,5,6,7,8,9} and
E={1,2,5,7,8} then (U-E) " +

"is","{1,2,5,7,8}","{3,4,5,6}","{3,4,6,9}","{1,2,3,4,7,8}","{3,4,6,9}");
        this.addQuestion(q63);
        Question q64=new Question("If U={1,2,3,4,5,6,7,8,9,10},X
={1,2,3,4} and " +
                    "Y ={2,3,6,10} then (X-Y)' (HSLC 2017)" +

"is","{1,4}","{2,3,5,6,7,8,9,10}","{2,3}","{6,10}","{2,3,5,6,7,8,9,10}");
        this.addQuestion(q64);
        Question q65=new Question("If X is a subset of Y, then X-Y is
equal " +
                    "to","Y-X","X","Y","{}","{}");
        this.addQuestion(q65);
        Question q66=new Question("If U={a,b,c,d,e,f},
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E={a,b,c},F={c,d,e,f} and G={c,d,e}," +
                "then (EUF)nG is equal
to","{c,d,e}","{a,b,c}","{c,d,e,f}","{a,b,c,d,e,f}","{c,d,e}");
        this.addQuestion(q66);
        Question q67=new Question("In a group of 65 people, 40 like
apples, 10 like both apples and bananas. " +
                "How many people like Bananas only? (HSLC 2017)
","25","35","50","75","25");
        this.addQuestion(q67);
        Question q68=new Question("In a committee, 50 people speak French,
20 speak Spanish and " +
                "10 speak both French and Spanish.How many speak at least
one of these " +
                "language","10","20","50","60","60");
        this.addQuestion(q68);
        Question q69=new Question("In a group of persons, 100 persons know
Hindi, 50 know English " +
            "and 25 know both.How many persons are there in the
group?","25","75","125","150","125");
        this.addQuestion(q69);
        Question q70=new Question("If X is universal set and A is a subset
of X, then AUA' is equal " +
                "to","{}","X","X'","A","X");
        this.addQuestion(q70);
        Question q71=new Question("D and E are the points on the sides AB
and AC of a triangle ABC " +
                "such that AD=2cm,BD=3cm,BC=7.5cm and DE parallel BC. Then
length of BC" +
                "is","2cm","3cm","4.5cm","5.5cm","3cm");
        this.addQuestion(q71);
        Question q72=new Question("In two triangles ABC and PQR, if
AB/QR=BC/PR=CA/PQ, " +
                "then","Triangle BCA is similar to triangle PQR","Triangle
CBA is similar to triangle PQR"
                ,"Triangle PQR is similar to triangle ABC","Triangle PQR
is similar to triangle CAB",
                "Triangle PQR is similar to triangle CAB");
        this.addQuestion(q72);
        Question q73=new Question("In two triangles ABC and DEF, angle B =
angle E, angle F = angle C " +
                "and AB = 3DE. Then the two triangles are ","Similar but
not congruent",
                "Congruent as well as similar","Congruent but not
similar",
                "Neither congruent nor similar","Similar but not
congruent");
        this.addQuestion(q73);
        Question q74=new Question("It is given that triangles ABC is
similar to triangle PQR, with " +
                "BC/QR=1/3. Then (area of PRQ)/(area of BCA) is equal
to","1/9","1/3","3","9","9");
        this.addQuestion(q74);
        Question q75=new Question("The lengths of the diagonals of
arhombus are 16cm and 12cm. Then " +
                "the length of the side of the rhombus
is","10cm","9cm","8cm","20cm","10cm");
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        this.addQuestion(q75);
        Question q76=new Question("In triangle ABC,AB=3cm, AC=5cm and
BC=4cm. Then the degree of angle B " +
                "is","120","60","90","45","90");
        this.addQuestion(q76);
        Question q77=new Question("Sides of the similar triangle are in
the ratio 4:9. Area of these" +
                " triangles are in the
ratio","2:3","4:9","81:16","16:81","16:81");
        this.addQuestion(q77);
        Question q78=new Question("If a line is drawn parallel to one side
of a triangle to intersect " +
                "the other two sides in distinct points, then the other
two sides are divided in the " +
                "same ratio. This is called","Pythagoras
theorem","Midpoint theorem","Thales theorem",
                "Alternate segment theorem","Thales theorem");
        this.addQuestion(q78);
        Question q79=new Question("In triangle ABC, AD is the internal
bisector of angle A, such that " +
                "AB=10cm,AC=14cm and BC=6cm, then CD
=","3.5cm","4.8cm","5cm","7cm","3.5cm");
        this.addQuestion(q79);
        Question q80=new Question("In right triangle ABC, right angled at
C, the hypotenuse " +
                "is","AC","BC","AB","CB","AB");
        this.addQuestion(q80);
        Question q81=new Question("ABCD is a cyclic quadrilateral such
that AB is a diameter of the " +
                "circle circumscribing it and angle ADC = 140, then angle
BAC is equal " +
                "to","70","50","40","30","50");
        this.addQuestion(q81);
        Question q82=new Question("If tangents PA and PB from a point P to
a circle with centre O " +
                "are inclined to each other at angle of 60, then angle POA
is equal " +
                "to","50","60","70","80","60");
        this.addQuestion(q82);
        Question q83=new Question("If radii of two concentric circles are
4cm and 5cm, then the " +
                "length of each chord of one circle which is tangent to
the other circle " +
                "is","9cm","1cm","3cm","6cm","6cm");
        this.addQuestion(q83);
        Question q84=new Question("At one end of a diameter AB of a circle
of radius 5cm, tangent " +
            "XAY is drawn to the circle. The length of the chord CD
parallel to XY at a distance " +
            "8cm from A is","5cm","6cm","7cm","8cm","8cm");
        this.addQuestion(q84);
        Question q85=new Question("How many tangents can be drawn to two
circles which intersect " +
                "each other at two points?","1","2","3","4","2");
        this.addQuestion(q85);
        Question q86=new Question("Every cyclic parallelogram is " +
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            "a","rectangle","rhombus","square","trapezium","rectangle");
        this.addQuestion(q86);
        Question q87=new Question("The ratio of the perimeters of two
similar triangles is the same " +
                "as the ratio of their
corresponding","medians","altitudes","angle bisector","sides","sides");
        this.addQuestion(q87);
        Question q88=new Question("If the bisector of an angle of a
triangle bisects the opposite side," +
                "then the triangle
is","Isosceles","Scalene","Equilateral","Right angled","Isosceles");
        this.addQuestion(q88);
        Question q89=new Question("At a point 5cm away from the centre of
the circle whose radius is " +
                "3cm. Then the length of the tangent from point P
is","1cm","2cm","3cm","4cm","4cm");
        this.addQuestion(q89);
        Question q90=new Question("AB and CD are two chords of circle
which when produced meet a " +
                "point P. If PA=16cm,PC=12cm,PD=8cm. Then the measure of
AB " +
                "is","10cm","20cm","26cm","28cm","10cm");
        this.addQuestion(q90);
        Question q91=new Question("To divide a line segment AB in the
ratio 3:7 a ary AX is drawn first " +
                "such that the points A1,A2,...are located at equal
distance on the ray AX then the" +
                " point B is joined to","A9","A10","A11","A12","A10");
        this.addQuestion(q91);
        Question q92=new Question("We can construct tangents to a circle",
                "At a point on it using the centre","At a point on it
without using the centre",
                "From a point outside it","All of the above","All of the
above");
        this.addQuestion(q92);
        Question q93=new Question("The distance between the points A(0,5)
and B(0,-3) " +
                "is","2 units","3 units","6 units","8 units","8 units");
        this.addQuestion(q93);
        Question q94=new Question("The distance of the points A(-6,8) from
the origin " +
                "is (HSLC 2017)","10 units","8 units","7 units","6
units","10 units");
        this.addQuestion(q94);
        Question q95=new Question("The distance between the points A(2,-2)
and B(-1,y) " +
                "is 5,one of the values of y is","1","-1","2","-2","2");
        this.addQuestion(q95);
        Question q96=new Question("AOBC is a rectangle whose three
vertices are A(0,3),O(0,0) and" +
                " B(5,0). The length of its diagonal is","3 units","4
units", "5 units","5.8 units","5.8 units");
        this.addQuestion(q96);
        Question q97=new Question("The mid point of the line segment
joining the points A(-1,7) and " +
                "B(-5,-3) is","(-3,-5)","(1,5)","(-3,2)","(3,1)","(-
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3,2)");
        this.addQuestion(q97);
        Question q98=new Question("The points which lies on the
perpendicular bisector of the line " +
                "segment joining the points A(-3,-6) and B(3,6)
is","(0,0)","(0,3)","(3,0)","(-3,0)","(0,0)");
        this.addQuestion(q98);
        Question q99=new Question("The mid-point of the line segment
joining the points A(2,-3) " +
                "and B(-4,7) lies in (HSLC 2017)","I Quadrant","II
Quadrant","III Quadrant","IV Quadrant","II Quadrant");
        this.addQuestion(q99);
        Question q100=new Question("If C(a/3,4) is the mid point of the
line segment joining the " +
                "points A(-6,5) and B(-2,3), then the value of a is","-
12","12","-4","4","-12");
        this.addQuestion(q100);
        Question q101=new Question("If the points P(2,1) lies on the line
segment joining the " +
                "points A(-4,-2) and B(8,4), then
","4AP=PB","2AP=AB","3AP=AB","3PB=AB","2AP=AB");
        this.addQuestion(q101);
        Question q102=new Question("If the points A(1,2),O(0,0) and B(a,b)
are collinear, " +
                "then ","2a=b","a=2b","a=-b","a=b","2a=b");
        this.addQuestion(q102);
        Question q103=new Question("9cot<sup><small>2</small></sup>A -
9cosec<sup><small>2</small></sup>A " +
                "= (HSLC 2017)","9","-9","1","0","-9");
        this.addQuestion(q103);
        Question q104=new Question("The value of
sin<sup><small>2</small></sup>A + " +
                "1/(1 + tan<sup><small>2</small></sup>A is","1","0","-
1","2","1");
        this.addQuestion(q104);
        Question q105=new Question("If
sec<sup><small>2</small></sup>A(1+sinA)(1-sinA)= k " +
                "the value of k is","-1","0","2","1","1");
        this.addQuestion(q105);
        Question q106=new Question("If 5x=secA and 5/x= tanA,the value of
" +
                "5(x<sup><small>2</small></sup>-
1/x<sup><small>2</small></sup>) " +
                "is","1","0","1/5","5","1/5");
        this.addQuestion(q106);
        Question q107=new Question("If (secA+tanA)=p and (secA-tanA)=q,
then 'pq' is equal " +
                "to","0","1","-1","2","1");
        this.addQuestion(q107);
        Question q108=new Question("cot<sup><small>2</small></sup>A - " +
                "cosec<sup><small>2</small></sup>A =","0","1","-1","2","-
1");
        this.addQuestion(q108);
        Question q109=new Question("If 3cotA = 4 and A is acute then cosA
=","3/4","4/3","3/5","4/5","4/5");
        this.addQuestion(q109);
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        Question q110=new Question("The value of tan29/cot61 is","-
1","0","1","2","1");
        this.addQuestion(q110);
        Question q111=new Question("The value of (sin46-cos44) is","-
1","0","1","2","0");
        this.addQuestion(q111);
        Question q112=new Question("The value of
(sin<sup><small>2</small></sup>47 + " +
                "sin<sup><small>2</small></sup>43) is","-
1","0","1","2","1");
        this.addQuestion(q112);
        Question q113=new Question("The value of
(sec<sup><small>2</small></sup>62 - " +
                "cosec<sup><small>2</small></sup>28) is","-
1","0","1","2","0");
        this.addQuestion(q113);
        Question q114=new Question("The value of
tan22.tan32.tan45.tan58.tan68 is (HSLC 2017)","-1","0","2","1","1");
        this.addQuestion(q114);
        Question q115=new Question("The value of cos55.cos35 - sin55.sin35
is","-1","0","2","1","0");
        this.addQuestion(q115);
        Question q116=new Question("The value of (sin12.sec60.sin78 +
sec60.cos12.cos78) " +
                "is","-1","0","2","1","2");
        this.addQuestion(q116);
        Question q117=new Question("A pole 6m long casts a shadow 6m long
on the ground, then the " +
                "Sun's elevation in degree is","30","45","60","90","45");
        this.addQuestion(q117);
        Question q118=new Question("A ladder 15 metres long just reaches
the top of a vertical wall " +
                "the ladder makes an angle of 60 degreewith the wall. Then
the height of the wall " +
                "is","7.5m","26m","8.7m","15m","7.5m");
        this.addQuestion(q118);
        Question q119=new Question("A 30m long rope is tightly stretched
from top of a vertical pole " +
                "to the ground and makes an angle of 30 degree. The height
of the pole " +
                "is","10m","15m","22m","30m","15m");
        this.addQuestion(q119);
        Question q120=new Question("A kite is attached to a string. If the
kite is flying at a height " +
                "of 45m and the string makes an angle of 30 degree with
the ground, then the length" +
                "of the string is","60m","90m","120m","225m","90m");
        this.addQuestion(q120);
        Question q121=new Question("If the circumference of a circle is
1232cm, then the radius of " +
                "the circle is (HSLC
2017)","176cm","186cm","196cm","198cm","196cm");
        this.addQuestion(q121);
        Question q122=new Question("If the area of a circle is 616 sq.cm,
then the radius of " +
                "the circle is","7cm","14cm","15.2cm","16.5cm","14cm");
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        this.addQuestion(q122);
        Question q123=new Question("If the perimeter and the area of a 
circle are numerically equal, " +
            "then the radius of the circle 
is","1units","2units","3units","4units","2units");
        this.addQuestion(q123);
        Question q124=new Question("If the perimeter of a circle is equal 
to that of a square, then " +
                "the ratio of their areas 
is","7:22","22:7","14:11","11:14","14:11");
        this.addQuestion(q124);
        Question q125=new Question("The area of a circle that can be 
inscribed in a square of side " +
                "6cm is","9.42 sq.cm","18.84 sq.cm","28.26 sq.cm","37.68 
sq.cm","28.26 sq.cm");
        this.addQuestion(q125);
        Question q126=new Question("A solid piece of iron in the form of a 
cuboid of dimensions " +
                "(49cm X 33cm X 24cm) is moulded to form a solid sphere. 
The radius of the sphere" +
                "is","19cm","21cm","23cm","25cm","21cm");
        this.addQuestion(q126);
        Question q127=new Question("Twelve solid sphere of the same size 
are made by melting a solid " +
                "metallic cylinder of base diameter 2cm and height 16cm. 
The diameter of each sphere " +
                "is","6cm","4cm","3cm","2cm","2cm");
        this.addQuestion(q127);
        Question q128=new Question("A hollow cube of internal edge 22cm is 
filled with spherical " +
                "marbles of diameter 0.5cm and it is assumed that 1/8 
space of the cube remains " +
                "unfilled. Then the number of marbles that the cube can 
accommodate " +
                "is","142296","145596","145496","143496","142296");
        this.addQuestion(q128);
        Question q129=new Question("The volume of the largest right 
circular cone that can be cut out" +
                " from a cube of edge 4.2cm is","19.4 cu.cm","9.7 
cu.cm","58.2 cu.cm","77.6 cu.cm","19.4 cu.cm");
        this.addQuestion(q129);
        Question q130=new Question("A right circular cylinder of radius R 
cm and height H cm(H>2R) " +
                "just encloses a sphere of diameter","R cm","H cm","2R 
cm","2H cm","2R cm");
        this.addQuestion(q130);
        Question q131=new Question("The radii of ends of a frustum of a 
cone 16 cm high are 20 cm and 8 cm. " +
                "Its slant height is (HSLC 2017)","20 cm","25 cm","28 
cm","33 cm","20 cm");
        this.addQuestion(q131);
        Question q132=new Question("If the radius of the base of a right 
circular cylinder is halved, " +
                "keeping the height same, then tha ratio of the volume of 
the cylinder thus obtained " +
                "to the volume of original cylinder
```

```
is","1:2","2:1","1:4","4:1","1:4");
        this.addQuestion(q132);
        Question q133=new Question("While computing mean of groupped data 
we assume that the frequencies " +
                "are","centered at the lower limits of the 
class","centered at the class marks of the class",
                "centered at the upper limits of the class","evenly 
centered over all the class",
                "centered at the class marks of the class");
        this.addQuestion(q133);
        Question q134=new Question("Construction of a cummulative 
frequency table is useful " +
                "in determining the","Mean","Median","Mode","All of the 
above","Mean");
        this.addQuestion(q134);
        Question q135=new Question("If Median = 10, Mode = 8, then the 
value of Mean " +
                "is","18","15","11","9","11");
        this.addQuestion(q135);
        Question q136=new Question("Which of the following is the 
probability of an " +
                "event? (HSLC 2017)","-
0.005","1.006","18/25","9/8","18/25");
        this.addQuestion(q136);
        Question q137=new Question("The probability of an impossible event 
" +
                "is","0","0.25","0.5","1","0");
        this.addQuestion(q137);
        Question q138=new Question("A letter of English alphabets is 
chosen at random. The probability " +
                "that it is a letter of the word 'MATHEMATICS' 
is","11/26","4/13","5/13","9/26","4/13");
        this.addQuestion(q138);
        Question q139=new Question("A card is selected at random from a 
well shuffled deck of 52 " +
                "playing cards. The probability of getting a face card 
is","9/13","6/13","4/13","3/13","3/13");
        this.addQuestion(q139);
        Question q140=new Question("A bag contains 3 red balls, 5 white 
balls and 7 black balls. " +
                "The probability of getting neither red balls nor black 
balls " +
                "is","1/3","1/5","7/15","8/15","1/3");
        this.addQuestion(q140);
        Question q141=new Question("The probability that a non-leap year 
selected at random will " +
                "contain 53 Sundays","1/7","2/7","4/7","6/7","1/7");
        this.addQuestion(q141);
        Question q142=new Question("The probability of getting a bad egg 
in a lot of 400 is 0.045. " +
                "The number of bad egg in the lot 
is","9","18","27","36","18");
        this.addQuestion(q142);
        Question q143=new Question("For any event E, P(E)+P(not E) is 
",">1","<1","1","0","1");
        this.addQuestion(q143);
```

