A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ARTIFICIAL INTELLIGENCE IN BRIDGING LEARNING GAPS BETWEEN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES

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DECLARATION

I hereby declare that this dissertation entitled **A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ARTIFICIAL INTELLIGENCE IN BRIDGING LEARNING GAPS BETWEEN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES** has been carried out by me during the academic year 2022-2024 in partial fulfillment of the requirement for the Degree of Integrated B.Ed-M.Ed from Barkatullah University, Bhopal.

The study has been conducted under the guidance and supervision of **Dr. Rajesh Kumar,** Assistant Professor, Department of Education, Regional Institute of Education (NCERT), Bhopal.

It is also declared that the research work done by me is original. This dissertation has not been submitted by me for the award of any degree or diploma in any university.

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CERTIFICATE

This is to certify that the dissertation entitled **"A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ARTIFICIAL INTELLIGENCE IN BRIDGING LEARNING GAPS BETWEEN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES**" being submitted by **MINISHA K**, student of Integrated B.Ed-M.Ed bearing roll number-**2306600322** and enrollment number-**R230664070019**, Regional Institute of Education, NCERT, Bhopal for the partial fulfillment of the degree of Integrated B.Ed-M.Ed , is a Bonafide research carried out by her in the Department of Education, Regional Institute of Education, Bhopal, Madhya Pradesh under my supervision and guidance. The work is original and it has not been submitted earlier in any form of degree at any university.

This is further certified that the dissertation in its present form is fit for the submission to Barkatullah University for the award of the degree of integrated B.Ed-M.Ed course.

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CHAPTER – 1

INTRODUCTION

1.1 Introduction

Education is universally recognized as both a fundamental human right and a powerful driver of personal and societal development. However, access to quality education and equitable learning outcomes remains a challenge for many learners, particularly those with disabilities. In developing countries like India, students with learning disabilities are among the most marginalized groups within the education system. These students often encounter academic, social, and structural barriers that hinder their progress, leading to significant learning gaps when compared to their typically developing peers.

Despite constitutional guarantees and progressive policies like the Right to Education (RTE) Act and the more recent National Education Policy (NEP) 2020, inclusive education in India continues to face implementation hurdles. Although mainstream schools are now more likely to enroll students with disabilities, the classroom practices, curriculum design, and teaching strategies often fail to accommodate their specific learning needs. A significant proportion of students with learning disabilities continue to experience poor academic performance, low motivation, and reduced participation, which ultimately leads to high dropout rates and limited career opportunities.

According to the 2011 Indian Census, approximately 2.21% of the population, or nearly 26.8 million individuals, live with some form of disability. Among these, a substantial number are children of school-going age who face challenges not only in accessing education but also in achieving learning outcomes comparable to their non-disabled peers. The literacy rate among children with disabilities lags significantly behind the national average. For instance, only 54.4% of visually impaired individuals were found to be literate, compared to the 74% literacy rate in the general population. Similarly, children with hearing and speech impairments, autism spectrum disorders,

and specific learning disabilities such as dyslexia and dyscalculia struggle to achieve basic reading, writing, and numeracy skills.

These disparities are not just statistics they represent a systemic failure to provide equitable educational opportunities to all learners. The traditional model of teaching, which assumes a uniform pace and style of learning, does not cater to the diversity of cognitive and sensory profiles found in today's classrooms. Teachers are often underprepared to deal with special educational needs (SEN) due to lack of specialized training and resources. Furthermore, existing teaching aids are often generic and fail to meet the specific needs of children with disabilities. As a result, these students are not only academically behind but also emotionally disengaged, which further widens the learning gap.

In this context, the integration of Artificial Intelligence (AI) into education emerges as a potentially transformative solution. AI, defined as the simulation of human intelligence by computer systems, is increasingly being applied in various sectors, including healthcare, transportation, finance, and education. In the field of education, AI offers unprecedented opportunities for personalization, adaptability, and data-driven decision-making. It enables the creation of intelligent tutoring systems, speech-to-text converters, adaptive assessments, and real-time feedback mechanisms—tools that can significantly enhance the learning experience of children with disabilities.

One of the most promising features of AI in education is its ability to offer personalized learning pathways. Unlike traditional instructional models that adopt a one-size-fits-all approach, AI tools can analyze student data to identify individual learning styles, strengths, weaknesses, and pace of learning. Based on this analysis, the system can adapt the content, format, and difficulty level of lessons, ensuring that students receive instruction tailored to their needs. This level of customization is particularly beneficial for learners with cognitive or language processing difficulties, who may require repeated practice, simplified instructions, or multisensory input to grasp concepts.

AI technologies are also making education more accessible for students with sensory impairments. For example, screen readers powered by AI can read digital text aloud for visually impaired students, while speech recognition tools can convert spoken

words into written text for those with mobility or writing challenges. Augmentative and alternative communication (AAC) devices enhanced by AI can assist children with speech impairments in expressing themselves. Such innovations not only improve academic outcomes but also foster independence and self-confidence among learners with disabilities.

Another significant advantage of AI is its capacity to continuously assess student progress. Traditional assessments, often paper-based and conducted at fixed intervals, may not capture the real-time learning trajectory of students, particularly those with fluctuating attention spans or specific processing delays. AI-based systems, on the other hand, can provide immediate feedback, highlight areas of difficulty, and recommend remedial content on an ongoing basis. This continuous assessment loop ensures that learning remains dynamic and responsive, reducing the likelihood of academic failure and disengagement.

In recent years, the use of AI tools in education has gained momentum globally. Platforms like Microsoft Immersive Reader, Google Read Along, and Khan Academy use AI algorithms to deliver interactive and adaptive learning experiences. Some of these platforms also support multiple languages, including regional Indian languages like Malayalam and Hindi, thereby enhancing their utility in multilingual classrooms. These tools incorporate gamification, voice input, visual aids, and AI-generated feedback, which collectively create a rich and engaging learning environment.

In the context of inclusive education, AI is not merely an assistive technology, it is an enabler of equity. It empowers teachers to differentiate instruction, helps students to learn at their own pace, and allows schools to identify and address learning gaps more efficiently. Moreover, AI tools are scalable and can be deployed across different settings, making them a cost-effective solution in resource-constrained environments.

While the potential of AI in education is immense, its actual impact on learning outcomes, particularly among students with learning disabilities, remains underexplored. Most existing studies focus on general education populations, with little emphasis on how AI tools affect learners with specific cognitive or developmental challenges. There is also a lack of comparative research assessing whether AI can reduce the learning gap between students with and without disabilities.

This gap in the literature is particularly evident in the Indian context, where cultural, linguistic, and infrastructural factors play a crucial role in shaping educational experiences.

This research seeks to address that gap by conducting a comparative study on the effectiveness of AI in bridging learning gaps between children with and without learning disabilities. The study focuses on three core academic domains reading, writing, speaking and numeracy, which are often the most affected in children with LD. By using AI-based instructional tools and measuring pre- and post-intervention performance, the study aims to evaluate whether these tools can significantly improve the academic achievement of children with learning disabilities and bring their performance closer to that of their typically developing peers.

The study also examines how AI tools can be integrated into multilingual learning environments, specifically targeting students learning in Malayalam, English, and Hindi. This aspect is particularly relevant given India's linguistic diversity and the need for inclusive solutions that accommodate regional and national languages. By assessing students' progress across multiple languages and skill areas, the study offers a comprehensive understanding of the role AI can play in inclusive, language-rich educational settings.

Furthermore, the research incorporates observational checklists and student feedback surveys to assess non-academic outcomes such as engagement, motivation, and confidence—factors that are critical to sustained academic success. The use of multiple data sources ensures that the analysis captures both quantitative gains in test scores and qualitative improvements in learning experiences.

It is also worth noting that the AI tools selected for this intervention are free and user-friendly, ensuring that they can be easily adopted by schools and educators with limited technical expertise or financial resources. This aligns with the goals of sustainable and scalable educational innovation, especially in public education systems.

Hence, the integration of Artificial Intelligence into the learning environment presents a unique and timely opportunity to address the educational challenges faced by

children with learning disabilities. By offering personalized instruction, continuous assessment, and adaptive support, AI tools can help reduce the academic gap between these students and their peers. However, for this potential to be realized, it is essential to generate empirical evidence on the effectiveness of such interventions in real classroom settings. This study aims to contribute to that evidence base and to the broader goal of making education more inclusive, equitable, and effective for all learners.

1.2 Statement of the problem:

A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ARTIFICIAL INTELLIGENCE IN BRIDGING LEARNING GAPS BETWEEN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES

This study investigates the effectiveness of Artificial Intelligence (AI) in reducing academic performance gaps between children with learning disabilities and their typically developing peers. Focusing on core skill areas such as reading, writing, speaking and numeracy, the research applies AI-integrated teaching methods to a group of students with learning disabilities and compares their outcomes to those of non-disabled students. The study aims to determine whether AI tools can personalize learning, enhance engagement, and improve achievement. By evaluating pre- and post-test performance, the research explores AI's potential to support inclusive education and promote equitable learning outcomes in diverse classroom settings.

1.3 Rationale of the Study

Inclusive education seeks to provide equitable learning opportunities for all students, including those with learning disabilities. However, in practice, many children with learning disabilities continue to lag behind their typically developing peers, particularly in foundational areas such as reading, writing, speaking and numeracy. Traditional instructional methods often fail to meet the diverse needs of these learners due to limitations in personalization, pacing, and adaptability. As a result, learning gaps remain a significant barrier to academic success and social inclusion for these students.

The rapid advancement of Artificial Intelligence (AI) in the field of education offers new possibilities for addressing these challenges. AI tools can deliver personalized, adaptive, and data-driven instruction that responds to individual learning needs. Such tools are especially promising for children with learning disabilities, who benefit from repeated practice, real-time feedback, and multisensory input. Despite this potential, there is a lack of empirical research examining the role of AI in bridging learning gaps in inclusive classrooms, particularly in the Indian context.

This study aims to fill that gap by evaluating whether AI-integrated teaching methods can significantly improve academic outcomes for students with learning disabilities, and whether these improvements help narrow the performance gap with their typically developing peers.

