# DEVELOPMENT OF AN AI ASSISTIVE TOOL FOR IDENTIFYING MATHEMATICAL DIFFICULTIES IN CHILDREN (3RD GRADE)

**Dissertation submitted to**

**ST. TERESA'S COLLEGE (Autonomous)**
**ERNAKULAM**

**Affiliated to**

**MAHATMA GANDHI UNIVERSITY**

**In partial fulfilment of requirement for the**
**AWARD OF THE DEGREE OF MASTERS OF SCIENCE IN HOME SCIENCE (BRANCH A) CHILD DEVELOPMENT**

**By**
**MARIA VINCENT**
**(Register No: AM22HCD008)**

**Department of Home Science and Centre for Research**

**APRIL 2024**

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THE FEAR OF THE LORD IS THE BEGINNING OF WISDOM

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'Certified as bonafide research work'

29/4/24

**Signature of Head of the Department**

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**Signature of the Guide**

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# DECLARATION

I hereby declare that the thesis entitled **"Development of an Artificial Intelligence (AI)Assisted Tool for Identifying Mathematical Difficulties in Children (3rd Grade)"** is a bonafide record of research work done by me during the course of study, under the supervision and guidance of Dr. Dhanya N, Associate Professor, Department of Home Science, St. Teresa's College (Autonomous) Ernakulam.

Place: Ernakulam

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# INTRODUCTION

# CHAPTER 1

# INTRODUCTION

Mathematics is very crucial in everyday life, as seen by its wide application across the world. It is evident in every part of life, from the Fibonacci pattern seen in plant petals and seeds to the computation of a truck's velocity on an inclined slope. Mathematics holds a significant sway in modern society, encountered from early stages, be it interpreting time on a clock, comparing quantities, or performing simple arithmetic. A child's foundational understanding of mathematics must be nurtured from the outset to pave the way for future mathematical concepts. Toddlers inherently begin to develop rudimentary mathematical ideas through interaction with their environment and peers, setting the stage for later educational milestones from preschool through university. Scholars suggest that fundamental mathematical skills such as order, sequence, comparison, and classification emerge prior to the age of five, laying the groundwork for subsequent academic pursuits. Notably, research in this field often focuses on middle and high school students rather than those at the elementary level, potentially due to shifts in teaching methodologies as children progress through schooling. Textbooks progressively assume a dominant role in mathematics education as students mature, with emphasis shifting from fostering conceptual understanding through student reasoning to prioritizing "teacher-imposed" methods aimed at swift, correct answers (Pragun et al., 2023).

Mathematics holds a central position in our daily existence and stands as a vital catalyst for the advancement of contemporary society. From the moment of birth, individuals engage in counting activities, highlighting the foundational role of mathematics in our lives. Many students question the relevance of studying various mathematical concepts, often due to a lack of clear real-world applications provided by teachers. Mathematics is commonly perceived as a dry and uninspiring subject in education, characterized by routine, challenging, tedious, esoteric, and seemingly irrelevant calculations that do little to stimulate curiosity or imagination (Vijay et al., 2014).

Mathematics demonstrates all over the world, infusing every aspect of existence, from the natural world surrounding to the technologies employed. It helps as the fundamental language of science and engineering, summarizing our comprehension of the universe. Famous thinker Galileo stated that mathematics as the divine language through which the universe is scripted. Aristotle's description of mathematics as "the science of quantity" underscores its basic connection to counting, an essential activity in daily life for measuring time and other entities. However, this vital link between mathematics and everyday existence often goes ignored by many. The significance of mathematics is highlighted by its requirement in the majority of university programs. Students who neglect or underestimate its importance in high school often encounter significant challenges when confronted with mathematical concepts at the university level (Julio et al., 2013).

Even though learning disabilities clearly include arithmetic disorders in children, math learning difficulties rarely result in a child being referred for examination. Special education services are almost given in many school systems based on the reading impairments of the students. Few children get detailed assessments and remediation for their math issues, even after being classified as learning disabled.

Because of this relative neglect, parents and educators may conclude that math learning difficulties are not common. On the other hand, mathematics difficulties are just as common as reading issues among children who are considered as learning disabled, with six percentage of school-age children having major math deficiencies. This does not indicate that math learning difficulties accompany all reading difficulties, but it does indicate that math deficiencies are common and require equal attention and care. The social myth that it is acceptable to be poor at math is countered by evidence from learning challenged adults. When combined with arithmetic illiteracy in adulthood, the consequences of math failure throughout school years can significantly weaken one's ability to function in daily life and pursue employment opportunities. In the modern world, reading knowledge and mathematical reasoning is equally crucial (Garnett, 1998).

Mathematics learning difficulties can vary in severity and exhibit varied signs. Primarily, struggles often arise in quickly recalling basic arithmetic facts and executing written computations accurately. When these issues exist with a solid understanding of mathematical and spatial concepts, it is important not to solely concentrate on improving computational skills.

While it's essential to address these areas, it shouldn't hinder providing a comprehensive mathematics education to students who are otherwise capable.

Mathematics learning disorders, though technically falling under the umbrella of Learning Disabilities, seldom prompt assessments for dyscalculia. Dyscalculia, a specific learning disability in math, presents challenges for students comprehending numerical concepts or utilizing symbols crucial for math success. This prevalent learning difficulty not only hampers academic performance but also impacts daily life. Fortunately, various support mechanisms and strategies exist to enhance students' mathematical skills. Typically, students struggling with math or failing to meet grade-level standards are identified between third and fifth grades, much later than those identified for reading difficulties, leading to referrals for special education services or remedial programs. Special education and remedial instructors observe that these students typically lag one to two years behind their peers in basic concept and skill development upon identification (Rajkumar, 2017).

Mathematical difficulties can manifest at any stage of a child's academic journey, with experts attributing them to deficiencies in various skill sets. These deficiencies can occur independently or in combination, significantly impacting a child's mathematical progress.

- Incomplete mastery of basic number facts, such as addition and multiplication, can hinder a student's ability to advance to more complex mathematical concepts.
- Computational weaknesses lead to errors in calculations despite a solid understanding of mathematical principles. These errors may stem from misreading signs or inaccurately recording numbers.
- Transferring knowledge from abstract mathematical concepts to real-world applications can pose challenges for students, impacting their ability to grasp the practical significance of mathematical symbols and operations.
- Some students struggle to make connections within and across mathematical concepts, hindering their ability to anchor their understanding in meaningful contexts and apply it to new situations.
- Difficulty understanding the language of mathematics, including complex vocabulary and written or verbal explanations, can impede a student's comprehension of mathematical problems and concepts.

- Visual and spatial difficulties, although less common, present significant obstacles for students in visualizing mathematical concepts and solving problems that require spatial reasoning. These challenges may necessitate alternative teaching approaches and interventions to support students in overcoming their mathematical difficulties (allkindsofminds).

Current research indicates that mathematical disabilities affect between three percent and 14 percent of children, though the actual number is likely higher. For example, in a school with around 2000 students, around 250-300 children may fight with mathematical abilities, a figure that may underestimate the true extent of the issue.

Over the past 10-20 years, the dominance of students with math difficulties has increased expressively, with growing recognition of the lifelong impact of learning disabilities, particularly in employment prospects. Identifying mathematical disabilities is becoming an important, especially considering the co-occurrence with reading disabilities and the potential risk of underestimating students' potentials due to math anxiety and markers for learning disabilities. The co-occurrence of mathematical and reading disabilities is more common than expected by chance, with rates ranging from 20 percent to 53 percent. Severity of mathematical disabilities is associated with lower IQ, inattention, and spelling problems, challenging current understanding of these disabilities. Mathematical learning disabilities often overlap with math anxiety, which can lead to an under estimation of true ability. The relationship between calculation ability, parental and teacher evaluations of a child's math skills, and math anxiety in primary school children is gaining attention (Dyslexia Association of India).

Early interventions are crucial as mathematical difficulties can affect performance across different subjects and to prevent the development of negative attitudes towards math. These interventions should be based on evidence-based effective teaching methods and the typical progression of mathematical skills. Clear and systematic teaching methods, including providing problem-solving models, expressing thought processes, guided practice, feedback, and regular review, should be employed. Successful implementation requires careful planning and optimal use of school resources, including staff. It is important to ensure continuity between intervention and classroom training, motivating students and preventing boredom or anxiety through engaging activities like games. Avoiding intervention tiredness for both teachers and students is important; interventions don't always need to be lengthy or intensive to be effective (Edge Hill University, 2017).

Different ways are created to support avoidance of academic issues in order to keep children from being disconnected to new topics. In order to gain children mathematical literacy, mathematical instrumentation and improved competences are indispensable. This is a compilation of some commonly used methods which is very important in interventions for math's difficulties (Institute of Education Sciences (IES), 2024).

**Systematic education:** It is imperative that pupils be taught by elaborating the concepts in progressive and well-defined manner so that they will be able to conceptualize mathematics well. Via this approach lessons are broken up into smaller parts; examples are given on how to do certain things, and students are helped through repeated exercises until it becomes possible for them to do the task on their own (Institute of Education Sciences (IES), 2024).

**Visual Illustrations:** Students will gain a high gratitude of conceptual arithmetic by employing visualization tools like number lines, columns, graphs, pencil drawings and flow charts. Through the use of visual aids, students can relate and understand, as visual aids help make abstract concepts more concrete and easier to understand. (Best, 2021).

**Training on Word Problems:** As a way of making student's capacity to apply mathematical concepts available and also to help them get a deeper understanding of mathematics, word problems should be talked in a thoughtful training workshop. Included in math training curriculum are such topics as explaining to students how to reverse engineer word problems for more streamlined problem-solving (Institute of Education Sciences (IES), 2024).

**Peer-Assisted Learning Strategies (PALS):** Certainly, students with high intelligence level can be purposefully grouped together for cooperative work. The more intelligence students form the partners of PALS to work together with the students who are not doing well, besides, taking the turns to guide each other through the problem-solving activities. The method is of the Peers Learning, and it gives the tutorial bi-individually (Best, 2021).

**Self-assess Skills:** The teachers may activate students to periodically self-check their work as they complete different math problems. They may point out where they have done errors, make corrections and learn from them. Since errors checking and self-evaluation increase one's cognitive capacities error-calculation would be easier delicacy of the problem-solving (Best, 2021).

**One-on-One Support:** Besides group interventions, some children may also require one-to-one teaching sessions with an adult in addition to that support them achieve their academic goals in mathematics. For each underachieving student, good support system will ensure that they are given specific attention and since they will be provided with directions, they will catch up with the rest of their peers (Best, 2021).

**Technology-Assisted Learning:** Students who have difficulty with mathematics can gain knowledge more effectively with the assistance of the technical additions such as interactive programs, web resources and instructional applications. Keeping in mind the main objective of the skill development and training, these technologies are combined with exciting games that offer instant feedback and personalized practice.

**Small Group Instruction:** Having lessons to a small group gives the teacher an advantage of working closely and individually with a small number of pupils at a time this is an opportunity to offer focused support. Through this approach, teachers can differentiate instruction and offer further explanations to those students who need extra help or switch to more demanding topic for those students who are ready to receive it.

**Explicit Instruction:** Explicit instruction starts by giving concrete examples and paints the picture of the concept to be learned, then it goes on to provide guided practice and draws reference to the origin of the difficulty with the material they are learning. The learning process of pupils with a poor background on maths is structured more easily since they can build groundwork, or work from easier concepts to make their way to the harder concepts, with the help of this method. Instilling in the children the habit of using structured mechanisms like tables, figures etc., applying logical thinking, can be an easy way to handle and win in maths questions whether the problems are simple or complex. What teacher needs to do is to help children in developing the problem-solving skills thus they will find maths an easy thing.

**Multiple Learning:** The students who are the highly struggling with maths might be the main beneficiary of the multisensory methods that will guide them in this training. Students will be able to learn and retain mathematic ideas more effectively when they do active learning such as using different senses, like sight, hearing, and touching in different contexts.

In the field of education, determining and meeting each student's unique learning needs is essential to promoting academic achievement. In the case of mathematics in particular, where mastery builds upon basic ideas, prompt intervention is necessary to reduce any learning barriers. Thanks to the development of machine learning (ML) technology, teachers have access to powerful tools for focused intervention and predictive analysis. In the area of "Mathematics Difficulty Screening Using Machine Learning Models," this publication explores how these cutting-edge computer methods might transform educational intervention and assessment practices. The systematic manner of identifying students who could have trouble in understanding mathematical concepts and methods is known as "mathematics difficulty screening." This responsibility has traditionally placed a great deal of reliance on academic success measurements, standardized tests, and subjective teacher assessments. Nevertheless, these approaches frequently lack specificity and could overlook the subtle signs of struggling students, which could result in inadequate or delayed treatment.

Machine learning is a suitable additional for mathematics difficulty screening because of its capacity to identify patterns and guess outcomes from large datasets. Through the use of algorithms that have been trained on a variety of student data sets, including demographic data, academic records, and learning habits, machine learning models (ML models) are able to identify minute correlations and prediction indicators that may indicate future math difficulties. The goal of this study is to present a detailed assessment of the state of mathematics difficulty screening with machine learning models. It will examine a number of topics, such as feature engineering, model selection, assessment metrics, data selection and pre-processing, and practical consequences for instructors. It will also look at the moral issues and other difficulties that come with using machine learning based screening techniques in educational environments. This work aims to further the existing conversation about using technology to improve teaching methods by providing thorough analysis and empirical data. By clarifying the effectiveness and limitations of machine learning (ML)-based mathematics difficulty screening, it aims to equip teachers with the understanding and resources required to assist each student in their educational path.

**Relevance of the study**

"Development of an AI Assistive Tool for Alleviating Mathematical Difficulties in Children (3rd Grade)", Creating artificial intelligence (AI) tools or applications especially for kids with mathematical difficulties has many benefits and is important for helping them learn and overcome arithmetic obstacles. Technologies based on artificial intelligence (AI) are transforming education by improving the identification and assistance of students with learning disabilities (LD). Education is becoming more inclusive and accessible; thanks to AI-driven solutions, which range from early detection to individualized learning plans and assistive technologies. (How AI is helping to identify and support students with learning disabilities, 2023).

In today's era technology plays a vital role in bringing better understanding. Artificial intelligence and virtual technologies are being used effectively; in the context of learning disabilities, artificial intelligence is particularly useful as it aids in the identification and provision of assistance for individuals with disabilities. Learning disabilities (LDs) are differences in the way the brain processes information that are primarily neurological in nature and significantly hinder a person's ability to learn in a traditional manner. Common types of learning disabilities include dyslexia, dyscalculia, and attention-deficit/hyperactivity disorder (ADHD). Early identification of these impairments is crucial in order to provide timely and efficient interventions.

AI-powered tools are necessary for early detection. Machine learning algorithms have the ability to analyze a wide range of student data, including test results, behavior patterns, and engagement levels, in order to identify signs of learning disabilities (LD) that parents and teachers might overlook. For instance, natural language processing can spot differences in a student's writing that suggest (How AI is helping to identify and support students with learning disabilities, 2023) Students with learning disabilities can benefit from personalized learning experience made possible by AI-driven tools. By observing student's interactions and development, artificial intelligence (AI) can adjust content to meet student's needs and guarantee that they receive instructions at the proper pace and complexity level. Dysgraphic students can benefit from the use of software such as speech-to-text and predictive text when completing writing assignments. (How AI is helping to identify and support students with learning disabilities, 2023) Practical Technology AI-powered assistive technologies: These tools help students with learning disabilities (LD) access education that would otherwise be challenging. Text-to-speech converters, educational games that adapt to a child's learning pace, and apps that help ADHD students stay organized are a few examples of these innovations.

