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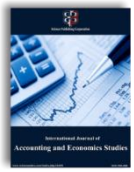

AI in Special Education: Enhancing Learning Outcomes for Students with Disabilities

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Abstract

Integration of Artificial Intelligence (AI) in education has opened different avenues for addressing challenges faced by special children. AI technologies like virtual facilitation, voice-to-text systems and adaptive learning tools offer a more personalised solution which further helps in overcoming the sensory and cognitive barrier in the traditional educational system. However, its implementation dynamic has faced different challenges, like societal stigma, infrastructural deficits, lack of teacher training and ethical biases mainly in developing countries such as India. This study employs a primary quantitative research methodology, drawing insights from a survey of 101 participants to assess in the AI effectiveness in special education. The research explores the supervised learning algorithms that drive these technologies and enhance inclusivity and accessibility as well. The findings emphasise are capable of enhancing teaching ability, helping to aid the educational needs of special education. AI has the potential to revolutionise Indian special children's learning outcomes through creating an accessible and inclusive educational landscape. Additionally, the research explores the economical value of AI technologies in special education with respect to their projected economic benefits concerning the minimization of dependency on professional staff, costly assistive devices, and other specialized resources.

Keywords: *AI;Special Children;Disability;Education;Learning;Teaching;Challenges;Training.*

1. Introduction

AI has emerged as a transformative force in the education sector; it offers new opportunities for addressing the needs of children with disabilities through leveraging AI-powered tools like virtual facilitating systems, adaptive platforms for learning and speech recognition software the educators can create tailored experiences of learning which cater to specific cognitive, behavioural and sensory needs for the special children (Poornima &Ananthamoorthy, 2016). This technology helps enable the students to overcome different traditional barriers including verbal communication and difficulties in writing and reading, thereby developing their ability to interact with the learning materials. The educational landscape of India faces distinct challenges in the implementation of these AI solutions. This research evaluates AI tools' working mechanisms, analyses the challenges involved in its implementation and identifies the factors which influence its success. The study aims to highlight AI's potential for revolutionising special children's education system, contributing to stakeholder collaboration, inclusive educational practices development and policy reforms (Forčaković&Dervišević, 2021; Rahman &Muktadir, 2021).

Problem Type:India's traditional education system poses significant challenges for disabled children, who often face problems accessing quality education due to infrastructural, policy-related and societal barriers. These challenges are evident in different forms, like lack of awareness about disabilities, limited access to a specialized resources and insufficient teacher training. As example, the children with conditions like dyslexia, ADHD and autism need a tailored learning process which is provided by traditional classroom settings. As per Barua et al., (2022), AI tools are not embedded in the cloud system which further limits their ability to give a realtime suggestions for a more personalised learning dynamic. Cloud-based AI-based tools, like digital apps, may represent a significant advancement in enabling real-time, individualized specialist education and learning for impacted individuals. Sharma et al., (2023) state that as accessibility-focused AI becomes more integrated into commonplace technologies, many expensive assistive devices for the disabled will no longer be necessary. The integration of AI has grown significantly in India; according to a 2018 discussion paper by NITI Aayog, AI could boost the country's GDP by an additional USD 1 trillion by 2035 (Jawad &Abdulameer, 2022; Sharma, 2021; Iyer et al., 2023; Ramu et al., 2022).

The key issue is the societal stigma for surrounded the disabilities that further leads to the exclusion and discrimination of special children in the educational settings. As per the census of 2011, 3% of the disabled females in India have achieved graduate-level education, reflecting deep-rooted inequalities in opportunities and access. This disparity is composed through inclusive infrastructure lack in schools, like ramps, assistive technologies and sensory-friendly classrooms. As mentioned by (Mitra, 2024) an educational strategy known as “adaptive learning (AL)” tailors each student's educational experience according to several factors, such as demographic background, cognitive ability, and affective state. AI and machine learning algorithms can be used to integrate this method into both traditional classroom settings and online learning environments. By dynamically modifying course materials to fit each student's unique skills or preferences, adaptive learning seeks to give them a quick, easy, and personalised educational experience (Mousa, 2022; Khyade et al., 2018).