```
        Question q144=new Question("In a throw of die, the probability of
getting prime number " +
                "is","1/2","2/3","5/6","1/3","1/2");
        this.addQuestion(q144);
        Question q145=new Question("In an examination the total marks
obtained by the student is 540. " +
                "If the student got 150 marks in Mathematics, then the
central angle for Mathematics " +
                "is","80","90","100","110","100");
        this.addQuestion(q145);
        Question q146=new Question("In a two digit number, if a is the
digits in the units place and b in the tens place, " +
                "then the two-digit number must be (HSLC
2017)","ab","10ab","10a+b","10b+a","10b+a");
        this.addQuestion(q146);
        Question q147=new Question("The areas of two similar triangles ABC
and DEF are in the ratio 9:16. If BC = 4.5 cm,  " +
                "then EF is equal to (HSLC 2017)","5.5 cm","6 cm","12.5
cm","25 cm","6 cm");
        this.addQuestion(q147);
        Question q148=new Question("From a point Q outside the circle, the
length of tangent to a circle is 8 cm and " +
                "the distance of Q from the centre is 5.29 cm. The radius
of the circle is (HSLC 2017)","6 cm","11 cm","15 cm","34 cm","6 cm");
        this.addQuestion(q148);
        Question q149=new Question("The two vertices of a triangle ABC are
given by A(-1,0) and B(5,-2), " +
                "its centroid is G(4,0). The coordinate of the third
vertex C is (HSLC 2017)","(6,0)","(12,0)","(2,8)","(8,2)","(8,2)");
        this.addQuestion(q149);
        Question q150=new Question("The area of sector of a circle with
central angle 45 and radius 14 cm is " +
                "(HSLC 2017)","18 sq.cm","28 sq.cm","31 sq.cm","77
sq.cm","77 sq.cm");
        this.addQuestion(q150);
    }
    @Override
    public void onUpgrade(SQLiteDatabase db, int oldV, int newV) {
        // Drop older table if existed
        db.execSQL("DROP TABLE IF EXISTS " + TABLE_QUEST);
        // Create tables again
        onCreate(db);
    }
    // Adding new question
    public void addQuestion(Question quest) {
        //SQLiteDatabase db = this.getWritableDatabase();
        ContentValues values = new ContentValues();
        values.put(KEY_QUES, quest.getQUESTION());
        values.put(KEY_ANSWER, quest.getANSWER());
        values.put(KEY_OPTA, quest.getOPTA());
        values.put(KEY_OPTB, quest.getOPTB());
        values.put(KEY_OPTC, quest.getOPTC());
        values.put(KEY_OPTD, quest.getOPTD());
        // Inserting Row
        dbase.insert(TABLE_QUEST, null, values);
    }
```

```
    public List<Question> getAllQuestions() {
        List<Question> quesList = new ArrayList<Question>();
        // Select All Query
        String selectQuery = "SELECT  * FROM " + TABLE_QUEST + " ORDER BY
RANDOM()";
        dbase=this.getReadableDatabase();
        Cursor cursor = dbase.rawQuery(selectQuery, null);
        // looping through all rows and adding to list
        if (cursor.moveToFirst()) {
            do {
                Question quest = new Question();
                quest.setID(cursor.getInt(0));
                quest.setQUESTION(cursor.getString(1));
                quest.setANSWER(cursor.getString(2));
                quest.setOPTA(cursor.getString(3));
                quest.setOPTB(cursor.getString(4));
                quest.setOPTC(cursor.getString(5));
                quest.setOPTD(cursor.getString(6));
                quesList.add(quest);
            } while (cursor.moveToNext());
        }
        // return quest list
        return quesList;
    }
    public int rowcount()
    {
        int row=0;
        String selectQuery = "SELECT  * FROM " + TABLE_QUEST;
        SQLiteDatabase db = this.getWritableDatabase();
        Cursor cursor = db.rawQuery(selectQuery, null);
        row=cursor.getCount();
        return row;
    }
}
```

14. FormulaActivity.Java

```
FormulaActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_formula);

        WebView webView = (WebView)findViewById(R.id.webView);
        webView.setWebViewClient(new WebViewClient());
        WebSettings webSettings = webView.getSettings();
        webSettings.setJavaScriptEnabled(true);
        String js = "<html><head>"
                + "<link rel='stylesheet'
href='file:///android_asset/mathscribe/jqmath-0.4.3.css'>"
                + "<script src='file:///android_asset/mathscribe/jquery-
1.4.3.min.js'></script>"
                + "<script src='file:///android_asset/mathscribe/jqmath-
```

```
etc-0.4.5.min.js'></script>"
                + "</head><body>"

                + "<script>var s = '1.Instalments : $$ A = P{(1+
R/100)}^n$$ "
                + "Where A = Amount, P = Principal, R = Rate of Interest
and n = Time period in years."
                + "<br/>"
                + "<br/>2.Time and Distance :$$Speed =
{Distance}/{Time}$$"
                + "$$Distance = Speed X Time$$ $$Time =
{Distance}/{Speed}$$"
                + "Unit Conversion :<br/> 1 km/hr = $5/18$ m/sec "
                + "<br/>1 m/sec = $18/5$ km/hr"
                + "<br/>"
                + "<br/>3.Time and Work :<br/>Suppose A can do a piece of
work in n days,Then "
                + "Work done by A in 1 day = $1/n$"
                + "<br/>Suppose an Inlet can fill an empty tank in n
hrs,Then "
                + "Work done by the Inlet in 1 hour = $1/n$"
                + "<br/>Suppose an Outlet can empty a full tank in m
hrs,Then "
                + "Work done by the Outlet in 1 hour = $-1/m$"
                + "<br/>Suppose both Inlet and Outlet are open,Then "
                + "Net part of the tank filled in 1 hour = $1/n - 1/m$"
                + "<br/>"
                + "<br/>4.Polynomial : "
                + "<br/> Algebraic Identities :"
                + "$${(x + y)}^2 = x^2 + 2xy + y^2$$"
                + "$${(x - y)}^2 = x^2 - 2xy + y^2$$"
                + "$$x^2 - y^2 = (x+y)(x-y)$$"
                + "$${(x + y)}^3 = x^3 + y^3 + 3xy(x+y)$$"
                + "$${(x - y)}^3 = x^3 - y^3 - 3xy(x-y)$$"
                + "$$x^3 + y^3 = (x+y)(x^2-2xy +y^2)$$"
                + "$$x^3 - y^3 = (x-y)(x^2+2xy +y^2)$$"
                + "Relationship between zeros and Coefficient"
                + "<br/>Let p(x)=$ax^2+bx+c=0$ with $a≠0$ be a quadratic
polynomial, then:"
                + "$$Sum of zeroes = -b/a = -{(Coefficient of
x)}/{Coefficient of x^2}$$"
                + "$$Product of zeroes = c/a = {Constant
term}/{Coefficient of x^2}$$"
                + "LCM of two Polynomials : If f(x) and g(x) are two
polynomials,then"
                + "$$LCM of f(x) and g(x) = {f(x) X g(x)}/{HCF of f(x) and
g(x)}$$"
                + "Linear equation in two variables :"
                + "<br/>If $a_1x+b_1y+c_1=0$ and $a_2x+b_2y+c_2=0$ be a
system of two linear equations, then:"
                + "$$x={b_1c_2 - b_2c_1}/{a_1b_2 -a_2b_1} provided
{(a_1b_2 -a_2b_1)}≠0$$"
                + "$$y={c_1a_2 - c_2a_1}/{a_1b_2 -a_2b_1} provided
{(a_1b_2 -a_2b_1)}≠0$$"
                + "<br/> When $ a_1/a_2≠b_1/b_2$, we get a Unique
Solution, i.e, consistent "
```

```
                + "<br/> When $ a_1/a_2=b_1/b_2=c_1/c_2$,there are
Infinitely many Solution, i.e, consistent "
                + "<br/> When $ a_1/a_2=b_1/b_2≠c_1/c_2$,there is No
Solution, i.e, inconsistent "
                + "<br/>Quadratic formula :"
                + "<br/>If $ax^2+bx+c=0$ with $a≠0$, then:"
                + "$$x={-b±√{b^2-4ac}}/{2a}$$"
                + "<br/> Nature of roots :"
                + "Discriminant(D)=$b^2-4ac$"
                + "<br/> If D > 0,we get Real and Unequal roots"
                + "<br/> If D = 0,we get Real and Equal roots"
                + "<br/> If D < 0,we get No Real roots"
                + "<br/>"
                + "<br/> 5.Arithmetic Progression :"
                + "<br/> $n^{th}$ term of an AP : "
                + "$$a_n = a + (n-1)d$$"
                + " Where a = first term of an AP, d = common difference"
                + "<br/> $n^{th}$ term of an AP from the end: "
                + "$$l_n = l - (n-1)d$$"
                + " Where l = last term of an AP, d = common difference"
                + "<br/> The sum of n terms of an AP :"
                + " $$ S = n/2[2a + (n-1)d]$$"
                + "$$ S = n/2(a+l)$$"
                + "<br/>"
                + "6.Sets : "
                + "<br/>Let A and B be two finite sets -"
                + "<br/>n(AUB) = n(A)+ n(B) - n$(A∩B)$"
                + "<br/>n(A) = n(A-B)+ n$(A∩B)$"
                + "<br/>n(B) = n(B-A)+ n$(A∩B)$"
                + "<br/>n(AUB) = n(A-B+ n(B-A) + n$(A∩B)$"
                + "<br/>"
                + "<br/>7.Coordinate Geometry :"
                + "<br/>Let $P(x_1,y_1)$ and Q(x_2,y_2) be the points on
the cartesian plane -"
                + "$$PQ = √{(x_2 - x_1)^2 + (y_2 -y_1)^2}units$$"
                + "Section formula : $({m_1x_2+m_2x_1}/{m_1 +
m_2},{m_1y_2+m_2y_1}/{m_1 + m_2})$"
                + "<br/> Midpoint formula : $({x_1+x_2}/2,{y_1+y_2}/2)$"
                + "<br/> Coordinates of centroid :
$({x_1+x_2+x_3}/3,{y_1+y_2+y_3}/3)$"
                + "<br/> Area of triangle = $1/2[x_1(y_2-y_3) + x_2(y_3-
y_1) + x_3(y_1-y_2)]$ Square Units"
                + "<br/>"
                +"<br/>8.Trigonometric Identities :"
                + "$$i.sin^2θ+cos^2θ=1,sin^2θ=1-cos^2θ,cos^2θ=1-sin^2θ$$"
                + "$$ii.sec^2θ=1 + tan^2θ,tan^2θ=sec^2θ-1,sec^2θ-tan^2θ =
1$$"
                + "$$iii. cosec^2θ=1 + cot^2θ,cot^2θ=cosec^2θ -1
,cosec^2θ-cot^2θ=1$$"
                + "$$iv.tanθ = {sinθ}/{cosθ} and cotθ = {cosθ}/{sinθ}$$"
                + "<br/>"
                +"9.Trigonometric Ratio :"
                + "$$sin(90^o-A) = cosA$$"
                + "$$cos(90^o-A) = sinA$$"
                + "$$tan(90^o-A) = cotA$$"
                + "$$cot(90^o-A) = tanA$$"
```

```
                + "$$sec(90^o-A) = cosecA$$"
                + "$$cosec(90^o-A) = secA$$"
                + "<br/>"
                + "10.Areas related to circles :"
                + "<br/>Circumference of the circle = $2πr$"
                + "<br/>Area of the circle = $πr^2$"
                + "<br/>Area of the Ring = $π(R^2-r^2)$"
                + "<br/>Area of the sector = $θ/{360^o} Xπr^2$"
                + "<br/>Length of the arc = $θ/{360^o} X2πr$"
                + "<br/>Perimeter of the sector = $2r + 2πrθ/{360^o}$"
                + "<br/>Area of minor segment = $πr^2θ/{360^o} -1/2
r^2sinθ$"
                + "<br/>Area of major segment = (area of circle) - (area
of minor segment)"
                + "<br/>"
                + "<br/>11.Volume and Surface area:"
                + "<br/>i.Cuboid - Let l,b and h be the length,breadth and
height of the cuboid.Then,"
                + "<br/>Total surface area = 2(lb+bh+hl) square units"
                + "<br/>Lateral surface area = [2(l+b)X h) square units"
                + "<br/>Volume = (l X b X h) cubic units"
                + "<br/>Diagonal of the cuboid = $√{l^2+b^2+h^2}$ units"
                + "<br/>ii.Cube - Let l be the edge of a cube.Then,"
                + "<br/>Total surface area = $6l^2$ square units"
                + "<br/>Lateral surface area = $4l^2$ square units"
                + "<br/>Volume = $l^3$ cubic units"
                + "<br/>Diagonal of the cuboid = $√{3l}$ units"
                + "<br/>iii.Sphere - Let r be the radius of a
sphere.Then,"
                + "<br/>Surface area = $4πr^2$ square units"
                + "<br/>Volume = $4/3πr^3$ cubic units"
                + "<br/>iv.Hemisphere - Let r be the radius of a
hemisphere.Then,"
                + "<br/>Curved surface area = $2πr^2$ square units"
                + "<br/>Total surface area = $3πr^2$ square units"
                + "<br/>Volume = $2/3πr^3$ cubic units"
                + "<br/>v.Spherical Shell - Let R and r be the outer and
inner radii of a spherical shell.Then,"
                + "<br/>Outer surface area = $4πR^2$ square units"
                + "<br/>Volume = $4/3π(R^3 -r^3)$ cubic units"
                + "<br/>vi.Cylinder - Let r be the base radius and h be
the height of a cylinder.Then,"
                + "<br/>Curved surface area = $2πrh$ square units"
                + "<br/>Total surface area = $(2πrh + 2πr^2)= 2πr(h+r)$
square units"
                + "<br/>Volume = $πr^2h$ cubic units"
                + "<br/>vii.Hollow Cylinder - Let R and r be the external
and internal base radius and h be the height of a hollow cylinder.Then,"
                + "<br/>Curved surface area = $2πh(R+r)$ square units"
                + "<br/>Total surface area = $2π(R+r)(h+R-r)$ square
units"
                + "<br/>Volume = $πh(R^2-r^2)$ cubic units"
                + "<br/>viii.Cone - Let r be the base radius and h be the
height of a cone.Then,"
                + "<br/>Curved surface area = $πrl$ square units (where
$l^2=r^2+h^2$)"
```

```
                + "<br/>Total surface area = $πr(l+r)$ square units"
                + "<br/>Volume = $1/3πr^2h$ cubic units"
                + "<br/>ix.Frustum of a Cone - Let R and r be the radii of
base and top of the frustum of cone." +
                "Let h be the height and l be its slant height.Then,"
                + "<br/>Lateral surface area = $πl(R+r)$ square units
(where $l^2=h^2+(R-r)^2$)"
                + "<br/>Total surface area = $π[R^2 + r^2 +l(R+r)]$ square
units"
                + "<br/>Volume = $1/3πh[R^2 + r^2 +Rr]$ cubic units"
                + "<br/>"
                + "<br/> 12.Mean,Median and Mode :"
                + "<br/> i.Mean  "
                + "<br/>Direct method - Mean =${∑f_ix_i}/∑f_i$"
                + "<br/>Where $f_i$ = Frequency and $x_i$ = Class mark or
Mid value."
                + "<br/>Assumed mean method - Mean =$a +{∑f_id_i}/∑f_i$"
                + "<br/>Where a = Assumed mean,$f_i$ = Frequency and $d_i
= (x_i - a)$."
                + "<br/>Step deviation method - Mean =$ a +
({∑f_iu_i}/∑f_i)X h$"
                + "<br/>Where a = Assumed mean,$f_i$ = Frequency, $u_i =
{(x_i - a)}/h$ and h = class size."
                + "<br/> ii.Median = $l + ({n/2-c}/f)X h$"
                + "<br/>Where l = Lower limt of median class"
                + "<br/>n = No. of observations"
                + "<br/>c = Cumulative frequency"
                + "<br/>f = Frequency and h = class size."
                + "<br/> iii.Mode = $l + ({f_1-f_0}/{2f_1 -f_0-f_2})X h$"
                + "<br/>Where l = Lower limt of median class"
                + "<br/>$f_1$ = Frequency of the modal class"
                + "<br/>$f_0$ = Frequency of the class preceding modal
class"
                + "<br/>$f_2$ = Frequency of the class succeeding modal
class "
                + "<br/>h = class size."
                + "<br/>"
                + "<br/> 13. Probability :"
                + "$$P(E) = {No. of outcomes favourable to E}/{No. of all
possible outcomes}$$"
                + "Probability of impossible event = 0"
                + "<br/>Probability of sure event = 1"
                + "<br/> P(E) + P(not E) = 1"
                + "<br/>"
                + "<br/> 14. Pictorial representation of data :"
                + "$$Central angle of a component = ({Value of the
component}/{Total value} X 360)^o$$"
                + "$$Value of the component = ({Its central angle}/{360} X
Total value)$$';M.parseMath(s);document.write(s);</script> </body>";
        webView.loadDataWithBaseURL( "" ,js,  "text/html",  "UTF-8",
null);