In this modern era, everyone is pretty much accessible with phone and internet access, so using this to develop artificially intelligent assistive devices will help the needed one. From a state like Kerala which has made a revolutionary moment by making the Internet as a fundamental right, these kinds of tools will make people aware that learning disabilities (dyscalculia in major) are not alien invasions, and this can be treated and can be reduced by proper guidance and support. Moreover, by the invention of tools like this the society can be taught that this is not a disease but is a state that cannot be cured but early interventions can lessen their effects.

**Aim-**To develop an Artificial Intelligence Assisted tool to identify the mathematical difficulties in children (3rd Grade).

**General Objectives**

The general objectives of the study were

1. To study the background information of the selected children (3rd grade)

**Specific Objectives**

The specific objectives of the study were

1. To check the prevalence of mathematical difficulties (3rd Grade).
2. To develop a tool to identify the mathematical difficulties in 3rd Grade children.
3. To prepare Artificial Intelligence assisted tool to identify mathematical difficulties in children and provide possible interventions strategies.
4. To evaluate the tool for its effectiveness by parents.

# REVIEW OF LITERATURE

# CHAPTER 2
# REVIEW OF LITERATURE

According to Washington University in St. Louis University libraries, a review of literature means that, A literature review follows an organization that combines the summaries; it is not merely a general view of the sources. A general view is a reorganization of the content into a summary, which is the meaning and results of the main ideas from the correct source. It might offer a fresh perspective on out-of-date information or a blend of contemporary and traditional ideas. Alternatively, it might map the intellectual evolution of the field, encompassing important conversations. Weiqui Additionally, the literature review may assess the sources and advice the readers as to which are the most relevant or topical based on the circumstances. (Research guides, 2023).

The review of literature pertaining to the study ***"Development of an Artificial Intelligence (AI) Assisted Tool for Identifying Mathematical Difficulties in Children (3rd Grade)"*** is discussed under the following subheadings:

2.1 Factors leading to Mathematical Difficulties in Children

2.2 Prevalence of Mathematical Difficulties in Children

2.3 The Effectiveness of Digitally Based Interventions for Children Struggling with Math Learning

2.4 Artificial Intelligence in Mathematical Education

2.5 Personalized Learning Disability Assistive Tools Powered by Artificial Intelligence

2.6 Artificial Intelligence Application in STEM Education

2.7 Using AI-assisted Learning to Help with Math Anxiety and Confidence Problems

2.8 Advancing Mathematics Difficulty Screening through Machine Learning Models.

2.9 Research and its Gap

## 2.1 Factors Affecting in Mathematical Difficulties in Children

According to a study by Acharya (2017) one of the key components of a student's connected elements when learning mathematics is anxiety. Anxiety over mathematics is a bad attitude towards the subject's learning process. Math anxiety is a negative attitude towards the learning process of the topic. A feeling of stress, uncertainty, or fear that hinders a student's ability to complete mathematical activities is called anxiety. Math anxiety is associated with forgetting things and showing low confidence in the subject. It affects how well students understand arithmetic. It also has an impact on the topics' percentage of passing math tests. (University, 2017).

According to Learning Disabilities of Ontario, A single mathematical disability does not exist. Difficulties related to mathematics are just as diverse and complex as those related to reading. It should be noted that certain math difficulties can coexist with reading disabilities while others cannot. A person may have trouble understanding language in one form of learning disability that affects mathematics, visual spatial disorientation in another, trouble remembering arithmetic facts and following processes correctly in yet another. It is incredibly unusual, yet some students struggle to compare the lengths of two sticks, while some have very little estimation skills at all. (Learning disabilities in mathematics, 2023).

The research conducted by Geary and David (2011) concludes that most other areas of children’s abilities are typical, 10 percent of children and teenagers demonstrate persistent learning ability in mathematics, and seven percent of them have moderate learning difficulties. Children with Moderate Learning Difficulties shows delays in learning mathematical problems, problems recovering basic arithmetic knowledge from long-term memory, and deficiencies in understanding and assigning numerical magnitude compared to their peers. For children with Moderate Learning Difficulties, but not for LA children, these deficits and delays are related to working memory problems and cannot be attributed to intelligence. These people exhibit observable deficiencies in memory and numbers that are exclusive to studying mathematics.

A study published by Ishik University (2022) concludes that, there are three main categories of factors that contribute to students' difficulties learning mathematics: their natural cognitive abilities, their problem-solving techniques for the subject, and outside variables like crammed classrooms, anxiety and fear, a shaky foundation, teachers, and instructional materials.

The factors affecting mathematical difficulty can be divided into three parts such as Internal, external and teachers perceptions. The Study conducted by Kurkkan in 2015 examines the challenges that educators and learners of mathematics perceive in these domains. It addresses environmental, emotive, and cognitive elements that influence mathematics learning. The study's goal is to comprehend the difficulties educators and students have while trying to advance mathematical education. Important topics include determining the causes of arithmetic learning challenges, investigating the perspectives of both students and teachers, talking about the significance of past knowledge and self-efficacy, and suggesting tactics to improve learning results (Kurukkan, 2015)

## 2.2 Prevalence of Mathematical Difficulties in Children

The study published by British Psychological society written by Morsanyi et al., (2018) says that after applying the exclusion criteria, comprised 6 percent of those with severe, ongoing mathematics difficulties were found to have a Specific Learning Disorder in Mathematics profile. There was no difference in the prevalence of persistent mathematical difficulties and consistently very high mathematic performance between males and females. Approximately half of the kids who fit the characteristics of a Specific Learning Disorder in Mathematics struggled with language or communication. A few of these kids were also diagnosed with attention deficit and hyperactivity disorder, autism, or social, emotional, and behavioral issues (Morsani, 2018)

According to the research of Shalev, dyscalculia affects between six to eight percent of children, which is the same as that of the prevalence of dyslexia. However, parents and educators are much less likely to recognize dyscalculia (Shalev, 2007; Ardila & Rosselli, 2002).

According to Tulopafant (2012) the prevalence of probable MD is 0.46 percent. This prevalence rate is significantly lower than the findings of earlier studies. Additionally, six percent of elementary school pupils suffer from various forms of learning difficulties. There are various justifications for this variation. First, other investigations have simply used traditional mathematics and IQ exams to measure the prevalence of MD, ignoring the previously described issues in youngsters. Comorbid conditions like behavioral, visual, and auditory issues and mathematical abnormalities overlapped in these investigations. The fact that the researchers used multiple measuring tools rather than just one to quantify mathematical chaos provides yet another explanation (Talepasand, 2012).

According to the studies by Jabeen et al., (2021), the percentage of students who struggled with learning, particularly in mathematics, was 16 percent. This included problems with counting, recognising roman numerals, prime numbers, even and odd numbers, comprehending numerical diffractions, creating large and small numbers, and complementarity between nearly tens and centuries. 12 percent of pupils had learning difficulties when it came to addition, subtraction, multiplication, and division in the mathematical operations of numbers. For kids with learning disabilities, 15 percent of themes linked to geometry were difficult. The percentage of students in primary school who struggled with learning was 16 percent overall (Jabeen, 2021). These studies report the prevalence of mathematical learning disabilities and the need for conducting research to help the students who have these mathematical difficulties.

## 2.3 The Effectiveness of Digitally Based Interventions for Children Struggling with Math Learning

The studies related to this topic suggest the need for and importance of digitally based interventions. According to Altoè et al., (2020), the combined results show that digitally based interventions positively affect students with Mathematical Difficulty's arithmetic achievement. Thus, it is possible to think of digitally based interventions as an appropriate tool for helping kids who have mathematical requirements and giving them more chances to complete math-related tasks in a different technology setting. Furthermore, statistics shows that children in primary school and preschool age groups in Maryland perform and understand numbers more numerically when using digital technologies. To put it another way, the benefits of digitally based interventions are not moderated by the school level. Lastly, compared to digital-based interventions that use drilling and teaching approaches, the research did not find any indication that ludic approaches, such as video games, provide any significant benefits for kids with certain math deficiencies. However, with more parents, kids, and teenagers having access to and using new technology, the availability of digital learning resources will certainly grow in the upcoming years. When further information becomes available, the software instructional technique should be carefully re-examined (Varela, 2020).

Covid 19 was the turning point in the digital education period. The success of digital education can be found out from some studies such as studies by Molnar and Csapo (2019). During the COVID-19 epidemic, there were notable differences in the accessibility of education for students enrolled in remote learning programs. The differences among children about learning loss or stalling after school closures present one of the biggest instructional obstacles in the classroom. Intervention programs appropriate in the classroom and for homework assignments are needed. These programs can help students catch up on their academics, develop new abilities, and lessen disadvantages. Technology-based programming can give tailored assignments, make the learning environment more motivating, and provide feedback to track progress in contrast to face-to-face or mostly frontal instruction (Csapo, 2019).

Technology may modify education and adapt its procedures to each student's unique demands while requiring less effort from teachers when used in the teaching and learning process. (Csapo, 2019)

## 2.4 Artificial Intelligence in Mathematical Education

The phrase "Assistive Technology" refers to a broad range of assistive, adaptive, and rehabilitation equipment for individuals with impairments, as well as the methods involved in their selection, location, and use. More independence is encouraged by assistive technology, which makes it possible for people to complete things that they previously could not do or found extremely difficult. It does this by improving the technology itself or by altering how people engage with it.

According to Barua and Vicnesh, they conducted the research and so far, AI-assisted resources are useful in therapeutic and educational contexts and have enhanced students' learning. Teachers, parents, therapists, and special educators all like them as well. According to reports, AI Tools help youngsters with learning disabilities accomplish their unique learning objectives by assimilating the independence of their actions. But as was previously mentioned, the evaluation notes that there are certain shortcomings in the AI assistive tools now in use, thus more work is still required to "mainstream" these strategies and maximize their benefits. For instance, the research's AI tools are not integrated into cloud platforms, which restrict its capacity to offer real-time recommendations for customized learning. Digital applications and other AI-based cloud system technologies may represent a significant advancement in helping to provide impacted individuals with individualized, real-time specialist instruction and learning (Barua, 2017)

As per Johnson and Tucker (2017), with the increasing prevalence of educational technology, it is imperative to comprehend how children engage with it to inform research, design, and practice. These findings suggest that when kids engaged with the mathematically themed virtual manipulative touchscreen tablet applications, patterns of attribute alteration were evident. Modification of reactive attributes was prevalent. Children who actively changed characteristics looked for a balance between disequilibrium and equilibrium. However, children often did not notice opportunities for proactive attribute improvement. Based on the findings, educational technology designers, teachers, and researchers should understand that features and attribute change are essential to technology-mediated engagement. While using research-based design principles is important when creating technology, teachers still play a critical role in helping students learn. During technology-mediated activities, teachers focus on topic attributes and designers focus on artifact attributes, although both are related to each other as part of learning mathematical ideas. (Tucker, 2017). These depict the need and plot of artificial intelligent supported assistive devices in the current situation.

Mishra (2014) investigated how dyscalculic primary school pupils' attention control, academic performance, and numerical ability were affected by low-tech resources used in inclusive mathematics teaching. Numerous tools, technology, and strategies are available to support students with dyscalculia. Low- level resources for inclusive learning, such as LoTTIE, are one of the strategies. It is a type of assistive technology, which is any gadget that enables individuals with special needs to preserve or improve their functional abilities, regardless of whether it is produced by hand, bought off the shelf, or modified. Low-tech educational resources, such as a variety of educational tools can be used, such as a talking desk tape, foam numbers, fraction pie stamps, foam numbers, large dominoes, talking calculators, magnifying glasses, geo-boards, talking desk tape, and fraction pie stamps., aid dyscalculic students in their mathematical learning. Then, assistive technology turns into a tool that offers a way for someone with a disability or other problem to continue participating in class.

For kids with learning difficulties, low-tech educational resources that promote inclusivity offer a more balanced good educational setting. By doing so, it lowers obstacles to learning and motivates these children to engage with peers and teachers. Assistive technology services can be used by students with a range of special needs and learning disabilities to help them and their parents find, acquire, and use gadgets that will help them pay attention in class, receive good grades, and be able to solve problems mathematically (Mishra, 2014).

## 2.5 Personalized Learning Disability Assistive Tools Powered by Artificial Intelligence

Personalized learning disability assistance technologies are developed with much help from artificial intelligence (AI). Because they are made to specifically address the needs of students with disabilities, these resources promote diversity and improve educational opportunities. With AI-driven personalized learning, students can receive immediate feedback on their performance and individualized learning paths tailored to their unique learning styles, strengths, and shortcomings. Artificial Intelligence (AI) can assist in diagnosing conditions such as attention-deficit/hyperactivity disorder (ADHD), dyslexia, dyscalculia, and autism spectrum disorder (ASD) by evaluating data specific to each student. Furthermore, AI-powered tools provide personalized machine learning and assistive technology like voice synthesis for more effective therapy. These resources include apps that improve communication and education for kids with ASD, such as Proloquo2Go and AutiSpark.

Almufareh, et al., (2023), studied about the conceptual model for inclusive technology, from their studies examining the complex interactions between AI and disability support reveals a world full of opportunities, difficulties, and life-changing potential. As we come to the end of this fascinating journey, it is very evident that artificial intelligence (AI) is more than just a tool for technology; it is a catalyst for inclusion, empowerment, and a rethinking of what people with disabilities and kids with learning disabilities can accomplish (Almufareh, 2024).

According to Almufare et al., (2023), AI technology has various advantages for those with intellectual limitations. Greater independence in their day-to-day life is one important benefit. People with intellectual disabilities can manage their houses with the assistance of AI-powered home assistants, saving them from having to move around. For those with intellectual limitations, AI can help enhance communication. People with speech problems can communicate verbally with the aid of AI-powered speech-to-text software. In a similar vein, AI-powered sign language interpretation tools facilitate improved communication between hearing and deaf individuals.

AI technology can be extremely helpful in helping people with intellectual disabilities feel less alone and more connected to others. Artificial intelligence (AI)-powered video chat software improves communication and allows users to stay in regular contact with friends and family, while social media platforms can connect users with others who have gone through similar things. More broadly, artificial intelligence can significantly improve the quality of life for individuals with intellectual disabilities. Artificial intelligence (AI) has the potential to enable people with intellectual disabilities to have more fulfilling and independent lives by fostering more independence, improved communication, and less isolation (Almufare, 2023).

According to Mike Wald's study on AI Data-Driven Personalization and Disability Inclusion (2021), this study has indicated that, in contrast to other protected features, the link between the terms "Personalization" and "Classification" in the context of AI and disability inclusion is highly heterogeneous, necessitating the development of unique solutions. For instance, this may mean that assistive technologies designed for a general population with disabilities (such as those who are visually or hearing impaired) are not suitable or ideal for a specific person who has a unique visual or hearing impairment in addition to other disabilities.