2. Review of Literature

2.1 Artificial Intelligence Working Dynamic

AI functions through leveraging the algorithms of machine learning to analyse data, deliver customized educational experiences and adapt to learning styles. In special education, the technologies like AI technologies help in adapting interfaces for the sensory-impaired students, converting visual content into audio and translating text into speech. AI has the potential to resolve communication issues by translating sign languages. Almufareh et al., (2023) state deaf and hard-of-hearing people can benefit immensely from real-time captioning technology, which uses AI to create captions for live audio in a variety of contexts, including meetings, concerts, and classrooms. AI can identify speech-related muscle movements, allowing for silent speech. As per the viewpoint of (Bhattacharya & Pal, 2021) students who are soft-spoken or non-verbal, have motor limitations, or have speech-related disabilities will benefit from this. The potential of machine learning is enormous and its consequences for visually impaired or blind students using digital formats to access math content.

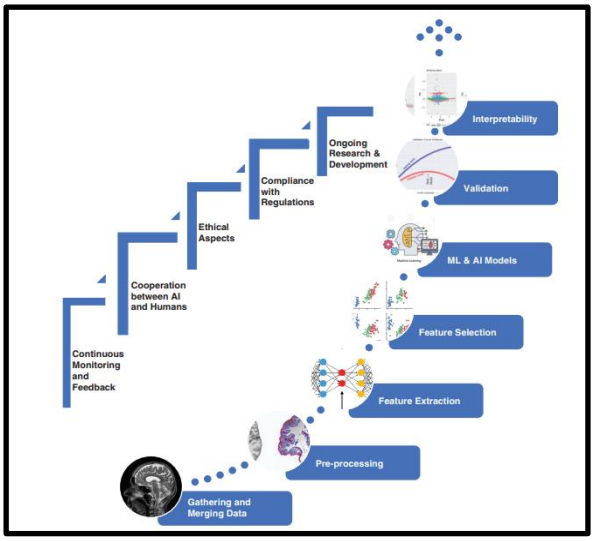

Fig. 1:AI-Based Framework for Classifying Diseases (Source: 4)

The key AI models involve different supervised learning systems, that help in the use of labelled datasets for predicting optimise and outcomes content delivery. Tools such as magnifiers, voice-activated assistants and screen readers are help in exemplifying the dynamic related to the work of AI. As (Bharathi & Sujatha, 2024) analyse dynamic-like machine learning in AI has the potential to improve the efficacy of the learning-disabled learner profile determination process. Implementing supervised, unsupervised, and reinforcement machine learning has the potential to address Learning Disabled learner profiling problems. Applications of AI and big data help extract valuable insights from datasets to comprehend students' learning paths and improve the effectiveness of educational systems. Duttet al., (2022). the use of data has permeated the educational system deeply enough to drastically alter its structure and form, from developing personalised study materials for a given student based on their unique learning needs to developing and assessing them from warning an instructor about possible learning obstacles to responding to a student's inquiries by mimicking a human dialogue.

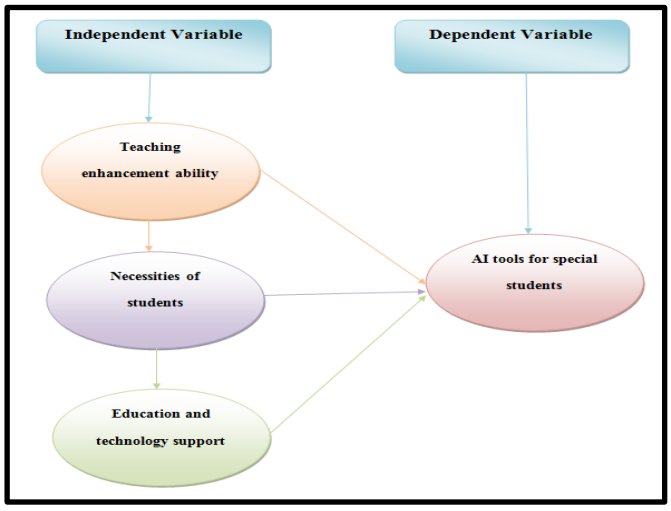

Fig. 2: Conceptual Framework(Source: Self-developed)

2.2 Factors influencing the AI-integrated Online Education

Several factors determine the success of AI-integrated education for special children, like student expectations, technological infrastructure and teacher competency. Bhutoria, (2022) mention that AI technology plays an important role in facilitate communication channels while fostering a student-centred and specific learning environment which caters to students' diverse needs. The readiness of teachers plays a pivotal, as the educators understand AI tools and incorporate them effectively within their pedagogy. As per the viewpoint of (Aftab et al.,

2024) smart sensor technologies have become essential instruments in the transformation of education in recent years. The use of many cutting-edge technologies in the classroom, including artificial intelligence (AI), intelligent learning, the Internet of Things, information technology, and big data, requires sensor technology as a fundamental component. Sensors in smart classrooms allow for the natural collection of learning data during the learning process, forming the foundation of intelligent systems and giving teachers previously unheard-of chances to enhance student learning and boost teaching effectiveness.