    }
}
```

15. HelpActivity.Java

```
package tluangacolney.learningmaths;


import android.support.v7.app.AppCompatActivity;
import android.os.Bundle;
import android.text.Html;
import android.widget.TextView;

public class HelpActivity extends AppCompatActivity {

    @Override
    protected void onCreate(Bundle savedInstanceState) {
        super.onCreate(savedInstanceState);
        setContentView(R.layout.activity_help);

        TextView tv ;
        tv = (TextView)findViewById(R.id.textView3);
        tv.setText(Html.fromHtml(getString(R.string.help)));


    }
}
```

16. Strings.XML

```
<resources>
    <string name="app_name">LearningMaths</string>
    <string name="about"> \n This application is developed for the purpose
of finding out the Effectiveness of Learning App for Studying Mathematics
among Secondary Schools Students of Mizoram.
        \n \n Developed By \n <b>Lalnuntluanga Colney </b>\n Ph.D Scholar,
Department of Education
        \n Mizoram University, Aizawl \n email :
tluangacolney@rocketmail.com
        \n <b>Dr. Lynda Zohmingliani </b>\n Professor, Department of
Education \n Mizoram University, Aizawl </string>
    <string name="intro"> \n <b> Learning App for Class X Mathematics
        \n Based on MBSE Prescribed Textbook </b></string>
    <string name="xsquare">
        x<sup><small>2</small></sup>
    </string>
    <string name="installment"> \n <b> KEY POINTS </b>
        \n 1. Instalment Formula for Amount(A)
        \n A = P(1 + R/100)<sup><small>n</small></sup>
        \n Where, P = Principal (A tira pawisa kan puk/bat zat)
        \n R = Rate of interest (Kum tina a pung zat, compounded half
yearly anih chuan rate hi 2 a sem tur)
        \n n = Years (Hun tiam chhunga a pun hman zat, compounded half
yearly anih chuan a kum kha 2 in puntir tur)
        \n 2. Kan zawn tur aiah x hman tur a ni.
        \n 3. Formula hman tur hi ziah lan ngei tur a ni.
        \n 4. Instalment hi HSLC ah compulsory nilo mahse 3 marks puin a
```

```
kal thina mahse instalment atangin 2 aia tam a chhuak ngailo.
    </string>

    <string name="tandd"> \n <b> KEY POINTS</b>
        \n 1. A question in min pek kha kan ziak chhuak phawt ang. Min pek
loh apiang kan zawng ang. Entirna: Speed leh Distance min pek chuan Time
kan zawng ang.
        \n 2. Speed hi km/hr leh m/s hmanga teh a ni a. Unit te hi hman
pawlh loh tur a ni. Unit min pek te hi a in kawprem loh chuan inkawp rem
turin kan siam ang.
        Km leh second min pek chuan km leh hr ah emaw metre leh second ah
emaw chantir tur a ni.(1km = 1000m and 1hr = 60 sec)
        \n 3. km/hr(unit lian zawk) hi m/s(unit te zawk) a kan chan tir
dawn chuan 5/18 in kan puntir ang. m/s hi km/hr a kan chan tir dawn chuan
18/5 in kan puntir ve thung ang.
        Entirna: 72 km/hr = 72 X 5/18 m/s = 20 m/s
    </string>
    <string name="tanddlink">Learn more about Time and Distance at\n<a
href="https://youtu.be/oh-D2PP30mM">Time and Distance Solved Problems
No.1-4 (in Mizo)</a>
    \n<a href="https://youtu.be/VFGdAE3ra5I">Time and Distance Solved
Problem No.5-7 (Class X MBSE Syllabus)</a>
        \n<a href="https://youtu.be/sLesba7YkhY">Time and Distance-Solved
Problem No.8-12 (MBSE Syalbus)</a>
         \n<a href="https://youtu.be/Y_6raH2F9Cs">Time and Distance Part 1
(in mizo)</a>
        \n<a href="https://youtu.be/WHpkpGlhu2s">Time and Distance Part 2
( in Mizo)</a>
    </string>
    <string name="tandw"> \n <b> KEY POINTS</b>
        \n 1. General rules for solving problems on time and work:
        \n Suppose A can do a piece of work in n days.
        \n Then, Work done by A in 1 day = 1/n
        \n Suppose that the work done by A in 1 day = 1/n.
         \n Then, Time taken by A to complete the work = n days
       \n 1. General rules for solving problems on pipe and cisterns:
        \n Suppose an inlet can fill an empty tank in n hours.
        \n Then, Work done by inlet in 1 hour = 1/n
       \n Suppose an outlet can empty a full tank in m hours.
        \n Then, Work done by outlet in 1 hour = 1/m
        \n(Pipe ah inlet leh outlet a awm chuan outlet hmathawh hi
negative sign a dah tur a ni.)

    </string>
    <string name="tandwlink">Learn more about Time and Work at\n<a
href="https://youtu.be/i_oukr3KQrc">Time and Work (in Mizo)</a>
    \n<a href="https://youtu.be/hZzyPZbNLLQ">Time and Work (in Mizo)-2</a>
        \n<a href="https://youtu.be/Aw3En7JUDB8">MBSE X Math Chapter 2 Ex
2 1 and 2 2 (Part 1)</a>
         \n<a href="https://youtu.be/psL9ruXvbps">MBSE X Chapter 2 Ex 2 2
TIME and WORK (Part 2)</a>
        \n<a href="https://youtu.be/iONF7XSMMoA">MBSE X Math Chapter 2
TIME and WORK (Part 3) - Solutions to Assignments</a>
    </string>
    <string name="polynomial"> \n <b> KEY POINTS</b>
        \n 1. p(x) = Ax<sup><small>2</small></sup>+Bx+C, ah hian
```

```
x<sup><small>2</small></sup> coefficient chu A ani a, x coefficient chu B
niin C hi constant term a ni.
    \n 2. Formula dahkhawmna a formula awm zawng zawng te thiam vek tur.
    \n 3. Polynomials chawh dawnin heng te hi en hmasak tur:
        \n common a lak theih em?
        \n formula a hman theih em?
        \n a split theih em?
    \n 4. Number reng reng additive inverse chu number hmaa negative sign
dah hi a ni.
        \n 5. Multiplicative inverse chu number letling thawk chu a ni.
    </string>
    <string name="polynomiallink">Learn more about Polinomials at\n<a
href="https://youtu.be/AqjG53RidgE">Polynomials (zeroes, coefficient,
constant term.. etc)</a>
   \n<a href="https://youtu.be/jiKl7xxYhSI">HCF and LCM of polynomials</a>
        \n<a href="https://youtu.be/iO4_H1--kq0">Reduction, simplify,
splitting middle term</a>
    \n<a href="https://youtu.be/i21keEy-p7Y">CLASS X CHAP 3
POLYNOMIALS</a>
        \n<a href="https://youtu.be/sw-Niokrlzo">CLASS IX and X HCF and
LCM</a>
         \n<a href="https://youtu.be/vE1BPrAaXnw">CLASS X CHAP 3 RATIONAL
EXPRESSION</a>
    </string>
    <string name="lineareqn"> \n <b> KEY POINTS</b>
    \n 1. Graphical method hi board exam ah mark 5 pua a kal thin avangin
thiam ngei ngei tur a ni.
    \n 2. Questionin kan solve na tur method a rawn sawi sa loh chuan kan
thiam ber method hmanga chawh mai tur a ni.
    </string>

    <string name="linearEqnlink">Learn more about Linear equations in two
variables at\n<a href="https://youtu.be/xTs5SuKgkSk">Graphical method of
solving Linear equation in two variables</a>
    \n<a href="https://youtu.be/8FQ3q_gEYf8">Algebraic method of solving
Linear equation in two variables</a>
        \n<a href="https://youtu.be/2gO9rLbNL1k">Cross multiplication
Method</a>
         \n<a href="https://youtu.be/Zx8X4dsw_rA">"Homogeneous and non
homogeneous " system of equations</a>
        \n<a href="https://youtu.be/bFvxuaa_Hig">Word Problems From linear
equation in two variables</a>
         \n<a href="https://youtu.be/4pethiwSiHc">Word problem from linear
equation in two variables (2)</a>
    </string>
    <string name="quadraticeqnlink">Learn more about Quadratic equations
at\n<a href="https://youtu.be/oPeVhzbYYkY">Quadratic equation in Mizo
(1)</a>
    \n<a href="https://youtu.be/NU7Bkz7Mg7Q">quadratic equations in Mizo
(2)</a>
        \n<a href="https://youtu.be/qS19omDWrDc">Quadratic Formula for
roots of equation</a>
         \n<a href="https://youtu.be/0kSM1eabJoQ">Nature of roots in
quadratic equation</a>
        \n<a href="https://youtu.be/Di84kuiBxqw">CLASS X CHAP 5 Quadratic
Eqn 1</a>
```

```
         \n<a href="https://youtu.be/d0VrSsaqYq8">CLASS X CHAP 5 Quadratic
Eqn 2</a>
          \n<a href="https://youtu.be/V5zyMO1IAHE">CLASS X CHAP 5
Quadratic Eqn 3</a>
         \n<a href="https://youtu.be/IAnJ7VWr3rc">CLASS X CHAP 5 Quadratic
Eqn 4</a>
        \n<a href="https://youtu.be/BfWTE9Fe0T4">CLASS X CHAP 5 Quadratic
Eqn 5</a>
          \n<a href="https://youtu.be/nOQukfH2ebM">CLASS X CHAP 5
Quadratic Eqn 6</a>
         \n<a href="https://youtu.be/VJXceZWpg9I">CLASS X CHAP 5 Quadratic
Eqn 7</a>
    </string>
    <string name="apkey"> \n <b> KEY POINTS </b>
        \n 1. An Arithmetic Progression(AP) is a list of numbers in which
each term is obtained by adding a fixed number to the preceeding term
except the first term.
        \n The fixed number is called the common difference of the AP.
        \n 2. General term or n<i> which term </i> term of an AP is a<i>
how many terms </i>= a + (n-1)d.
       \n Where, a = first term(term hmasa ber) and d = common
difference(number te inthlauhna).
        \n 3. Term engzatna nge hriatloh <sub><small>n</small></sub> leh
term awm zat hriatloh <sub><small>n</small></sub> ah reng reng
a<sup><small>th</small></sup> hi hman zel tur a ni.
        \n 4. n<sup><small>th</small></sup> term from the end = l - (n-1)d
formula ah hin l hi last term a ni.
        \n 5. Question in min pek kha kan ziak chhuak phawt ang. Kan zawn
tur leh questionin min pek te awm kawpna formula hmanga chawh tur a ni.
    </string>
    <string name="aplink">Learn more about Arithmetic Progression at \n<a
href="https://youtu.be/jqSTnpc27z0">CLASS X CHAP 6 AP 1</a>
    \n<a href="https://youtu.be/W6MYWJfvXrk">CLASS X CHAP 6 AP 2</a>
        \n<a href="https://youtu.be/FiQ25TEEqC8">CLASS X CHAP 6 AP 3</a>
        \n<a href="https://youtu.be/Hc-RCumzMak">MBSE X Math Chapter 6 A P
Ex 6 1</a>
        \n<a href="https://youtu.be/gi9jdnXyZPA">MBSE X Math Chapter 6 A.P
Ex 6.2 (Part - 1)</a>
        \n<a href="https://youtu.be/vgmKDpTjml4">MBSE X Math Chapter 6 A.P
Ex 6.2 (Part - 2)</a>
    </string>
    <string name="sets"> \n <b> KEY POINTS </b>
        \n 1.Sets hi chi hnihin a entir theih a,
        \n Tabular or Roster form: Set a element te chu braces chhungah,
an inkara comma dah zelin ziah tlar a ni.
        \n Set builder form or Rule method: Element te nihphung kha a
thuin kan ziak chhuak.
        \n 2. Union of sets: Union of sets chu set pahnih emaw a aia tam
emawa a element awm zawng zawng te, a ngai la nawn loa lak khawm a ni.
        \n 3. Intersection of sets: Intersection of sets chu set ten
element in ang(Common element an neih hi a ni)
        \n 4. Difference of sets: Set pakhata element awm, set danga awm
velo tihna a ni. Kan ziah hmasak zawk zela awm, a hnuhnung zawka awm velo
ziah tur a ni.
        \n 5. Disjoint set: Set in elememnt in ang an neih loh chuan
disjoint sets a ni.
```

```xml
    </string>
    <string name="setslink">Learn more about Sets at\n<a
href="https://youtu.be/XdWr45WZcrM">CLASS X CHAP 7 SETS 1</a>
    \n<a href="https://youtu.be/EhNapnXIhU0">CLASS X CHAP 7 SETS 2</a>
        \n<a href="https://youtu.be/lt9pgs3_3xE">CLASS X CHAP 7 SETS 3
mp4</a>
    </string>
    <string name="triangle"> \n <b> KEY POINTS </b>
        \n 1.Triangles a problem kan chawh hma in heng theorem te hi thiam
phawt tur a ni.
        \n i. Basic Proportionality theorem(Thales theorem) - Page 154
        \n ii. Converse of Basic Proportionality theorem - Page 155
        \n iii. Angle Bisector theorem - Page 160
        \n iv. Pythagoras Theorem - Page 181
        \n 2. Criteria for similarity of triangles:
        \n i. AAA similarity - If in two triangles, corresponding angles
are equal, then the triangles are similar.
        \n ii. SSS similarity - If the corresponding sides of two
triangles are proportional, then the triangles are similar.
        \n iii. SAS similarity - If one angle of a triangle is equal to
one angle of the other triangle and the sides including these angles are
proportional, then the triangles are similar.
    </string>
    <string name="trianglelink">Learn more about Triangles at
        \n<a href="https://youtu.be/t5pYSirHsdk">CLASS X CHAPTER 8
TRIANGLES</a>
        \n<a href="https://youtu.be/cnu0TtwTye0">Similar Triangles I
Thales Theorem and Angle Bisector Theorem</a>
        \n<a href="https://youtu.be/ARkFtcuAGZ8">Similar Triangle II AA,
SSS and SAS</a>
        \n<a href="https://youtu.be/699brICzcnE">Pythagoras Theorem Class
X Maths</a>
    </string>

    <string name="help"> <![CDATA[ <p><b>Contents -</b> Contents chhungah
hian chapter hrang hrang te a indawt dan a dah khawm a ni.
    Chapter 8- Sets thleng hian siam zawh tawh a ni a a bak zawng hi
chhunzawm leh tura ruahmanna siam a ni.</p>
    <p><b>Quiz(Multiple Choice Questions) -</b> Quiz(Multiple choice
question) hi objective type test a ni a,
    board exam a multiple choice question chhuak thei(probable question)
150 dah luh a ni.
    Zawhna lo langah a chhanna dik ni a i hriat i hmeh hnuah NEXT tih alo
lang anga,
     chhan dik chuan score a in belh zel anga chhan dikloh chuan chance a
tla hniam ve zel ang.
     Vawi khat test ah chance vawi 5 zel a awm a chance hi 0 a nih hma chu
a test chhunzawm theih a ni.
     Question pakhat chhan nan minute 2 chhung hun a awma, hemi chhunga
chhan hman loh chuan test a tawp ang.</p>
     <b>Formula -</b> Class X zirlaibu a formula hrang hrang te chapter
indawt dan a dah khawm a ni.
     Chapter tin te thiam tur chuan kan formula hman tur te hi by-heart
vek phawt tur a ni.</p>
     <p><b>Instalments -</b>Instalment chhungah hian Key Points,
Instalment Calculator, Textbook Excercise, Multiple Choice Question leh
```

Self Assessment Test te dah a nih bakah

instalment chapter zirna video hrang hrang youtube ami chu awlsam taka en mai theih tura dah lan a ni.

Key points -Key points hi hmeh chuan instalments chawh dawna hriat tur pawimawh te alo langa,

hmeh nawn leh chuan a bo leh dawn a ni.

Instalment Calculator -Instalment Calculator hi hmeh chuan field hrang hrang dah kha tur a lo langa,

hetah hian kan zawhna ami value kan neih sa kan dah khah hnuah Solution hmehin a chhanna a lo lang ang.

Instalment calculator ah hian textbooka question awmsa mai bakah texbook pawn ami thlengin chawh theih a ni.

Instalment calculator hmang thiam tur chuan instalment chaptera term hrang hrang te hriat fiah hmasak phawt a ngai a ni.

Textbook Excercise - Textbook Excercise hi hmeh chuan textbook chhunga zawhna awmsa thenkhat a lo lang anga,

zawhna lo lang hmeh hnuah a chhanna a lo lang ang.

Zirlai ten an mahnia an chawh chhuah ve theihna atan textbooka zawhna thenkhat dah tel veloh a ni.

Multiple Choice Questions - Multiple Choice Questions hi hmeh chuan Instalment chapter chhhunga multiple choice question awm thei te leh a solution dah lan nghal a ni.

Self Assessment Test -Self Assessment Test hmeh chuan Instalment chapter objective type a test na tur question leh chhanna tur a lo lang anga chhanna hmeh hnuah NEXT tih alo lang ang,

zawhna pakhat chhanna chawh chhuahna hun atan minute 4 zel a awm a ni.

Zawhna 10 chhan zawh hnuah test a tawp anga, result a lo lang ang.

Mark score dan a zirin star hmuh zat a danglama 4 star hmu pha chin tan Hming, Roll No. leh Section dahkhahna tur a lo lang anga dahkhah kim hnuah submit result tih hmetin result hi submit tur a ni.

Result submit te hi researcher hnenah direct in a lut nghal zel a ni.

4 star hmu pha tur hian zawhna 70% tal chhan dik a ngai a, 4 star hmuh tlin hma chu result submit na tur hi a lo lang thei dawnlo a ni.

</p>

<p>Time and Distance -, Time and Work -, Polynomials -, Linear Equations in two variables -,

Quadratic Equations -, Arithmetic Progresion - leh Sets - te hi Instalment nen kalphung in ang a duan an ni a,

amaherawhchu Instalment Calculator aiah Polynomials, Linear Equations in Two variables leh Quadratic Equations ah te hian Algebra calculator dah a ni a,

Arithmetic Progression leh Sets ah te hian AP Calculator leh Sets Calculator te dah an ni.

Algebra calculator ah hian Linear equation in two variables leh Quadratic equation bak a chawh theih rih loh a,

Linear equation in two variables i solve dawn chuan a question type luh dan tur awmsa

a_{<small>1</small>}x + b_{<small>1</small>}y + c_{<small>1</small>} = 0,a_{<small>2</small>}x + b_{<small>2</small>}y + c_{<small>2</small>} = 0

format ang hian type luh tur a ni.

Entir nan : 2x+y=4,3x-y=11 hi i solve duh chuan 2x+y-4=0,3x-y-11=0 type lut in i siam rem hmasa phawt dawn nia.