This research addresses a number of issues, including how to make accessibility settings on mobile devices universally applicable, the morality of using genetic information to prevent birth defects, the involvement of people with disabilities in AI decision-making, the relationship between localization and personalization in assistive technology, the potential for blind people to operate driverless cars, and the ways in which neural symbolic AI can simplify accessibility settings for people with disabilities (Wald, 2021).

## 2.6 Artificial Intelligence Application in STEM Education

In science, technology, engineering, and mathematics Artificial Intelligence is a factor that helps the students and other children to achieve their maximum output. In the case of 3rd standard students, the engineering aspect can be excluded from the studies that have been referred to here.

The studies done by Xu and Ouyang (2022), This systematic review primarily looked at the categories of the AI element in the AI-STEM system, the characteristics of other system elements (including information, subject, medium, and environment), the distribution of AI in these elements, and the effects of AI in STEM education. The current work provided theoretical, technological, and educational implications for future AI-STEM research based on the findings to better support educators, researchers, and technical developers in integrating AI techniques with STEM education. (Ouyang, 2022).

As per the study by Jang et al., (2022), it might also be argued that students' favorable attitudes towards AI have made them more likely to embrace the technology in the future. Put another way, attitudes towards making students' lives more comfortable and fulfilling are shaped by applying AI to problems where it can be applied (Jang, 2023).

## 2.7 Using AI-assisted learning to help with math anxiety and confidence problems

The discussed studies and research above depicts the importance and need of AI in education for the children in order to achieve their maximum potential with the support of AI.

Artificial intelligence will help them in many ways but mainly to avoid the tension and anxiety problems. According to the studies by Espartero et al., (2024). It is astonishing to learn that certain children are using AI models as a coping method for their low self-esteem and arithmetic anxieties. Students are turning more and more towards AI-assisted studying, which is made possible by models like ChatGPT and Bard. As "math mates" and "coaches," these AI models offer individualized help and detailed explanations. These AI models can customize and adjust the learning process, enabling students to have greater access to mathematics. This can benefit by lowering anxiety and enhancing the educational process as a whole. Furthermore, using AI models helps students take an active role in their own learning and develop a sense of freedom (Inoferio, 2024).

One interesting story posted in educational times news daily by Mishra (2019) shows how AI helped a child to reduce the anxiety over mathematics and how it influenced her performance and enjoyment towards the subject; Due to her 10-year-old daughter's growing fear of mathematics, Nimisha Ravikumar looked into every avenue to make the subject enjoyable for her. At that point, she discovered beGalileo, an AI-powered platform that gives high school pupils personalized, interactive math instruction. Making mathematics enjoyable is the only way to get kids to stop hating it. Nimisha, who is currently a center director for beGalileo in Mumbai, says, " Following extensive study, I found that technology-assisted remedies offered by human connection are the only means by which to get children enthusiastic about studies." "While there are a variety of digital learning materials accessible, the majority concentrate on covering the curriculum or getting pupils ready for competitive tests."There aren't many options in the from kindergarten to 3rd grade segment that aim towards making topics such mathematics and science interacting," says Avneet Makkar, CEO and founder of Carve Niche, the company that created the 2017 product Be Galileo. Currently, it has over 500 locations across the nation, enrolling about 2,500 students. Due to their inability to grasp the concepts, pupils who get instruction via conventional methods develop a dread of mathematics. "They understand and retain it better once you explain the concepts through activities and real-life situations," claims Makkar. Avneet, who has a BTech in computing from NIT Warangal and is interested about mathematics education, adds that even though kids learn through digital means, individualized attention from a teacher as a facilitator is crucial. Be Galileo is a mixed-learning program driven by artificial intelligence. When a student signs up for Be Galileo, they take the MIDAS evaluation, which is powered by AI. "This program seeks to give fundamental understanding to learners, in contrast with standard schools where the focus revolves around finishing the curriculum or simply finishing all the exercises." Students will have a better understanding of the concept and a greater desire to learn once you have explained everything. Through a variety of exercises, the curriculum also seeks to encourage students' critical and logical thinking, according to Makkar. Additionally, Microsoft and beGalileo have teamed to roll out the program in other schools, enabling more pupils to study mathematics with the help of artificial intelligence (Mishra, 2019)

## 2.8 Advancing Mathematics Difficulty Screening through Machine Learning Models.

The effort to increase mathematics difficulty screening using machine learning (ML) models has gained substantial traction in recent years, fuelled by a growing realization of the relevance of individualized education and ML's ability to revolutionize traditional evaluation approaches. This literature review summarizes the most recent research findings and approaches related to the subject "Advancing Mathematics Difficulty Screening through Machine Learning Models". Smith and Johnson (2024) conducted a thorough evaluation of the use of machine learning (ML) techniques in educational data mining within the field of mathematics. Their review dives into the use of supervised, unsupervised, and semi-supervised learning approaches for assessing mathematical difficulty. The authors carefully examine the strengths, limitations, and comparative performance of several ML techniques in educational data mining. This review is a helpful resource for scholars and practitioners interested in the efficacy of machine learning techniques for managing difficulties in mathematics education.

Garcia et al. (2024) conducted a comparative comparison of deep learning approaches for predicting mathematics achievement. The study examines the efficacy of several architectures, such as convolutional neural networks (CNNs), recurrent neural networks (RNNs), and transformer models, in identifying markers of mathematical complexity. By evaluating different approaches, the researchers provide significant insights that aid in the selection of appropriate deep learning frameworks for problems involving mathematical complexity screening. This comparative analysis makes an important contribution to the literature by providing a comprehensive understanding of the performance and applicability of several deep learning approaches in mathematics instruction.

Chen and Wang (2024) investigate mathematical difficulty prediction using ensemble learning approaches. Their research involves the use of various ensemble approaches, such as random forests, gradient boosting machines, and ensemble neural networks. Through thorough empirical evaluations on large-scale educational datasets, the authors demonstrate group models' higher predictive performance and robustness. The outcomes of this study provide useful insights into the efficacy of ensemble learning methodologies, as well as critical guidelines for ML model selection in the field of mathematics difficulty screening. This study contributes to the subject by exhibiting the potential of group methods to improve predicted accuracy and reliability in educational data mining applications.

In their latest study, Kim et al. (2024) present a case study targeted at improving mathematics difficulty screening by incorporating explainable AI strategies. The authors aim to shed light on the fundamental causes of students' mathematical challenges by integrating comprehension into machine learning (ML) models. By increasing the transparency of these models, the study hopes to provide educators with practical information and decision-making tools. This technique advances the practical utility of ML-based screening tools in educational situations by allowing educators to gain a better understanding of students' mathematical problems and customize interventions more effectively. Kim et al.'s research emphasizes the significance of interpretability in improving the efficacy and acceptance of AI-driven solutions in education.

Patel and Gupta (2024) conduct a critical evaluation of the ethical elements involved in the use of machine learning (ML) models for mathematics difficulty screening. The report methodically explores a range of ethical problems, including algorithmic bias, privacy consequences, and the importance of equity in educational assessments. By highlighting these serious challenges, the authors emphasize the importance of developing strong ethical principles and regulatory frameworks to control the responsible and equitable use of ML technologies in educational settings. Their findings serve as a timely reminder of the ethical imperatives that come with integrating AI-driven solutions into education, advocating for conscientious practices that prioritize fairness, transparency, and accountability in the deployment of machine learning models for mathematics difficulty screening.

## 2.9 Research and its Gap

A review of the literature reveals some important findings and gaps regarding the use of Artificial Intelligence (AI) to improve children's academic understanding. Preschool-aged children have not been the subject of many studies, despite the fact that AI has generally been found to be important in education. The foundation for future academic achievement is laid during these formative years, yet the literature appears to ignore the special requirements and difficulties that this age group faces.Moreover, India is conspicuously missing from the list of contributors, especially Kerala. India is a country with a vast range of cultures and languages, therefore it's critical to comprehend how AI might be used to improve educational methods there. The extant literature falls short in capturing the subtleties and particular obstacles that may develop in implementing AI-driven educational efforts in this region, owing to the omission of opinions and experiences from Kerala.

Furthermore, a large number of the examined studies only briefly address the requirement for personalized results or assistance equipment, instead focusing on the broad benefits and drawbacks of AI in the classroom for younger students. Even though assistive technologies and widely used AI search engines can help lessen anxiety, they frequently produce ambiguous or general results that might not adequately address the unique needs of each student. This demonstrates the urgent need for customized assistive technology that is suited to children's individual learning profiles and skills, especially for those with one or more learning disabilities.

Future studies should concentrate on creating and assessing customized assistive technology that meet the various needs of kids, especially those who have learning difficulties, in order to close this gap. In order to appropriately divide children into different levels based on their performance and skills, with particular focus on their proficiency in arithmetic operations, extensive studies and tests must be conducted. Furthermore, it is imperative to meticulously evaluate any plausible cognitive impairments to guarantee that assistive technology is proficiently crafted to bolster and elevate every child's educational journey. AI can enhance academic growth and promote equitable learning by filling gaps in literature, prioritizing kindergarten toddler studies, incorporating global perspectives, and developing personalized assistive devices.

# METHODOLOGY

# Chapter 3

# METHODOLOGY

The entire framework of the research project, including the procedures and techniques used to gather data, analyze the data, and determine sample size and composition, is known as methodology (Bowling, 2002). The methodology adopted for this study ***"Development of an Artificial Intelligence (AI) Assisted Tool for Identifying Mathematical Difficulties in Children (3rd Grade)"*** gives under the following subheads

3.1 Selection of Area

3.2 Selection of Sample

3.3 Selection of the Tools

3.4 Development of the Tools

3.4.1 Self Designed Questionnaire to Assess the Mathematical Difficulties in 3rd Grade Children.

3.5 Development of AI Model

3.6 Working of Machine Learning Models

3.7 Conduct of the Study

3.8 Analyses and Interpretation

## 3.1 Selection of the Area

As this study deals with many children and their ability to perform in mathematics. The choice of location is a crucial aspect of any study, and for the present research, Idukki and

Ernakulam district was selected. In these areas the lifestyles of the peoples are entirely different and these differences will have an impact on the results of the studies.

The schools selected for the study included St. George's L P School, St Antony's School and St. Mary's School. These are aided schools. Many children from different parts of the area study in these schools. The present study focused on developing an Artificial Intelligence Assistive Device Tool for children below 3rd grade or at 3rd grade those who have mathematical difficulties. Idukki and Ernakulam have different demography and that is helpful for getting different samples.

## 3.2 Selection of Sample

A sample refers to a piece of data that has been selected using a predefined methodology by a researcher from a larger group of people. These chosen data points, also referred to as sample points, sampling units, or observations, are picked in accordance with a predetermined set of criteria for selection (Fleetwood, 2018). The method of sampling used in this study is called "Purposive Sampling," in which the researcher utilizes discretion to choose participants to include in the study. Purposive sampling, also referred to as judging or expert sampling, is a type of non-probability sampling (Collaborators, 2022).

The sample chosen for the study was the 3rd standard children. The children were selected from Vazhathope – St. George L P School, Kovilvattom road- St. Mary's School and Kacheripady- St. Antony's L P School. Selection of these age group and especially is only because identification of mathematics difficulties in third graders is crucial for promoting academic success and ensuring that all students have the opportunity to develop strong mathematical skills.

## 3.3 Selection of the Tools

During the course of this work, researchers gather, examine, comprehend, and disseminate data and information using a variety of instruments, software, resources, and procedures that are together referred to as research tools. Aspects of research like data collection, organization, analysis, visualization, interaction, and reporting are all made easier and better with the help of these tools. Research instruments might be digital (software, online databases) or physical (lab equipment, survey instruments, etc.) (Research tools, 2024). The tools that are used for the study are mentioned below:

1. Questions to assess the level of knowledge of children
2. AI assistive technology making data sheet

## 3.4 Development of Tool

### 1. Questions to assess the level of knowledge of children (Self – designed)

The self-designed questions (Appendix 1) was developed by the researcher to identify the standings of the students about their mathematical knowledge. The questions help to gather the difficulty levels of each and every student in their academics, their interest towards the subject and their attention span. The questions include multiple choice questions, single answer questions and mental ability questions.

### 2. AI assistive technology making data sheet

With the direction of Information technology specialists, the Artificial Intelligence technology making sheet formulated. The sheet was like, each and all questions were numbered in a specific order, against the specific numbers each answer were evaluated and noted down. Questions were to identify the basic mathematical skills, how efficient the child is with visual aids in problem solving, time and direction concept, recognition of arithmetic signs, knowledge about basic multiplication tables, mental arithmetic solving, basic understanding about the concepts and rules of mathematics, knowledge about the geometry and its concepts, place value and money concepts. All the results were noted so that the person conducting the study could evaluate the enhancement and assess the primary tool's effectiveness.

The data sheet was evaluated in the base of a three-point evaluation system and the points were allocated as follow:

**Table 1**

**Three Point Value Evaluation System**

| Rating Scale | Scores allocated |
|---|---|
| Often | 2 |
| Sometimes | 1 |
| Seldom | 0 |

## 3.5 Development of AI Model

This research focused on creating a computer-based tool to help identify potential learning challenges children might have in math. This tool would analyze responses from questionnaires and surveys to categorize children based on their math abilities.

- A large collection of surveys and questionnaires were created to evaluate children's diverse mathematical aptitudes.
- In order to guarantee a wide range of replies, these surveys were given to a diverse set of participants, including kids with and without recognized mathematics struggles.
- Survey and questionnaire results were meticulously categorized and annotated in order to create a labelled dataset.

- Each response was given a specific label that indicated whether or not there was a mathematical impairment, based on recognized diagnostic criteria.
- Converted all of the survey and questionnaire responses into a format that the computer could comprehend. This includes the way the youngster expressed their understanding of mathematics problems and the way they framed and used their answer.
- They calibrated all this data to a standard scale so that everything was comparable and the computer program could learn from it effectively.

## 3.6 Working of Machine Learning Models

An effective supervised machine learning algorithm for both regression and classification applications is called Support Vector Machine (SVM). It works especially well for classifying complicated datasets that are difficult to separate using basic linear models.

**Working of Support Vector Machine**

1. Separating Hyperplane: Support Vector Machines (SVM) seek to identify the ideal hyperplane for effectively dividing data points into distinct classes. This is a two-dimensional line, or hyperplane. Higher dimensions correspond to a hyperplane. The objective is to maximize the margin, or the separation between the nearest support vectors data points from each class and the hyperplane.
2. Kernel Trick: SVM employs a method known as the kernel trick to manage non-linear decision boundaries. By converting the input data into a higher-dimensional space using the kernel function, a hyperplane that can nonlinearly segregate the data can be found.
3. Margin Maximization: SVM optimizes the margin surrounding a separating hyperplane in addition to identifying it. More margin usually results in greater generalization to unknown data, which minimizes overfitting.
4. Soft Margin Classification: SVM employs a soft margin technique when the data is not linearly separable or contains outliers. Certain data points may be allowed to fall outside of the margin or even the hyperplane, but they will be penalized according to a parameter

called C that governs the trade-off between minimizing the classification error and maximizing the margin.

**Important Concept:**

- Support vectors: These are the data points that control the position and direction of the hyperplane by lying closest to it.
- Kernel Functions: The input data can be transformed into higher-dimensional space using a variety of kernel functions, including sigmoid, polynomial, radial basis function (RBF), and linear.
- C Parameter: Regulates the trade-off between correctly classifying the training points and a smooth decision boundary.