2.3 Supervised Learning Theory

Supervised learning is a foundation of the model of AI model which helps in mapping input data for a corresponding output by using a labelled dataset. This theory focuses on underpinning different educational technologies specially designed for the special children. Algorithms included k-nearest neighbours, support vector machines and decision trees to classify the data and predict their outcomes based on patterns of the past. Supervised learning is the process where the machines learn to generalise and enhance the customization of content. As per (Greeshma & Sujatha, 2024) recently, flow and elastic networks—actual physical systems—with specific desired functions, like allostery, were designed using global supervised learning. Greeshma & Sujatha, (2024) evaluate that for healthcare data analysis, maximum supervised machine learning-based analytics particularly deep learning need access to sizable datasets, and all supervised learning necessitates a labelled training set. In the dynamic of special education, the classification of algorithms categorises the learning content as per the cognitive abilities (Khazanchi&Khazanchi, 2024).

2.4 Challenges in the implementation of AI in Education for Special Students

Despite the several potentials, AI also faces significant barriers in special education. Privacy concerns, technical limitations and ethical issues are among some of the prominent challenges. As per (Zhang et al., 2024), state that for special students who might have physical, sensory, cognitive, or emotional difficulties special education encompasses a range of services and therapeutic approaches. Meeting these needs, which usually call for human-driven planning, has proven to be an expensive and difficult undertaking for the education sector. However, AI is quickly expanding the boundaries of technology, enabling the creation of automated procedures that support these activities and tasks by encouraging teachers to offer more efficient, individualized learning opportunities. Stern et al., (2021) special education has a broad umbrella, covering sensory impairments, behavioural issues and learning disabilities. Ethical programming is essential for addressing biases which arise from skewed training data. However, AI tools are also collecting sensitive student data that also raises questions on data protection.

3. Methodology

The following section of methodology is focused on discussing the research methods for the selection and evaluation of information that is being explored as comprehensive findings to the research. This study is focused on recognising and comprehending the situation of effectiveness of AI-based training processes for special children in India. The study has utilised a positivist research philosophy. GM & Sujatha, (2024) state positivism is regarded to involve observation and consideration of pure data and facts influenced by the bias of human interpretation. The study includes a deductive research approach. Sasikumar & Sujatha, (2024) mentioned, that it is due to alignment that the deductive approach has towards positivism research philosophy. The study collected and evaluated empirical data that had been directly accumulated through online survey. This had involved applying a primary and quantitative research strategy. The study has selected applying an explanatory research design for the study executed.

The study has collected information through primary data collection methods involving accumulating statistical and numeric data from applying survey questionnaires as a major for primary quantitative data collection. Bharathi & Sujatha, (2022) mentioned that the primary data involves unpublished and original information directly gathered for particular research purposes. The study included a selection of 101 survey participants and implemented purposive sampling for the selection of Indians for analysing the effectiveness of AI-based training processes for special children. Primary data collection integrates surveys as a broad and common data collection instrument using Google Forms for an online survey. The survey involvedclose-ended questionnaires, involving a total of 16 questions with 3 demographics and 13 research subjects specific to participants.

The data analysis segment involves processing all data collected from surveys and evaluating them with the use of IBM SPSS as a data analysis tool. As per (Habib & Janae, 2024) quantitative analysis involves statistical methods of evaluating numerical information gathered through questions of the survey. The data analysis would involve the evaluation of the quantitative findings that have been gathered from the surveys and have been included for the examination of the relationship between the variables concerning the research subject.

3.1 Results&Reliability Analysis

Table 1: Reliability Test

Cronbach's Alpha	N of Items
.858	13

The reliability analysis involves evaluation of the reliability of the item's representative of the survey questions that had been based on the intent of the research study. The Cronbach's Alpha value has resulted to be 0.858 for 13 items that represent the survey questions based on the research subject. The reliability analysis being evaluated through the assessment of the Cronbach's Alpha value indicates the internal consistency of the items in ascertaining the reliability of the data that have been collected in the survey. The high Cronbach's Alpha value had been identified to indicate that there is a strong internal consistency in the data of the items, denoting the reliability of the data.