1.4 Operational Definition of Key Terms

1. Artificial Intelligence (AI): Refers to computer-based educational tools and systems that use machine learning, data analytics, and adaptive algorithms to provide personalized instruction, real-time feedback, and content adjustment based on student performance.
2. Learning Disabilities (LD): Neurodevelopment disorders that significantly affect a child's ability to acquire and use academic skills such as reading, writing, or mathematics, despite having average or above-average intelligence. In this study, LD includes conditions like dyslexia, dysgraphia, and dyscalculia.
3. Typically Developing Peers: Children who do not exhibit learning disabilities and progress through academic milestones at the expected age-appropriate level.
4. Learning Gaps: The measurable difference in academic performance, particularly in reading, writing, and numeracy, between students with learning disabilities and their typically developing peers.
5. AI-Integrated Teaching: A teaching approach that incorporates AI-based tools (such as adaptive learning apps, text-to-speech software, or intelligent tutoring systems) into the instructional process to enhance student learning outcomes.

1.5 Objectives of the Study

The study aims to investigate the role of Artificial Intelligence (AI) in bridging academic performance gaps between children with and without learning disabilities. The specific objectives are:

1. To assess and compare the academic performance of children with and without learning disabilities in reading, writing, and numeracy.
2. To evaluate the effectiveness of AI tools in improving the post-test academic performance of students with learning disabilities compared to their pre-test academic performance
3. To determine whether AI-based instruction reduces the learning gap between students with learning disabilities and their typically developing peers.
4. To examine the effect of AI-based instructional tools on the behavioral, cognitive, and emotional engagement of children with learning disability.

1.5 Hypothesis of the study

- **Null Hypotheses (H_0)**

- Null Hypothesis ($H0_1$): There is no significant difference in the academic performance (reading, writing, speaking and numeracy) between children with learning disabilities and those without learning disabilities.
- Null Hypothesis ($H0_2$): AI-integrated teaching methods do not significantly improve the academic performance of students with learning disabilities.
- Null Hypothesis ($H0_3$): AI-based instruction does not significantly reduce the learning gap between students with learning disabilities and their typically developing peers.
- Null Hypothesis (HO_4): The use of AI instructional tools does not significantly impact the behavioral, cognitive, or emotional engagement of children with learning disabilities.

- **Alternative Hypothesis (H1)**

- Alternative Hypothesis ($H1_1$): There is a significant difference in the academic performance (reading, writing, numeracy) between children with learning disabilities and those without learning disabilities.
- Alternative Hypothesis ($H1_2$): AI-integrated teaching methods significantly improve the academic performance of students with learning disabilities.
- Alternative Hypothesis ($H1_3$): AI-based instruction significantly reduces the learning gap between students with learning disabilities and their typically developing peers.
- Alternative Hypothesis ($H1_4$): The use of AI instructional tools significantly impacts the behavioral, cognitive, or emotional engagement of children with learning disabilities.

1.6 Delimitations of the Study:

This study is delimited to a specific context for focused and manageable research. It is conducted in a single school located in Kannur, Kerala, where Malayalam is the medium of instruction. The study specifically involves students of Class 10, generally aged around 15 years.

The research focuses on evaluating the effectiveness of AI tools in bridging learning gaps among children with and without learning disabilities within this group. Consequently, the findings may primarily reflect the experiences of this particular age group, linguistic medium and geographic location.

The study does not extend to students from other classes, age groups, schools, or regions, or to those studying in other language mediums. Limitations related to sample size, available resources, and time frame within the selected school may also affect the generalizability of the results to broader populations.

CHAPTER -2

REVIEW OF RELATED LITERATURE

2.1 Introduction

This chapter deals with the review of literature that is directly or indirectly related to the study proposed by the investigator. Resourceful information on the problem to be investigated is one of the most important steps in the planning of any research. Every piece of ongoing research needs to be connected with the work already done to attain overall relevance and purpose. The review of literature acts as a link between the studies already conducted in the field/area and the research proposed. There are mostly three stages in most of the reviews which are- finding relevant information, appraisal of relevant and contextual information and synthesizing and summarizing findings into a set of collective conclusions.

2.2 Review of Related Literature

Athanasios S. Drigas and Rodi-Eleni Ioannidou (2012) conducted a review-based research study in the field of Special Education at the Institute of Informatics and Telecommunications, NCSR Demokritos, Athens, Greece. The research is titled, "A Review on Artificial Intelligence in Special Education". This study presents an analytical overview of research conducted during the decade 2001–2010 that examined the role of Artificial Intelligence (AI) in supporting students with special educational needs, particularly those with learning difficulties or learning disabilities. The researchers focused on how AI tools have been applied in two main areas: diagnosis of learning disabilities and intervention strategies for academic improvement.

The authors adopted the definition of learning disabilities from the Individuals with Disabilities Education Act (IDEA), referring to disorders in basic psychological processes that affect a student's ability to read, write, speak, or perform mathematical tasks. The study highlights that AI applications such as expert systems, intelligent tutoring systems, and machine learning-based tools have increasingly been used to

support personalized education and real-time learner assessment. These AI-based educational approaches are designed to simulate expert human decision-making to aid in identifying learning challenges and delivering tailored instructional support.

The review concluded that Artificial Intelligence has a significant potential to bridge academic gaps for students with learning disabilities by offering timely interventions and differentiated instruction. The authors advocate for the increased integration of AI in inclusive education frameworks, emphasizing its value in both school and home learning environments. This work supports the notion that AI can transform special education by improving the quality of diagnosis, personalizing learning pathways, and ultimately promoting equity in academic achievement.

Rashi Kohli, Sparsh Phutela, Anchal Garg, and Mark Viner (2021) contributed a scholarly chapter titled "Artificial Intelligence Technology to Help Students With Disabilities: Promises and Implications for Teaching and Learning" in the Handbook of Research on Critical Issues in Special Education for School Rehabilitation Practices. This work investigates the promises of artificial intelligence (AI) in addressing the diverse learning needs of students with disabilities. The authors emphasize that with proper design and implementation, AI technology can be transformative in diagnosing learning difficulties, enhancing classroom instruction, and personalizing learning pathways.

The study explores existing AI applications, including Natural Language Processing (NLP), robotics, neural networks, and expert systems, and explains how they can support both teachers and students. These technologies aid in differentiating instruction, providing real-time feedback, and engaging learners in more interactive and adaptive educational environments. Of particular note is the way AI enables instructors to better identify academic gaps and apply targeted interventions, especially for learners with learning disabilities. The chapter also discusses AI's potential in facilitating inclusive practices by making education more accessible and responsive to individual student needs.

The authors conclude that the thoughtful integration of AI can significantly bridge learning gaps, especially for students with special educational needs, and promote a more equitable and effective educational system.

Prabal Datta Barua et al. (2022) conducted a comprehensive review titled "Artificial Intelligence Enabled Personalized Assistive Tools to Enhance Education of Children with Neurodevelopment Disorders—A Review." This study offers a wide-ranging analysis of the use of artificial intelligence (AI) and machine learning (ML) technologies in addressing learning challenges associated with neurodevelopment disorders (NDDs), such as ADHD, autism spectrum disorders (ASD), and specific learning disabilities including dyslexia.

The authors emphasize that AI-based interventions hold significant promise for enabling personalized learning strategies tailored to the cognitive and behavioral profiles of children with NDDs. By examining various AI-enabled tools—ranging from intelligent tutoring systems to emotion-aware learning platforms—the study highlights how these technologies support individualized diagnosis, improve learning engagement, and foster better educational outcomes. Notably, the review discusses how AI contributes to early identification and personalized interventions, thereby helping to bridge academic gaps for students struggling due to their disabilities.

A unique contribution of this review is its focus on the high co-morbidity of neurodevelopment and mental health disorders and how AI tools can support complex, multifaceted learning needs. The authors also explore socio-economic and environmental factors that affect the efficacy of these tools. They recommend the development of more inclusive, adaptive, and accessible AI systems that can dynamically respond to diverse learner profiles. Their findings underscore the need for a more robust, ethical, and user-centered approach in future AI development to support children with NDDs in educational contexts.

Sinan Hopcan, Elif Polat, Mehmet Emin Ozturk, and Lutfi Ozturk (2022) conducted a systematic review titled "Artificial Intelligence in Special Education: A Systematic Review" to explore recent trends, developments, and implications of AI in special education. Drawing upon 29 peer-reviewed studies published between 2008 and 2020, this review presents a comprehensive analysis of how artificial intelligence has been applied to support learners with disabilities in diverse educational contexts.

The findings indicate a growing prevalence of AI technologies, particularly software-based applications, in enhancing cognitive and affective skill development for

students with special educational needs. Notably, the review highlights a strong focus on supporting learners with autism spectrum disorders (ASD), suggesting that AI's role has been most prominent in this domain. The tools evaluated across studies often incorporate technical models like Artificial Neural Networks (ANN) and Support Vector Machines (SVM), emphasizing data-driven decision-making and personalized learning experiences. Despite the increasing technological sophistication, the authors point out a relative underrepresentation of educational models that integrate pedagogical frameworks alongside technical designs.

This review is significant to the discourse on academic gap reduction, as it provides evidence that AI-based approach though still evolving—can effectively cater to the diverse needs of learners with disabilities. However, the authors caution that while technological advances are promising, future developments must incorporate educational theory and teacher feedback to ensure that AI tools are not only efficient but also pedagogically sound and inclusive. The study concludes with strategic recommendations for improving AI integration in special education, including more interdisciplinary collaboration and emphasis on holistic learner development.

Matthew T. Marino, Eleazar Vasquez, and Jose Blackorby (2023) explore the evolving role of artificial intelligence (AI) in special education through their article "The Future of Artificial Intelligence in Special Education Technology." This conceptual discussion evaluates the potential of AI as a transformative, disruptive force within special education, offering both current observations and future projections based on early-stage evidence and theoretical insights.

The authors outline AI's developmental milestones—ranging from Alan Turing's early contributions to the emergence of deep learning—and contextualize them in relation to modern applications for individuals with disabilities. AI-based assistive technologies such as speech-to-text, voice recognition, and personalized tutoring systems are discussed as powerful tools for increasing accessibility, enhancing individualized instruction, and improving learning outcomes. Several tools, such as AI-based assessment platforms and adaptive tutoring systems (e.g., TutorAI, EducationCopilot), are cited as promising interventions that could support both students and educators.

While acknowledging the potential of AI to deliver real-time feedback and customized educational experiences for learners with physical, cognitive, and sensory impairments, the authors emphasize the need for caution. They stress that ethical considerations, teacher training, and data privacy must be integrated into AI policy and implementation frameworks. Furthermore, they advocate for substantial empirical research to examine the actual efficacy of AI-based tools before fully integrating them into educational systems.

This article is particularly relevant to the academic gap discourse, as it presents AI as a dual-purpose solution: enabling individualized learning pathways for students with disabilities while supporting educators in making data-driven instructional decisions. Its forward-looking approach provides valuable insight into how AI might shift traditional special education paradigms and assist in minimizing disparities in learning achievement.