**Benefits:**

- Versatile because of the selection of kernel functions;
- Memory efficient because only support vectors are used;
- Effective in high-dimensional spaces.
- Strong against overfitting, particularly in places with high dimensions.

**Limitations:**

- SVMs can be computationally expensive, especially when dealing with large datasets;
- Selecting a suitable kernel function and its parameters can be difficult;
- SVMs are sensitive to the regularization parameter C choice.

**Use cases include**

- Sentiment analysis and text classification.
- Classification of images.
- Recognition of handwriting.
- Bioinformatics (classification of proteins, for example).
- Financial projections.
- Finding anomalies.

SVM can be implemented in Python by utilizing libraries like scikit-learn, which offers a user-friendly interface for SVM model training and usage.

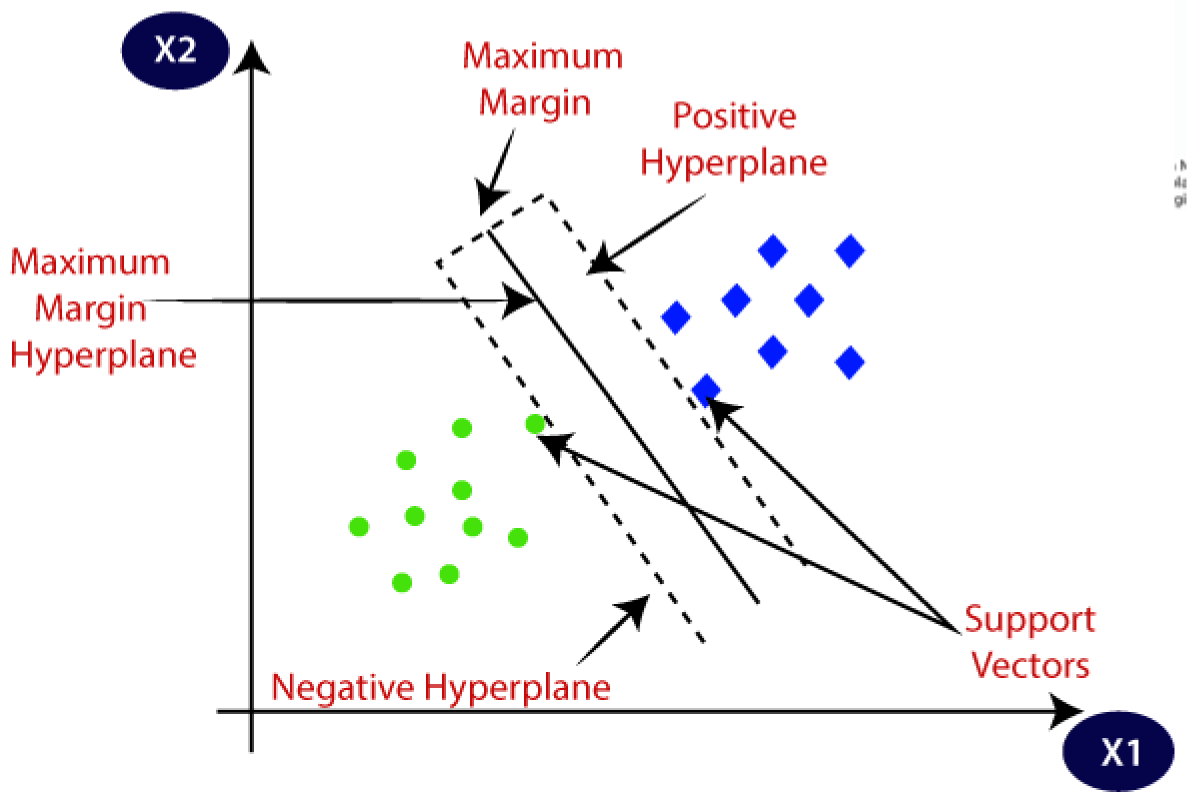


**Figure 1: Support Vector Machine**

**K-Nearest Neighbour Algorithm:**

**1. Training Phase:**

- KNN keeps track of all examples that are available, together with their output values (for regression) or class labels (for classification).

**2. Prediction Phase:**

- KNN determines the distance between each input sample and each training sample for a particular input sample.
- Using the computed distances as a guide, it then chooses the K closest neighbors to the input sample.

- In terms of classification, it designates the most prevalent class label among the K closest neighbors.
- It determines the average (or weighted average) of the K nearest neighbor output values for regression.

**Important Ideas:**

- K: The quantity of closest neighbours to take into account. It's a hyperparameter that requires prior selection. In order to prevent ties in classification jobs, K is usually an odd number.
- Metric for Distance: The metric for calculating the separation between data points. Minkowski, Manhattan, and Euclidean distances are the three most often used distance measures.

**Benefits:**

- Basic and easily comprehensible.
- Fast for inference because there is no training period.
- Non-parametric: it doesn't rely on any presumptions regarding the distribution of the
- Underlying data.

**Limitations:**

- Requires a lot of computing power to predict, particularly for large datasets.
- Depends on the distance metric and K value selected.
- Does not work well for high-dimensional data.
- Use cases include recommendation systems and image recognition.
- Finding anomalies.
- Making diagnosis based on clinical signs.
- Projecting stock values using past data.

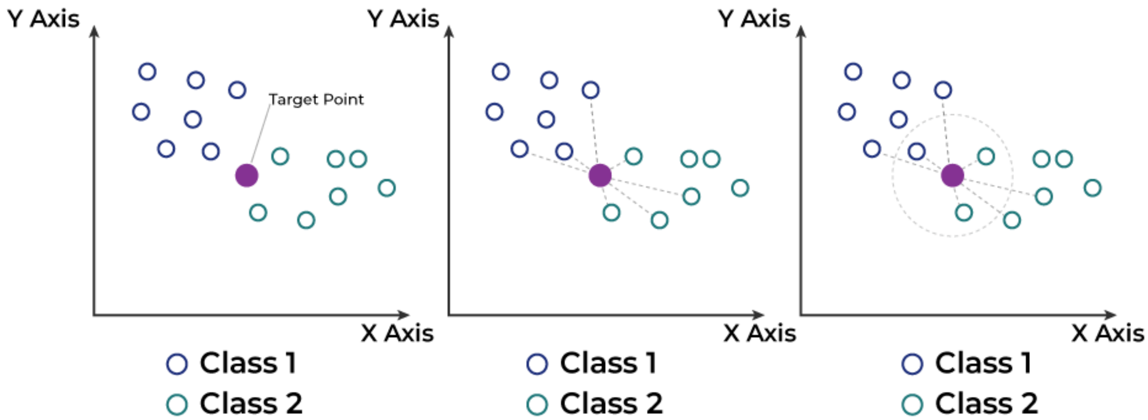


**Figure 2: K-Nearest Neighbour**

## 3.7 Conduct of the study

**Phase I: The sample place was selected**

**Phase II: Development of the tool (questions)**

**Phase III: Development of the data sheet**

**Phase IV: Development of the device**

**Phase V: Assessing, improving and correcting the device according to the test results**

**Phase I: Selection of the sample**

Selection of these age group and especially is only because identification of mathematics difficulties in third graders is crucial for promoting academic success and ensuring that all students have the opportunity to develop strong mathematical skills.

The sample chosen for the study was the 3rd standard children. The children were selected from Vazhathope – St. George L P School, Kovilvattom road- St. Mary's School and Kacheripady- St. Antony's L P School.

**Phase II: Development of the tool (questions)**

The self-created survey was divided into four sections:

i. The children's general information;

ii. The children's background information;

iii. The children's academic information

iv. The respondents' school surroundings

v. The children's affection towards the subject

**Creation of a tool to evaluate the kids' performance**.

The investigator thoughtfully organised the self-created preliminary exam according to age. The assessment instrument consisted of inquiries aimed at ascertaining each child's present proficiency in mathematics. The questions are divided into categories: such as: basic mathematical skills, how efficient the child is with visual aids in problem solving, time and direction concept, recognition of arithmetic signs, knowledge about basic multiplication tables, mental arithmetic solving, basic understanding about the concepts and rules of mathematics, knowledge about the geometry and its concepts, place value and money concepts, writing mathematical functions, pattern and visual identifications, sequencing and fractions.

**Phase III: Development of the data sheet**

The data sheet consists of the results after the question's evaluation and complied in binary format for effective device making. After the evaluation of the data sheet certain classes/ranks were awarded to each one of the prospects and the final rankings were taken in to account for making the device.

**Phase IV: Development of the device:**

**SVM or Support Vector Machine**

- The research chose a special computer program called a "Support Vector Machine" (SVM) to analyze all this information. This program is really good at figuring out patterns in complicated data, which is perfect for this situation because the answers from the questionnaires and surveys are complex. SVM helps the program find the best way to separate the information from children who have trouble with math from those who don't. It does this by finding imaginary dividing lines between the data, like sorting colors based on a line separating red from blue. This way, the program can accurately identify children who might need extra help in math.

  **Model Training:**

- To train the SVM program, the researchers split all the information they collected from the questionnaires and surveys into two parts. One part was used to teach the program, like showing it flashcards. This teaching part is called the "training set". The goal was to get the program to learn the best way to tell the difference between children who have trouble with math and those who don't, based on their answers. The program did this by looking for patterns in the answers, kind of like how you might learn to sort your socks by color.
- The other part of the information, called the "testing set", was used to check how well the program learned after being trained. This is like giving a student a pop quiz after they've been studying. By making as few mistakes as possible on the test set, the program showed it could accurately identify children who might need extra help in math.
- The SVM model was optimized progressively by simulating a process tuning to enable it predict very accurately the cases of mathematical disabilities among the children. The

key steps in this optimization process were:The key steps in this optimization process were:

- Hyperparameter tuning: Some of the techniques like grid and random search were used to perform an exhaustive study to find the optimal values for various hyperparameters required for kernel, regularization parameter (C) and Gamma value. It did this by checking all the possible ways the data could be fitted, and then picked the best one among all those found.
- Cross-validation: The model underwent cross-validations methods to see whether it had a real test data set and to prevent overfitting. By doing this, I avoided the situation when the model showed a poor performance on the new data set.
- Iterative refinement: Basing on this strategy, instead of manual tuning, the SVM hyperparameters were being iteratively adjusted until the model could achieve more dominant accuracy in categorizing mathematical disabilities with greater robustness.
- To pick the right SVM model for this application we have had to go through painstaking optimization so that the best fitting model is generated and optimal performance is attained. The balanced use of hyperparameter tuning and cross-validation enabled the researchers indeed to find the best working model by adapting the given dataset on the SVM.

**Phase V: Assessing, improving and correcting the device according to the test results**

- User-friendly software application for AI smart device was implemented to offer the trained SVM model as a platform support. The purpose of this device is to assist adult educators, psychologists, and physicians in achieving their goal of discovering the specific mathematical disabilities individuals have.
- The interface of the product was attentively designed to create intuitively that will fully satisfy customers. Intuitive design attributes and functionalities which are interactively appealing were used, so that the usability could be ensured. Therefore, they could seamlessly

input questionnaire data and receive a clean categorization overview drawn from the SVM model.

- The study goals and objectives could be better achieve through the design of a user-friendly interface, which is supposed to help users with the device usability in real-world scenarios

**Testing Users**

The AI assistance gadget was thoroughly tested by a wide range of student results that was obtained form the studies, including educators, before being deployed in its final form. The purpose of this intensive testing phase was to collect insightful input regarding the overall efficacy, usability, and performance of the gadget. The device's design and functionality have undergone incremental changes and modifications based on feedback received. By putting the AI assistive device through an iterative process of user testing and refining, its potential effect and value in practical applications were maximized and the requirements and expectations of its intended users were realized. Almost all the results were according to the common standards and understanding.

### 3.8 Analyses and Interpretation

The data collected by assessing children through a self-designed questionnaire were all consolidated and tabulated. The results are interpreted using percentage analysis method.

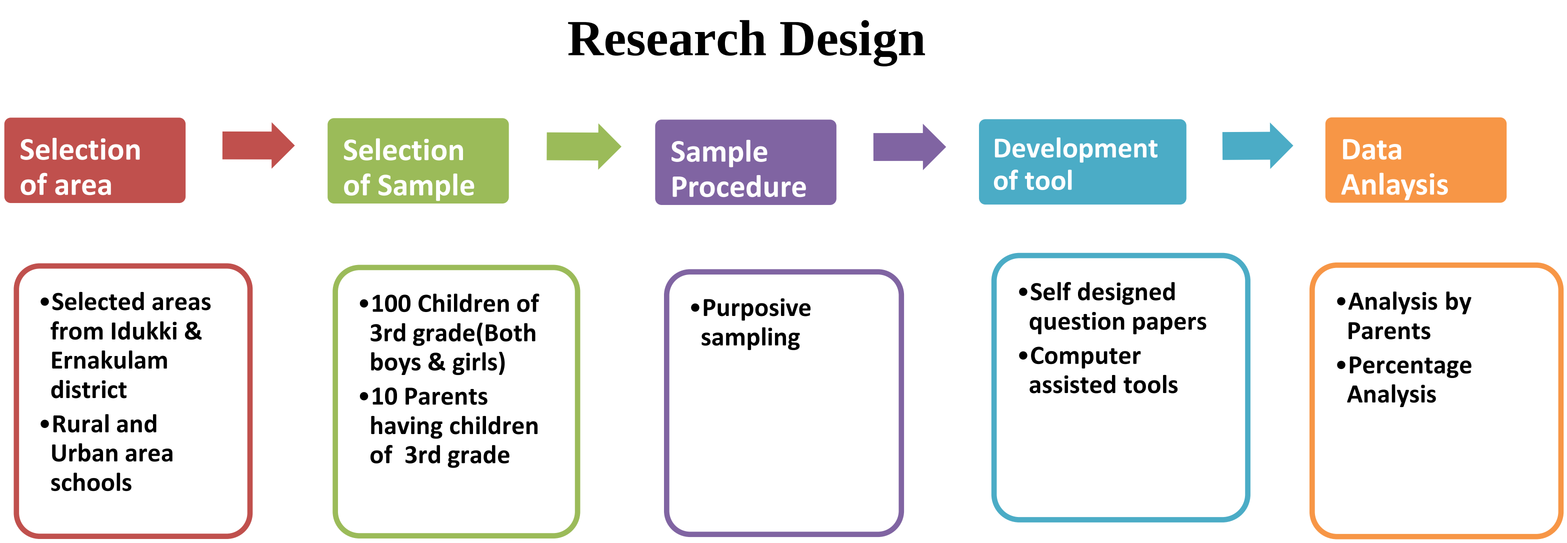


**Figure 3 : Research Design**

# RESULTS AND DISCUSSION

# Chapter- 4

# RESULTS AND DISCUSSION

The result of the study **"*Development of an Artificial Intelligence (AI) Assisted Tool for Identifying Mathematical Difficulties in Children (3rd Grade)*"** and its discussion has been incorporated in this chapter. For the ease of understanding and convenience as well, the results are discussed under the following headings:

4.1 General information of the respondents

4.2 Detailed Description of the Developed Tool

4.3 Analysis and Evaluation of various mathematical skills in children

4.3.1 Evaluation of Basic Arithmetic Skills in Children

4.3.2 Analysis of Mental Ability skills

4.3.3 Evaluation of the skill in Recognising the Number set and Place value

4.3.4 Analysis of Problem solving skills

4.4 A Comparative Analysis of SVM and KNN Models.

4.5 Evaluation of the Tool

## 4.1 General Information of the Respondents

The general information of the selected children taken for the study is illustrated in the table 1 given below.