3.2 Demographic Statistics

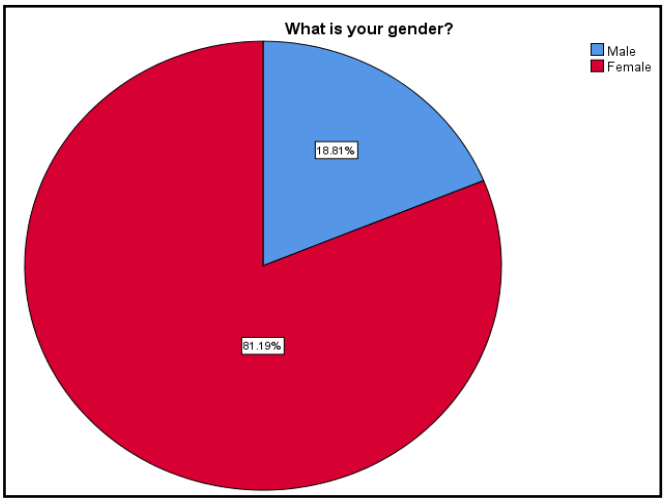

Fig. 3: Gender Demographics of Sample(Source: IBM SPSS)

The responding population was observed to have a higher concentration of women in the sample population. A whopping 81.19% of the total respondents had been female respondents. Only 18.81% of the total responding sample identified as male.

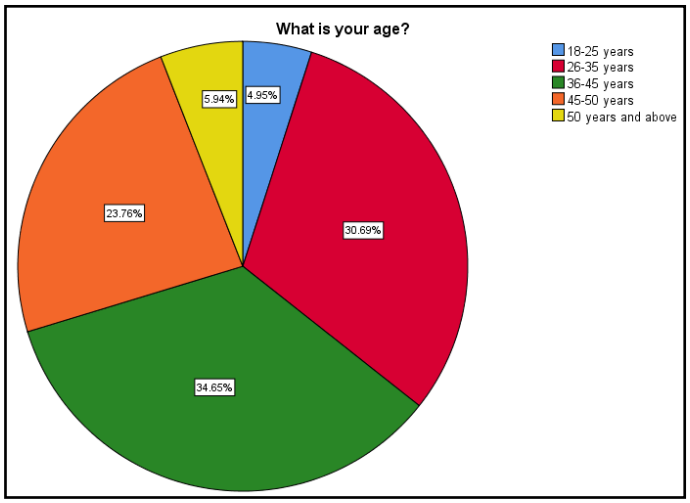

Fig. 4: Age Demographics of Sample (Source: IBM SPSS)

The greatest number of the respondents had been estimated as within their Middle Ages. This is due to the fact that most of the respondents, around 34.65% of them, had been within ages 36 to 45 years, followed by around 30.69% of the respondents in the age group 26 to 35 years and 23.76% of them being ages 45 to 50 years. Only 4.95% of the total respondents had been among the age group 18-25 years and 5.94% of the population had been either or over 50 years.

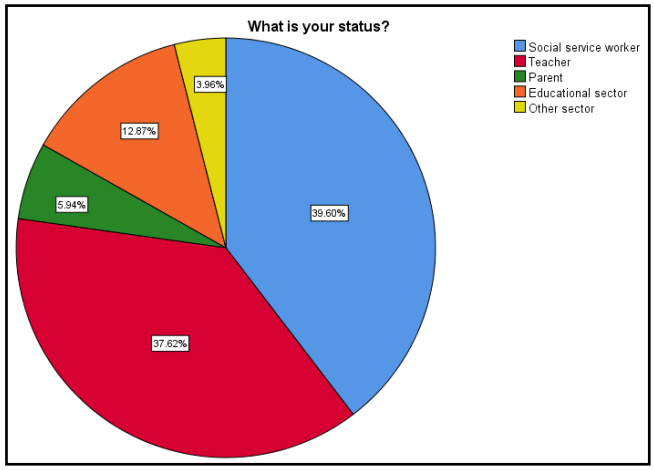

Fig. 5: Socio-Economic Status Demographics of Sample (Source: IBM SPSS)

A major segment of the respondents had involved social service workers (39.60%) and teachers (37.62%), people in professions that are more closely and personally involved with academic and educational development of students. This is followed by respondents working in the educational sector (12.87%), parents (5.94%) and people working in other sectors (3.96%).