```
        Quadratic equation i solve duh chuan ax<sup><small>2</small></sup>
+bx+c=0 format ang hian type luh tur a ni.
        AP Calculator hman dawnin i zawn chhuah duh kha select phawt la, a
hnuaiah dahkhah tur hrang hrang alo awm anga i dah khah vek hmu ah
Solution kha i hmet dawn nia.
        Sets Calculator hman dawn chuan Question atanga i neih sa ho kha i
dah lut anga,
         i zawn chhuah duh i select hnuah Solution i hmet dawn nia. </p>
        <p><b>Triangle -</b>Triangle chhungah hian Thales Theorem leh
Pythagoras theorem te dah luh a ni a, Calculator anga hman tur a ni.</p>
        <p><b>Construction -</b>Construction ah hian a textbook a example
te step by step a solve na dah luh a ni a, Example 7(pasarih) dah a
ni.</p>
        <p><b>Co-ordinate Geometry -</b>Coordinate geometry i chawh dawn
chuan i zawn chhuah duh kha i select phawt anga,
        dahkhah tur alo lang anga i dah khah vek hnu ah Solution i hmet
dawn nia. Tin, Solution hnuaiah Example dah zel a ni bawk.</p>
        <p><b>Height and Distance -</b>Textbook a Height and Distance
exercise a zawhna te dah luh sa a ni a, a chhanna i en duh apiang kha i
hmet dawn nia.</p>
        <p><b>Areas Related to Circle -</b>A chung lama Perimeter and Area
of Circle, Areas of Sector and Segment of circle leh Areas of combination
of plane figures atang khan i
        duh ber i hmet anga, i zawn chhuah duh i select leh hnuah dahkhah
tur lo awm kha i dahkhat anga Solution kha i hmet dawn nia. Tin, a hnuai
lamah Example
        en tur a awm bawk a ni.</p>
        <p><b>Surface Areas and Volumes -</b>A chung lama Combination of
Solids, Conversion of Solids leh Frustum of Cone atang khan i duh ber i
hmet anga, a lem sir a < leh >
         te kha a lem tih danglam nan i hmang dawn nia. I chawh chhuah duh
ang kha i hmuh hunah dahkhah tur awm kha i dahkhat anga Solution i hmet
dawn nia.</p>
        <p><b>Mean, Median and Mode -</b>A chung lama Mean, Median leh
Mode atang khan i duh ber i hmet anga, dahkhah tur i dah khah hnuah a
hnuaia select tur awm kha i select anga
          Solution alo lang anga a chawh chhuah nan Solution chu i hmet
dawn nia.</p>
        <p><b>Probability -</b>Textbook a Probability exercise a zawhna te
dah luh sa a ni a, a chhanna i en duh apiang kha i hmet dawn nia.</p>
        <p><b>Pictorial Representation of Data -</b>Item name hnuaiah khan
zawhna a item hming kha i chhu lut anga, Value of component hnuaiah khan a
number i chhu lut anga
          i zawhna i chhutluh hnuah Solution kha i hmet dawn nia. A tlem
berah a pathumna thleng tal kha dahluh tur a ni.</p>
]]>
    </string>
    <string name="menu_settings">Settings</string>
    <string name="polyhint"><![CDATA[I zawhna type lut rawh le.. <p> E.g.
: 2x<sup><small>2</small></sup> +6x+4=0</p>
    <p> OR 2x+y-4=0,3x-y-11=0 etc.</p>]]></string>
    <string
name="title_activity_m_c_q_instalments">MCQInstalments</string>
    <!-- Strings used for fragments for navigation -->
    <string name="first_fragment_label">First Fragment</string>
    <string name="second_fragment_label">Second Fragment</string>
```

```
    <string name="next">Next</string>
    <string name="previous">Previous</string>

    <string name="hello_first_fragment">Hello first fragment</string>
    <string name="hello_second_fragment">Hello second fragment. Arg:
%1$s</string>
    <string
name="title_activity_self_assessment_inst">SelfAssessmentInst</string>