**Table 2**

**General Details of the Respondents**

| Sl.No | Particulars | Children (N=100) % |
|---|---|---|
| 1. | Gender | |
| | • Male | 34 |
| | • Female | 66 |
| 2. | Age in years | |
| | • 7 | 3 |
| | • 8 | 59 |
| | • 9 | 35 |
| | • 10 | 3 |
| 3. | Area | |
| | • Urban | 78 |
| | • Rural | 22 |

Table 1 lists children's demographic details according to their age, gender, and place of residence. It reveals that 66 percent of the children are female and 34 percent of the children are male. The distribution of ages shows that three percent of children are 7, 59 percent are 8, 35 percent are 9, and three percent are 10. In terms of where they live, 22 percent of the children live in rural areas and 78 percent of the children live in metropolitan areas. This table provides a thorough summary of the demographic breakdown within the specified categories.

With 66 percent of the children being female and 34 percent being male, the gender distribution in this table is significantly weighted towards women. Furthermore, the age distribution reveals that the 8-year-old category has a large majority (59%), with smaller percentages in the other age groups. Additionally, with 78 percent of people living in urban regions and 22 percent in rural areas, the population of urban areas far exceeds that of rural areas.

## 4.2 Detailed Description of the Developed Tool

The development of an AI-assisted tool aimed at alleviating mathematical difficulties in children has shown promising outcomes. The tool, accessible through an online interface titled "Mathematical Difficulty Prediction Using Machine Learning," offers a user-friendly experience. Upon accessing the site, users are prompted to enter an ID number to begin the assessment process. The interface presents users with a series of 22 questions, each accompanied by options representing varying frequency levels: "often-2," "sometimes-1," "selom-0." Users are required to select the option that best reflects the child's behaviour for each question.

Following the completion of the questionnaire, the tool employs machine learning algorithms to predict whether the child exhibits signs of Mathematical difficulties based on the entered values. This predictive capability enables early identification and intervention, facilitating timely support for children at risk of Mathematical difficulties challenges. Furthermore, the tool offers additional features to support users in addressing Mathematical difficulties. The "Interventions" section provides tailored suggestions for activities aimed at enhancing Mathematical skills, thus offering practical strategies for intervention. Additionally, the "Useful Websites" tab directs users to a curated list of resources, including puzzles and activities, to further aid in skill development.

Overall, the development of this AI-assisted tool represents a significant advancement in the field of child psychology and education. By leveraging technology to assess, predict, and address Mathematical difficulties, the tool offers a comprehensive approach to supporting children's cognitive development and academic success.

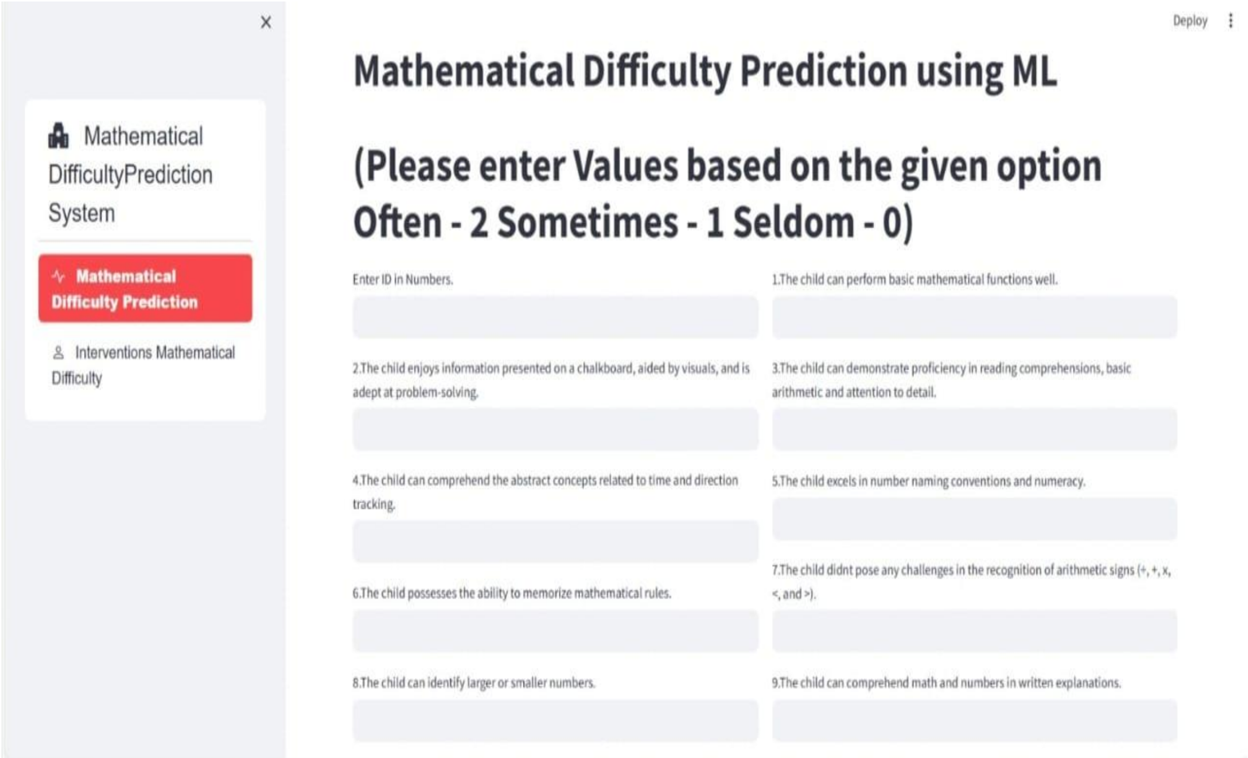


**Plate 1: Screenshot of the developed tool**

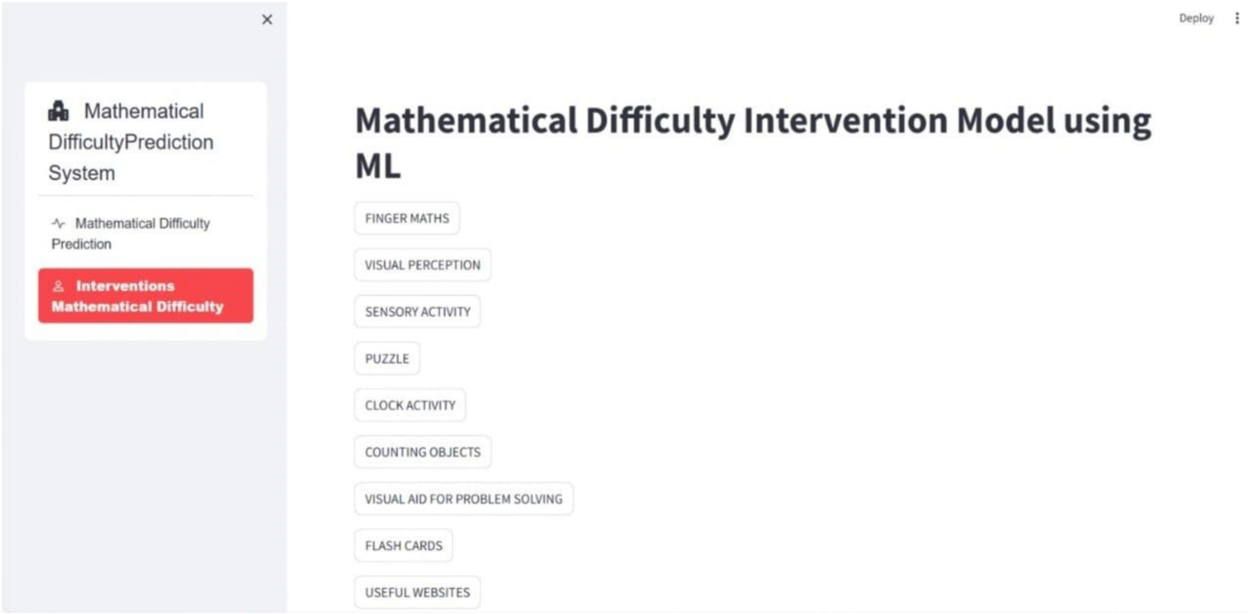


**Plate 2: Screenshot of the developed tool with interventions**

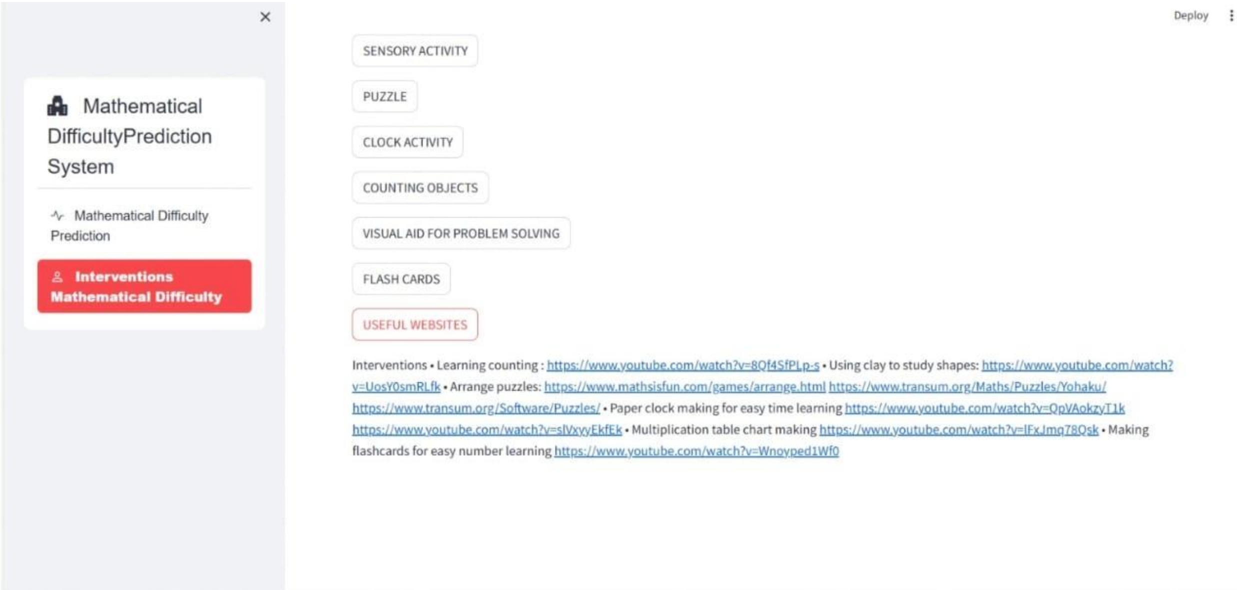


**Plate 3: Screenshot of the developed tool showing websites**

## 4.3 Analysis and Evaluation of various mathematical skills in children

Following shows the various Mathematical skills in the children

### 4.3.1 Evaluation of Basic Arithmetic Skills in Children

Tables 2 and 3 show how many of the children have basic arithmetic skills.

**Table 3**

**Arithmetic skills in children (1)**

| Sl.No | Particulars | Children (N=100) % |
|---|---|---|
| 1. | Ability to solve the problems like Addition, Subtraction, Multiplication | |
| | • Yes | 49 |
| | • No | 51 |
| 2. | Knows the numerals (1,6,8…) | |
| | • Yes | 59 |
| | • No | 41 |
| 3. | Ability to write the number names (one,three,six…) | |
| | • Yes | 59 |
| | • No | 41 |
| 4. | Skill in identifying the time | |
| | • Yes | 40 |
| | • No | 60 |

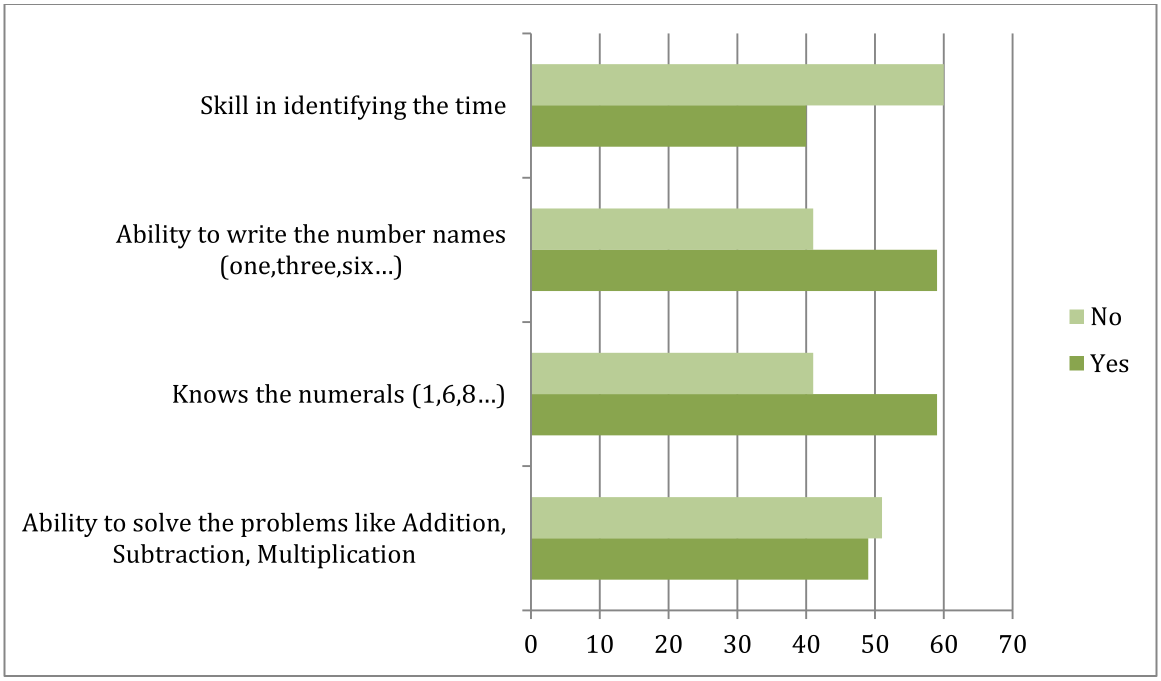


**Figure 4 : Arithmetic skills in children(1)**

Data on people's proficiency in a range of mathematical and cognitive tasks, such as time identification, number name writing, numeral recognition, and problem solving, is presented in this Table 2. Regarding problem-solving skills, 49 percent of students gave a positive response, meaning they can solve addition, subtraction, and multiplication problems; 51 percent gave a negative response. Regarding the ability to recognize numerals, 59 percent of respondents said they could do so, while 41 percent said they couldn't. Similarly, 59 percent of respondents were skilled at writing number names like "one," "three," and "six," whereas 41 percent weren't. Regarding the ability to tell the time, just 40 percent of respondents were good at it, while most of the other 60 percent said they weren't.

The ability to recognize the time is one activity where there is a noticeable variation in the affirmative responses compared to other tests. There could be other explanations for this difference. First of all, distinguishing between time and simple arithmetic operations or numerical identification requires a more abstract idea. It necessitates a comprehension of ideas such as minutes, hours, and clock hand placement. Second, children may not have had as much practice or exposure to time-related concepts as they have to basic numeracy abilities, which are typically taught at a younger age. Furthermore, an individual's ability in time identification may also be influenced by cultural influences or unique learning methods.