3.3 Descriptive Analysis

Table 2: Descriptive Statistics

	Mean	Std. Deviation
AI tools innovate teaching and learning experience through personalised support to special children needs	3.93	.919
Teachers can improve existing learning experiences for special children using AI for customising individual education plans	4.27	.859
Teachers can use AI as an improvement tool for processing study materials	4.26	.976
AI tools can streamline grading and evaluation for teachers, giving them more time to creatively handle lesson plans	4.35	.910
Teaching using AI tools can customising lessons to be more engaging and enabling for children with special needs	4.16	1.093
Students can be assisted with audio and visual aids for study material during teaching sessions	4.13	1.146
Students with learning disabilities, visual and speech impairments can benefit from customisable text to speech features of AI tools during learning	3.97	1.261
Students with hearing impairments and learning disabilities can benefit from personalisable speech to text features of AI tools during learning	4.09	1.167
AI tools could assist disabled students and children with special needs to engage with learning better	4.02	1.216
Education environment for students can be improved through including AI tools support for better education opportunities	4.20	1.105
AI tools can process notes and study materials for special children to fit their individual needs	4.25	1.004
AI integration supports visual, audio and customisable formats for study and learning materials as special children needs support	4.09	1.105
Education and AI technology can go hand in hand for improved learning opportunities for special children	4.10	1.091
Valid N (listwise)		

The descriptive statistic indicates the relation of the research variables “AI tools for special students”, “Teaching enhancement ability”, “Necessities of students”, and “Education and technology support” in association to the items representing them through the evaluation of the range of the relationship that the data illustrates. As per the evaluation of the survey data, the mean and standard deviation values for the dependent variable “AI tools for special students” was 3.93 and 0.919 respectively. The range of mean values for the first independent variable “Teaching enhancement ability” was 4.16 to 4.35, while the standard deviation values ranged between 0.859 and 1.093. The second independent variable “Necessities of students” had a mean value range of 3.97 to 4.13, and standard deviation values ranged 1.146 to 1.261. The third independent variable “Education and technology support” involved the mean values to be ranging around 4.09 and 4.10, whereas the standard deviation values were 1.004 to 1.105. These values indicate that there is a close clustered relation among the data of the items and their representative variables.

3.4 Correlation Analysis

Table 3: Correlation Analysis DV and IV 1

		AI tools innovate teaching and learning experience through personalised support to special children needs
Teachers can improve existing learning experiences for special children using AI for customising individual education plans	Pearson Correlation	.201*
Teachers can use AI as an improvement tool for processing study materials	Pearson Correlation	.109
AI tools can streamline grading and evaluation for teachers, giving them more time to creatively handle lesson plans	Pearson Correlation	.125
Teaching using AI tools can customising lessons to be more engaging and enabling for children with special needs	Pearson Correlation	.389**
*. Correlation is significant at the 0.05 level (2-tailed).		
**. Correlation is significant at the 0.01 level (2-tailed).		

The above Pearson correlation analysis evaluated the correlation between the first dependent variable “AI tools for special students” and the independent variable “Teaching enhancement ability”. The correlation evaluation indicates the presence of a positive correlation among the two research variables. The correlation value for the independent variable related statement “Teachers can improve existing learning experiences for special children using AI for customising individual education plans” was 0.201. The correlation value for the statement “Teachers can use AI as an improvement tool for processing study materials” was 0.109. The statement “AI tools can streamline grading and evaluation for teachers, giving them more time to creatively handle lesson plans” had a correlation value of 0.125. The statement “Teaching using AI tools can customising lessons to be more engaging and enabling for children with special needs” had gathered a correlation value of 0.389. All the statements of the first independent variable had been evaluated in association with the dependent variable and its statement “AI tools innovate teaching and learning experience through personalised support to special children needs”. There is a positive relation between the variables according to the results.

