EFFECTIVENESS OF AI-BASED LEARNING TOOLS FOR AUTISTIC CHILDREN: A STUDY ON SPECIAL EDUCATORS IN CHENNAI

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Abstract

Artificial Intelligence (AI) is transforming education by enhancing learning experiences, personalizing instruction, and addressing accessibility challenges. This study explores the perceived effectiveness of AI-based learning tools, their impact on student engagement, and their role in special education, particularly for children with Autism Spectrum Disorder (ASD). AI-driven technologies, such as speech recognition software, virtual reality platforms, and adaptive learning systems, have demonstrated potential in improving communication, cognitive development, and personalized learning experiences. However, challenges such as screen dependency, reduced human interaction, and the need for teacher training pose significant concerns.

*The study examines AI adoption in education from international, national (India), and regional (Tamil Nadu) perspectives. UNESCO emphasizes AI's role in achieving Sustainable Development Goal 4 (SDG 4) for inclusive education, while India's **National Education Policy (NEP) 2020** promotes AI integration through personalized learning, AI-powered assessments, and digital literacy initiatives. Tamil Nadu has taken progressive steps in implementing AI-based adaptive learning platforms, yet challenges such as limited access, cost barriers, and ethical concerns remain.*

*Data analysis reveals mixed perceptions of AI in education. While **43.1% of respondents** reported that AI slightly increases student engagement, **13.7% believed it significantly decreases engagement**. Additionally, concerns over **increased screen dependency (35.3%)** and **reduced human interaction (35.3%)** highlight potential drawbacks of AI implementation. However, AI has been recognized for its benefits in **enhancing communication skills (18.9%)**, **improving social interaction (17.4%)**, and **boosting engagement and attention (13.0%)**.*

For children with autism, AI provides innovative interventions that support social skills, engagement, and behavior management. AI-assisted educational tools, including communication applications and interactive robots, help bridge learning gaps and create tailored learning experiences. However, ethical concerns such as data privacy, algorithmic bias, and teacher preparedness must be addressed to ensure effective AI implementation.

*The study also identifies key barriers to AI adoption, including **high costs of AI tools (24.0%)**, **limited accessibility in schools (21.9%)**, and **lack of training and technical support (19.8%)**. Findings suggest that enhancing AI awareness, providing educator training, and ensuring equitable access to AI tools are essential for maximizing AI's potential in education.*

Keywords: *Artificial Intelligence, AI in Education, Special Education, Autism, Personalized Learning, Adaptive Learning, Digital Literacy, AI Ethics, Assistive Technology*

INTRODUCTION

The Role of AI in Education

Artificial Intelligence (AI) is rapidly transforming the global educational landscape, offering innovative solutions to enhance learning experiences, personalize education, and improve accessibility. Organizations like UNESCO emphasize AI's potential to address educational challenges and accelerate progress towards Sustainable Development Goal 4 (SDG 4), which focuses on ensuring inclusive and equitable quality education for all. AI-driven tools, including **grammar checking software, text-to-speech applications, plagiarism detection tools, and automated grading systems**, are reshaping traditional education methodologies. However, while AI holds promise, its rapid advancements necessitate thoughtful regulatory frameworks to mitigate risks such as data privacy concerns, accessibility disparities, and ethical considerations.

AI in Education: The Indian Perspective

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In India, the **National Education Policy (NEP) 2020** underscores the significance of integrating AI into the education system. The NEP advocates for **AI-driven personalized learning, teacher training programs, and AI-powered assessment systems** to enhance the quality and accessibility of education. Additionally, AI and coding have been introduced into school curriculums from **Class 6 onwards** to equip students with essential digital skills for the future workforce. The **National Educational Technology Forum (NETF)** has been established as a platform to promote AI's best practices in education, ensuring that AI implementation aligns with national educational objectives. However, key challenges such as **limited access to AI tools, the need for teacher training, and concerns over bias in AI systems** must be addressed to fully harness AI's potential in Indian education.