</resources>
```

NOTE: The source code for topics such as Time and Distance, Time and Work, Polynomials, Linear Equations in Two Variables, Quadratic Equations, Arithmetic Progression, and Sets have not been included because they follow the same pattern as the Instalment section. Including them would require considerable space, as each topic involves similar structures and logic. Repeating the code for each would unnecessarily increase the length of the document. Since the approach and coding methodology remain consistent across these topics, one example (Instalment) has been provided for clarity.

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34. Detecting and Blocking Bullying Posts in Online Social Networks

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35. National Education Policy (2020) With Special Reference To Higher Education System In India:An Analysis Of The Perspectives Of Teachers

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Development of Learning App for Studying Secondary School Level Mathematics

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Abstract

The use of smartphone as an educational device has gained importance over the years and can be expected to be one of the most useful devices for learning in the coming years. This study developed smartphone-based learning applications for studying Mathematics based on Class X Mathematics textbook prescribed by Mizoram Board of School Education. The working of android smartphone and class X mathematics syllabus are highlighted in this paper and the process involved for developing mathematics learning app are also identified in this paper. An offline mathematics learning application for android has also been developed for further research studies to find out the effectiveness of smartphone usage in mathematics learning among secondary school students of Mizoram by using Android Studio.

Keywords: *Develope, Smartphone, Application, Mathematics learning, Android, Operating System.*

INTRODUCTION

Education is essential for reaching full human potential, development of a nation and a community as well. Quality education that is accessible to everyone is the basic needs and it is the very building block for growth in all aspects of life. Indian government took this education as an important source for the improvement of the country in many ways. Digitalization has brought tremendous change in the field of education also. The growth in smartphone usage has resulted in the existence and development of educational applications. Different educational apps have been developed for the benefit of students. In the past few decades, the e-learning industry has been growing very fast, different apps are now available for different age groups. While some of these apps needs to purchased, there are some apps that are available for free. If we can combine these e-learning and current normal educational system, there would be drastic improvement in the teaching-learning process.

The use of smartphone as an educational device has gained importance over the years and can be expected to be one of the most useful devices for learning in the coming years. The compatibility and easy access of learning resources anywhere, anytime even on beyond the school and the coverage of multiple areas will determine the place of smartphone in the field of education. A part from these the cause factor as compared to other ICT devices, the compactness and easy handle, long battery life and the speed of smartphones has made it one of the most desirable ICT devices for learning.

NEED OF THE STUDY

Among the secondary school students, the widespread usage of smartphones is now a matter of grave concern. It may not be entirely wrong to surmise that most of the secondary school going students know how to use the smartphone. In fact, with the covid-19 pandemic inhibiting school going for nearly a year, majority have become dependent on smartphones. In this area, it becomes important for teachers, policy makers, administrators and anyone else who is a stakeholder on education to understand the effectiveness of learning app for studying.

There are a lot of reliable and useful application available in India. However, in spite of this overwhelming digital advancement, a lot of areas in Mizoram, mostly in the remote and rural area are still not able to enjoy and experience all the access digital advancement is offering due to absent or poor internet connection where students are not able to benefit from internet in comparison to areas where there is good internet connection. This situation is worsened following Covid-19 Pandemic where many classes and study materials were available only through online classes. Thus, developing an offline application will be especially helpful and will be of tremendous importance for learning in these difficult areas as well as in the areas where internet connection is not a problem due to easy access of offline applications.

Another matter of great importance is mathematics education. Mathematics is the backbone of all sciences and its understanding is a fundamental necessity for anyone with a desire to embark on technical education. Since nations all over the world are now competing with each other, technological growth is of major significance and this further increases the importance of mathematics for the future of the students. It may be quite right to say that mathematics is the most feared subjects among secondary school students. Therefore, it is important for the researchers to developed a new method of teaching and learning mathematics so that the student may easily understand the concept and enjoy mathematics rather than fear it.

OBJECTIVE OF THE STUDY

1 To prepare a summary of the contents of Class X Mathematics as proposed by Mizoram Board of School Education.

2 To develop a learning app on mathematics for secondary school students of Mizoram.

LITERATURE REVIEW

Bayaa and Daher (2009) accomplished a study to find out Students' Perceptions of Mathematics Learning Using Mobile Phones which took place at an Arab middle school in Israel. They found that the novelty of the experiment and the use of mobile phones in mathematics learning were the main characteristics perceived by the students as influencing their decision to join the experiment. Furthermore, the students perceived various qualities of the mathematics learning that were enabled by the use of mobile phones: (1) exploring mathematics independently (2) learning mathematics through collaboration and team work; where the collaboration is on equal terms (3) learning mathematics in a societal and humanistic environment (4) learning mathematics in authentic real life situations (5) visualizing mathematics and investigating it dynamically (6) carrying out diversified mathematical actions using new and advanced technologies (7) learning mathematics easily and efficiently. In the overall, the students were positively impressed by the potentialities and capabilities of the mobile phones used in the mathematics learning process. This indicates that mathematics education could benefit from utilizing these new technological tools.

Roberts and Vanska (2011) presented the Nokia Mobile Learning for Mathematics project, in South Africa. In the 24 project, from January to June 2010, participated about 3000 10th grade mathematics learners from 30 schools across three provinces in South Africa. With the voluntary participation in this project, students and teachers had access to interactive mathematics learning materials through a mobile platform with a social media application support. Learners could work through theory sections and answer questions from a database of 10000 questions (multiple choice, true or false, spot the error, open-ended questions), categorized by topic and difficulty. Results showed that it is possible to use networking platform for teenagers' mathematics homework. However, the establishment of this kind of teaching presupposes the equal access of the students to mobile devices, in all over the country.

Kalloo and Mohan (2012) presented "MobileMath", a mobile learning application designed to help secondary school students improve their performance in algebra. The application, which is available on mobile phones with internet access, offers lessons, examples, tutorials, quizzes and games that support users to practice certain mathematical skills. The results reveal that the students were able to improve their performance and they were excited about using a mobile device for learning. They adapted well to using this method of learning for the first time. The students who improved were those who had done algebra in a previous school term but may have been failing the subject. However, the mobile application did not make a significant impact on students who were learning the algebraic content for the first time.

Lalduhawma (2018) conducted a study in teaching and learning of Mathematics through Technology at Senior Secondary School. An effort is made to find ways to motivate and create interest among students. They organized a training programme and introduced open source software, namely, GeoGebra to a group of senior secondary students of Synod Higher Secondary School, Aizawl, Mizoram, India. They discussed some of the problems from their text book and analyzed the impact of the training programme through the pre and post questionnaires. The analysis showed that the training programme was successful in motivating and generating more interest among the students. It was concluded that in classroom teaching, the teacher should put more emphasis in motivating the students and use software based methods as far as possible.

Moreno-Guerrero et al., (2020) conducted a study on e-Learning in the Teaching of Mathematics: An Educational Experience in Adult High School to identify the effectiveness of the e-learning method in the teaching of mathematics with adults who are in high school, in contrast to the traditional expository method. The results show that the use of the e-learning method has a positive influence on motivation, autonomy, participation, mathematical concepts, results and grades. It can be concluded that the e-learning method leads to improvement in adult students who are studying the mathematical subject in the educational stage of high school, provided that it is compared with the expository method. Therefore, this method is considered effective for its implementation in adults.

Yaniawati et al., (2020) did sa study in Sumedang, Indonesia on the integration of e-Learning for Mathematics on Resource- Based Learning: Increasing Mathematical Creative Thinking and Self-Confidence. The purpose of their study is to introduce utilization of e-Learning for mathematics on Resource-Based Learning (RBL) with a scientific approach to increase mathematical creative thinking ability and to develop students' self-confidence. Integration of e-learning into Resource-Based Learning method produced a better enhancement in mathematical creative thinking ability and self-confidence development in comparison to learning without learning. The scientific approach contributed positive influence on students' learning achievement. Creative mathematical thinking ability showed increases from one cycle. Analysis of mathematical creative thinking ability covered aspect of fluency, flexibility, originality, and elaboration. The post-test result showed lower achievement in comparison to test result of the final learning cycle.

STUDY OF THE WORKING OF SMARTPHONE(ANDROID)

A smartphone is a handheld electronic device that provides a connection to a cellular network capable of performing many the functions of a computer, which have a touchscreen interface, internet access, and an operating system capable of running downloaded apps. Most smartphones run on processors and computer chips. A processor is simply the phone's brain; it controls everything the phone can do.

Perhaps the most obvious components of a modern smartphone are its display, and while every detail that can be seen on the outside is actually an internal component of the device. This part of the mobile phone generates light to display all information. The battery is the only source of power supply to a mobile phone. Several types of Chargers are used to recharge the battery of a smartphone. Batteries of phones normally use lithium-ion technology that are either removable or non-removable in mobile devices.

A smartphone has its own Memory which is used for storing information, be that photo's, installed apps, phone numbers or music. There are different types of memory; *RAM* - This is short for Random Access Memory and it is type of short-term memory the phone uses when doing tasks. *Cache* - This helps out the RAM if it cannot keep up with the processor because it is working so fast. *Hard storage* - the phones internal memory chip and micro-SD cards - these are little removable memory chips. All smartphones have some inbuilt memory for storage but on cheaper models this will be limited and can soon get full.

However, the most important feature is the Operating System (OS). This is what keeps all of the smartphones in the world up-to-date. The operating system manages all the phones hardware and software. The operating system allows the phone to run multiple application at one time. It also allows the user to download all of the applications that they want and produce them as well. The smartphone is a multipurpose device because of the OS. It allows a user to be able to watch a video, receive a call, and then return you back to the video after the call ends.

There are two main popular operating system for smartphone i.e Android and IOS. Since, Android phone users far surpass iPhone users. Developing an app for Android means there'll be more audience the app can reach, including people who can't afford expensive phones.

Android is an open source and Linux-based Operating System for mobile devices such as smartphones and tablet computers. Android was developed by the *Open Handset Alliance*, led by Google, and other companies.

Android offers a unified approach to application development for mobile devices which means developers need only develop for Android, and their applications should be able to run on different devices powered by Android.

The first beta version of the Android Software Development Kit (SDK) was released by Google in 2007 where as the first commercial version, Android 1.0, was released in September 2008.

The source code for Android is available under free and open source software licenses. Google publishes most of the code under the Apache License version 2.0 and the rest, Linux kernel changes, under the GNU General Public License version 2.

The android operating system is a stack of software components which is divided into five sections and four main layers that is

Linux Kernel: The android uses the powerful Linux kernel and it supports a wide range of hardware drivers. The kernel is the heart of the operating system that manages input and output requests from the software. This provides basic system functionalities like process management, memory management, device management like camera, keypad, display, etc the kernel handles all the things.

Libraries: On the top of a Linux kernel there is a set of libraries including open-source web browsers such as WebKit, library libc. These libraries are used to play and record audio and video. The SQLite is a database that is useful for the storage and sharing of application data. The SSL libraries are responsible for internet security etc.

Android Runtime: The android runtime provides a key component called Dalvik Virtual Machine which is a kind of java virtual machine. It is specially designed and optimized for android. The Dalvik VM is the process virtual machine in the android operating system. It is software that runs apps on android devices.

Application Framework: The application framework layer provides many higher-level services to applications such as windows manager, view system, package manager, resource manager, etc. The application developers are allowed to make use of these services in their applications.

Applications: All the android applications are found at the top layer and applications are installed on this layer. Examples of such applications are contacts, books, browsers, services, etc. Each application performs a different role in the overall applications.

1. Objective 1: Summary of class x mathematics syllabus

At the secondary stage, mathematics is a compulsory subject and the students starts to perceive Mathematics as an academic discipline. At this stage, students are aware of the structure of Mathematics, leaving behind the method of rote learning gradually, thereby entering this stage with understanding. Here, they have the knowledge to practise and apply Mathematics terms, formulae, signs and symbols. They started getting to be aware of Geometry and Trigonometry and that led to have a deeper knowledge and understanding about Algebra which they already learnt at elementary level. Students are able to identify and realize the relationship between algebra and what they learnt from Geometry and Trigonometry, as well as with Mathematics and other subjects.

Mathematics syllabus under Mizoram Board of School Education (MBSE) is based on the mathematics curriculum prescribed by NCERT. The contents of the syllabus are:

UNIT I: Commercial Mathematics

Instalments: - Instalments payments and instalments buying.

UNIT II: Time, Distance and Work

- Solution of problems based on time, work and distance.

UNIT III: Algebra

Polynomials : - Zeros of a polynomial. Relationship between zeros and co-efficients of a polynomial. HCF and LCM. Rational Expressions.

Linear Equation in Two Variables : - System of linear equation in two variables. Solution of the system of linear equations - (i) Graphical Method (ii) By Algebraic Methods: (a) Elimination/substitution method (b) Elimination by equating the co-efficients (c) Cross multiplication.

Quadratic Equations : - Standard form of quadratic equation $ax^2 + bx + c = 0, (a \neq 0)$. Solution by (i) factorisation (ii) quadratic formula. Application of quadratic equations in solving word-problems from different areas. Relationship between discriminant and nature of roots.

Arithmetic Progression (AP): - Introduction to AP by pattern of number. General term of an AP, sum to n-terms of an AP.

Sets : - Revision. - Venn Diagrams (not more than three sets). Complement of a set, operations on sets (union, intersection and difference of two sets)

UNIT – IV: Geometry

Triangles: - Definitions, examples, counterexamples of similar triangles. Thales theorem/Basic proportionality theorem, converse of basic proportionality theorem, Angle bisector theorem.

Criteria for similarity of triangles. Areas of two similar triangles. Pythagoras theorem, Baudhayan theorem

Circles : - Relationship between arcs and chords of a circle. Angle subtended by an arc of a circle. Cyclic quadrilaterals. Tangent to a circle, Number of tangents from a point on a circle. Segments of Chord (Segment theorem and Alternate segment theorem).

Constructions : - Division of a line segment in a given ratio (internally). Construction of tangents to a circle (i) At a point on it without using the centre. (ii) At a point on it using the centre. (iii) From a point outside it. Construction of a triangle similar to a given triangle. Construction of a triangle, given its base, vertical angle and either altitude or median through the vertex.

UNIT-V: Co-Ordinate Geometry

Co-ordinate Geometry : - Review the concepts of coordinate geometry done earlier including graphs of linear equations. Awareness of geometrical representation of quadratic polynomials. Distance between two pairs and section formula (internal). Area of a triangle.

UNIT VI: Trigonometry

(a) Proving simple identities based on the following: (i) $\sin^2A + \cos^2A = 1$ (ii) $\sec^2A= 1+\tan^2A$ (iii) $\mathrm{cosec}^2A = 1 + \cot^2A$.

(b) Problems on trigonometric ratios of complementary angles: (i) $\sin (90°- A) = \cos A$

(ii) $\cos (90°- A) = \sin A$ (iii) $\tan (90° - A) = \cot A$ (iv) $\mathrm{cosec} (90° - A) = \sec A$

(v) $\cot (90° - A) = \tan A$ (vi) $\sec (90° - A) = \mathrm{cosec} A$

Heights and Distances : - Simple problems on heights and distances.

UNIT – VII: Mensuration

Areas Related to Circle : - Motivate the area of a circle; area of sectors and segments of a circle. Problems based on areas and perimeter/circumference of circles.

Surface Areas and Volumes : - Problems on finding surface areas and volumes of combinations of any two of the following-cubes, cuboids, spheres, hemispheres and right circular, cylinders/ cones. Frustum of a cone. Problems involving converting one type of metallic solid into another and other mixed problems. (Problems with combination of not more than two different solids be taken).

UNIT – VIII: Statistics and Probability

Mean : - Mean of grouped data. (Calculation by taking assumed mean should also be discussed). Median and mode of grouped data.

Probability: - Elementary idea of probability as a measure of uncertainty.

Pictorial representation of data: - Reading and construction of pie chart.

2. Objective 2: Development of learning app for mathematics

Learning app on Mathematics called 'LearningMaths' is developed based on Class X mathematics textbook prescribed by MBSE. The source code was written using the Java language and the application was implemented using Android Studio which is a free open-source software. Android Studio is the official integrated development environment (IDE) for Android application development. It is based on the IntelliJ IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools.

To support application development within the Android operating system, Android Studio uses a Gradle-based build system, emulator, code templates, and Github integration. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and Google App Engine modules.

Android Studio uses an Instant Push feature to push code and resource changes to a running application. A code editor assists the developer with writing code and offering code completion, refraction, and analysis. Applications built in Android Studio are then compiled into the APK format for submission to the Google Play Store.

The software was first announced at Google I/O in May 2013, and the first stable build was released in December 2014. Android Studio is available for Mac, Windows, and Linux desktop platforms. Android Studio and the Software Development Kit can be downloaded directly from Google(https://developer.android.com/studio/).

Use Case Diagram

The use case diagram (Figure 1) indicates the graphical depiction of a user's possible interactions with a system. The user is a student who wants to learn class X mathematics.

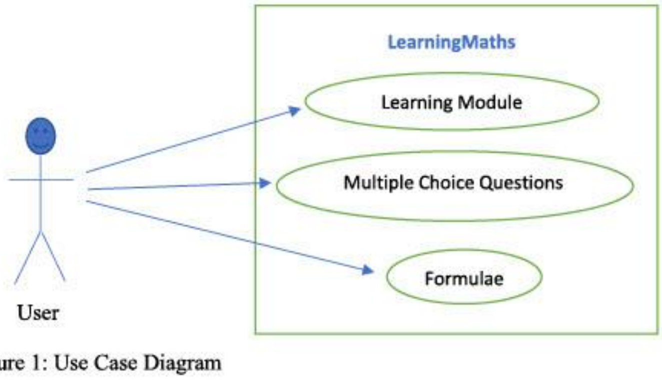

Figure 1: Use Case Diagram

9

Flow Charts