This Pearson correlation analysis evaluated the correlation between the dependent variable “AI tools for special students” and the second independent variable “Necessities of students”. The data for the statements representing the independent variables had been evaluated in relation to the dependent variable and the data of its representative statement regarding AI tools causing teaching and learning experience innovation through customisation of the support for special children needs. The statement “Students can be assisted with audio and visual aids for study material during teaching sessions” had 0.217 as its resulting correlation value. The statements “Students with learning disabilities, visual and speech impairments can benefit from customisable text to speech features of AI tools during learning” and “Students with hearing impairments and learning disabilities can benefit from personalisable speech to text features of AI tools during learning” had correlation values of 0.188 and 0.285 respectively. The statement “AI tools could assist disabled students and children with special needs to engage with learning better” has a correlation value of 0.126. The values further indicate that, statistically, there is a positive correlation between the dependent variable and the second independent variable.

Table 4: Correlation Analysis DV and IV 2

		AI tools innovate teaching and learning experience through personalised support to special children needs
Students can be assisted with audio and visual aids for study material during teaching sessions	Pearson Correlation	.217*
Students with learning disabilities, visual and speech impairments can benefit from customisable text to speech features of AI tools during learning	Pearson Correlation	.188
Students with hearing impairments and learning disabilities can benefit from personalisable speech to text features of AI tools during learning	Pearson Correlation	.285**
AI tools could assist disabled students and children with special needs to engage with learning better	Pearson Correlation	.126

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

Table 5: Correlation Analysis DV and IV 3

		AI tools innovate teaching and learning experience through personalised support to special children needs
Education environment for students can be improved through including AI tools support for better education opportunities	Pearson Correlation	.240*
AI tools can process notes and study materials for special children to fit their individual needs	Pearson Correlation	.214*
AI integration supports visual, audio and customisable formats for study and learning materials as special children needs support	Pearson Correlation	.232*
Education and AI technology can go hand in hand for improved learning opportunities for special children	Pearson Correlation	.127

*. Correlation is significant at the 0.05 level (2-tailed).
**. Correlation is significant at the 0.01 level (2-tailed).

In this Pearson correlation analysis, the correlation between the dependent variable "AI tools for special students" and the third independent variable "Education and technology support" had been evaluated. The correlation analysis was executed through evaluation of the data of statements associated with the independent variable alongside the dependent variable representing the statement and its data. The statement association to the independent variable mentioning "Education environment for students can be improved through including AI tools support for better education opportunities" had a correlation value of 0.240.

The correlation value for the statement "AI tools can process notes and study materials for special children to fit their individual needs" was 0.214. This is followed by the correlation between the statement of the dependent variable with the independent variable related statement "AI integration supports visual, audio and customisable formats for study and learning materials as special children needs support" with the value being 0.232. Also, the statement "Education and AI technology can go hand in hand for improved learning opportunities for special children" had a correlation value of 0.127. These values further indicate that there is a statistically positive correlation between the dependent variable and the third independent variable.

3.5 Regression Analysis

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.498[a]	.248	.146	.850

a. Predictors: (Constant), Teaching enhancement ability, Necessities of students, Education and technology support

The R and R square values as per the analysis of the model summary indicate the variance of the dependent variable being explainable through the linear relation with the independent variables. The R and R square values are 0.498 and 0.248 respectively. This indicates that the variance of the dependent variable is mildly explainable and there is a linear relation between the dependent and independent variables.

Table 7: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.984	12	1.749	2.422	.009[b]
	Residual	63.531	88	.722		
	Total	84.515	100			

a. Dependent Variable: AI tools for special students
b. Predictors: (Constant), Teaching enhancement ability, Necessities of students, Education and technology support

The ANOVA analysis indicates the statistical significance of the linear relation between the dependent and independent variables in the study. The p- value as per the sig value outcome of the ANOVA analysis is 0.009. The set threshold for testing the statistical significance for the variables is identified to be 0.05 for the research's regression analysis. The p- value is lower than the set threshold of the evaluation. Therefore, the linear relation between the dependent variable "AI tools for special students" and the independent variables "Teaching enhancement ability", "Necessities of students", and "Education and technology support" have a statistical significance.