Tamil Nadu's AI Initiatives in Education

Tamil Nadu has been at the forefront of implementing **digital learning initiatives**, recognizing AI's role in transforming education. The state government has introduced **AI-driven adaptive learning platforms** in public schools, providing tailored learning experiences for students. Special programs focusing on **e-learning, AI-based skill development, and teacher training in AI technology** are also gaining momentum. However, bridging the **digital divide in rural areas, ensuring equitable access to AI-driven education, and addressing ethical concerns** remain key areas of focus for policymakers and educators in Tamil Nadu.

AI in Education for Children with Autism

AI has shown significant potential in **special education**, particularly in assisting **children with autism spectrum disorder (ASD)**. AI-powered applications such as **speech therapy tools, emotion recognition software, and personalized learning assistants** help children with autism improve communication skills and social interactions. Virtual reality (VR) and augmented reality (AR) platforms offer **immersive learning experiences** that aid cognitive development and behavioral training. AI-driven assistive technologies also enable educators to design **customized educational programs** based on the individual needs of students with autism, fostering **inclusive and adaptive learning environments**.

Despite these advancements, challenges such as **screen dependency, reduced human interaction, and the need for specialized teacher training** must be carefully managed. Ethical concerns, including **data privacy and algorithmic bias**, also need to be addressed to ensure AI applications in special education align with best practices and educational values.

LITERATURE REVIEW

AI in education presents immense opportunities for **enhancing learning experiences, personalizing education, and supporting students with special needs**. While global organizations, national policies, and regional governments are working towards AI integration, addressing **accessibility gaps, ethical considerations, and teacher training** is crucial for AI's successful implementation. With a balanced approach, AI can serve as a **powerful tool in fostering inclusive and equitable education for all students, including those with autism, in India and beyond**

AI in Special Education: Global Trends in AI Applications for Children with Autism

Artificial Intelligence (AI) has significantly impacted the field of special education, particularly in assisting children with **Autism Spectrum Disorder (ASD)**. AI applications have been widely used in early autism diagnosis, social skills training, and personalized learning programs. Studies indicate that **AI-driven robots like NAO and QTrobot** have been effective in improving social engagement and communication among autistic learners (Cabibihan et al.). Similarly, **adaptive learning platforms** help customize educational content based on the child's pace and cognitive abilities (Pennisi et al.).

A bibliometric study analyzing global trends in **AI-based autism education** categorized research into three areas:

1. **Predictive AI for autism detection** – AI algorithms analyze behavioral and neurological data to detect ASD symptoms at an early stage.
2. **AI-driven social robotics** – Robots assist children with ASD in developing social and emotional skills.
3. **Personalized AI learning models** – Adaptive AI systems tailor educational content based on the child's needs (Boucenna et al.).

Despite advancements, **developing nations face barriers in integrating AI into special education** due to limited infrastructure, lack of training, and high costs (Sharma & Choudhary).

Existing AI Tools for Autism: Speech Recognition Software, Virtual Reality, and Adaptive Learning Platforms

AI-powered **assistive tools** have become instrumental in supporting children with autism. Some of the most commonly used AI technologies in autism education include:

1. **Speech Recognition Software** – AI applications such as Google's Speech-to-Text and Microsoft's Azure Speech Services help **non-verbal autistic children** communicate by converting spoken language into text and vice versa (Goodwin).

2. **Virtual Reality (VR) Interventions** – AI-enabled VR environments create controlled simulations where autistic children can practice social interactions and emotional recognition skills. Studies show that VR-based interventions improve cognitive and behavioral responses among ASD learners (Pennisi et al.).

3. **Adaptive Learning Platforms** – AI-based platforms such as **Knewton and Carnegie Learning** analyze students' performance and adjust educational content accordingly, providing personalized instruction for autistic children (Boucenna et al.).

These AI-driven tools have shown **positive impacts on learning outcomes**, but accessibility remains a challenge, particularly in low-resource settings (Sharma & Choudhary).

Challenges in AI Adoption: Cost, Accessibility, Training Gaps, and Institutional Policies

Despite the potential of AI in autism education, several **barriers hinder its widespread adoption**:

1. **Cost and Accessibility** – AI-driven educational tools are often expensive, making them **inaccessible to many special education institutions**, particularly in developing countries (Sharma & Choudhary).