The flow chart (Figure 2) represents the workflow of the learning modules, the module is divided according to the textbook and each module has different set of contents based on the textbook exercise. Generally, all the module has two main activities namely app-based learning (Key points, Calculator and solved textbook exercise) and learning through external sources. For learning through external sources, a valid and related YouTube links are provided for further explanation and by clicking the links the user is redirected to that site.

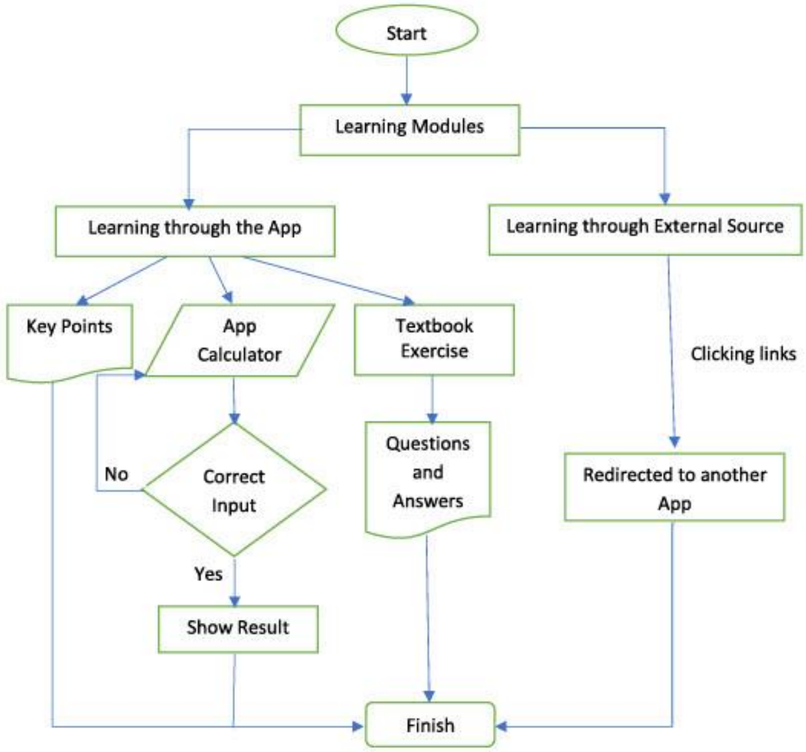

Figure 2: Flow Chart for Learning Modules

The flow chart for Multiple Choice Question (Figure 3) requires user input, which is the answer type. The application displays a question along with four choices. When the user selects one of the answer choices, the application lets the user know if the choice is correct or not. If the answer is correct, the user gets the next question and 1 is added to the score. If the answer is not correct, one chance is reduced and the next question still display until the chance is reduced to 0. The user gets a total of 2 minutes for the multiple-choice question test and the result of the test is displayed when the timer is 0 or when the chance is 0.

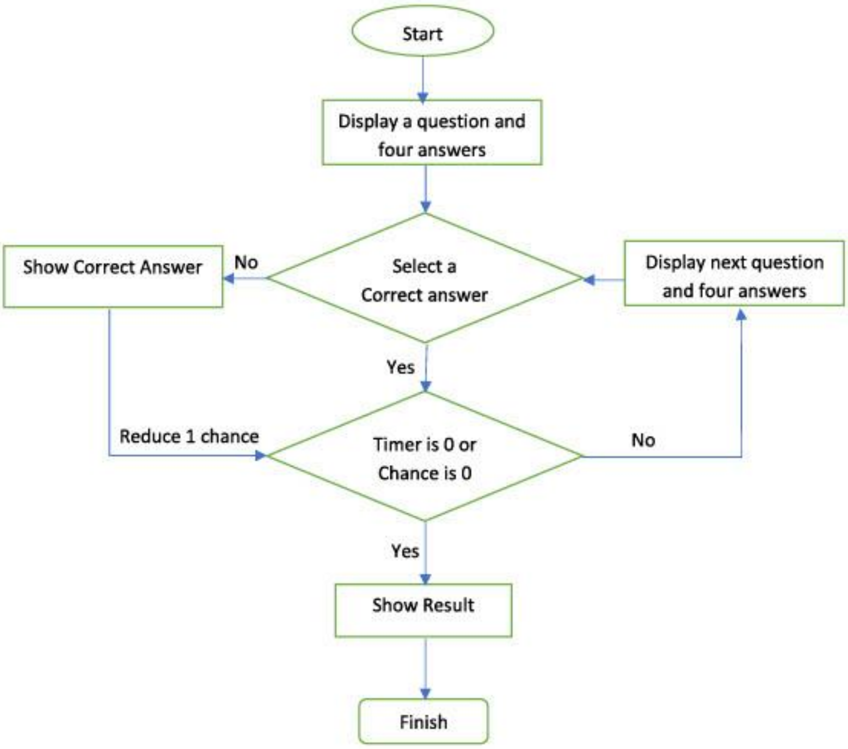

Figure 3: Flow Chart for Multiple Choice Questions

Test Results

When the application starts running, it loads the main interface. The main interface consists of five buttons namely Contents, Multiple Choice Questions, Formulae, Help and Exit. The Contents, Multiple Choice Questions, Formulae and Help buttons lead the users to a secondary menu interface while the Exit button closed the app. Figure 4 shows the main interface of the app and Figure 5 shows the learning module when the Contents button is clicked.

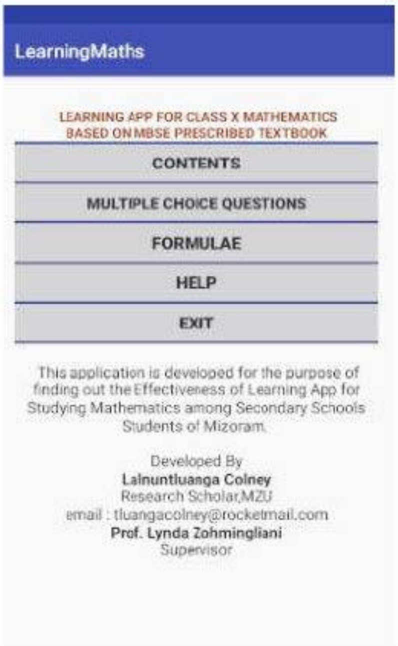

Figure 4: Main Interface

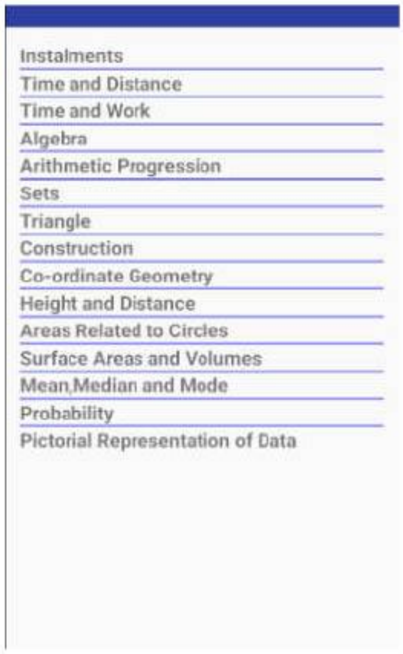

Figure 5: Learning Module

The learning modules are arranged according to the textbook chapter. Instalment module provide information requires for learning instalments and are highlighted as key points. The user can calculate instalment problems by providing valid input to the instalment calculator after clicking the button. Solved question and answer form the textbook can be viewed by clicking the Textbook Exercise button. For a student who wants to learn more about instalment concept, YouTube links are provided and the video can be viewed by clicking the links which redirected the user to the YouTube app or website. The video is directly played for further

12

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explanation about instalments and another links is also available. Likewise, each module is of the same design with different topic. Figure 6 shows the user interface of the instalment module.

Figure 6: Instalment module.

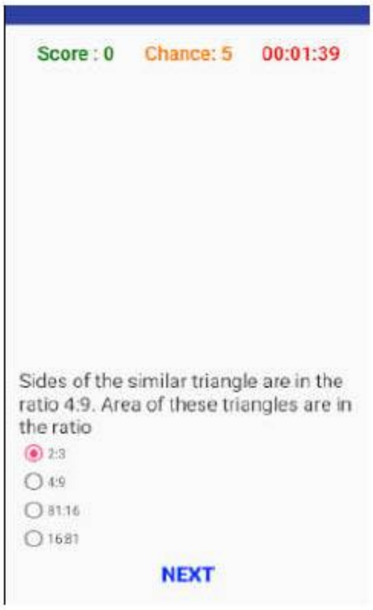

Figure 7: Multiple Choice Questions

If Multiple Choice Question is chosen from the main interface, the application loads the multiple-choice question menu as shown in figure 7. The user selects one answer from the list of answers after reading the question and the next button appear on the screen, the user can change the answer until the next button is clicked. The test ends when the timer countdown reaches 0 or when the chance of the user is 0, initially the user gets 5 chances when taking the multiple-choice question test. The result is shown at the end of the test by rating the user performance from 0 to 5 stars and by showing the score.

Figure 8 and Figure 9 shows the Formula interface and the Help interface which loads all the formula from the textbook and the guide to use the application written in Mizo language respectively.

13

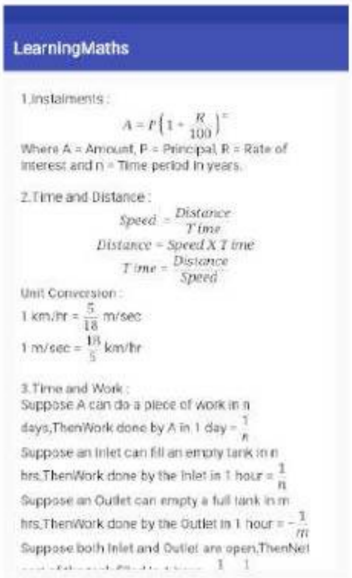

Figure 8: Formula

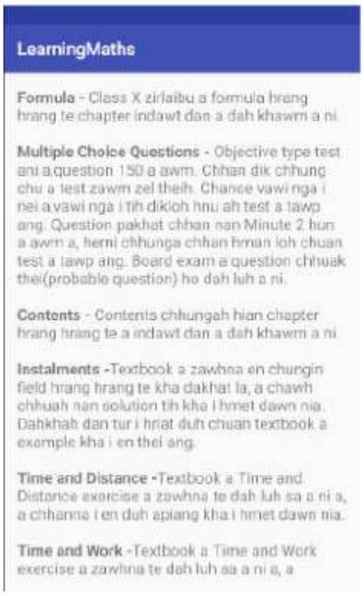

Figure 9: Help

The test results indicates that the application runs smoothly on the android emulator and android phone. The android package kit (.apk) of the application will be created for further distribution to the students.

CONCLUSION

Learning app on mathematics was developed only for the purpose of further research studies to find out the effectiveness of learning app for studying mathematics among secondary school students of Mizoram. This application only works on android operating system; therefore, the author plan on this application available for other operating systems if there is a positive result on the study of the effectiveness of learning app. It was hoped that this method of teaching and learning mathematics made the students easily understand the concept and enjoy mathematics rather than fear it and would be of practical use for students and even other researchers and policy makers. The National Education Policy 2020 mentioned that "A rich variety of educational software will be developed and made available for students and teachers at all levels for the purposes of improving teaching and learning". It was believed that a research study to find out the effectiveness of technology integration in education will be helpful for the successful implementation of the National Education Policy 2020.

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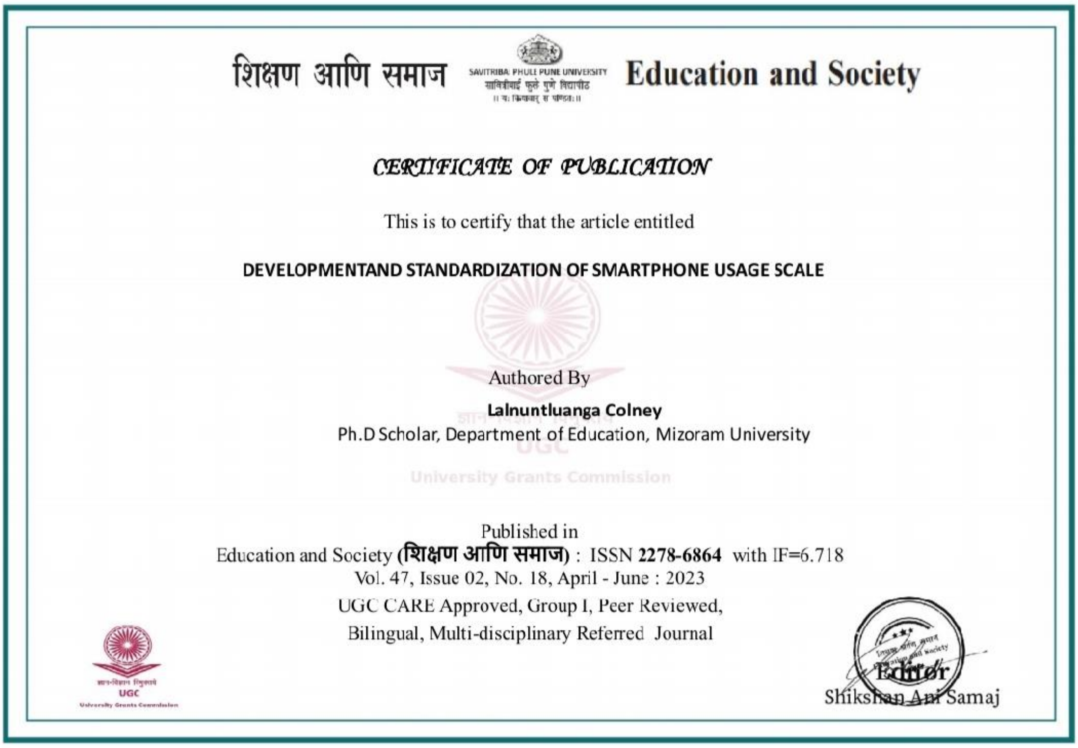
16

2. Development and Standardization of Smartphone Usage Scale



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DEVELOPMENTAND STANDARDIZATION OF SMARTPHONE USAGE SCALE

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Abstract

Smartphone usage among students has become increasingly prevalent in recent years. Understanding the extent to which students use their smartphones is crucial for teachers, policymakers, administrators, and everyone else involved in education.With this background, the present study aimed to develop and standardize a scale to measure the frequency and intensity of smartphone usage among secondary school students in India. A total of 40 statements were gathered after an extensive literature review to explore all the possible dimensions of students' smartphone usage.After the first try-out and seeking the opinion of the experts some of the items were reframed and 1 item was deleted.Item analysis was done by calculating the 't' value for each statement to determine the discriminating power for each of the 39 items of the pilot study. Based on the results of statistical analysis 10 items were deleted and 29 items were retained and those items were selected for the final study. The reliability of the scale was determined by using a test-retest method and that came out to be 0.813which determines the smartphone usage scale is a highly reliable tool. The z-score norms and the norms for score interpretation were also prepared.

Keywords:*development, standardization,Smartphone usage scale, validity, reliability, norms.*

Introduction

A smartphone is a mobile device that combines the functions of a computer and a cellular phone. It is typically designed to offer a wide range of features, such as Internet access, email, social media, video calls, music and video playback, GPS navigation, and a variety of apps. Smartphones are usually operated through a touchscreen interface and offer a user-friendly experience with customizable settings, notifications, and accessibility options. They can be connected to wireless networks, cellular data networks, and other devices, and come with different operating systems such as iOS, Android, and Windows. Smartphones have become an essential part of modern life, providing a convenient and powerful tool for communication, entertainment, and productivity.

Smartphone usage among students has become increasingly prevalent in recent years. Many students rely on their smartphones to stay connected with their peers, access information, and complete schoolwork. While smartphones can be a useful tool for learning, excessive usage can also have negative impacts on student's academic performance and overall well-being.

One of the primary concerns with smartphone usage among students is the potential for distraction. With social media, games, and other apps readily available on smartphones, students may find it difficult to stay focused on their studies. This can lead to lower grades, missed deadlines, and reduced learning outcomes.

Despite these potential drawbacks, there are also many ways in which smartphones can be beneficial for students. For example, smartphones can be used to access educational resources, such as online textbooks and study materials. They can also be used to collaborate with classmates and communicate with teachers outside of class.

To help mitigate the potential negative effects of smartphone usage among students, it is important for parents and educators to set boundaries and establish guidelines around usage. This may include setting limits on the amount of time spent on the phone each day, encouraging students to take breaks from technology, and monitoring usage to ensure it is not interfering with academic performance or mental health.

Overall, while there are potential downsides to excessive smartphone usage among students, when used appropriately, smartphones can be a valuable tool for learning and staying connected.

Purpose of Smartphone Usage Scale

The growing use of smartphones among secondary school students has recently drawn significant attention. It may not be altogether incorrect to assume that the majority of secondary school kids are familiar with using smartphones. In fact, the majority has grown reliant on smartphones as a result of the COVID-19 pandemic that has prevented schools from normal classes for almost a year. Understanding the extent to which students use their smartphones is crucial for teachers, policymakers, administrators, and everyone involved in education.

A smartphone usage scale is a tool used to measure the frequency and intensity of smartphone usage in individuals. The purpose of such a scale is to assess the extent of smartphone usage or problematic usage among individuals and to identify those who may be at risk for negative consequences related to excessive smartphone usages, such as academic or social impairment, anxiety, depression, or sleep disturbance.

A smartphone usage scale includes items related to the frequency and duration of smartphone usage, the types of activities engaged in on the smartphone (e.g., social media use, gaming, texting), the perceived impact of smartphone usage on daily life, and potential withdrawal symptoms when the smartphone is not available.By measuring the severity of smartphone usage, researchers and clinicians can better understand the impact of technology on daily life and work to develop strategies to promote healthy smartphone usage.

Objective of the Study

Following were the main objectives of the study.

1)To select and validate theitems for the smartphone usage scale.
2)To calculate the discriminating power for each item in the scale.
3)To determine the reliability of the smartphone usage scale.
4)To prepare the norms for interpretation of the raw score.

Methodology and Procedure

The Smartphone UsageScale was developed and validated through the following standard procedure:

Item Collection

The first stage of building the scale involved gathering a significant number of statements about smartphone usage from electronic and print media, books andexisting psychometric scales as well as through interactions with subject matter experts.A preliminary list of the elements was created with consideration for their application or suitability to the study's topic. The items have been arranged under three dimensions so as to find out the true level of smartphone usage among secondary school students as follows:

Extent of Smartphone usage for Studies: This component deals with the relationship between the student's smartphone usage and his/her studies; the degree and attitude to which the students use their smartphone in learning activities.

Extent of Smartphone use in Personal life: This component addresses the scope of student's smartphone use and the associated negative, positive, cognitive, and emotional reactions including the awareness of its influences on daily life.

Smartphone use in relationship with others: This component deals with the students' relationships, emotional reactions and interactions with others while usingsmartphones and the negative and positive influence of smartphones on the student's relationships with others due to smartphone usage.

Thus, a total of 40 statements were gathered in this manner to explore all the possible dimensions of students' smartphone usage.Negative statements were also included in the test to increase its validity. The evaluation is more accurate because these negative remarks contradict the positive ones.

Content Validity of the Scale

The selection of the statements for the scale was based on the opinions of seven experts in the same field to improve the quality of the tool. After fully comprehending the operational definitions, they were asked to review the statements.The overall design, the language's situational appropriateness and clarity, as well as the cognitive and logical validity of the material, were all considered in the evaluation of the scale. After the experts' valuable suggestions, one item was rejected as it was found to be repetitive and some of the statements were restructured as a result of the experts' opinions; suggestions were reviewed and added to the draft by eliminating and correcting all errors.The revised version of the scale, consisting of 39 items measuring the extent of student's smartphone usage was approved by the experts and used for the try-out.

Item Analysis

The final scale consisting of 39 items was administered to a random sample of 100secondary school students. Each item is rated on a 5-point Likert type and the scheme of scoring response categories involved differential weighting such that the response category, 'Always' is given a weightage of 5, 4 for 'Frequently', 3 for 'Sometimes', 2 for 'Rarely' and 1 for 'Never', in respect of response pertaining to positive statements. The scoring is reverse for the statements that were negative. All 100 respondents' total scores were ranked from highest to lowest. Twenty-sevenpercent (27 respondents), from the highest and lowest scores, respectively, were chosen as the high and low groups for item analysis. These were used as a group of criteria to assess each individual statement. The effectiveness of each item's ability to distinguish between the high and low groups was then examined. The 't' value was calculated for each statement to determine each item's discriminating power in scale.

Table 1: Analysis of Statements.

Sl. No.	Statements	Group	Mean	t-value
	Extent of Smartphone usagefor Studies			
1	I use my smartphone to record important assignments.	High	3.15	2.019
		Low	2.74	
2	*I like to learn from my textbook than from my smartphone.	High	2.48	3.543
		Low	1.37	
3	*I find it hard to get answers for my studies through smartphone.	High	4.19	2.690
		Low	3.37	
4	I use my smartphone to access learning materials.	High	3.81	0.593
		Low	3.63	
5	I use my smartphone for storing study materials.	High	3.19	0.210
		Low	3.26	
6	*Teacher explanation is effective than learning through smartphone.	High	1.93	3.139
		Low	1.07	
7	*I find it hard to understand concept and ideas through my smartphone.	High	3.44	2.293
		Low	2.78	
8	I like to search for queries about my studies from my smartphone rather than ask my teachers.	High	3.15	3.729
		Low	1.89	

Sl. No.	Statements	Group	Mean	t-value
9	Smartphone enables me to find answers that are not available in the textbooks.	High	3.48	0.331
		Low	3.37	
10	*Learning in a classroom is more enjoyable than learning through smartphone.	High	2.11	4.589
		Low	1.11	
11	I miss planned work due to smartphone use.	High	3.29	2.815
		Low	2.44	
12	I feel tired due to smartphone use.	High	2.19	1.436
		Low	1.74	
13	I use my smartphone to relieve stress.	High	3.37	3.459
		Low	2.19	
14	*I leave my smartphone at home while I'm going out.	High	3.22	1.803
		Low	2.67	
15	*I fail to pick phone calls because my smartphone is not nearby.	High	2.93	1.129
		Low	3.29	
16	*I forget where I keep my smartphone.	High	3.11	0.593
		Low	2.93	
17	*I use my smartphone only in my spare time.	High	3.41	1.968
		Low	2.85	
18	I bring my smartphone to the toilet.	High	4.56	4.236
		Low	3.37	
19	I check Social Networking Service sites like WhatsApp or Facebook right after waking up.	High	4.29	4.732
		Low	2.78	
20	I sleep less because of smartphone usage.	High	3.41	3.492
		Low	2.07	
21	I check my smartphone even when there is no notification.	High	4.11	4.408
		Low	2.74	
22	I use my smartphone longer than intended.	High	3.93	3.121
		Low	2.96	
23	*My daily schedule is unaffected by smartphone use.	High	3.41	1.423
		Low	2.93	
24	*I feel unpleasant and depressed while using a smartphone.	High	4.44	1.283
		Low	4.07	
25	*I miss important information from social media because I forgot to check my smartphone.	High	2.41	0.663
		Low	2.62	
26	People tell me that I use my smartphone too much.	High	3.19	2.888
		Low	2.19	
27	I get irritated when bothered while using my smartphone.	High	3.22	3.623
		Low	2.07	
28	I start a conversation with unknown person using my smartphone.	High	2.44	2.375
		Low	1.70	
29	*I feel anxious meeting more people via smartphone use.	High	3.19	1.022

Sl. No.	Statements	Group	Mean	t-value
		Low	2.81	
30	*I like to play games outside with my friends than playing games on my smartphone.	High	2.85	3.02
		Low	1.85	
31	*I like to hang out with my friends than chatting through my smartphone.	High	2.48	4.112
		Low	1.33	
32	*I refrain myself from using smartphone while I'm with my friends or family.	High	2.78	3.896
		Low	1.63	
33	I consider my smartphone buddies as my real friends.	High	3.48	4.948
		Low	1.85	
34	I feel that my relationships with my smartphone buddies are more intimate than my relationships with my real-life friends.	High	2.49	4.878
		Low	1.11	
35	Not being able to use my smartphone would be as painful as losing a friend.	High	3.89	7.871
		Low	1.81	
36	Smartphone enables me to interact with friends without wasting time to pay visits with each other.	High	4.25	2.613
		Low	3.59	
37	*During conversation, I give priority to the people around me than checking my smartphone notification.	High	2.63	2.578
		Low	1.74	
38	*I have more real-life friends than smartphone buddies.	High	2	2.833
		Low	1.19	
39	Because of the smartphone, I have friends whom I have not met who are willing to help me in times of need.	High	3.26	4.522
		Low	1.93	

Item Selection after Item Analysis

Following item analysis, the statements with significant t-values (greater than 1.676). as determined by the calculation of each statement's "t" value, were kept in the smartphone usage scale. Only 29 items altogetherout of the 39 total itemswere kept in the scale for determining the extent of smartphone usageamong secondary school students and ten items were discarded. Out of 29 items 17 were positive and 12 were negative.

Table 2: Overview of selected items.

Dimension	Condition	Item wise serial No.		Total
Extent of Smartphone usagefor Studies	Positive	1,6	2	7
	Negative	2,3,4,5,7	5	
Extent of Smartphone use in Personal life	Positive	8.9,12,13,14,15,16	7	9
	Negative	10,11	2	
Smartphone use in relationship with others	Positive	17,18,19,23,24,25,26,29	8	13
	Negative	20,21,22,27,28	5	

Reliability of the Scale

To identify the reliability of the Smartphone Usage Scale, a test-retest design was used. 120 students from Govt. Mamit High School and Presbyterian English School, Mamitcompleted the test-retest assessment. From the first and the second test, the following scores were obtained:

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Total score of first test (ΣX) = 9307

Total score of second test (ΣY) = 9302

$\Sigma XY = 733487$ $\Sigma X^2 = 736951$ $\Sigma Y^2 = 735568$

Pearson's correlation coefficient (r) is

$$r = \frac{N\Sigma XY - \Sigma X.\Sigma Y}{\sqrt{[N\Sigma X^2 - (\Sigma X)^2][N\Sigma Y^2 - (\Sigma Y)^2]}}$$

$$= \frac{120 \text{ X } 733487 - 9307 \text{ X } 9302}{\sqrt{[120 \text{ X } 736951 - 9307^2][120 \text{ X } 735568 - 9302^2]}}$$

$$= 0.813$$

The test-retest reliability of the Smartphone Usage Scale was significant as evidenced by a Pearson's correlation (r) of 0.813 which indicates a high correlation (good reliability).

Norms for Smartphone Usage Scale

For the purpose of finding out the extent to which students uses their smartphone, z-score norms have been prepared for interpretation of the Raw scores. The raw score on the Smartphone Usage Scale could range between 29 to 145. The z-score norms are given in Table 3 and the norms for interpretation in Table 4.

The mean and standard deviation from the sample was found as:

N= 320

Mean = 77.378

Standard deviation = 12.337

Table 3: z-score norms for Smartphone Usage Scale

Raw Score	Z - Score	Raw Score	Z - Score	Raw Score	Z - Score	Raw Score	Z - Score
52	-2.05706	65	-1.00332	78	0.050417	91	1.104158
53	-1.97601	66	-0.92227	79	0.131474	92	1.185215
54	-1.89495	67	-0.84121	80	0.212531	93	1.266272
55	-1.81389	68	-0.76015	81	0.293588	94	1.347329
56	-1.73284	69	-0.6791	82	0.374645	95	1.428386
57	-1.65178	70	-0.59804	83	0.455702	96	1.509443
58	-1.57072	71	-0.51698	84	0.536759	97	1.5905
59	-1.48967	72	-0.43592	85	0.617816	98	1.671557
60	-1.40861	73	-0.35487	86	0.698873	99	1.752614
61	-1.32755	74	-0.27381	87	0.77993	100	1.833671
62	-1.24649	75	-0.19275	88	0.860987	101	1.914728
63	-1.16544	76	-0.1117	89	0.942044	102	1.995785
64	-1.08438	77	-0.03064	90	1.023101	103	2.076842

Table 4: Norms for interpretation of z-score for Smartphone Usage Scale

Sl. No.	Range of Raw score	Range of z-Score	Grade	Usage Level
1	103 and above	+2.01 and above	A	Extremely High
2	93 to 102	+1.26 to + 2.00	B	High
3	84 to 92	+0.51 to +1.25	C	Above Average
4	72 to 83	-0.50 to +0.50	D	Average
5	62 to 71	-0.51 to -1.25	E	Below Average
6	53 to 61	-1.26 to -2.00	F	Low
7	52 and below	-2.01 and below	G	Extremely Low

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Conclusion

The scale can be used by anyone who wants to assess the level of student smartphone use and determine whether they are prone to smartphone addiction or not. This can include individuals who feel that they may be spending too much time on their smartphones or those who are concerned about the impact of smartphone use on their well-being.Moreover, researchers may also use smartphone usage scales to measure the extent of smartphone usage among their students or study participants. The scale covers the extent of Smartphone usage for studies, extent of Smartphone use in personal life and Smartphone use in relationship with others. Thus, it may also be used by policy makers and stakeholders in education to determine whether smartphones can be a valuable tool for teaching and learning or it is necessary to set boundaries and establish guidelines on the use of smartphone for students.

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Reskilling and Upskilling Stakeholders of Higher Education through Artificial Intelligence under G20 Initiative, 2023

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This is to certify that *Mr. Lalnuntluanga Colney, Ph.D. Scholar, Department of Education, Mizoram University* has presented a paper on *Use of Chat GPT in Educational Research: Possibilities or Threat* in the International Conference On 'Reskilling and Upskilling Stakeholders of Higher Education through Artificial Intelligence under G20 Initiative, 2023' held on 19th -20th May, 2023, organized by the Department of Education, Mizoram University.