Yolanda Mpu (2023) conducted a comprehensive literature review titled Bridging the Knowledge Gap on Special Needs Learner Support: The Use of Artificial Intelligence (AI) to Combat Digital Divide Post-COVID-19 Pandemic and beyond. The study explores how AI technologies—such as intelligent tutoring systems, speech recognition tools, and wearable devices—can personalize learning for special needs learners by adapting content, pace, and assessment methods. Mpu emphasizes that despite the growing use of AI in education, learners with disabilities are still underrepresented in research. The paper also highlights the widening digital divide post-pandemic and the need for inclusive, accessible learning environments supported by AI. Ethical concerns, data bias, and privacy issues are noted as limitations. The study advocates for equity, representation in datasets, and policy frameworks to support AI integration in special education.

Vered Vaknin-Nusbaum and Israel Rachevski (2023) conducted a study titled perpetuating the Gaps: 21st-Century Skills in Students with Learning Disabilities and Their Typically Developing Peers to examine differences in 21st-century skills among students with learning disabilities (LD) and their typically developing peers. The research explored whether these gaps differ across educational stages—high school and postsecondary. Results showed that postsecondary students, regardless of learner

type, reported higher self-assessed 21st-century skills than high school students. However, students with LD consistently scored lower in most skill areas compared to their peers. Notably, the skill gap widened over time, especially during the transition to higher education, indicating that some 21st-century competencies develop unevenly. The study highlights the need for inclusive educational strategies to cultivate essential skills for lifelong learning and workforce integration, especially among learners with disabilities.

Sahrish Panjwani-Charania and Xiaoming Zhai (2023) conducted a systematic review to explore the use of Artificial Intelligence (AI) in supporting students with learning disabilities (SWLDs). Among 16 reviewed studies, most focused on dyslexia, with limited research on dyscalculia and broader learning disabilities. Only half the studies targeted school-age children. The review identified seven AI applications—adaptive learning (most common), chat bots, facial expression analysis, communication aids, intelligent tutors, interactive robots, and mastery learning. Using the SAMR-LD model (Substitute, Augment, Modify, Redefine), the authors classified the integration levels of AI tools, noting most fell within substitution and augmentation categories. The findings highlight AI's potential to enhance learning experiences for SWLDs, but also underscore a significant research gap. Most studies concentrate on identifying disabilities rather than offering sustained educational interventions. The study calls for more empirical research to explore AI's broader, long-term role in inclusive education.

Johny Daniel (2023) investigates the persistent academic achievement gap between students with special educational needs and disabilities (SEND) and their typically developing peers in England. Drawing on data from the National Pupil Database, the study analyzed academic performance in reading, writing, and mathematics among approximately 2.5 million Year 6 students across four academic years. The research highlights significant and consistent achievement gaps, with the most pronounced deficits observed in students with intellectual disabilities. While some variation existed across different SEND categories, the overall trend showed that all SEND groups underperformed compared to their peers. Furthermore, these achievement gaps have widened over time despite existing legislative efforts to support inclusive education. The study emphasizes the urgent need to reassess current educational

policies and practices to ensure that students with SEND receive more effective support to bridge these enduring academic disparities.

R. Krishna Kumari (2024) explores the transformative potential of Artificial Intelligence (AI) in Special Education (SE), focusing on how AI can enhance learning outcomes for students with disabilities. The chapter highlights key areas where AI contributes—personalized learning, early detection of learning disabilities, and improved communication among stakeholders. AI tools can tailor instruction to individual student needs and analyze performance data to identify learning difficulties early, enabling timely interventions. The chapter also discusses ethical concerns, such as data privacy and algorithmic bias, emphasizing the need for fairness and human oversight. While AI cannot replace the empathy of human educators, it can augment teaching and support inclusive practices. Through case studies and practical insights, the work offers guidance for educators and policymakers to responsibly integrate AI into SE settings. Ultimately, it aims to empower stakeholders to leverage AI for equitable and effective education for students with disabilities.

Abdulaziz S. Alsolami (2024) investigated the effectiveness of artificial intelligence (AI) in enhancing academic skills among Saudi school-aged boys with mild intellectual disabilities (ID). Seventy students aged 9–12 were divided into experimental and control groups. The experimental group received AI-assisted instruction over ten sessions, while the control group followed the standard special education curriculum. Assessment was conducted using the Woodcock-Johnson IV test before, after, and one month post-intervention. The AI-assisted group showed significant improvements in reading and math skills, with moderate to large effect sizes (η^2 = 0.685–0.921). These gains persisted at follow-up, highlighting AI's potential in personalizing instruction and addressing learning challenges in students with ID. The study emphasized the importance of integrating AI tools within the "whole child" educational framework and called for future research to explore long-term and broader applications of AI for inclusive education across diverse learning environments.

Chalkiadakis et al. (2024) conducted a systematic review exploring the impact of Artificial Intelligence (AI) and Virtual Reality (VR) on educational inclusion for

students with disabilities. Grounded in the principles of the UN Convention on the Rights of Persons with Disabilities (CRPD), the review highlights how AI-driven adaptive systems can personalize learning by analyzing individual needs, while VR offers immersive environments that enhance experiential learning. These technologies hold promise to improve educational accessibility, engagement, and social inclusion for learners with physical, cognitive, sensory, and intellectual disabilities.

Despite the potential benefits, the review identifies several barriers to widespread adoption, such as high costs, technical challenges, and insufficient teacher training. Ethical issues, including privacy concerns and algorithmic bias, also require careful attention. The authors emphasize that AI and VR should be integrated thoughtfully within existing education systems to create equitable and inclusive learning environments. They advocate for further empirical research on the long-term effects and call for equitable access to these technologies, especially in underserved communities. Ultimately, the review underscores AI and VR as essential tools for transforming education to meet the diverse needs of all students and advance inclusive education globally.

Zhang et al. (2024) conducted the first meta-analysis to examine the effects of AI-based interventions on learning outcomes for students with disabilities (SWDs) in pre-K–12 education. Drawing on 29 quasi-experimental studies worldwide, the research reports a moderate positive effect (Hedges' g = 0.588) of AI tools—including robots, computer software, and intelligent VR systems—on SWDs' academic and social-emotional development. The study uniquely applies Cultural-Historical Activity Theory (CHAT) as a framework to analyze the complex interactions between AI tools, learners, and stakeholders such as educators and families. Despite identifying no statistically significant moderators, the authors emphasize the sociocultural context of disabilities and advocate for AI systems that promote agency and active participation of SWDs rather than a deficit-based approach. The review highlights the interdisciplinary nature of AI, its growing capabilities in natural language processing, computer vision, and machine learning, and its transformative potential for personalized and inclusive education. Finally, the study calls for more rigorous research to ensure AI tools not only enhance accessibility but also empower SWDs to contribute meaningfully in AI-mediated learning environments.

In conclusion the integration of artificial intelligence (AI) and assistive technologies has shown promising potential in addressing the unique learning needs of children with disabilities. Studies reviewed reveal that AI-driven interventions can significantly improve cognitive, emotional, and behavioral engagement, particularly through personalized learning, adaptive feedback, and interactive support. Technologies such as socially assistive robots, virtual reality, and AI-based diagnostic tools have demonstrated benefits across various disability categories—including learning, sensory, physical, intellectual, and behavioral challenges. Despite these advancements, several critical research gaps remain. Many existing studies are limited in scope, often focusing on specific disabilities or conducted in controlled settings with small sample sizes. There is also a lack of longitudinal research to assess long-term impacts, and limited exploration of real-world classroom integration. Additionally, ethical concerns around accessibility, equity, and data privacy are underexplored in practical application. This highlights the urgent need for inclusive, large-scale, and interdisciplinary research that bridges these gaps. Understanding the full impact of AI tools on engagement and learning outcomes is crucial for developing effective, equitable, and scalable educational interventions. Therefore, future research should prioritize user-centered design, inclusive testing environments, and cross-curricular implementation to ensure that AI technologies truly enhance the educational experiences of all learners, especially those with special needs.

CHAPTER – 3

RESEARCH METHODOLOGY

3.1 Introduction

The present chapter is devoted to the description of the methodology given in the present study. In this chapter, the discussion will be in detail about the variables, population, sample, tool used for collecting the data, steps for tool construction, the procedure of the data collection, and statistical techniques used for the given study.

3.2 research design

The present study adopts a quasi-experimental research design with a pre-test and post-test comparison. This design is chosen to evaluate the effectiveness of Artificial Intelligence (AI)-integrated instruction in bridging learning gaps between children with and without learning disabilities.

The study involves two groups:

- An experimental group consisting of students with learning disabilities who receive AI-based teaching intervention.
- A comparison group consisting of typically developing peers whose pre-test scores is used as a benchmark.

Academic performance in four areas—reading, writing, speaking and numeracy—is measured using standardized tools both before and after the intervention for the experimental group. The comparison group is assessed only during the pre-test phase to establish the initial performance gap.

This design enables the researcher to determine whether there is a significant improvement in the academic achievement of children with learning disabilities after the AI intervention, and whether the gap between the two groups has been reduced. The quasi-experimental approach is suitable for educational settings where random

assignment is not feasible, but where group comparisons can still yield meaningful insights into intervention effectiveness.

3.3 Research Methods

The present study employs a quantitative research method to examine the effectiveness of Artificial Intelligence (AI) in bridging learning gaps between children with and without learning disabilities. The method involves the collection and analysis of numerical data obtained through standardized tests administered before and after the intervention.

The quasi-experimental method used in this study includes a pre-test and post-test design applied to the experimental group (students with learning disabilities). The scores of a comparison group (typically developing students) are used to evaluate the extent of the learning gap and to measure the relative improvement of the experimental group after the AI intervention.

This method allows for objective measurement of academic performance in four core skill areas: reading, writing, speaking and numeracy. It also provides a framework to statistically analyze the impact of AI-based instruction on learners with disabilities, using tools such as t-tests to determine the significance of observed differences.

By applying a structured and systematic research approach, the study aims to generate reliable and valid conclusions regarding the role of AI in enhancing educational outcomes in inclusive classroom settings.

3.4 Population

The population for the present study consists of students aged 15 years who are enrolled in mainstream schools located in the Kannur district of Kerala. This population includes both students with learning disabilities and their typically developing peers. The study focuses on this age group as it represents a crucial stage in the academic journey where foundational skills in reading, writing, speaking and numeracy are expected to be well established. Selecting students from mainstream schools ensures that the learning environment reflects inclusive educational practices

and allows for a meaningful comparison between students with and without learning disabilities within the same academic context.