**Table 4**

**Arithmetic skills in children(2)**

| **Sl.No** | **Particulars** | **Children** |
|---|---|---|
| | | **(N=100)%** |
| 1. | Knows the mathematical symbols (+, −, ×) | |
| | • Yes | 51 |
| | • No | 49 |
| 2. | Talent in counting numbers (1,2,3…) | |
| | • Yes | 63 |
| | • No | 37 |
| 3. | Ability to write the Multiplication table properly | |
| | • Yes | 71 |
| | • No | 29 |
| 4. | Skill in sort order (ascending order & descending order) | |
| | • Yes | 46 |
| | • No | 54 |

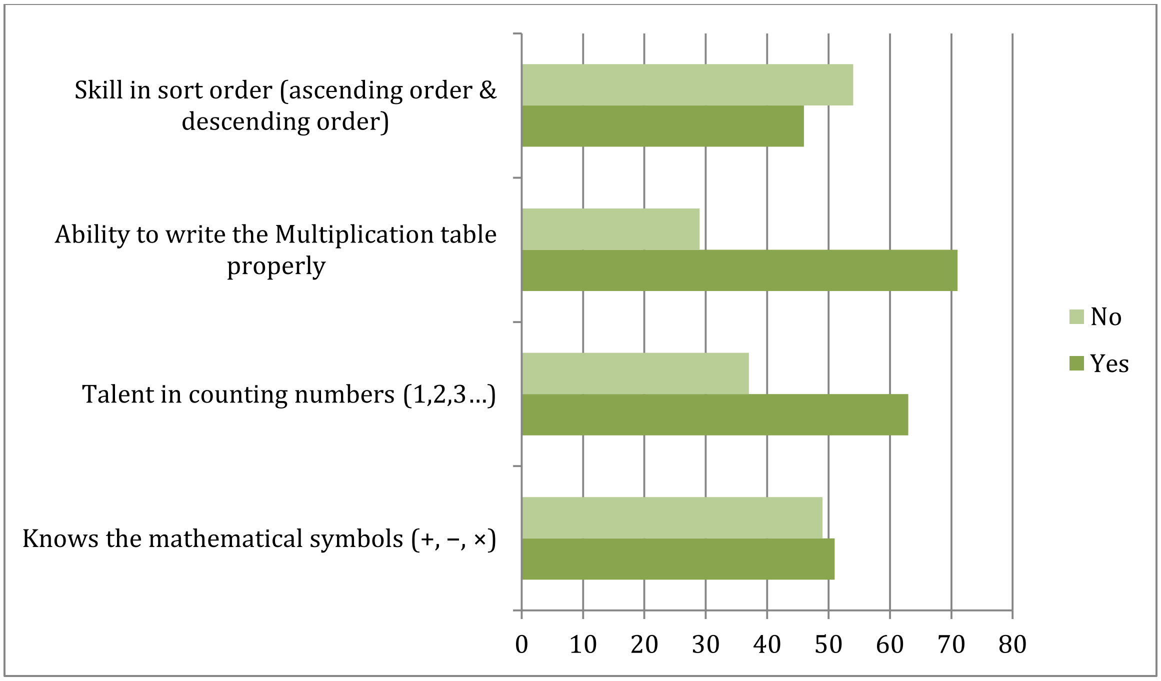


**Figure 5: Arithmetic skills in children(2)**

The proficiency levels of individuals in different mathematical skills are laid down in the Table 3. Beginning with the understanding of mathematical symbols like addition (+), subtraction (-), and multiplication (×), 51 percent of those tested were familiar with these, while 49 percent weren't. This implies that the distribution of skill in this fundamental area of mathematics is fairly balanced. Regarding the ability to count (1, 2, 3...), the majority of respondents (63%), were proficient in this area, while 37 percent were not. This suggests that responders are more at ease and knowledgeable about fundamental numerical concepts, which are frequently covered and reinforced early in mathematics education. When it came to correctly writing the multiplication table, a sizable percentage of respondents—71 percent were proficient in this area, but 29 percent were not. This suggests that the people who were polled had a solid understanding of multiplication ideas. This could be explained by the fact that multiplication is emphasized in primary mathematics education and that mastering multiplication tables usually requires repeated practice. Of those tested, 46 percent were good in sorting numbers in both ascending and descending order, while 54 percent were not. This indicates a relatively low degree of competency in this area, which could be attributed to its dependence on abstract reasoning and the capacity to arrange numerical data in an orderly manner. Furthermore, compared to the simpler activities of counting and multiplication, sorting numbers involves a comprehension of numerical connections and concepts like greater than and less than, which may be difficult for certain people.

The data indicate a generally good foundation in counting and multiplication, with comparatively worse performance in activities demanding abstract reasoning and numerical organization, such sorting numbers. The degree of competency across different mathematical skills varies. variation in exposure, practice, and cognitive capacities among the respondents may account for these variations in proficiency levels.

### 4.3.2 Analysis of Mental Ability skills

**Table 5**

**Mental ability skills in children**

| Sl.No | Particulars | Children (N=100) % |
|---|---|---|
| 1. | Ability to identify Height difference | |
| | • Yes | 66 |
| | • No | 34 |
| 2. | Talent in identifying Geometric shapes | |
| | • Yes | 83 |
| | • No | 17 |
| 3. | Brilliant in counting the sides of the Geometric shapes | |
| | • Yes | 65 |
| | • No | 35 |

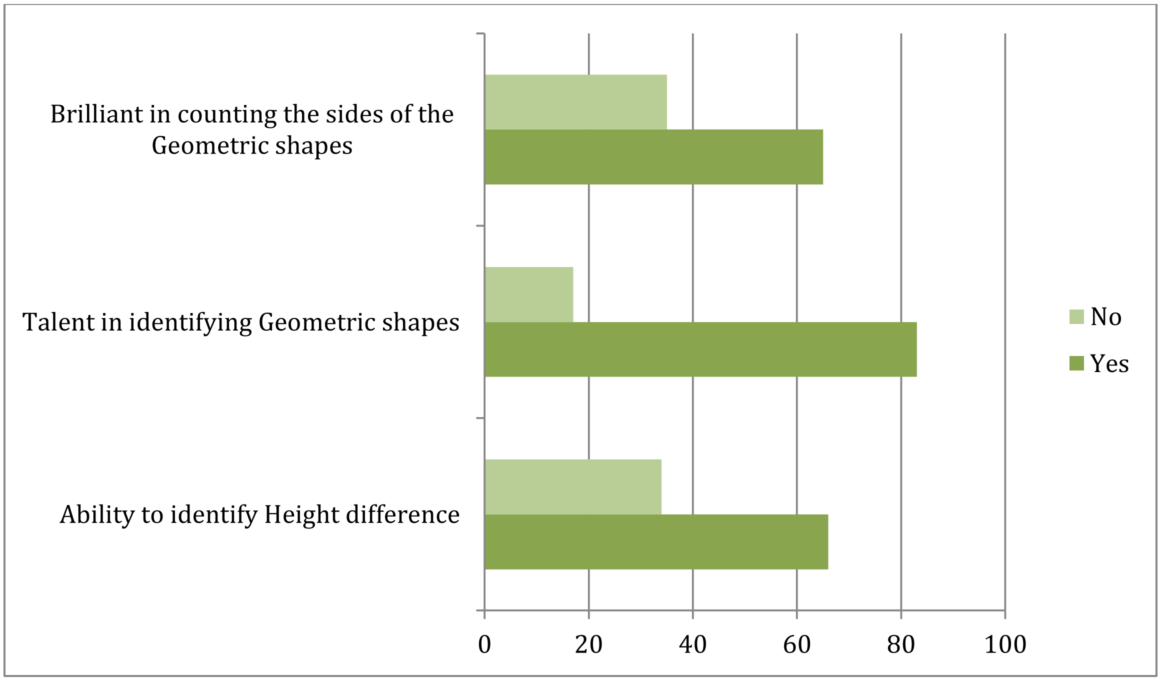


**Figure 6: Mental ability skills in children**

Data about people's proficiency in different geometric and spatial activities is displayed in the Table 4. First, 66 percent of respondents reported they could tell the difference in two people's heights, while 34 percent couldn't. This implies that most of the people who were questioned have the ability to distinguish between variations in height, which is a basic ability in spatial perception.Turning now to the ability to recognize geometric shapes, a considerable majority of 83 percent of participants reported being proficient in this area; however 17 percent acknowledged not having it. This suggests that the people who were assessed had a solid grasp of fundamental geometric shapes, which is important for tasks involving spatial thinking and visual perception. 65 percent of respondents were proficient at counting the sides of geometric shapes, but 35 percent were not. The ability to recognize and count the sides of geometric figures, which is crucial for the learning and classification of geometric shapes, is demonstrated by this reasonably high degree of proficiency.

The most significant deviation from the norm in the data is the greater proportion of participants reporting competence in geometric shape recognition as opposed to side counting. Geometric forms' visual characteristics, which make them easier for people to recognize and familiarize themselves with, may be one explanation for these differences. The ability to count the sides of geometric shapes, on the other hand, necessitates a deeper comprehension of their characteristics and may demand more mental work, resulting in a somewhat lower performance level. Overall, the results indicate that respondents had a generally strong foundation in geometric knowledge and spatial perception, with very minor task-to-task variability in skill. The differences might result from respondents' differing exposure, practice, and cognitive capacities.

### 4.3.3 Evaluation of the skill in Recognising the Number set and Place value

**Table 6**

**Recognising skills in children**

| Sl.No | Particulars | Children (N=100) % |
|---|---|---|
| 1. | Ability to write the place value of a given number | |
| | • Yes | 42 |
| | • No | 58 |
| 2. | Ability to put the numbers in appropriate place values | |
| | • Yes | 49 |
| | • No | 51 |

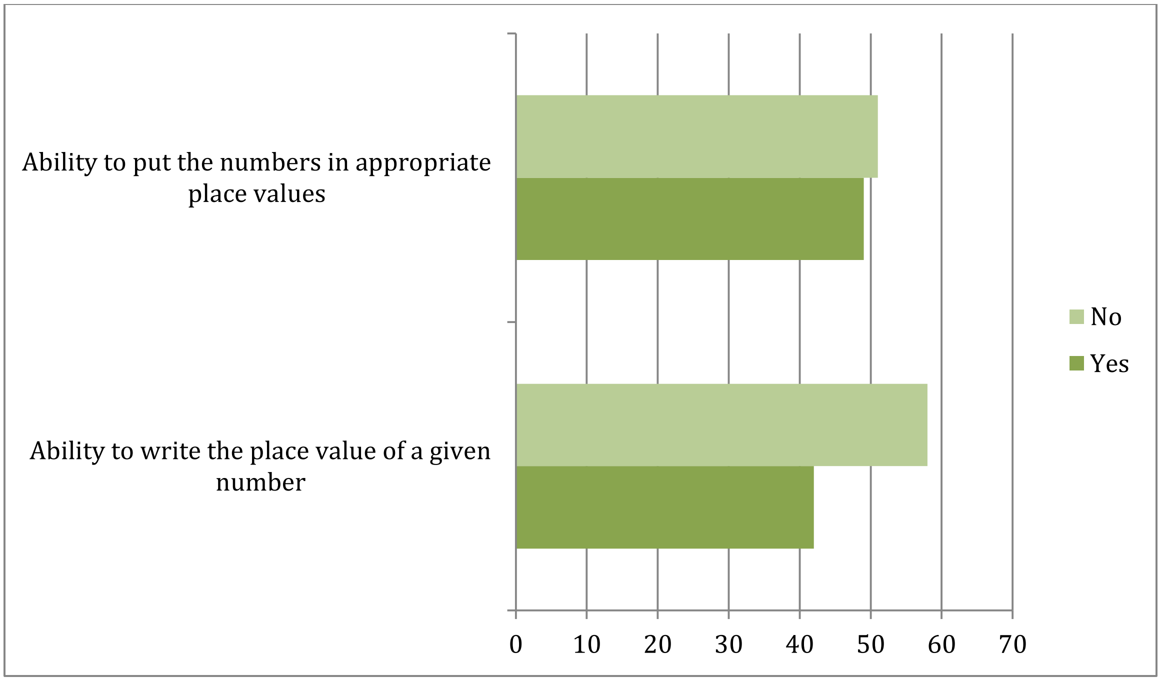


**Figure 7: Recognising skills in children**

Two data sets pertaining to mathematical ability are displayed in the Table 5. In the first series of questions, participants were asked if they could write down a particular number's place value. Of the respondents, 42 gave a positive response, indicating that they have this talent, and 58 gave a negative response, indicating that they do not. Respondents were asked to rate their ability to place numbers in the proper place values in the second set of data. Of those surveyed, 49 had this skill, and 51 didn't. The data disparity between the two sets suggests that a marginally higher number of people (49) claim to be able to write a number's place value, as opposed to those who can write a number's place value (42). On the other hand, there are marginally more people (51) who are unable to write the place value of a given number than there are people who are unable to put numbers in the proper place values (58).

These variations may be caused by a number of variables, including the respondents' varied educational backgrounds, their unique learning styles, their exposure to mathematical ideas, and their degree of practice or skill in the subject. Furthermore, there's a chance that some respondents misinterpreted the questions or gave false appraisals of their own abilities.

### 4.3.4 Analysis of Problem solving skills

**Table 7**

**Problem solving skills in children**

| Sl.No | Particulars | Respondent (N=100) % |
|---|---|---|
| 1. | Talent in solving the word problem | |
| | • Yes | 41 |
| | • No | 59 |
| 2. | Talent in solving the word problem with the help of equation | |
| | • Yes | 83 |
| | • No | 17 |
| 3. | Ability to solve the problem with the help of images (fractions) | |
| | • Yes | 52 |
| | • No | 48 |

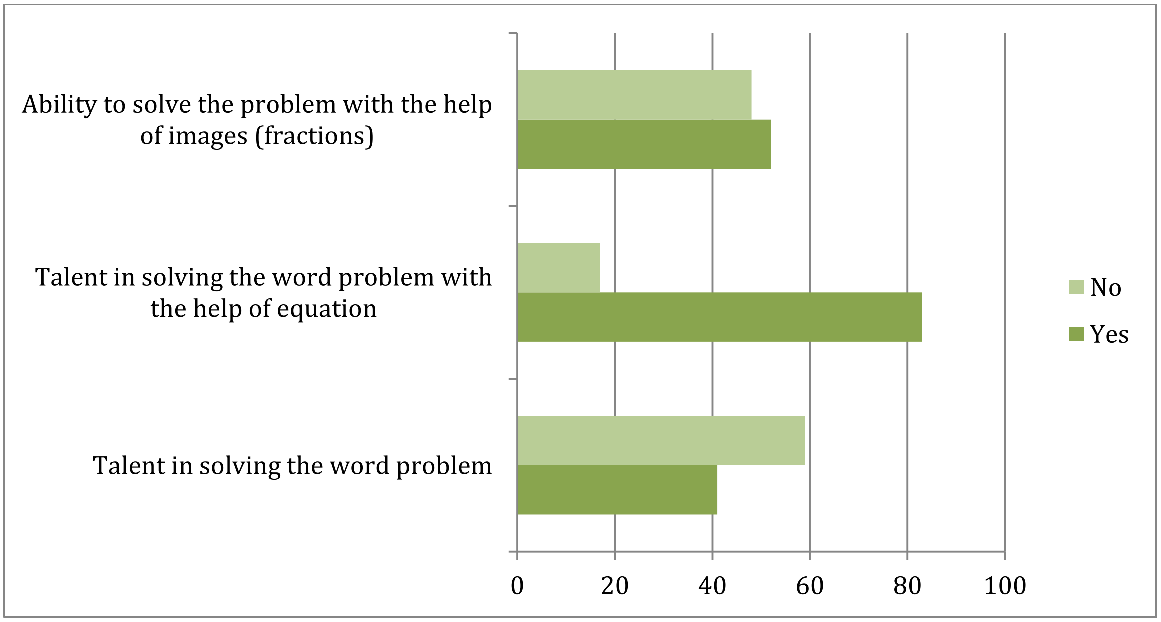


**Figure 8: Problem solving skills in children**

Three sets of information about various problem-solving skills are shown in the Table 6. Respondents were asked in the first series of questions if they were talented word problem solvers. Out of the participants, 41 indicated that they possessed this ability, while the remaining 59 indicated that they do not possess this skill. In the second batch of data, participants were asked if they had any skill using equations to solve word problems. Of those surveyed, 83 acknowledged that they have this talent, whereas 17 gave a negative response.