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PARTICULARS OF THE CANDIDATE

NAME OF THE CANDIDATE	: LALNUNTLUANGA COLNEY
DEGREE	: DOCTOR OF PHILOSOPHY
DEPARTMENT	: EDUCATION
TITLE OF THESIS	: SMARTPHONE USAGE AND EFFECTIVENESS OF LEARNING APP FOR STUDYING MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS OF MIZORAM.
DATE OF ADMISSION	: 22nd October 2020

APPROVAL OF RESEARCH PROPOSAL

1. DRC	: 30th & 31st March 2021
2. BOS	: 16th April 2021
3. SCHOOL BOARD	: 20th May 2021
MZU REGISTRATION NO.	: 1500225

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(PROF. H.MALSAWMI)
Head i/c
Department of Education

ABSTRACT

SMARTPHONE USAGE AND EFFECTIVENESS OF LEARNING APP FOR STUDYING MATHEMATICS AMONG SECONDARY SCHOOL STUDENTS OF MIZORAM

AN ABSTRACT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

LALNUNTLUANGA COLNEY

MZU REGN.NO: 1500225

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DEPARTMENT OF EDUCATION

SCHOOL OF EDUCATION

JANUARY, 2025

Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram

By

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Department of Education

Supervisor

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Submitted

In partial fulfilment of the requirement of the Degree of Doctor of Philosophy in Education of Mizoram University, Aizawl

Introduction

In India, secondary education plays a pivotal role in bridging the gap between primary and higher education. After the independence of India, several reforms and commissions aimed to enhance this phase. The National Education Policy (NEP) 2020 introduces changes to align with international standards, focusing on subject choice and reducing rote learning. Mathematics at the secondary level of education, stressed by the 1964-1966 Commission and the National Curriculum Framework (NCF) 2005, aims to make mathematics learning engaging by promoting practical skills and abstract reasoning, encouraging students to enjoy, discuss, and solve meaningful problems, thus improving overall engagement and understanding.

Mathematics education benefits from a variety of learning resources, including textbooks, digital tools, and interactive platforms. Digital resources, driven by ICT, enhance learning by providing structured lessons, interactive exercises, and adaptive technologies. These tools support individualized learning, promote active engagement, and facilitate better educational outcomes. The Indian government has recognized the importance of ICT in education through various initiatives, such as the ICT@School Scheme and the National Education Policy 2020, which aim to modernize and improve the quality of secondary education nationwide.

The increasing use of smartphones, a key ICT tool, is driving a surge in educational app development. These apps improve learning by providing flexible and accessible education, bridging gaps between students, teachers, and parents, and offering interactive features, making them valuable digital resources for studying mathematics. Despite the vast array of educational apps available, there remains a gap in resources aligned with specific regional curricula like Mizoram.

Rationale of the study

The massive growth in digital literacy and its impact on different areas of the world is a known fact. India has also become a major beneficiary and the increase in online education is testimony to this fact. The growing use of smartphones among secondary school students has recently drawn significant attention. It might not be completely incorrect to assume that the majority of secondary school students are familiar with using smartphones. In fact, the majority has become reliant on smartphones as a result of the COVID-19 pandemic which prevented opening schools for more than a year and necessitated emergency digital-based education throughout the world. Understanding the length of time students spend with their smartphones as well as the merits and demerits of smartphone usage, are key considerations for teachers, policymakers, administrators, and anyone else involved in the education sector.

The National Education Policy 2020 mentioned that “a rich variety of educational software will be developed and made available for students and teachers at all levels for the purposes of improving teaching and learning” (Ministry of Human Resources Development, 2020). Moreover, researchers and policymakers must understand the effectiveness of this software in the educational process. In this context, conducting a research study to find out the effectiveness of technology integration in education will be helpful for the successful implementation of the National Education Policy 2020.

However, despite this overwhelming digital advancement, many areas in Mizoram, mostly in the remote and rural areas, are still unable to benefit from and experience all that digital advancement has to offer due to a lack of or poor internet connection, which prevents students from using the internet as effectively as they could in areas with a good internet connection. The COVID-19 pandemic made many classes and study materials only accessible through online classes, which made the problem worse. As a result, creating an offline application will be crucial for learning in both these challenging situations and in those where an internet connection is not an issue because offline applications are so accessible.

Mathematics education is of another great importance. All sciences are built on the foundation of mathematics, so anyone who wants to pursue technical education must first comprehend this subject thoroughly. The relevance of mathematics for students' futures is further increased by the fact that nations around the world are now competing with one another, making technological advancement of considerable consequence. It may be accurate to state that among secondary school students, mathematics is the subject they fear the most. Therefore, researchers must create a new approach to teaching and learning mathematics so that the student may quickly understand the subject and enjoy mathematics rather than fear it.

Since it is clear that smartphones are here to stay, preventing students from using them would be a useless feat. What is more important would be to channel this activity into a worthwhile one. Therefore, it becomes a major concern to not only understand the level of usage of smartphones by secondary school students but also devise some way to manipulate students' affinity with smartphones in a way that would benefit their ability to understand mathematics. With these thoughts in mind, the researcher has decided to take up a research work that would successfully combine the two elements i.e., smartphone usage and mathematics learning and come up with results that would be of practical use for students and even other researchers and policymakers.

Research Questions

1. What is the major purpose for smartphone usage among secondary school students of Mizoram?
2. What is the level of smartphone usage among secondary school students of Mizoram?
3. Is there any difference on the level of smartphone usage between male and female secondary school students of Mizoram?
4. Is there any difference on the level of smartphone usage between rural and urban secondary school students of Mizoram?
5. Is there any difference on the level of smartphone usage between private and government secondary school students of Mizoram?
6. Is it possible to develop a learning app on mathematics for secondary school students of Mizoram?
7. What is the effectiveness of learning app on mathematics among secondary school students?
8. Will there be a difference in the effectiveness of learning app on mathematics between male and female secondary school students?

Statement of the Problem

The problem of the study is entitled as 'Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram'.

Objectives of the Study

1 To find out the major purpose for smartphone usage among secondary school students of Mizoram.

2 To find out the level of smartphone usage among secondary school students of Mizoram.

3 To compare the level of smartphone usage among secondary school students of Mizoram based on gender.

4 To compare the level of smartphone usage among secondary school students of Mizoram based on locality.

5 To compare the level of smartphone usage among secondary school students of Mizoram based on management of school.

6 To develop a learning app on mathematics for secondary school students of Mizoram.

7 To find out the effectiveness of learning app on mathematics among secondary school students.

8 To compare the effectiveness of learning app on mathematics among secondary school students in terms of gender.

9 To suggest measures for the improvement of Mathematics learning in Mizoram.

Null Hypotheses of the Study

1. There is no significant difference in the level of smartphone usage between male and female secondary school students of Mizoram.
2. There is no significant difference in the level of smartphone usage between rural and urban secondary school students of Mizoram.
3. There is no significant difference in the level of smartphone usage between private and government secondary school students of Mizoram.
4. There is no significant difference in mathematics competency between the control group and the experimental group of secondary school students after the experimental group used the learning app.
5. There is no significant difference in the effectiveness of learning app on mathematics between male and female secondary school students.

Review of Literature

A review of literature related to smartphone usage among students, mathematics learning at the secondary level of education and mathematics learning using ICT was done by the scholar to know more about the status of research done and also to understand the findings of other researchers on the topic. For a period of 16 years spanning from 2005 to 2021, a total of 66 related research works were traced. From a review of 66 studies, with 2 in Mizoram, 27 in the rest of India, and 37 outside India, the most researched area was smartphone usage among students (24 studies), followed by mathematics learning at the secondary level (23 studies), and mathematics learning using digital resources (19 studies).

Research Approach

The present study used descriptive research design to investigate the major purpose of smartphone usage and the level of smartphone usage among secondary school students in Mizoram as it requires survey and test findings. To find out the effectiveness of learning app on mathematics among secondary school students, the researcher used a quasi-experimental research design. The approach is of mixed type as both quantitative as well as qualitative methods are employed for data analysis.

Population and Sample

The population of the present study comprised all the secondary school students of both Govt. and Non-govt. schools in Mizoram.

There were two kinds of samples for the present study to realize different objectives:

i. Sample for administration of questionnaire: This sample was collected to assess the extent and primary purposes of smartphone usage among secondary school students in Mizoram. A sample of 700 secondary school students was randomly selected from the population. Sampling was done based on a multistage simple random sampling method. In the first stage, four districts (Aizawl, Lunglei, Champhai, and Mamit) were randomly selected from 11 in Mizoram. In the second stage, secondary schools in these districts were clustered into government and private schools, with six schools selected from the latter three districts and eight from Aizawl. In the third stage, 80 students each from government and private schools were randomly chosen from Lunglei, Champhai, and Mamit, and 220 students (110 from each school type) were selected from Aizawl for the final sample.

ii. Sample for quasi-experiment: This sample was collected to assess the effectiveness of the mathematics learning app for secondary school students in Mizoram. For this purpose, all secondary schools with a Class X enrolment higher than 90 during the academic year 2022-2023 in Mizoram were identified. Among these schools, one school was randomly selected to ensure an unbiased representation. From the chosen school, 90 students were randomly selected as the sample and later divided into control and experimental groups.

Tools for Data Collection

1. Smartphone Usage Scale (SUS), developed and standardized by the researcher to find out the level and major purpose of smartphone usage among secondary school students.
2. Mathematics Achievement test for class X students developed by the researcher to measure the effectiveness of the mathematics learning app.
3. Android learning app called Learning Maths for studying Mathematics on a smartphone based on the MBSE class X syllabus developed by the researcher to find out the effectiveness of the mathematics learning app.

Collection of Primary Data

1. To find out the major purpose and level of smartphone usage, the selected sample schools were visited by the researcher, after discussing the purpose of the study with the school authority or headmaster, written permission was obtained. Following Subsequently, a research schedule was established. On the fixed date, the researcher personally collected the data by distributing questionnaires to the selected students.

2. To find out the effectiveness of the learning app on mathematics among secondary school students, the researcher personally visited a selected sample school. After explaining and discussing the objectives and methodology of the study to the school headmaster, written approval was acquired and a schedule for the experimental study was set.

A pre-test on mathematics competency was conducted on a randomly selected sample of Class X students using the Mathematics Achievement test developed by the researcher for the pre-test. After their scores had been recorded, they were divided into two equivalent groups i.e., control and experimental groups.

After 91 working days from the introduction of the intervention (Learning app) to the experimental group and completion of all the learning modules, a post-test was conducted on the two groups using a mathematics achievement test for post-test developed by the researcher. The data obtained on the post-test was used for further analysis and interpretation to see the effectiveness of the learning app on students.

Data Analysis

In the data analysis phase, the researcher employed both quantitative and qualitative methods to analyse the collected data comprehensively.

Quantitative analysis involves the use of descriptive and inferential statistics to examine numerical data quantitatively such as percentages, means, normality tests, t-tests and correlation. Microsoft Excel and Statistical Package for the Social Sciences (SPSS) were the primary tools utilized for conducting statistical tests and analyses.

Qualitative data were analysed thematically to identify recurring themes, patterns, and insights that emerged from participants' responses.

Major Findings and discussions of the study

1. Major findings and discussions regarding the finding of major purpose for smartphone usage among secondary school students of Mizoram

This study revealed that-

- 90.14% of secondary school students in Mizoram used smartphones for social media platforms such as Facebook, WhatsApp, Instagram, and TikTok.
- 89.43% of secondary school students in Mizoram used smartphones for entertainment purposes like listening to music and watching videos/movies.
- 73.14% of secondary school students in Mizoram used smartphones for traditional communication methods, such as making phone calls and chatting.
- 72.43% of secondary school students in Mizoram used smartphones to search for information on Google.
- 54.86% of secondary school students in Mizoram used smartphones for playing games, both online and offline.

- 49.71% of secondary school students in Mizoram used smartphones for photography and video recording.
- 40.71% of secondary school students in Mizoram used smartphones for reading news and entertainment.
- 39% of secondary school students in Mizoram used smartphones to access learning materials.
- 19.29% of secondary school students in Mizoram used smartphones for interaction with teachers.
- 1.14% of secondary school students in Mizoram used smartphones for other purposes like editing, business-related activities, and using dictionaries.

The majority (75%) of the secondary school students in Mizoram used their smartphones for social interaction and entertainment purposes while only a smaller percentage (25%) of students use their smartphones for educational purposes.

Discussion: Findings on smartphone usage among secondary school students in Mizoram reveal a dominant trend towards social interaction and entertainment over educational use. This aligns with broader research indicating adolescents prefer social media, entertainment, and gaming over academic activities (Harfield et al., 2014; Cha and Seo, 2018; Fook et al., 2021). A high percentage of students use smartphones for social media (90.14%) and entertainment (89.43%), reflecting global trends where platforms like Facebook, WhatsApp, and TikTok are prevalent (Mahalakshmi, 2013; Jesse, 2015; Savio, 2016; Soegoto, 2019). Additionally, 54.86% use smartphones for gaming, consistent with findings that gaming is a major recreational activity among youth (Liu et al., 2016). However, lower percentages of students use smartphones for educational purposes (39% for accessing learning materials and 19.29% for interacting with teachers), indicating a potential gap in integrating technology into education. This underscores the importance of understanding barriers to educational technology adoption and designing interventions to promote its effective use in academic settings (Ertmer, 1999). Identifying ways to optimize educational technology use among students is crucial.

2. Major findings and discussions regarding the finding of the level of smartphone usage among secondary school students of Mizoram

This study revealed that-

- Grade A, representing the "Extremely High" smartphone usage level, has a small proportion (2.43%) of students. These students have raw scores significantly above the mean, indicating heavy dependence or usage.
- Grade B, representing the "High" smartphone usage level, has a moderate group (9%) of students, with raw scores well above average, suggesting frequent use.
- Grade C, representing the "Above Average" smartphone usage level, has a significant portion (18.72%) of students with raw scores more than the average student, but not excessively.
- Grade D, representing the "Average" smartphone usage level, has the largest group (38.57%) of students, indicating a balanced or typical use among these students.
- Grade E, representing "Below Average" smartphone usage level, has a considerable number (20.14%) of students who used their smartphones less than average, which might indicate moderate or restricted use.
- Grade F, representing the "Low" smartphone usage level, has a smaller group (9.43%) of students, suggesting limited interaction with their devices.
- Grade G, representing the "Extremely Low" smartphone usage level, has a very small fraction (1.71%) of students, which could indicate minimal dependency or access to smartphones.
- Overall, the majority (77.43%) of students fall into Grades C, D, and E, representing "Above Average," "Average," and "Below Average" usage levels.

Thus, it can be concluded that the overall smartphone usage among secondary school students in Mizoram is average, indicating typical smartphone use with lesser risks for negative consequences.

Discussion: The study concluded that the majority (77.43%) of secondary school students in Mizoram had an average level of smartphone usage, with the largest group in Grade D, followed by Grades C and E. A smaller percentage of students exhibited very high or very low usage. This indicates that while smartphone usage was common, extreme behaviours were less prevalent. Grades A and B, representing high and very high usage, included only 11.43% of students, aligning with similar studies such as Haug et al. (2015), which found 16.9% of students experienced smartphone addiction. Comparisons with global research showed varying levels of smartphone addiction risks: Heo and Lee (2018) found 24.7% of high school students at risk, Cha and Seo (2018) reported 30.9%, and Lee et al. (2021) in Malaysia found 57.6% at high risk. These differences might result from variations in geographic regions or differences in the timeframes of the studies. The balanced smartphone usage among Mizoram students suggested a healthy integration of technology into their lives, avoiding the pitfalls of excessive use. Understanding these patterns is crucial for educators and policymakers to promote healthy smartphone usage habits.

3. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on gender

A comparison of the level of smartphone usage among secondary school students of Mizoram based on gender revealed that-

- The mean scores for male and female students were relatively close, with females scoring slightly higher on average (78.19 vs. 77.81).
- The calculated t-value of 0.403 with 698 degrees of freedom indicated a statistically non-significant difference in mean scores between male and female students at the 0.05(1.96) significance level.

Thus, it can be concluded that there is no significant difference between male and female secondary school students of Mizoram in the level of their smartphone usage. Suggesting that gender does not play a major role in influencing the extent of smartphone use among the students.

Discussion: The absence of statistically significant differences in the mean scores of smartphone usage between male and female secondary school students in Mizoram indicates that gender may not play a major role in influencing smartphone usage patterns in this context. This implies that potential concerns or benefits of smartphone usage might affect both genders equally. Al-Barashdi et al. (2015) found mixed results in studies on gender differences in smartphone use, with some indicating a significant relationship and others not. Nayak (2018) reported that female students used smartphones more than males, suggesting gender-specific preferences or needs such as app types, social media engagement, or communication habits. Conversely, studies by Savio (2016), Negi (2019), and Rekha (2019) found that male students used smartphones more, often due to gaming, technical interest, or social interactions on digital platforms. These contrasting findings indicate that gender differences in smartphone usage are not uniform and may be influenced by factors like cultural norms, regional differences, and specific demographic characteristics.

4. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on locality