3.5 Sample

The sample for the present study consists of 20 students aged 15 years, selected from mainstream schools in the Kannur district of Kerala. The sample was purposefully chosen to include students with and without learning disabilities, allowing for a comparative analysis of academic performance before and after the intervention.

Among the 20 students:

- 10 students identified with learning disabilities formed the experimental group, who received instruction through AI-integrated learning tools.
- 10 typically developing students served as the comparison group, and their pre-test scores were used to measure the initial academic gap.

The selection was guided by the objective of the study—to explore the effectiveness of Artificial Intelligence in reducing learning disparities. All participants were chosen in consultation with school authorities, based on academic records, teacher recommendations, and observed learning difficulties in reading, writing, speaking or numeracy. This focused sampling ensures that the study addresses its aim with relevance and precision.

3.6 Sampling

The present study employed a purposive sampling technique, a form of non-probability sampling that involves selecting participants based on predefined characteristics relevant to the research objectives. This method was chosen to ensure the inclusion of students who specifically fit the criteria of having learning disabilities, as well as their typically developing peers for comparison.

A total of 20 students, aged 15 years and enrolled in mainstream schools in the Kannur district of Kerala, were selected as the sample. Among them:

- 10 students with learning disabilities constituted the experimental group, who received instruction through AI-integrated tools.
- 10 typically developing students formed the comparison group, whose pre-test academic scores served as a reference point for evaluating the performance gap.

The purposive sampling method was deemed appropriate for this study, as it allowed the researcher to target individuals directly relevant to the investigation, thereby ensuring the validity and focus of the study outcomes.

3.7 Tools Used

The following tools were developed and employed in the present study to collect data and measure the effectiveness of Artificial Intelligence (AI) in bridging learning gaps between children with and without learning disabilities:

a) Numeracy Test (Operations and Reasoning)

A teacher-made test was constructed to assess basic mathematical operations—addition, subtraction, multiplication, and divisionand reasoning ability. The test was adapted to suit the learning level of students with disabilities, with simple and age-appropriate word problems. The total marks were 25, and the test duration was 45 minutes.

b) Literacy Assessment

The literacy component was assessed through three skill areas:

- Reading: Simple reading passages were given in Malayalam, English, and Hindi to evaluate fluency and comprehension.
- Writing: Students were asked to write a short paragraph about “The Most Memorable Day of My Life” in all three languages.
- Speaking: Students were asked to introduce themselves in Malayalam, English, and Hindi to assess oral expression and language confidence.

c) Observation Checklist

A structured observation checklist was used to assess behavioral, cognitive, and emotional engagement, as well as overall improvement. It consisted of 15 statements rated on a 5-point Likert scale ranging from 1 (Never) to 5 (Always).

Each tool was carefully aligned with the objectives of the study and designed to provide both quantitative and qualitative insights into the impact of AI-assisted instruction.

3.8 Procedure of Data Collection

The data collection process began with the researcher visiting mainstream schools in Kannur district, Kerala, and obtaining formal permission from the school authorities to conduct the study. Once approval was granted, students aged 15 years were selected using purposive sampling. The final sample consisted of 20 students—10 students identified with learning disabilities (experimental group) and 10 typically developing peers (comparison group). A pre-test was administered to both groups to assess their academic performance in reading, writing, speaking and numeracy using teacher-made tools adapted from the WIAT-III framework. Following the pre-test, the experimental group received instruction through AI-integrated learning tools designed to support foundational skills. This intervention took place over a specific period during regular school hours. During the sessions, the researcher used an observation checklist to record students' behavioral, cognitive, and emotional engagement. After the completion of the intervention, a post-test was administered to the experimental group using the same academic tools to evaluate improvement. This systematic procedure enabled a comprehensive assessment of both academic gains and the effectiveness of AI-assisted instruction.

CHAPTER – 4

DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

The present chapter focuses mainly on the analysis and interpretation of the data that was collected for the study. Data analysis is the process of inspecting, cleansing, transforming, and modeling data with the goal of discovering useful information, informing conclusions, and supporting decision-making.

4.2 Analysis of the Data

Data is a collected form of facts for extracting factual information from the set of raw data. Analysis of data in a structured and systematic procedure of categorizing, arranging, ordering, and summarizing the data to discover facts and for getting answers related to the research purpose. The basic purpose of data analysis is to reduce data into a simple and interpretable form so that inferences may be drawn from it (Kothari, 2004). Analysis and interpretation of data are helpful in knowing the relationship between the variables and drawing appropriate conclusions. Data analysis is the process of breaking the data into smaller parts to extract useful information for forecasting the outcomes. Careful analysis with the help of appropriate statistical techniques leads to better prediction and accurate assessment. Therefore, data analysis is an important step that involves a whole composite procedure for assessing data utilizing appropriate descriptive and inferential statistics.

4.3 Objective-wise Analysis, Interpretation and Discussion of Result

To facilitate and bring clarity, the entire analysis is presented and the result based on it is discussed under the following sections.

4.3.1 OBJECTIVE-1: To assess and compare the academic performance of children with and without learning disabilities in reading, writing, speaking and numeracy.

Analysis of Pre-Test Scores: Normal vs. LD Students:- To investigate the initial academic gap between students with and without learning disabilities, an independent samples t-test was conducted using the pre-test total scores of both groups. The test compared the means of normal students (Group 1) and students with learning disabilities (Group 2) to determine if there was a statistically significant difference at the beginning of the study.

Table 4.1 Pre-Test Total Scores of Students With and Without Learning Disability

Total scores of students without learning disability(pre-test)	44	44	43	44	43	42	43	43	44	44
Total scores of students with learning disability(pre-test)	12	12	12	12	12	14	14	14	14	14

Table 4.2 T-Test Analysis of Pre-Test Scores of both the Groups

	Normal Students	**LD Students**
Mean	43.33333	13.11111
Variance	0.5	1.111111
Observations	10	10
Hypothesized Mean Difference	0	
df	14	
t Stat	71.4307	
P(T<=t) one-tail	1.2E-19	
t Critical one-tail	1.76131	
P(T<=t) two-tail	2.41E-19	
t Critical two-tail	2.144787	

Interpretation

- The mean pre-test score of normal students (M = 43.33) was substantially higher than that of students with learning disabilities (M = 13.11).
- The t-statistic value of 71.43 far exceeds the critical value of 2.14, indicating a highly significant difference between the two groups.
- The p-value (two-tailed) = 2.41×10^{-19} is far below 0.05, confirming that the difference in means is statistically significant.

These results clearly show that before the AI-based intervention, there was a significant academic performance gap between students with learning disabilities and their typically developing peers.

Table 4.3 Mean Score of both the Groups

group	Mean score
Normal students	43.33
LD students	13.11

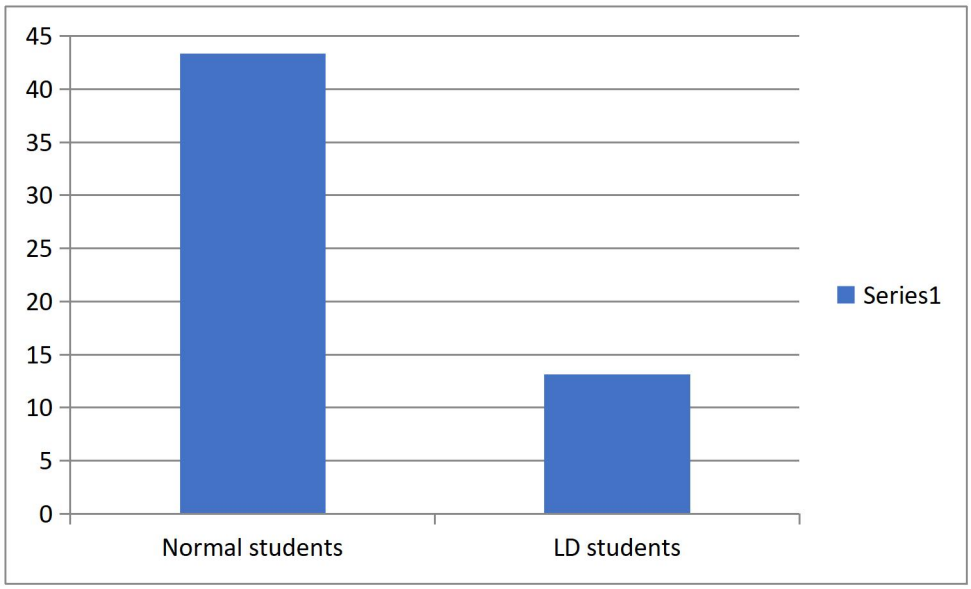

Figure 4.1: Mean Comparison of Pre-Test Scores of Normal Students and LD Students

Findings;-

The statistical analysis confirms the presence of a substantial and statistically significant academic performance gap between students with and without learning disabilities at the pre-test level. This validates the need for targeted interventions, such as AI-integrated teaching, to help bridge this gap and promote educational equity.

4.3.2 OBJECTIVE-2: To evaluate the effectiveness of AI tools in improving the post-test academic performance of students with learning disabilities compared to their pre-test academic performance

Analysis of LD Students (Pre-Test) vs. LD Students (Post-Test);-

To assess the improvement in academic performance among students with learning disabilities (LD) following the AI-based intervention, an independent samples t-test was conducted between their pre-test and post-test scores**.**

Table 4.4 Pre-Test and post-test total scores of students with learning disability

Total scores of students with learning disability(pre-test)	12	12	12	12	12	14	14	14	14	14
Total scores of students with learning disability(post-test)	28	28	28	28	28	30	30	30	30	30

Table 4.5 t-test analysis of pre-test and post-test scores of LD students

	Pre-test (LD)	*Post-test(LD)*
Mean	13.11111	29.11111
Variance	1.111111	1.111111
Observations	10	10
Pooled Variance	1.111111	
Hypothesized Mean Difference	0	
df	16	
t Stat	-32.1994	
P(T<=t) one-tail	2.81E-16	
t Critical one-tail	1.745884	
P(T<=t) two-tail	5.63E-16	
t Critical two-tail	2.119905	

Interpretation

- The post-test mean score of LD students increased significantly to 29.11, compared to a pre-test mean of 13.11. This 16-point gain reflects a marked improvement in academic performance after the implementation of the AI-based teaching strategy.
- The calculated t-statistic is -32.20, which far exceeds the critical t-value of ±2.12, indicating a highly significant difference.
- Additionally, the two-tailed p-value is 5.63×10^{-16}, well below the conventional alpha level of 0.05, confirming that this improvement is statistically significant and unlikely due to chance.