4. Discussion

The potential of AI in special education mainly lies in their ability to create a more personalized and adaptive environment of learning. However, their success also depends on overcoming the systemic barriers. As per (Habib et al., 2023), WHO estimates that there are near about 62 million people with visual impairments in India, 8 million of whom are blind. However, as numerous academics and experts have noted, AI solutions can significantly improve the lives of those who are visually impaired, and this is already the case. Robotic arms, prosthetic limbs with AI support, and decision support tools for individuals with disabilities are examples of the advancements these solutions have brought about for those with disabilities. A major segment of the respondents involved social service workers and teachers,

people in professions that are more closely and personally involved with the academic and educational development of students. The ANOVA analysis indicates the statistical significance of the linear relation between the independent and dependent variables of study.
The lack of teachers in the training program also hindered the integration of AI necessitating the comprehensive initiatives of professional development. Limitations of infrastructure in rural India need policy support and targeted investments. The finding of the study indicates that there is a strong internal consistency in the data of the items, denoting the reliability of the data. Alharahsheh& Pius, (2020) state that through leveraging AI technologies, researchers and educators are exploring different new ways to support children and enhance its language skills. The findings of the descriptive statistics explore that there is a closely clustered relation among the data of the items and their representative variables. Ethical concerns have to be addressed by transparent governance frameworks and also continuous refinement of algorithms. The creation of different assistive technologies for individuals with visual impairments tends to encourage independence and usability, which eventually improves quality of life, but it also presents many challenges.
Collaboration among technologists, educators and policymakers is vital to creating an accessible and inclusive learning solution. Al-Ababneh, (2020) state that Project-based learning will give "Special education teachers" (SETs) collaborative learning opportunities and practical, hands-on training to help teachers feel more successful in the classroom. These courses ought to concentrate on giving SETs the abilities and information they need to successfully instruct students with disabilities in an inclusive classroom setting. Project-based learning, which is emphasized in teacher education programs, will assist SETs in acquiring theoretical knowledge and developing their practical skills in managing a range of classroom situations. The finding of the correlation states that there is a positive relation between the dependent and all the independent variables of the results. Karunarathna et al., (2024) states that by using crowd sourced training from experts and more experienced students, AI can fill in the gaps, the technological programs, and tutoring is now more affordable and accessible than it was in the past.

4.1 Economic Analysis of AI Integration in Special Education

The initial price of implementing AI-based tools in special education may seem high, but the ROI is significant over time. Adaptive learning software, speech-to-text programs, and virtual tutors alleviate the financial strain incurred by specialized instructors, curriculum development, and teaching aids. Different benefit-cost comparisons suggest that AI systems have long-lasting value alongside their affordability and efficiency. Transforming from rigid, hardware-based assistive devices to cloud-based applications can, according to Sharma et al. (2023) slash spending by 35% in under-resourced educational institutions. Furthermore, AI's role in managing inclusive settings helps to reduce the drop-out rate while increasing academic performance which enhances productivity and decreases reliance on support services.

4.2 Policy and Funding Mechanisms for AI Implementation

The effective integration of AI into special education contexts entails blended policy frameworks and funding models. Government-funded programs like Samagra Shiksha and NEP 2020 need to unreservedly adopt AI for the purposes of learning inclusion. Policies must guarantee schools in rural and urban areas access to equitable digital infrastructure. At the same time, public-private partnerships can foster innovation while adhering to established cost-sharing models. Educational technology grants underwritten by CSR initiatives, as well as subsidized tax and innovation stall programs, can assist under-resourced institutions in obtaining AI technology. In addition, sponsoring training for educators through certification programs will enable these institutions to build the human capital needed to utilize AI tools.

5. Conclusion

AI tools help in revolutionise education for the special children by offering a more personalised learning experience which adapts to the individual needs. However different systemic barriers, like ethical concerns, infrastructure deficits and inadequate training, are addressed to unlock the potential of AI. Strategic investments in ethical, technology and policy reforms in AI designs allow to creation of an inclusive educational environment. Through prioritising inclusivity and accessibility and accessibility, AI fosters to empower the children who have disabilities and bridges the educational gaps to achieve academic success. AI in education, mainly in the dynamic of special education, has received attention from the research and practitioner community. The implementation of AI technology in special education is not only pedagogically innovative, but economically advantageous as well, optimizing returns on educational investments for families and institutions alike.

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Conflict of Interest

The authors hereby declare no conflict of interest having taken place.

Ethics Approval

Voluntary participation for survey was duly communicated to participants. Ethical measures of privacy and confidentiality maintained with participants' knowledge. Data hence accumulated implemented for academic purposes.

Data Availability

Direct data collected from 101 participants from India.

Abbreviation

Nil

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