A comparison of the level of smartphone usage among secondary school students of Mizoram based on locality revealed that-

- The mean score for urban students (78.91) is higher than that for rural students (76.92). Additionally, the standard deviation, which measures variability in scores, is lower in urban students (12.102) compared to rural students (13.192).
- The calculated t-value of 2.079 with 698 degrees of freedom indicated a statistically significant difference in the means of rural and urban student scores at the 0.05(1.96) significance level but not at the 0.01(2.58) level.

The analysis indicated a slight difference in smartphone usage between urban and rural students, though the effect size was not large enough to be substantial. Therefore, it was reasonable to conclude that the level of smartphone usage was higher in students from urban as compared to students from rural areas.

Discussion: The performance gap between rural and urban students in smartphone usage reveals that urban students generally exhibit higher usage across most categories. This aligns with Bhanderi et al. (2021) in Himachal Pradesh, who found that urban students had greater access to and utilized smartphones more extensively than their rural counterparts, highlighting a broader digital divide in India. The OXFAM India Digital Divide: Inequality Report 2022 indicates that “only 31% of the rural population used the Internet compared to 67% of the urban population”, emphasizing the uneven distribution of digital infrastructure. This divide affects access to digital education and economic opportunities, with disparities also seen between under-resourced and affluent urban areas (Laskar, 2023). Lower smartphone and internet usage among rural students is attributed to inadequate digital infrastructure, lower socioeconomic status, and limited availability of affordable devices and internet services. However, the digital divide is not uniform across all states. Rekha (2019) found similar mobile phone usage levels among students in rural and urban Haryana, suggesting regional variations in the digital divide influenced by state-level policies, local infrastructure, and community initiatives. Some states may have implemented effective measures to ensure equitable digital access, reducing disparities observed at the national level.

5. Major findings and discussions regarding Comparisons of the level of smartphone usage among secondary school students of Mizoram based on management of school

A comparison of the level of smartphone usage among secondary school students of Mizoram based on management of school revealed that-

- The mean score for students in private schools was 79.62, with a standard deviation of 12.048, indicating less variability in scores. Students in government schools had a lower mean score of 76.39 and a higher standard deviation of 13.020, suggesting greater variability in their academic performances.
- A t-test comparing the mean scores of students from private and government schools yielded a calculated t-value of 3.408. With 698 degrees of freedom, this difference is statistically significant at the 0.01(2.58) significance level.

Thus, it can be concluded that there is a significant difference in the level of smartphone usage between private and government secondary school students of Mizoram, with private school students exhibiting significantly higher usage than their government school counterparts.

Discussion: The study highlighted significant disparities in smartphone usage between private and government school students in Mizoram, favouring private school students. This disparity is largely due to socioeconomic differences, with private school students often coming from more affluent backgrounds that facilitate greater access to digital technologies. Government schools, serving economically disadvantaged students, struggle to provide consistent access to these resources. This aligns with broader research, such as Tewathia et al. (2020), which found significant variations in ICT ownership and usage across socioeconomic groups in India. Sharma and Banerjee (2022) also noted substantial computer and internet usage gaps and English language skills linked to social and economic marginalities. These findings indicate that India's socioeconomic divide is a major contributor to its digital divide, as Laskar (2023) pointed out. The implications are significant: private school students benefit from enhanced educational experiences due to higher smartphone ownership and usage, accessing a wealth of online resources and educational tools. Conversely, government school students miss out on these opportunities, underlining the need for targeted interventions to bridge this digital divide.

6. Major findings and discussions regarding the objective: To develop a learning app on mathematics for secondary school students of Mizoram

This objective was successfully realized and a learning app on mathematics for secondary school students was developed by the researcher with the hope that this application presents an opportunity to enhance educational outcomes through technology.

- The app, named "LearningMaths," was developed specifically for Class X students in Mizoram, aligning with the Mizoram Board of School Education curriculum.
- Developed exclusively for the Android operating system, the app benefited from the platform's extensive reach and developer-friendly environment.
- Utilizing Android Studio as the primary development platform, the researcher opted for Java as the primary programming language, given its versatility and the researcher's familiarity.
- Emphasizing user-centric design, the app featured structured learning modules, interactive quizzes, formula references, and language support in Mizo.
- LearningMaths contained only eight learning modules, which covered the first eight chapters of the textbook. Each module adheres to a consistent structural design.

- Thorough development and testing phases ensured the app's compatibility across various devices, providing a seamless learning experience.
- The app included self-assessment tests with real-time feedback and comprehensive tracking of student progress.

Through continuous refinement and feedback-based iterations, LearningMaths aims to stay attuned to the evolving needs of students and educators, enhancing learning outcomes and educational experiences in Mizoram.

Discussion: The development of the LearningMaths app marked a significant advancement in incorporating technology into educational practices in regions like Mizoram, where such digital resources were less common. Targeted at secondary school students in class X, the app was designed based on research indicating improved performance when students engaged with contextualized and localized modules (Bendijo et al., 2022). The focus on Android was a strategic choice, as Android held a dominant 70.69% share of the global smartphone market compared to iPhone's (iOS) 28.58% (Sherif, 2024). Utilizing Android Studio and Java leveraged well-supported, open-source technologies, facilitating easier troubleshooting and access to a vast array of libraries, frameworks, and online resources (Anand, 2023). The app's interactive elements and structured learning modules supported findings by Lukita et al. (2017), suggesting that interactive learning enhances the educational experience. Features like quizzes, formula access, and self-assessment tests made the learning environment more engaging and responsive compared to traditional methods, aligning to improve mathematics competency among students in Mizoram.

7. Major findings and discussions regarding the finding of effectiveness of learning app on mathematics among secondary school students

The major findings of the current research revolved around the efficacy of the LearningMaths app in enhancing mathematics competency among secondary school students in Mizoram. A pre-test and post-test design was employed, with a specific mathematics achievement test administered to both control and experimental groups. The post-test scores were then analysed to determine the app's effectiveness.

- The normality of the post-test scores was assessed for both groups using the Shapiro-Wilk test. Results indicated that the control group did not deviate significantly from a normal distribution (p=0.157), suggesting that the distribution of scores was normal. In contrast, the experimental group's scores deviated from normality (p=0.003), indicating a non-normal distribution.
- The mean post-test score for the experimental group was 12.84, higher than the mean post-test score of 11.42 for the control group.
- The calculated t-value (2.001) exceeded the critical value at the 0.05 level (1.99) but was below the critical value at the 0.01 level (2.64). Indicating that the test results were not significant at the 0.01 level but showed significance at the 0.05 level.

Thus, it can be concluded that incorporating interactive and structured digital learning tools, like the LearningMaths app might have a positive impact on secondary school students when compared to students who did not use the app.

Discussion: The findings suggested that while the LearningMaths app may have improved students' mathematics competency, the effect was not highly significant. Various factors such as the duration of app usage, individual learning preferences, or limitations in the app's content or design might have influenced the results. Despite this, the findings aligned with previous research indicating that digital educational tools could enhance mathematics learning outcomes. Studies by Senthamaraikannan (2019) and Safdar et al. (2011) showed ICT's effectiveness in secondary-level mathematics education compared to conventional methods. Keong et al. (2005) found ICT made teaching more effective, while Li and Ma (2010) demonstrated significant positive effects of computer technology on mathematics achievement, with improved student motivation and engagement. Bayaa and Daher (2009) noted students' positive reception of mobile phones in learning, and Lalduhawma (2018) found enthusiasm for technology-based math education in Mizoram. Joshi (2017) highlighted ICT's potential to enhance lesson design, teaching strategies, and teachers' content and pedagogical knowledge, creating a more dynamic and effective learning environment. The overall consensus is that ICT can significantly contribute to better teaching and learning experiences in mathematics.

8. Major findings and discussions regarding Comparisons of the effectiveness of learning app on mathematics among secondary school students in terms of gender

A comparison of the effectiveness of learning app on mathematics among secondary school students in Mizoram in terms of gender revealed that-

- There was a slight disparity in mean scores between males and females. However, these differences lack statistical significance.
- The calculated t-value of 0.532, with a significance level not meeting the level of significance at 0.05, indicated that the null hypothesis "There is no significant difference in the effectiveness of the learning app on mathematics between male and female secondary school students" was retained.

Thus, it can be concluded that there was no significant difference in the post-test mathematics scores between male and female students. Both groups benefited similarly from the use of the learning app.

Discussion: The analysis revealed that both male and female students showed comparable improvements in post-test mathematics scores after using the LearningMaths app. Despite minor differences in mean scores, these were not statistically significant, indicating that the app is equally effective for both genders without needing gender-specific adjustments. This aligns with previous research, such as Palomares-Ruiz et al. (2020), which found higher motivation and better marks in an experimental group using educational technology, with a slightly higher, yet not significant, improvement for women (1.708) compared to men (1.584). Similarly, Kay (2020) demonstrated significant increases in student learning performance using mathematics apps for various cognitive tasks, with no significant impact from factors like gender, ability, attitudes, or age. These findings collectively support the efficacy of digital educational tools in enhancing student performance across diverse gender groups.

Suggestions for the improvement of Mathematics learning in Mizoram

Improving mathematics education in regions like Mizoram necessitates a comprehensive strategy that takes into account the distinct socio-cultural, economic, and educational landscapes of the region. Here are some strategies, supported by research and examples from similar contexts, that could be adapted and implemented in Mizoram:

1. Curriculum Localization and Contextualization*:* Localization and contextualization entail a detailed analysis of the surrounding conditions and factors relevant to a subject matter. This process includes tailoring products or services to meet the specific preferences and cultural norms of a targeted audience. Studies indicated that performance tends to improve following the exposure of students to modules that are contextualized and localized (Bendijo et al., 2022; Fabrigas and Taban, 2023; Mam et.al., 2017). Reyes et. al., (2019) concluded that context in students' lives made the class lively and engaging where the students construct their own meaning.

Suggestion:

- To design mathematics problems and examples that relate to local industries, such as agriculture, forest-based economies, and local market transactions.

- To incorporate local cultural and historical references into mathematics problems and examples.

2. Professional Development for Teachers*:* According to Loucks-Horsley et al. (2009), effective professional development can lead to improved teaching practices. Professional development represents the sole strategy used by educational systems to enhance teacher performance. It also serves as the primary method through which educators can acquire new skills and knowledge, enabling them to improve their teaching effectiveness and increase student achievement (Baporikar, 2015).

Suggestion:

- To set up regular workshops and training sessions in collaboration with educational institutions like Mizoram University.

- To use these sessions to introduce innovative teaching methods such as inquiry-based learning and collaborative learning.

***3. Use of Technology in Education**:* The present study revealed that there was a positive impact of technology integration in mathematics learning among secondary school students of Mizoram. Similarly, Poçan et al. (2023) have found that mobile technology used in informal educational settings enhances learning outcomes. Research by Cheung and Slavin (2013) also supported the notion that effective integration of technology can improve mathematics learning. Furthermore, Young et al. (2018) recommend that the successful incorporation of technology in math classrooms should take into account factors such as the student's grade level, the duration of technology use, and its role in instruction.

Suggestion:

- To develop and promote educational applications tailored to cater to the educational requirements of Mizo students.
- To employ platforms such as Khan Academy, Geogebra, and similar apps that offer interactive and personalized math learning opportunities.
- To ensure that schools in rural and isolated locations are equipped with the essential infrastructure to facilitate the use of these technologies.

***4. Student-Centered Learning Approaches**:* Garner (2015) found that the student-centred learning methods led to an increase in student understanding as evidenced by various assessment measures. Also, it was made clear that students enjoyed these problem-based tasks and appreciated the collaboration made available through this method of learning. Student-centred teaching methods were more effective on math achievement and attitude and anxiety toward mathematics than the traditional methods (Emanet and Kezer 2021). Rehman et.al., (2023) concluded that project-based learning activities boosted the level of collaboration and problem-solving skills among students.

Suggestion:

- To incorporate project-based learning, where students work on longer-term projects that integrate mathematics with other subjects and real-world problems.
- This could include projects on budgeting for family or community events, or designing simple structures.

5. Bilingual Education Approaches*:* Cummins (2000) advocated for the cognitive benefits of bilingual education. Saldate et.al., (1985) in their study concluded that students in the bilingual program outperformed their control counterparts in reading and mathematics achievement. The mother tongue should be employed in the teaching of mathematics at the primary school level to internalize mathematics language and make the pupils mathematics-friendly at their tender age (Oginni and Owolabi 2013). Siyang (2018) concluded that the use of the mother tongue as a medium of instruction is more effective than the English language.

Suggestion:

- To utilize bilingual education methods to teach mathematics in both the local language (Mizo) and English.
- To develop resources and teaching materials from the primary school level in Mizo that can help bridge the language gap in mathematics learning.
- To train teachers to deliver math lessons effectively in both languages.

Educational Implications of the Study

The findings of the research presented several educational implications as follows:

- *Digital Literacy Programs:* With a significant portion of students using their smartphones for social interaction and entertainment purposes while only a smaller percentage of students used their smartphones for educational purposes, there was a need for digital literacy programs to teach students how to effectively and responsibly use their devices for educational purposes.

- *Balanced Integration of Technology:* Given that the majority (77.43%) of students fell into the average range of smartphone usage, educational institutions could have leveraged this familiarity with technology to integrate digital tools and resources into the curriculum. This could have enhanced learning experiences while maintaining healthy usage habits.

- *Balanced Interventions for Both Genders:* Since the study revealed no significant difference in smartphone usage between male and female students, educational interventions aimed at responsible smartphone use should have targeted both genders equally. Programs focusing on digital literacy and policy development on smartphone use could have been designed to benefit all students.

- *Policy Implications for Bridging the Gap:* The significant difference in smartphone usage levels of students across different school localities and management highlighted the need for policies aimed at bridging the digital divide by ensuring that socio-economically backward and rural students had equal access to smartphones and other digital technologies. Such measures could have helped level the playing field and ensured that all students benefited from digital learning opportunities.

- *Use of Technology in Education*: The successful development and implementation of the "LearningMaths" app highlighted the potential of using technology to enhance educational outcomes. It demonstrated how digital tools could be integrated into the education system to provide innovative learning solutions. The positive impact of the LearningMaths app on secondary students' mathematics performance suggested that schools in Mizoram and potentially other similar contexts should have considered integrating interactive digital tools into their mathematics curricula. The non-normal distribution of scores in the experimental group suggested that the app's impact might have varied widely among students. This variability should have been considered when implementing such tools, ensuring all students benefited from digital learning resources.

- *Gender Equity in Technology Integration*: The lack of significant differences in the effectiveness of the learning app on mathematics between male and female secondary school students suggested that such educational technology interventions could promote gender equity in learning outcomes. These results had practical implications for educators and policymakers. Given that the learning app was beneficial to all students, regardless of gender, schools could integrate this technology into their curriculum with confidence, knowing it did not perpetuate gender biases.

Suggestions for Further Research

The researcher suggested the following for further research:

1. Effect of Smartphone usage on the academic performance of students at different levels of study.
2. A longitudinal study to trace changes in smartphone usage among secondary school students in Mizoram.

3. An investigation into the role of socio-economic factors in smartphone usage among students.
4. A comparative study of smartphone usage among secondary school students in Mizoram and Meghalaya. (or any other northeast state)
5. An analysis of the impact of the whole curriculum coverage in educational apps on student outcomes in Mathematics education.
6. Longitudinal study on the impact of Educational Technologies on academic performance across different subject areas.

Conclusion

The research titled "Smartphone Usage and Effectiveness of Learning App for Studying Mathematics among Secondary School Students of Mizoram" explored the complex interaction between smartphone usage and the efficacy of mobile learning applications in enhancing mathematical proficiency among secondary school students in Mizoram. Findings indicated that while smartphones were mainly used for social interaction and entertainment, they held significant potential for educational use. Most students balanced their smartphone usage without adverse effects, with no significant gender differences in usage patterns.

However, a digital divide was evident between urban and rural students, and between private and government school students, with urban and private school students using smartphones more frequently. These highlighted broader issues of digital inequality affecting educational access.

The "LearningMaths" app, designed to align with the local curriculum and available in the Mizo language, showed positive outcomes in enhancing mathematics competency among students. Its success indicated that similar digital tools could be developed for other subjects and levels. The app's effectiveness was consistent across genders, supporting the use of gender-neutral digital tools in education.

The research underscored the importance of integrating technology into education to address regional socio-economic challenges. It emphasized the need for localized educational tools, promoting gender-neutral strategies, and addressing digital divides to enhance educational outcomes in Mizoram and India. By aligning with national educational policies and addressing local needs, the study offered a comprehensive approach to improving education through technology.