Table 4.6 Means Score of the LD Students

	Mean score
Pre-test	13.11
Post- test	29.1

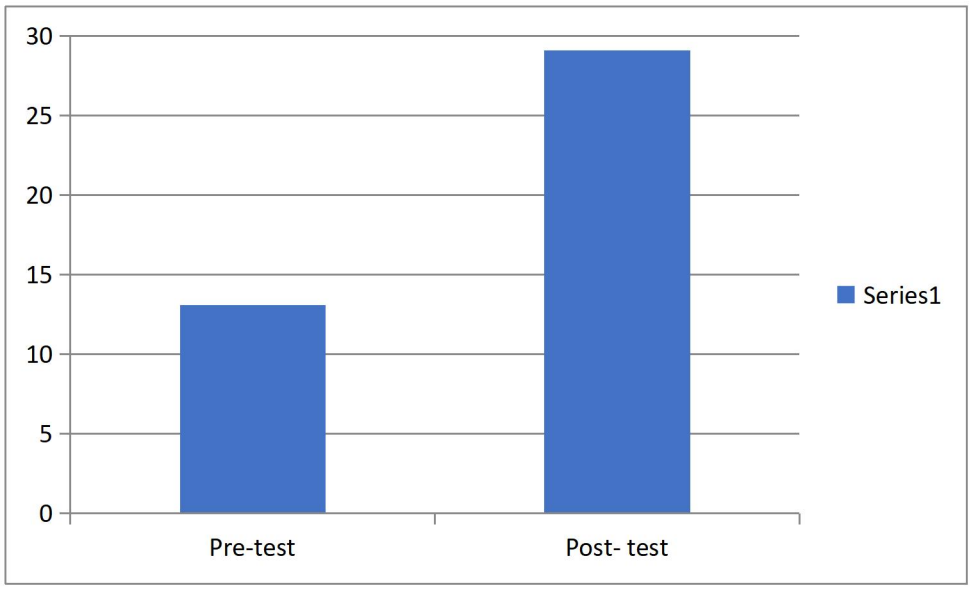

Figure 4.2: Mean Comparison of Pre-Test and Post-Test Scores of LD Students

Findings:-

The results show a statistically and educationally significant improvement in the academic performance of students with learning disabilities after the AI-based intervention. The mean score nearly doubled, rising from 13.11 to 29.11. This finding strongly suggests that the AI-supported learning strategy was effective in enhancing academic outcomes for LD students and holds promise as a supportive tool in inclusive education settings.

4.3.3 OBJECTIVE-3: To determine whether AI-based instruction reduces the learning gap between students with learning disabilities and their typically developing peers.

Analysis of Normal Students (Pre-Test) vs. LD Students (Post-Test):-

To evaluate the effectiveness of the AI-based intervention in reducing the academic performance gap, an independent samples t-test was conducted between the pre-test scores of normal students and the post-test scores of students with learning disabilities.

Table 4.7 Pre-Test total Scores of Students Without Learning Disability and Post-Test Score of Students With Learning Disability

Total scores of students without learning disability(pre-test)	44	44	43	44	43	42	43	43	44	44
Total scores of students with learning disability(post-test)	28	28	28	28	28	30	30	30	30	30

Table 4.8 T-Test Analysis of Pre-Test Scores of Normal Students and Post-Test Scores of Students With Learning Disability

	44	*28*
Mean	43.33333	29.11111
Variance	0.5	1.111111
Observations	10	10
Hypothesized Mean Difference	0	
df	14	
t Stat	33.61445	
P(T<=t) one-tail	4.33E-15	
t Critical one-tail	1.76131	
P(T<=t) two-tail	8.66E-15	
t Critical two-tail	2.144787	

Interpretation

- The mean score of LD students after AI intervention increased to 29.11, up from 13.11 in the earlier pre-test.
- The performance gap between LD and normal students narrowed from a 30-point difference to a 14-point difference**.**
- However, the t-statistic (33.61) is still much larger than the critical value (2.14)**.**
- The p-value = 8.66×10^{-15} is far below 0.05, indicating the difference between the groups is still statistically significant**.**

Table 4.9 Mean Score of Normal Students (Pre-Test) Vs. LD Students (Post-Test)

group	Mean score
Normal students	43.33
LD students	29.11

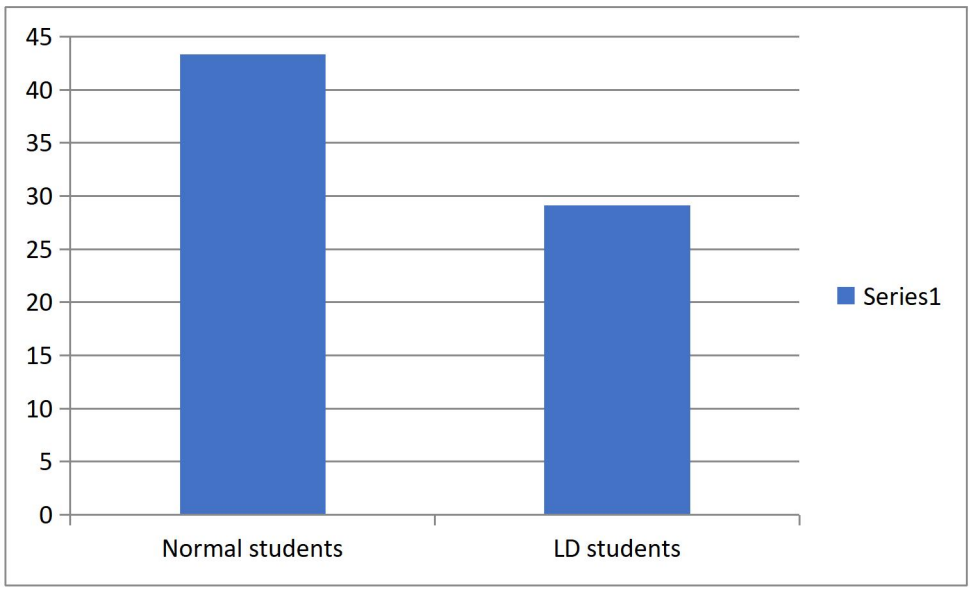

Figure 4.3: Mean Comparison of Pre-Test Scores of normal students and post-test scores of LD students

Findings:-

Although the difference between the two groups remains statistically significant, the results indicate a substantial improvement in the academic performance of students with learning disabilities following the AI intervention. The mean post-test score of LD students rose from 13.11 to 29.11, suggesting that the AI-based teaching strategy was effective in partially closing the learning gap. These findings support the potential of AI as a beneficial tool in inclusive education.

4.3.2 OBJECTIVE- 4: To examine the effect of AI-based instructional tools on the behavioral, cognitive, and emotional engagement of children with learning disabilities in comparison to traditional teaching methods.

A) Behavioral Engagement

QUESTION NO. 1: The student shows consistent interest in interacting with AI tools.

Table 4.10 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
50%	40%	10%	0%	0%

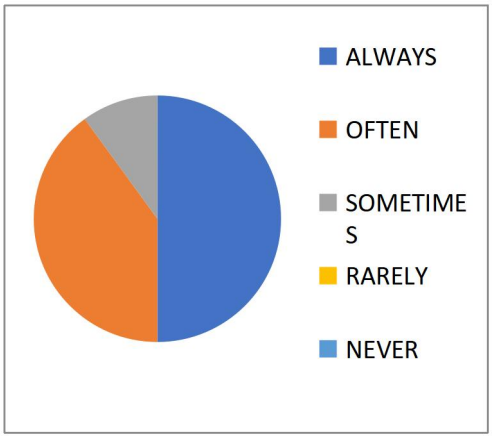

Figure 4

QUESTION NO. 2 : The student actively participates in AI-based learning activities.

Table 4.11observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
40%	30%	30%	0%	0%

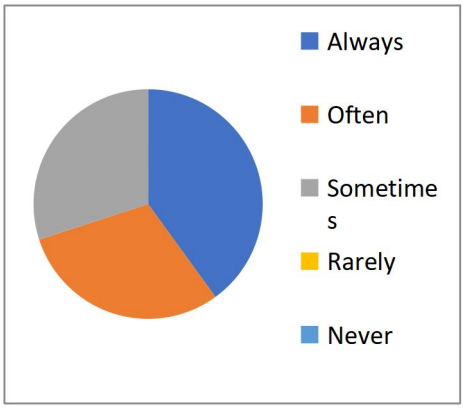

Figure 5

QUESTION NO. 3: The student seeks help or clarification when facing difficulties with AI tools.

Table 4.12 observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
40%	40%	20%	0%	0%

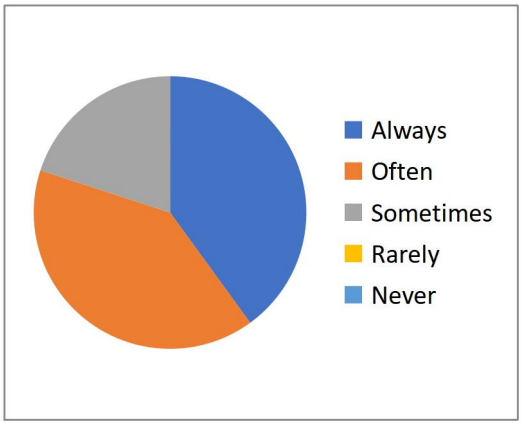

Figure 6

QUESTION NO. 4: The student maintains focus and concentration during AI-assisted sessions.

Table 4.13 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
20%	70%	10%	0%	0%

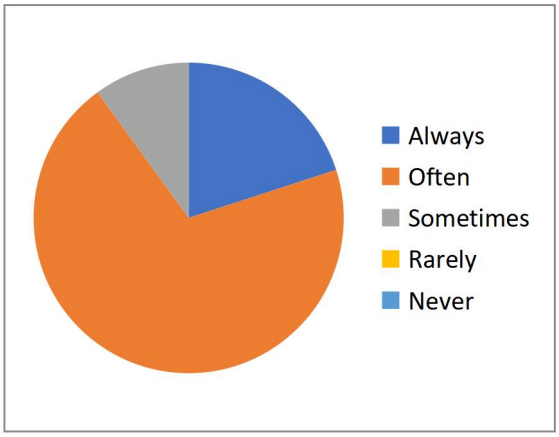

Figure 7

B) Cognitive Engagement

QUESTION NO. 5: The student demonstrates understanding of concepts introduced through AI tools.