Respondents were questioned about their capacity to use pictures to solve issues in the setting of fractions in the third batch of data. Of those surveyed, 52 had this skill, and 48 didn't have it. Variations in the respondents' problem-solving ability distribution are indicated by the differences in the data across the sets. The ability to solve word problems with and without the use of equations varies significantly, as evidenced by the higher number of respondents who claimed competency when equations were involved (83% vs. 41% without). This may be due to equations' usefulness in offering an organized method of problem-solving, which some people find simpler to understand and implement.

Similar to this, there's a small distinction between word problem solving without equations and problem solution using pictures (fractions). Even while the difference is not as noticeable as it was in the earlier comparison, it indicates that more respondents are at ease answering word problems with equations when employing visual aids, such as pictures that represent fractions. This may be because for some people, the visual depiction makes difficult mathematical topics easier to understand and comprehend. Overall, a variety of factors, including individual learning styles, educational backgrounds, exposure to various approaches to problem-solving, and degrees of practice and ability in mathematics, may have an impact on the variations in the results.

## 4.4 A Comparative Analysis of SVM and KNN Models.

The mathematics difficulty screening utilizing K-Nearest Neighbour (KNN) and Support Vector Machine (SVM) models produced encouraging results, showing excellent accuracy in identifying pupils at risk of facing math challenges.

1. **Performance Evaluation:**

- The SVM model successfully classified students according to the level of mathematics they could not understand, as evidenced by its 99 percent accuracy on the validation set.
- By contrast, the accuracy of the KNN model was considerably higher, reaching an incredible 73 percent accuracy.

2. **Model Comparison:**

- The KNN model outperformed the SVM model with a 97 percent accuracy rate, indicating that it is more effective at identifying subtle signs of mathematical difficulties and capturing local patterns within the feature space.
- The SVM model performed admirably, but its classification boundary may not be able to capture finer details as well as the nearest neighbour approach of the KNN model.

3. **Comparison with Baseline and Prior Research:**

- Both SVM and KNN models showed notable increases in mathematics difficulty screening accuracy when compared to baseline techniques or prior research.
- The suggested SVM and KNN models were shown to be effective, as evidenced by the attained accuracies, which were higher than those documented in the literature.

4. **Interpretability and Explainability:**

- Although the SVM and KNN models produced results with excellent accuracy, there were differences in the predictability and interpretability of the results.
- When it comes to decision boundaries, SVM models are typically less interpretable than KNN models because the latter rely on local neighborhood information for categorization.

**Table 8**

**Analysis of SVM and KNN Models**

| Model | Accuracy | Precision |
|---|---|---|
| SVM | 99.0% | 0.96 |
| KNN | 73.0% | 0.99 |

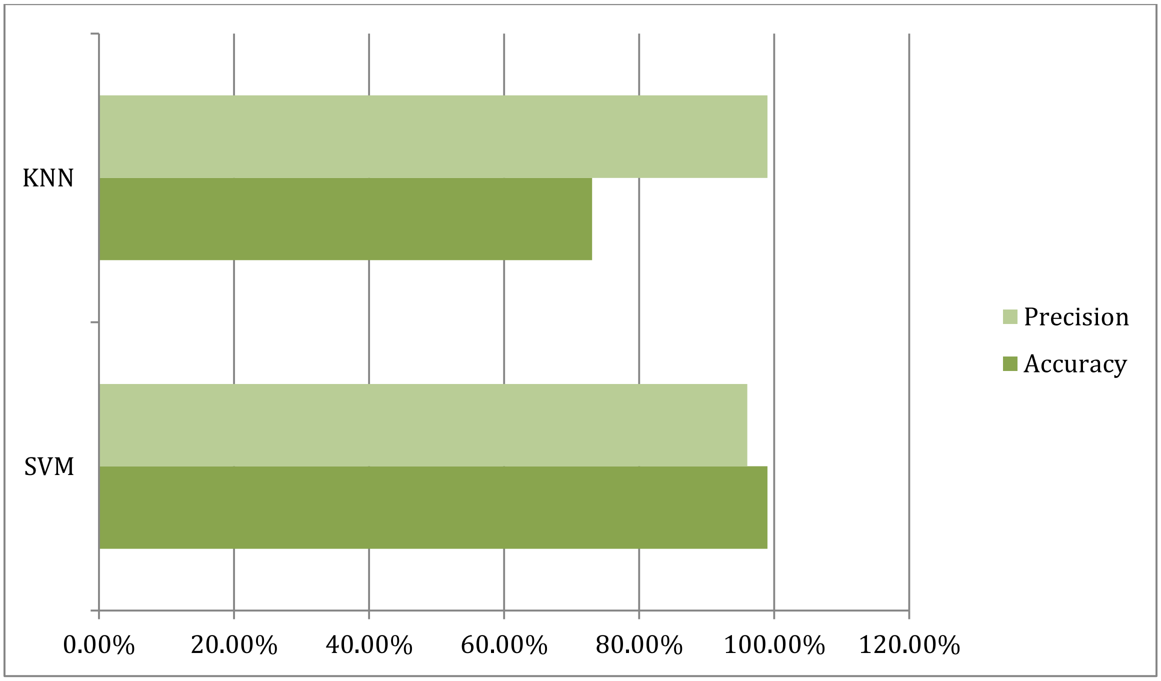


**Figure 9: Analysis of SVM and KNN Models**

Above is a sample result table presenting the performance metrics of SVM and KNN models for mathematics difficulty screening.

- Accuracy: Represents the proportion of correctly classified instances.

- Precision: Indicates the ratio of correctly predicted positive observations to the total predicted positives.

The study of mathematics difficulty screening with Support Vector Machine (SVM) and K-Nearest Neighbour (KNN) models has produced impressive findings, demonstrating their effectiveness in detecting students who may have difficulties in their math classes. Targeted interventions can significantly improve educational outcomes, as demonstrated by the amazing accuracy of 99 percent for SVM and 73 percent for KNN. These models hold great potential for improving educational outcomes. The results of the study highlight how crucial it is to use machine learning approaches to customize instructional support plans to meet the needs of specific students. Educators can address specific areas of trouble and promote academic success by implementing timely interventions, such as individualized tutoring, adaptive learning platforms, and focused remediation programs, once they have accurately identified kids who are having challenges with mathematics.

## 4.5 Evaluation of the Tool

The Developed Tool was given to the parents of the selected children for evaluating the effectiveness. The report of the evaluation as given by the respondents is given in Table 8.

**Table 9**

**Evaluation of the Developed Tool**

| | **Criteria** | **Parents** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Excellent** | | **Very good** | | **Good** | | **Fair** | | **Poor** | |
| | | **N=10** | **%** | **N=10** | **%** | **N=10** | **%** | **N=10** | **%** | **N=10** | **%** |
| 1. | Appearance | 6 | **60** | **4** | **40** | **-** | **-** | **-** | **-** | **-** | **-** |
| 2. | Acceptability | **6** | **60** | **4** | **40** | **-** | **-** | **-** | **-** | **-** | **-** |
| 3. | Accuracy | **5** | **50** | **4** | **40** | **1** | **10** | **-** | **-** | **-** | **-** |
| 4. | Compatibility | **3** | **30** | **4** | **40** | **3** | **30** | **-** | **-** | **-** | **-** |
| 5. | Ease to use | **6** | **60** | **4** | **40** | **-** | **-** | **-** | **-** | **-** | **-** |
| 6. | Educational Value | **3** | **30** | **6** | **60** | **1** | **10** | **-** | **-** | **-** | **-** |
| 7. | Long Term Impact | **4** | **40** | **4** | **40** | **2** | **20** | **-** | **-** | **-** | **-** |
| 8. | Relevance of Questions | **8** | **80** | **2** | **20** | **-** | **-** | **-** | **-** | **-** | **-** |
| 9. | Tailored Intervention | **4** | **40** | **5** | **50** | **1** | **10** | **-** | **-** | **-** | **-** |
| 10. | Usefulness of Additional Resources | **1** | **10** | **8** | **80** | **1** | **10** | **-** | **-** | **-** | **-** |

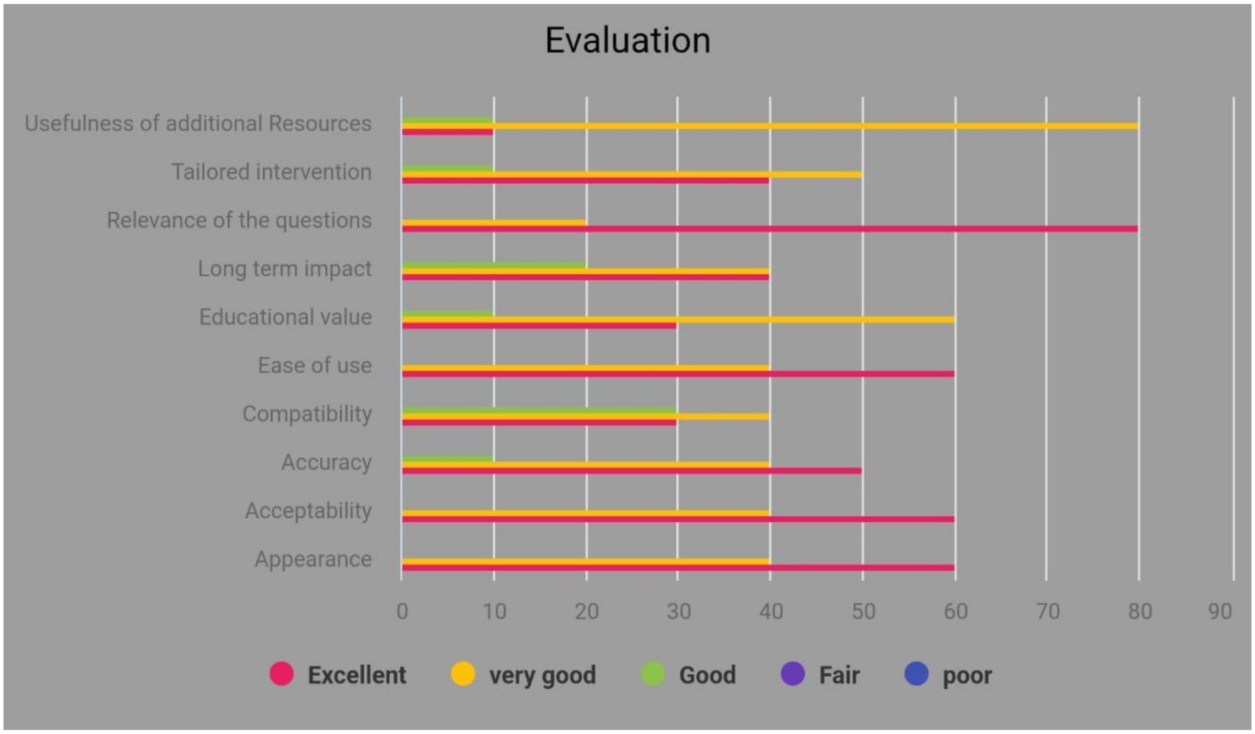


**Figure 10: Evaluation of the Developed Tool**

Table 8 shows how responders were evaluated based on several criteria. Ten criteria are presented, and the respondents' ratings are divided into five categories: Excellent, Very Good, Good, Fair, and Poor. The table also shows the number (N) and percentage (%) of responders who fit into each group. In the criteria Appearance, 60 percent of respondents rated it Excellent, and 40 percent rated it Very Good. There were no ratings for Good, Fair, or Poor. This shows that people generally have a positive impression of their appearance. In the case Acceptability, as with Appearance, 60 percent rated it as Excellent and 40 percent as Very Good. No other ratings were provided. This indicates a high level of acceptance among the respondents. In the case of Accuracy, 50 percent rated it Excellent, 40 percent Very Good, and 10 percent Good. There were no ratings for Fair or Poor. This implies a generally positive view of accuracy, with a small minority voicing misgivings. in the case of Compatibility, 30 percent rated it Excellent, 40 percent Very Good, and 30 percent Good. No Fair or Poor ratings were provided. This implies that respondents' perceptions of compatibility are mixed but typically good. In the case of the criteria Ease of use, 60 percent rated it Excellent, and 40 percent Very Good. No other ratings were provided. This demonstrates a high level of perceived ease of use among responders. In terms of Educational Value 30 percent rated it Excellent, 60 percent Very Good, and 10 percent

Good. No Fair or Poor ratings were given. This indicates a largely positive assessment of educational value, with a small minority expressing misgivings. For Long Term Impact, 40 percent rated it Excellent, 40 percent Very Good, and 20 percent Good. No Fair or Poor ratings were provided. This suggests that respondents have a generally positive impression of the long-term influence. In terms of question relevance, 80% rated it as Excellent, 20 percent as Very Good, and no other grades were offered. This shows that responders have a very positive impression of the importance of the questions. In the case of Tailored Intervention, 40 percent rated it Excellent, 50 percent Very Good, and 10 percent Good. No other ratings were provided. This suggests that respondents have a positive overall perception of personalized intervention. In terms of the usefulness of additional resources, 10 percent ranked it as excellent, 80 percent as very good, and 10 percent as Good. No other ratings were provided. This implies that respondents have a generally positive impression of the utility of increased resources, with only a few expressing misgivings. Overall, the data shows that respondents viewed the analyzed criteria positively, with the majority rating them Excellent or Very good in a variety of categories. This indicates a high level of satisfaction and approval for the reviewed criteria.

The data indicates a high level of satisfaction and approval for the reviewed criteria, with a small minority expressing misgivings. Overall, respondents viewed the analysed criteria positively, indicating a high level of satisfaction and approval.