Table 4.14 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
20%	80%	0%	0%	0%

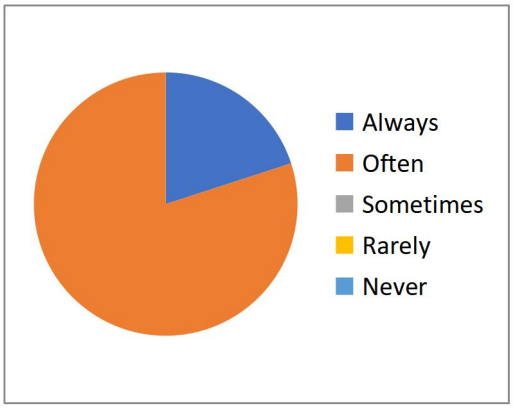

Figure 8

QUESTION NO. 6: The student applies learned skills and knowledge to other tasks effectively.

Table 4.15 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
0%	0%	50%	50%	0%

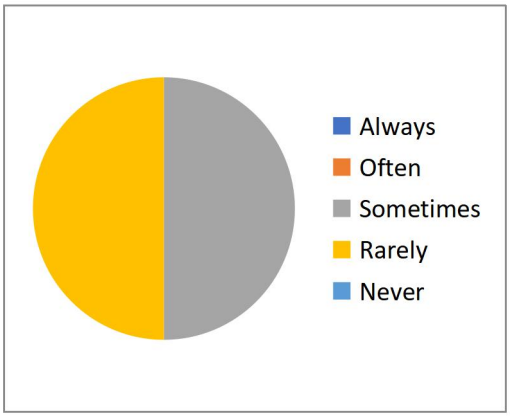

Figure 9

QUESTION NO. 7: The student accurately responds to AI-generated questions and exercises.

Table 4.16 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
10%	40%	30%	20%	0%

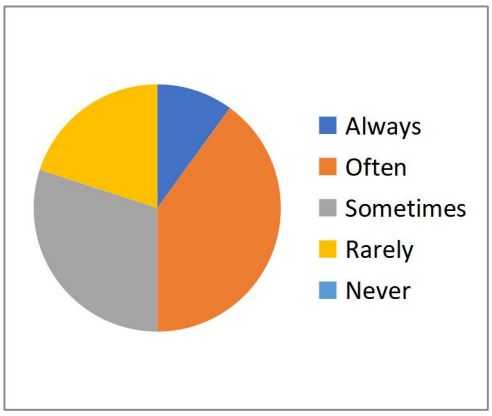

Figure 10

QUESTION NO. 8: The student completes tasks independently with minimal guidance.

Table 4.17 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
0%	50%	50%	0%	0%

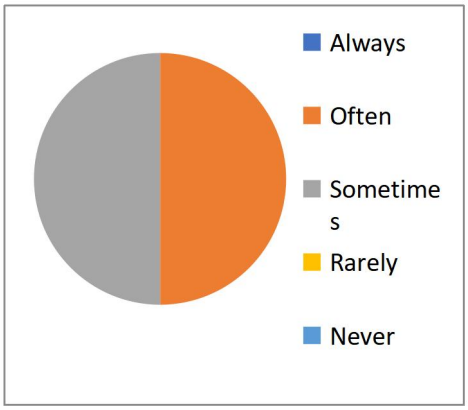

Figure 11

C) Emotional Engagement

QUESTION NO. 9: The student shows enthusiasm and enjoyment while using AI tools.

Table 4.18 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
50%	50%	0%	0%	0%

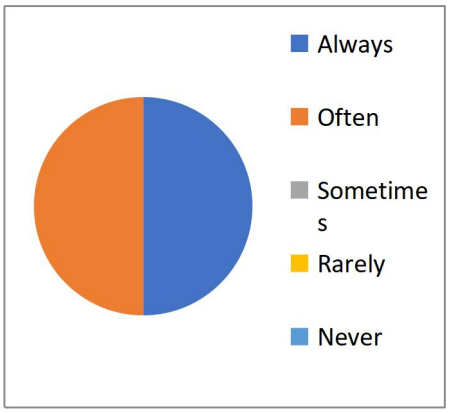

Figure 12

QUESTION NO. 10: The student expresses satisfaction or pride upon successfully completing activities.

Table 4.19 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
10%	70%	20%	0%	0%

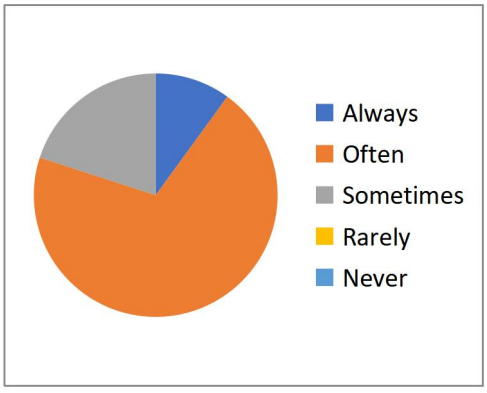

Figure 13

QUESTION NO. 11: The student displays reduced frustration and anxiety during AI-assisted learning.

Table 4.20 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
0%	50%	50%	0%	0%

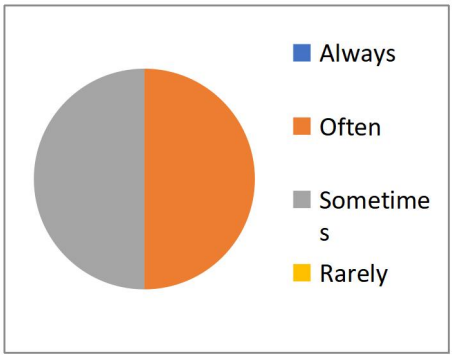

Figure 14

QUESTION NO.12: The student maintains a positive attitude towards AI-based learning activities.

Table 4.21 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
100%	0%	0%	0%	0%

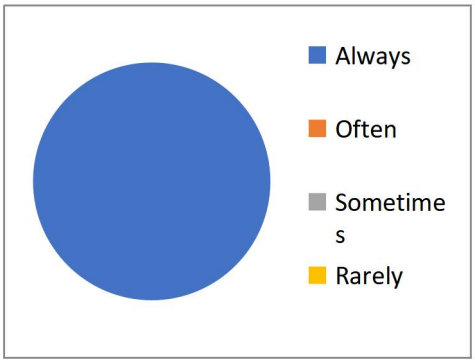

Figure 15

D) Overall Improvement

QUESTION NO. 13: The student shows noticeable improvement in overall language skills across all languages and in numeracy.

Table 4.22 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
0%	100%	0%	0%	0%

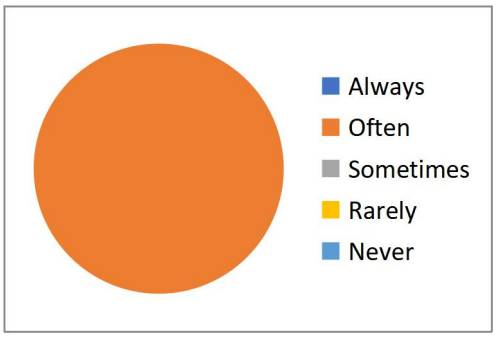

Figure 16

QUESTION NO. 14: The student demonstrates a consistent improvement in engagement and participation.

Table 4.23 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
20%	50%	30%	0%	0%

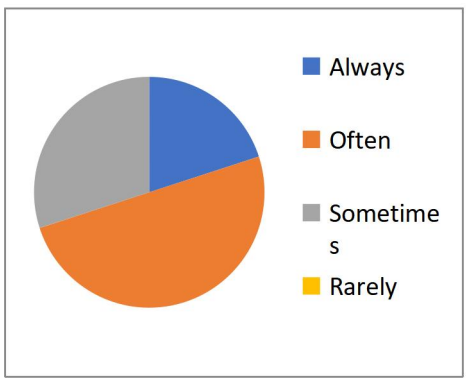

Figure 17

QUESTION NO. 15: The student's achievement level has increased as a result of AI-integrated teaching.

Table 4.24 Observations

Marks in percentage				
Always	Often	Sometimes	Rarely	Never
100%	0%	0%	0%	0%

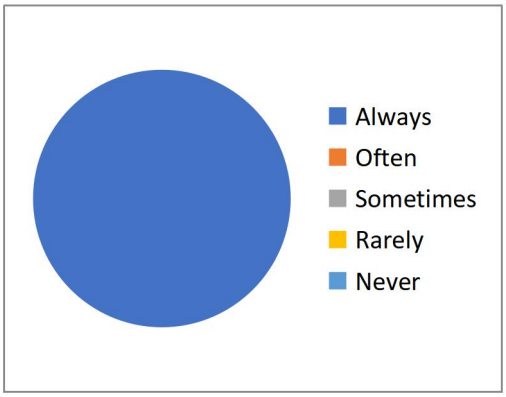

Figure 18

Findings:-

The analysis of the observation checklist revealed positive outcomes across behavioral, cognitive, emotional, and overall improvement domains among students with learning disabilities following AI-integrated instruction. In the **behavioral engagement** domain, students showed consistent interest and active participation, with most scoring "always" or "often" in maintaining focus and seeking help when needed. This reflects high attentiveness and involvement during AI sessions.

Cognitive engagement showed mixed responses. While most students understood the concepts presented by the AI tools, fewer were able to independently apply this knowledge or respond accurately to AI-generated tasks. This suggests that while comprehension was achieved, the ability to transfer learning still requires reinforcement.

In contrast, **emotional engagement** was remarkably strong. All students expressed enthusiasm, enjoyment, and satisfaction during learning, and none showed signs of

anxiety or frustration. A positive attitude was consistently observed, highlighting the emotionally supportive nature of AI-based learning.

In terms of **overall improvement**, all students demonstrated visible academic growth, with increased engagement and performance in literacy and numeracy. The AI tools evidently played a significant role in bridging learning gaps, not only academically but also by enhancing student motivation, confidence, and participation.

CHAPTER-5

SUMMARY, FINDINGS AND CONCLUSION

5.1 Introduction

The investigator arrives at this stage after a rigorous exercise of analyzing the data and providing insight to make objectives more high-yielding and significant. The writing of research findings is usually the concluding task of a research endeavor. Research is directed towards the goal of discovering new knowledge which can contribute to the expansion of the ocean of knowledge.

5.2 Summary of the Study

Education is the cornerstone of personal and societal development, and equitable access to quality education remains a primary goal of inclusive schooling. However, children with learning disabilities often experience significant challenges in achieving educational outcomes equivalent to their typically developing peers. These challenges include difficulties in reading, writing, numeracy, language comprehension, and classroom participation. Traditional methods of teaching, although effective for many learners, often fall short in addressing the unique needs of students with learning disabilities. In this context, the present study investigated the role of Artificial Intelligence (AI) in bridging academic performance gaps between children with and without learning disabilities, specifically within the mainstream educational setting.

The study was conducted among a purposively selected sample of 20 students aged 15 years from mainstream schools in the Kannur district of Kerala. Among them, 10 students were identified with learning disabilities and constituted the experimental group, while 10 students without learning disabilities formed the comparison group. The students with learning disabilities were exposed to AI-integrated teaching in the areas of reading, writing, speaking (in Malayalam, English, and Hindi), and numeracy (addition, subtraction, multiplication, division, and reasoning). The study was

structured around a quasi-experimental design employing pre-test and post-test methodology.

A teacher-made test was used to assess students' performance in literacy and numeracy, adapted from the framework of the Wechsler Individual Achievement Test–Third Edition (WIAT-III). Reading comprehension, written expression, speaking ability, and mathematical operations were evaluated through simple, grade-appropriate tasks. In addition to academic tests, an observation checklist was used to track student engagement across behavioral, cognitive, and emotional domains, and a student feedback survey was conducted to gather their perspectives on the AI tools used during the intervention.

Before the AI intervention, the pre-test scores indicated a clear and significant academic performance gap between the normal students and the students with learning disabilities. The average total score of normal students was substantially higher than that of their peers with disabilities, confirming the need for an intervention. Following this, the experimental group received structured lessons supported by free and user-friendly AI tools such as Khan Academy for numeracy, Google Read Along and YouTube Kids for reading, and text-to-speech or speech-to-text tools for writing and speaking practice.

During the AI intervention, students were observed and rated across 15 behavior indicators grouped under four domains—behavioral engagement, cognitive engagement, emotional engagement, and overall improvement. The observation checklist helped capture the depth of student involvement, responsiveness, and progress in real-time classroom settings. The Likert scale format allowed the recording of behavioral trends that offered a qualitative layer to the numerical data.

Post-intervention, the experimental group underwent a post-test using the same assessment tools administered during the pre-test. The results were then analyzed using Microsoft Excel, and appropriate statistical techniques, including independent sample t-tests and paired sample t-tests, were applied to test the significance of observed differences. The pre-test scores of the normal students were also compared with the post-test scores of the students with learning disabilities to evaluate the extent to which AI-based instruction helped reduce the learning gap.

The data analysis revealed several noteworthy findings. Firstly, a paired sample t-test comparing pre- and post-test scores of students with learning disabilities showed a statistically significant improvement in performance. The mean post-test score increased markedly, indicating that AI tools were effective in improving academic achievement. Secondly, an independent samples t-test comparing the post-test scores of students with learning disabilities with the pre-test scores of normal students indicated that although a performance gap still existed, it had significantly reduced. This finding strongly supports the idea that AI can play a crucial role in narrowing learning disparities in inclusive classrooms.

In addition to test scores, the observation checklist showed that most students demonstrated strong behavioral and emotional engagement during AI-supported sessions. Items such as "The student actively participates in AI-based learning" and "The student maintains a positive attitude" received high frequencies of “Always” and “Often” responses. Cognitive engagement scores were slightly lower, especially in the ability to independently apply learned concepts, suggesting the need for continued support and reinforcement. Emotional responses were particularly positive, with students reporting enjoyment, reduced anxiety, and pride in completing AI-based tasks.

Based on the analysis of pre- and post-intervention data, it is evident that AI-integrated teaching methodologies offer significant advantages for children with learning disabilities. The tools used were not only accessible and free but also adaptive, visually supportive, and learner-friendly. They allowed for repetition, immediate feedback, and multimodal learning—all of which are essential for students with special learning needs.

Overall, the study supports the hypothesis that AI tools can bridge learning gaps between children with and without learning disabilities, particularly in the domains of literacy and numeracy. While the intervention did not completely eliminate the performance gap, it considerably reduced it and led to improvements in student engagement, self-esteem, and academic participation.

Hence, this study emphasizes the potential of technology to transform inclusive education. By implementing AI tools in a structured and meaningful way, teachers can address diverse learning needs and create equitable learning opportunities for all

students. This research adds to the growing body of evidence that AI, when used responsibly and with pedagogical intent, can significantly enhance the learning experience of students with disabilities, empowering them to reach closer to their full academic potential.

5.3 Statement of the Problem

The problem of the present study is stated as A COMPARATIVE STUDY ON THE EFFECTIVENESS OF ARTIFICIAL INTELLIGENCE IN BRIDGING LEARNING GAPS BETWEEN CHILDREN WITH AND WITHOUT LEARNING DISABILITIES.

5.4 objectives of the study

1. To assess and compare the academic performance of children with and without learning disabilities in reading, writing, and numeracy.
2. To evaluate the effectiveness of AI tools in improving the post-test academic performance of students with learning disabilities compared to their pre-test academic performance
3. To determine whether AI-based instruction reduces the learning gap between students with learning disabilities and their typically developing peers.
4. To examine the effect of AI-based instructional tools on the behavioral, cognitive, and emotional engagement of children with learning disabilities in comparison to traditional teaching methods.

5.5 Sample

The sample for the present study consists of 20 students aged 15 years, selected from Chembilod Higher Secondary Schools in the Kannur district of Kerala. The sample was purposefully chosen to include 10 students with and 10 students without learning disabilities, allowing for a comparative analysis of academic performance before and after the intervention.

5.6 Research Tools

The study used a teacher-made achievement test and an observation checklist, to assess academic performance and engagement levels of the students.

5.7 Research Methodology

The study adopted a quasi-experimental design with a pre-test and post-test approach to examine the effectiveness of AI-integrated instruction for students with learning disabilities. A purposive sample of 20 students aged 15 from mainstream schools in Kannur district was selected, including 10 students with learning disabilities and 10 typically developing peers. The research tools included a teacher-made achievement test and an observation checklist. Data were collected before and after the AI intervention, and statistical analysis using t-tests was conducted to evaluate academic improvement and engagement levels, comparing pre-test, post-test, and between-group performance.

5.8 Findings of the Study

The main findings that come out of the study according to objectives are listed below:

Objective 1- To assess and compare the academic performance of children with and without learning disabilities in reading, writing, and numeracy.

Findings related to Objective 1 of the study:

- Students without learning disabilities scored higher than students with learning disabilities in literacy and numeracy assessments.
- The largest performance gap was observed in numeracy skills between the two groups.
- Literacy scores showed consistent differences, with students with learning disabilities scoring lower.
- Overall academic performance was significantly better among students without learning disabilities.

Objective 2- To evaluate the effectiveness of AI tools in improving the post-test academic performance of students with learning disabilities.

Findings related to Objective 2 of the study:

- Post-test scores in literacy improved notably after AI tool intervention.
- Numeracy skills showed significant gains in post-tests following the use of AI instructional tools.
- Total academic performance increased by approximately 12-15% after AI-based learning sessions.
- Students demonstrated better retention and application of concepts with AI-supported instruction.

Objective 3- To determine whether AI-based instruction reduces the learning gap between students with learning disabilities and their typically developing peers.

Findings related to Objective 3 of the study:

- The gap in literacy scores between students with and without learning disabilities narrowed after AI intervention.
- Numeracy performance differences also reduced but remained statistically significant.
- AI tools contributed to improved overall academic parity between the two groups.
- The learning gap reduction was more pronounced in literacy than in numeracy.

Objective 4 - To examine the effect of AI-based instructional tools on the behavioral, cognitive, and emotional engagement of children with learning disabilities in comparison to traditional teaching methods.

Findings related to Objective 4 of the study:

- Engagement levels of students with learning disabilities increased during AI-supported lessons compared to traditional methods.
- Improved academic motivation was observed in students using AI tools.

- Students showed higher participation and interest in learning activities with AI integration.
- Teachers reported positive changes in student attitudes and engagement following AI instruction.

5.9 Educational Implications of the Study

This study offers significant educational implications for enhancing inclusive teaching practices and optimizing learning outcomes for children with learning disabilities (LDs) through the integration of artificial intelligence (AI) tools. One of the foremost implications is the demonstrated effectiveness of AI in improving academic performance in core areas such as literacy and numeracy. The notable increase in post-test scores among LD students indicates that AI tools can serve as powerful instructional aids, providing personalized support tailored to individual learning needs, which traditional teaching methods may lack.

Furthermore, the study shows that AI-assisted instruction can help narrow the learning gap between students with and without LDs. This suggests that educational institutions can adopt AI-based interventions to promote equity and reduce disparities in achievement, ensuring that every learner has an opportunity to succeed regardless of their learning challenges. The improved engagement levels—cognitive, behavioral, and emotional—also highlight the motivational aspect of AI tools, making learning more interactive, enjoyable, and meaningful for students who often struggle to stay focused in conventional classroom settings.

Teachers can also benefit from these technologies by using AI-generated analytics to track student progress and identify specific areas requiring intervention. This data-driven approach enables more effective lesson planning and individualized instruction. Additionally, the study underscores the need for teacher training programs to include digital literacy and AI integration skills, so educators can confidently and effectively implement such tools in diverse classroom settings.

In conclusion, the findings encourage educational policymakers and school administrators to incorporate AI-based learning technologies into special education curricula. With appropriate implementation, these tools have the potential to foster

inclusive education, bridge achievement gaps, and significantly enhance the overall educational experience and outcomes for children with learning disabilities.

5.10 suggestions for further study

The investigator while conducting research work observed that still there are many more research area to be researched, some of the further studies that can be carried out are as follow

1. Longitudinal Impact Studies:- Future research can explore the long-term effects of AI-based learning tools on academic retention and progression in children with learning disabilities.
2. Comparative Studies Across Age Groups:- Studies can be conducted to compare the effectiveness of AI tools across different age groups or grade levels to identify developmental variations in outcomes.
3. Tool-Specific Effectiveness:- Research can focus on evaluating specific AI applications or platforms to determine which tools are most effective for different types of learning disabilities.
4. Teacher Perception and Readiness:-Investigate teachers' attitudes, preparedness, and challenges in implementing AI tools in inclusive classrooms to inform professional development programs.
5. Parent Involvement and Feedback:- Studies can examine the role of parents in supporting AI-based learning at home and their perceptions of its effectiveness.
6. Cost-Effectiveness Analysis:- Future studies could assess the economic feasibility and cost-benefit ratio of implementing AI tools in low-resource educational settings.
7. Integration with Traditional Pedagogy:- Explore models of blended instruction combining AI with traditional teaching strategies to evaluate their combined impact on learning outcomes.
8. Customization for Specific Disabilities:- Investigate how AI tools can be adapted or customized for specific learning disabilities like dyslexia, dysgraphia, or dyscalculia.
9. Impact on Non-Academic Skills:- Conduct research on how AI-assisted learning influences soft skills such as self-confidence, communication, and problem-solving in students with LDs.