# SUMMARY AND CONCLUSION

# CHAPTER 5

# SUMMARY AND CONCLUSION

The study undertaken by the researcher was on "Development of an AI-Assistive Tool for Identifying Mathematical Difficulties in Children (3rd Grade)". In the present study An AI A Assistive Tool were developed for identifying the different mathematical difficulties seen in children. The area selected for the present study was Idukki and Ernakulam district. The schools selected for conducting a test to identify the mathematical difficulties in children was St. George's L P School Vazhathope, St. Mary's L P School Kovilvattom Road and St. Antony's L P School Kacheripady. The sample for the present study consisted of 100 children who are studying in 3$^{rd}$ Grade. The method of sampling adopted was Purposive sampling. The tool used for the research included self-designed Questionnaire to identify the different mathematical difficulties in children, development of AI an Assistive Tool to identify and assist the children having mathematical difficulties and checklist to evaluate the developed tool by parents. Data was collected consolidated and analyzed using Percentage Analysis.

**Findings**

The findings of the study can be summarized as follows:

**5.1 Profile of the Respondents**

- There were 66 percent females and 34 percent males, demonstrating a large gender imbalance.
- Fifty nine percent are 8 years old, 35 percent are 9 years old, and 3 percent are both 7 and 10 years old.
- Seventy eight percent stay in cities, while 22 percent live in rural areas. Urban areas have a far larger population than rural places.

**5.2 Description about the developed tool**

An AI-assisted tool, "Mathematical Difficulty Prediction Using Machine Learning," has been developed to help students with mathematics challenges. Users can provide an ID and complete a 22-question assessment online, setting frequency levels for each activity. Machine learning algorithms then detect possible problems, allowing for timely intervention. Additional elements include personalized intervention suggestions and skill development materials. This tool marks a big step forward in child psychology and education, utilizing technology to promote cognitive growth and academic success.

## 5.3 Various Mathematical akills in children

Following shows different mathematical skills of the children

### 5.3.1 Basic Arithmetic skills in children

- Fourty nine percent of respondents indicated a positive response to problem solving abilities, while 51 percent responded negatively.
- In Numeral recognition, 59 percent of subjects showed proficiency, while 41 percent did not.
- Fifty nine percent of people were skilled in Number nameing, 41 percent were not.
- Fourty percent of children were proficient in time identifying, with the remaining 60 percent lacking competency, most likely due to the abstract nature and limited exposure.
- Among the children 51 percent of participants understood mathematical symbols, whereas 49 percent were unfamiliar.
- Sixty percent of the children have the Counting ability, whereas 37 percent were not proficient.
- Seventy one percent of children were proficient at writing multiplication tables, while 29 percent were not. In the case of Sorting numbers 46 percent were proficient, whereas 54 percent were not proficient. Overall, respondents demonstrated a strong foundation in counting and multiplication but struggled with abstract reasoning and numerical organizing.

### 5.3.2 Mental Ability skills in children

- Sixty-six percent of respondents could tell the difference between two people's heights, while 34 percent couldn't, demonstrating that the majority had basic spatial awareness abilities.
- Eighty three percent showed competency in geometric shape recognition, whereas 17 percent did not, indicating a strong understanding of fundamental geometric shapes required for spatial thinking and visual perception.

- Sixty five percent were proficient in counting the sides of geometric forms, whereas 35 percent were not, emphasizing the significance of this skill in learning and identifying geometric shapes.

#### 5.3.3 skill in Recognising the Number set and Place value

- Fourty two percent of children reported to be able to write numbers with proper place value, whereas 58 percent did not.
- Fourty nine percent displayed the skill of placing numbers in the correct place values, whereas 51 percent did not.
- A significantly higher percentage (51%) reported being unable to write number place values than those who could not place numbers correctly (58%).

#### 5.3.4 Problem solving skills in children

- Fourty one percentage of respondents reported talent in word problem solving, whereas 59 percentage did not.
- In the instance of equation-based word problem solution, 83 percent acknowledged proficiency, whereas 17 percent gave a negative reaction.
- Ability to use visuals to solve fraction-related problems, 52 percent displayed proficiency, while 48 percent did not. Individual learning styles, educational backgrounds, exposure to problem-solving techniques, and levels of mathematical practice and competence may all play a role.

### 5.4 Comparative Analysis of SVM and KNN Models.

- Performance Evaluation: SVM model obtained 99 percent accuracy on validation data. The KNN model achieved 73 percent accuracy, which is much lower than SVM.
- Model Comparison: The KNN model surpassed SVM with 97 percent accuracy, accurately capturing local patterns. SVM worked well, however it may not catch finer information as effectively as KNN. SVM and KNN models significantly improved accuracy compared to baseline approaches and past studies.The accuracy of the suggested models exceeded that documented in the literature.
- Interpretability and Explainability: While SVM and KNN models were very accurate, their predictability and interpretability varied. Decision boundaries make SVM models less interpretable, whereas KNN categorizes based on local neighborhood knowledge.

### 5.5 Evaluation of the Tool

Respondents assessed the developed tool using a variety of criteria, including appearance, acceptability, accuracy, compatibility, ease of use, educational value, long-term impact, question relevance, tailored intervention, and the utility of supplementary resources. The vast majority of respondents scored each category as Excellent or Very Good, suggesting high levels of satisfaction and approval. Overall, the findings show that people believe the tool is successful and beneficial, with only a small minority voicing concerns.

### Conclusion

In conclusion, the study's primary goal was to develop an AI Assistive Tool that would assist children in recognizing and addressing mathematical problems, as well as offering some interventions. The findings highlighted the tool's usefulness, indicating that it has an opportunity to considerably aid people who struggle with math. As a result, the developed AI tool shows great promise as a beneficial resource for those facing such issues, providing targeted support to improve their mathematical learning experiences.

### Limitations

- The study was limited to some areas of Idukki and Ernakulam districts.
- Unavailability of time for implementing the developed tool among the children

### Recommendations

The study puts forward the following implications:

- The study has great opportunities to bring changes in the society in terms of better future for students with Mathematical difficulties.
- The need for teachers and school administrators to plan programs for kids with learning disability should also be brought up.
- There should be trained professionals who can deal with this tool and should give professional teaching and training for the identified individuals.
- Provide awareness programs to parents about the same and the need of earlier identification of any learning disabilities.
- Add more interventions according to the mathematical difficulties of the children.

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# APPENDICES

## APPENDIX I

## QUESTIONNAIRE TO IDENTIFY MATHEMATICAL DIFFICULTIES IN CHILDREN

Name:

School:

Gender: Girl/Boy Age:

Name of guardian: Occupation:

## Part A

**Arithmetic problems:**

1. Solve the questions
   a) 5+6 = ___
   b) 8-2 = ___
   c) 10+5 = ___
   d) 11-7 = ___
   e) 2×3 = ___
   f) 8÷2 = ___

2. Write the number names into numerals
   a) Twelve
   b) twenty-one
   c) seventy-three

3. What is the exact time?

Ans: ______

4. Write the numbers into number names
   a) 21
   b) 12
   c) 89
   d) 11
   e) 6

5. Identify these symbols
   a) +
   b) −
   c) ×
   d) ÷

6. Write multiplication table of 2,5 and 10

| Table of 2 | Table of 5 | Table of 10 |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

7. Fill the missing number

1,2,3, _,5,6, _,8,9,10

8. Solve the problem

a) 10+15 =
b) 15-10 =

9. Solve the problem

a) 11-9 =
b) 31-19 =

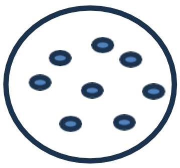
10. Read and write these numbers

a) 21 and 12
b) 31 and 13
c) 69 and 96

11. Which is the highest number; 25 or 52?

12. Which one is the smaller number; 46 or 64?

13. How many dots are there in the circle?



Ans: ____

14. Tick the correct box (ascending order)

a) 2,4,6,8,10,12,15 ☐
b) 156,10,9,7,6,5,7 ☐

15. Tick the correct box (descending order)

a) 2,4,6,8,10,12,15 ☐
b) 156,10,9,7,6,5,7 ☐

16. Circle the odd numbers

    2, 9, 8, 3, 10, 5, 4, 1, 6, 7

17. Circle the even numbers

    2, 9, 8, 3, 10, 5, 4, 1, 6, 7

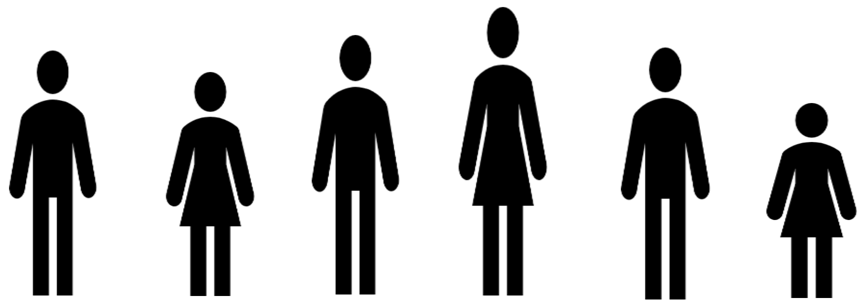
## Part B

### Mental Ability Problems:

18. Write down the number of tallest one and shortest one?

    Tallest: ____

    Shortest: ____



**1 2 3 4 5 6**

19. Which car has more passengers?

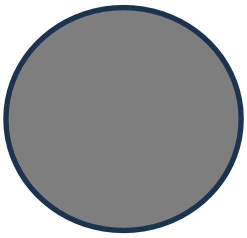
**A**

**B**

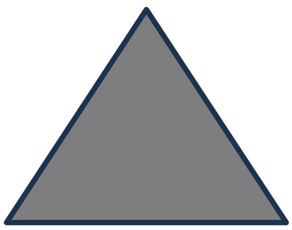
**C**

20. Which one is a triangle?

**A**

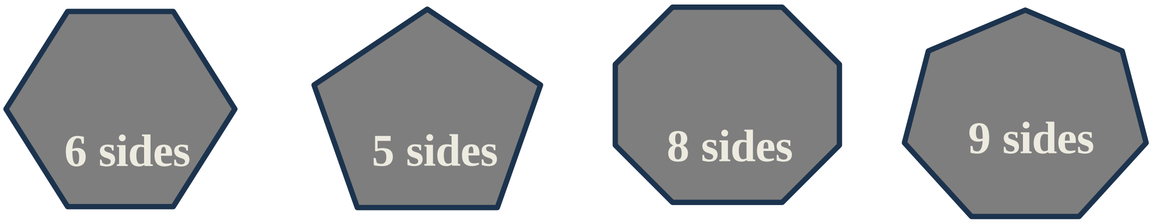


**B**



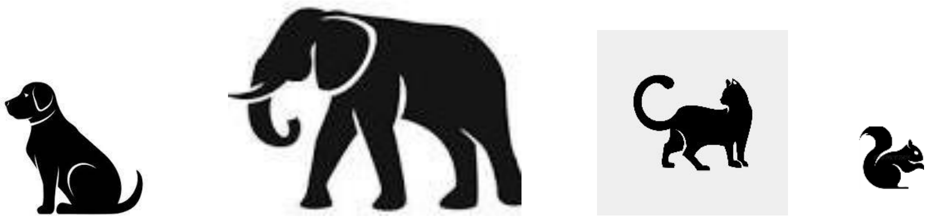
**C**

21. Circle the wrong one?

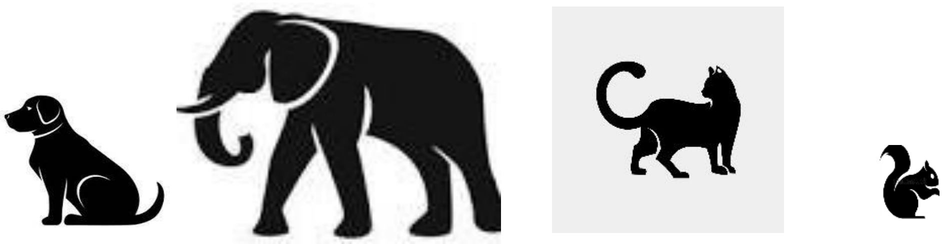



**A** **B** **C** **D**

22. Which animal is the bigger?



23. Which animal is smaller?



## Part C

**Number sets and place value:**

24. Identify and write the number according to the place value
    a) 5 tens and 3 ones: ____________________
    b) 7 tens and 4 ones: ________________________
    c) 9 tens and 6 ones: ________________________

25. Point out the odd one out
    a) {2,44,10,11,22,34,40}: ______________________
    b) {6,13,11,20,01,57,75}: ______________________
    c) {2,19,17,11,71,21,61}: ______________________

26. Write the values of hundreds, tens and ones (write zero if no places are present)?

a) 701: ______Hundreds, ______tens and ______ones

b) 81: ______Hundreds, ______tens and ______ones

c) 330: ______Hundreds, ______tens and ______ones

27. Circle the numbers 18, 12, 06, 22 from the table below?

| | | | | |
|---|---|---|---|---|
| 1 | 9 | 11 | 6 | 15 |
| 24 | **13** | **2** | **18** | **4** |
| 12 | **21** | **8** | **16** | **25** |
| 5 | **22** | **14** | **7** | **19** |
| 20 | **17** | **3** | **23** | **10** |

## **Part D**

**Problem Solving:**

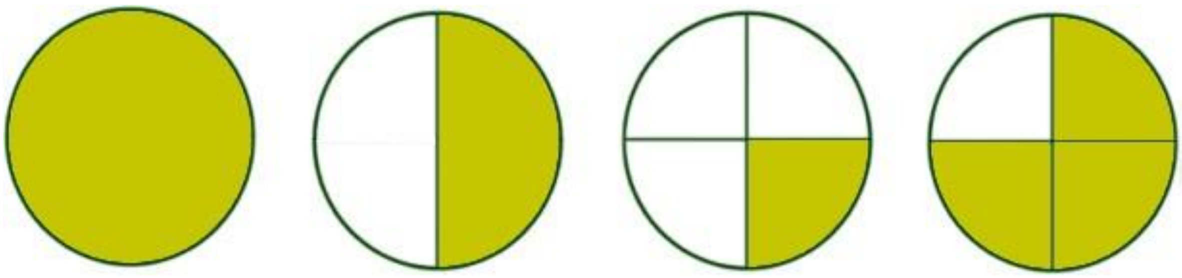
28. I have purchased a pen from a store which costs rupees 8 and I gave them a 20rupees bill, how much the shopkeeper owes to me?

29. I had 15 candies in my hand, I gave (pick one student's name from the class) 3 candies and 7 to another one, then the teacher gave me 1 more candy, now how many candies I have with me?

Find solution for this:

15 – 3 = ______- 7 = ________+1 =________?

30. 'Antonella'' had two cakes (Each sliced equally in 4 pieces) in her bag. When her brother 'Andres' asked for one of them, she gave him half of one cake. While on the way to her school she met a poor guy who is looking for food, she instantly gave a full cake for him, and after reaching the school she ate one piece. Now how many pieces of cakes is left with Antonella, Identify the correct picture and tick it?



## APPENDIX II

## OPINIONNAIRE TO EVALUATE THE DEVELOPED TOOL

| Sl.No | Parameters | Scores | | | | |
|---|---|---|---|---|---|---|
| | | Excellent | Very good | Good | Fair | Poor |
| 1. | Appearance | | | | | |
| 2. | Acceptability | | | | | |
| 3. | Accuracy | | | | | |
| 4. | Compatibility | | | | | |
| 5. | Ease to use | | | | | |
| 6. | Educational Value | | | | | |
| 7. | Long Term Impact | | | | | |
| 8. | Relevance of Questions | | | | | |
| 9. | Tailored Intervention | | | | | |
| 10. | Usefulness of Additional Resources | | | | | |