10. Cross-Cultural Validation:- Comparative studies across different regions or cultural contexts can assess whether AI tools are equally effective and inclusive in diverse educational environments.

5.11 Conclusion

The present study critically examined the role of artificial intelligence (AI)-based instructional tools in supporting children with learning disabilities and bridging the academic gap between them and their typically developing peers. The research findings indicate a significant improvement in literacy and numeracy performance among students with learning disabilities after the implementation of AI tools, highlighting the potential of these technologies to personalize learning, reinforce concepts, and offer consistent feedback. Additionally, the study revealed notable enhancements in behavioral, cognitive, and emotional engagement, demonstrating that AI-based instruction positively influences student motivation, focus, and classroom interaction compared to traditional teaching methods.

The literature review further reinforced these findings, showing that AI-assisted educational technologies have a broad impact across various disabilities—from improving mobility and communication in children with physical or sensory challenges to enhancing emotional regulation and social interaction in those with neurodevelopment and behavioral disorders. However, despite these advancements, several critical research gaps persist. There is a clear need for longitudinal studies to measure sustained outcomes, evaluations of specific AI tools, and a better understanding of teacher and parent perspectives. Issues like ethical concerns, accessibility, and the digital divide must also be addressed to ensure equitable implementation.

This study makes a valuable contribution to the growing body of research on inclusive education, suggesting that AI has the capacity to transform special education by offering scalable, adaptive, and data-informed learning experiences. Educational institutions must now consider integrating AI tools not as replacements but as supplementary aids that support personalized and inclusive teaching. Future research and policy efforts should aim at refining AI tools, ensuring accessibility, training educators, and evaluating implementation models across diverse learning environments. Ultimately, embracing AI in education holds promise for fostering

equitable learning opportunities and supporting the holistic development of children with learning disabilities.

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APPENDIX

Tools:-

1) **Numeracy (operations and reasoning)**

QUESTION PAPER

Subject:-Mathematics

Topic:- Simple Addition, Subtraction, Multiplication, and Division

Grade Level: Suitable for students with learning disabilities (Adapted for simplicity)

TotalMarks:25

Time: 45 Minutes

Section A: Addition (3 Marks)
(Each question carries **1 mark**)

1. 9 + 5 = _____
2. 13 + 12 = _____
3. 78 + 33 = _____

Section B: Subtraction (3 Marks)
(Each question carries **1 mark**)

1. 9 - 2 = _____
2. 64 - 12 = _____
3. 72 - 15 = _____

Section C: Multiplication (3 Marks)
(Each question carries **1 mark**)

1. 8 × 7 = _____

2. 22 × 6 = _____
3. 45 × 13 = _____

Section D: Division (3 Marks)
(Each question carries **1 mark**)

1. 9 ÷ 3 = _____
2. 75 ÷ 5 = _____
3. 144 ÷ 11 = _____

Section E: Fill in the blanks (8 Marks)
(Each question carries **2 mark**)

1. 2, 4, ___, ___, 10
2. 5, 8, 12, 17, ___, ___
3. 3, 5, ___, 9, ___
4. 15, ___, 45, ___, 75

Section D (5 Marks)

Riya went to a shop to buy some school supplies. She bought:

- 3 Pens and each pen costs ₹5.
- 2 Books and each book costs ₹20.
- 4 scales and each scale costs ₹3.

Questions:

1. How much money did Riya spend on the pens? (mark-1)
2. How much money did Riya spend on the books? (mark-1)
3. How much money did Riya spend on the scales? (mark-1)
4. What is the total amount Riya spent on all the items? (mark-2)

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2) Literacy

I. Reading

a. Malayalam

Read the given passage

പത്ത്

യുദ്ധത്തിന്റെ പരിണാമം

ധർമ്മക്ഷേത്രമായ കുരുക്ഷേത്രത്തിൽ വച്ചു നടന്ന ഭാരതയുദ്ധം തുടങ്ങുമ്പോൾ രണ്ടു ചേരിക്കാരും തമ്മിൽ ചെയ്ത കരാർ ഇപ്രകാരമായിരുന്നു: "യുദ്ധം നടക്കാത്ത സമയങ്ങളിൽ ഇരുകക്ഷിയും പണ്ടേപ്പോലെ പരസ്പരപ്രീതിയോടെ വർത്തിക്കണം. യുദ്ധം തുടങ്ങിയാൽ, ഗജാശ്വരഥങ്ങളിലിരിക്കുന്നവർ ആ നിലയിലുള്ളവരോടേ എതിർക്കാവൂ, കാലാൾ കാലാളോടും. അണിവിട്ടുപോയവനെ കൊല്ലരുത്. വയോവീര്യോത്സാഹങ്ങളിൽ കിടന്നിൽക്കുന്നവരോടു പറഞ്ഞറിയിച്ചിട്ടേ നേർക്കാവൂ, ഓർക്കാതെയും ക്ഷീണിച്ചുമിരിക്കുന്നവരോടരുത്. മറ്റൊരാളോടു നേരിടുന്നവനെ, പ്രമാദം പറ്റിയവനെ, പിന്തിരിഞ്ഞവനെ, ആയുധം തീർന്നവനെ, കവചം പോയവനെ, ഒന്നും ഒരുവിധവും കൊല്ലരുത്. സൂതന്മാർ, കുതിരകൾ, ആയുധച്ചുമട്ടുകാർ, വാദ്യക്കാർ എന്നിവരെയൊന്നും ഉപദ്രവിക്കരുത്." ചുരുക്കത്തിൽ, എതിരാളിയുടെ കുറവുകൊണ്ടല്ല, സ്വന്തം മികവുകൊണ്ടുതന്നെ ജയിക്കാൻ നോക്കണമെന്നർഥം - കുറ്റമറ്റ ധർമ്മയുദ്ധം!

യുദ്ധത്തിന്റെ ആദ്യദിവസങ്ങളിൽ ഈ കരാറെല്ലാം ഏറെക്കുറേ പാലിക്കപ്പെട്ടു. പിന്നീട് അതുമിതുമായി ലംഘിക്കപ്പെട്ടുതുടങ്ങി. പാണ്ഡവപക്ഷം, എതിർപക്ഷത്തിലുള്ള മിക്ക മഹാരഥന്മാരെയും വീഴ്ത്തിയതു യുദ്ധധർമ്മത്തിനെതിരായിട്ടാണ്; ഒടുക്കം ദുര്യോധനനെയും. അങ്ങനെ വല്ലപാടും വിജയം നേടിയ പാണ്ഡവർ സന്ധ്യക്കു ജയഘോഷത്തോടെ കൂടാരങ്ങളിലേക്കു തിരിച്ചു.

b. English
Read the given passage

Basheer, the Sultan of stories is a true lover of nature. He highlights the blend of all creatures and nature in his stories. The stories evoke humour and sarcasm on the follies of man. Here is such a story. Read and enjoy.

The Snake and the Mirror

1 'Has a snake ever coiled itself round any part of your body? A full-blooded cobra?' All of us fell silent. The question came from the **homeopath**. The topic came up when we were discussing snakes. We listened attentively as the doctor continued with the tale.

2 It was a hot summer night about ten o' clock. I had my meal at the restaurant and returned to my room. I heard a noise from above as I opened the door. The sound was a familiar one. One could say that rats and I shared the room. I took out my box of matches and lighted the kerosene lamp on the table.

3 The house was not electrified; it was a small rented room. I had just set up medical practice and my earnings were **meagre**. I had about sixty rupees in my suitcase. Along with some shirts and dhotis, I also possessed one solitary black coat which I was then wearing.

1. What was the topic that came up for discussion between the doctor and his friends?

2. What does the expression 'a full-blooded cobra' suggest?

3. 'The sound was a familiar one.' What was the sound?

c. Hindi

Read the given passage

संस्मरण

फ़िल्मी लेख

आई एम कलाम के बहाने

मिहिर

4W1RQ5

गाँव के स्कूल में मेरा एक साथी था– मोरपाल। वही मोरपाल जिसने एक बार हमारे अंग्रेज़ी के मास्टर तिवारी जी को look का मतलब और सही हिज्जे पूछे जाने पर बताया था, "एल डबल ओ के लुक, लुक यानी लुक-लुक के देखना।" नाम का पहला अक्षर मिलने की वजह से क्लास की दरीपट्टी पर हमारी बैठने की जगहें भी साथ ही थीं। वही मोरपाल जिसकी मेरे खाने के डिब्बे में राजमा देखते ही बाँछें खिल जाती थीं। हमारा सौदा था खेल घंटी में खाने की अदला-बदली का। यानी मेरे टिफ़िन के राजमा-चावल उसके और उसके घर से आया बड़ा-सा छाछ का डिब्बा मेरा। उसे पता था कि छाछ मेरी कमज़ोरी है। लेकिन मुझे मोरपाल से मिलने से पहले कतई

'हमारा सौदा था खेल घंटी में खाने की अदला-बदली का।'– इस तरह की अदला-बदली से हम क्या समझ सकते हैं?

II. Writing

Write about the most memorable day of your life in Malayalam, English, and Hindi.

III. Speaking

Introduce yourself in Malayalam, English and Hindi

3. **Observation Checklist Statements**

1. Behavioral Engagement

1. The student shows consistent interest in interacting with AI tools.
2. The student actively participates in AI-based learning activities.
3. The student seeks help or clarification when facing difficulties with AI tools.
4. The student maintains focus and concentration during AI-assisted sessions.

2. Cognitive Engagement

5. The student demonstrates understanding of concepts introduced through AI tools.
6. The student applies learned skills and knowledge to other tasks effectively.
7. The student accurately responds to AI-generated questions and exercises.
8. The student completes tasks independently with minimal guidance.

3. Emotional Engagement

9. The student shows enthusiasm and enjoyment while using AI tools.
10. The student expresses satisfaction or pride upon successfully completing activities.
11. The student displays reduced frustration and anxiety during AI-assisted learning.
12. The student maintains a positive attitude towards AI-based learning activities.

4. Overall Improvement

13. The student shows noticeable improvement in overall language skills across all languages and in numeracy.
14. The student demonstrates a consistent improvement in engagement and participation.
15. The student's achievement level has increased as a result of AI-integrated teaching.

- 1 - Never
- 2 - Rarely
- 3 - Sometimes
- 4 - Often
- 5 - Always