2. **Lack of Teacher Training** – Special educators require technical knowledge to integrate AI tools into classrooms. However, **most Indian teacher training programs do not include AI-based pedagogical approaches** (IDR Online).

3. **Ethical Concerns** – The use of AI in education raises concerns about **data privacy, algorithmic bias, and the potential replacement of human educators** (Pennisi et al.).

4. **Institutional Barriers** – Many **schools and therapy centers lack the necessary infrastructure** and **policy support** to implement AI-based interventions effectively (Sharma & Choudhary).

Addressing these challenges requires **collaborative efforts from policymakers, AI developers, and educators** to develop cost-effective and accessible AI solutions.

Studies on AI Adoption in India: A Review of Relevant Indian Research

India has started integrating **AI-based learning tools into education** through initiatives such as the **National Education Policy (NEP) 2020**, which emphasizes AI-driven digital learning solutions (NextIAS). Some notable AI applications in Indian education include:

- **Nipun Assessment Test (NAT)** – The Uttar Pradesh government has introduced AI-driven assessment tests to evaluate the **cognitive and linguistic abilities of over 16 million students** (IDR Online).

- **AI-based Translation Tools** – AI applications help translate educational materials into **multiple Indian languages**, making special education more inclusive (Sharma & Choudhary).

- **AI for Early Autism Detection** – Indian researchers have developed **machine learning models** that analyze behavioral and neurological data to identify ASD symptoms at an early stage (Manu Kohli et al.).

The literature on AI in autism education highlights significant **global advancements in AI-driven interventions**, including **predictive analytics for autism detection, social robots for communication training, and adaptive learning platforms** for personalized instruction. AI tools such as **speech recognition software and VR-based interventions** have demonstrated promising results in improving cognitive and social skills in autistic learners.

Despite these developments, **India faces significant challenges in AI adoption**, including **high costs, lack of teacher training, and institutional barriers**. While policies such as **NEP 2020** promote AI integration into education, empirical research on its effectiveness in special education remains **limited**. Addressing these gaps requires **policy support, cost-effective AI solutions, and targeted training programs for special educators**. Future research should focus on **expanding AI accessibility, evaluating long-term impacts, and optimizing AI-based interventions for diverse learning environments**.

METHODOLOGY

This study employs a **quantitative research approach** to examine the **awareness, adoption, and perceived effectiveness of AI-based learning tools** among special educators in Chennai. It aims to understand **how AI-driven interventions are integrated into autism education**, identify **challenges faced by educators**, and assess their **perceptions regarding AI's impact on autistic children's cognitive and social development**. A **structured interview method** was used to ensure a **consistent and measurable assessment** of AI adoption patterns in special education. The study was conducted among **103 special educators** in Chennai, selected through a **stratified random sampling technique** to ensure representation from various **educational settings**, including **special schools catering exclusively to autistic children, inclusive schools integrating autistic students into mainstream classrooms, and therapy centers providing behavioral and cognitive interventions**. Participants were required to have **at least one year of experience in special education** and **basic familiarity with AI-based tools**. The structured interview focused on key areas such as **educator demographics (qualifications, experience, and institution type), AI awareness levels, usage patterns, perceived impact, and barriers to AI adoption (cost, lack of training, and technical difficulties)**. The collected data was analyzed using **descriptive statistics, correlation analysis, and chi-square tests** to identify **trends and relationships between educator characteristics and AI adoption levels**. The study adhered to **ethical research practices**, ensuring **confidentiality of participant information and obtaining informed**

consent before data collection. However, limitations include **sample size constraints, reliance on self-reported data, and the rapidly evolving nature of AI in education**, highlighting the need for **longitudinal studies** to track the long-term impact of AI-driven learning tools in special education.

DATA ANALYSIS

Through the study, the researcher explores the **perceived effectiveness of AI-based learning tools** in education, focusing on their **impact on student engagement, potential negative effects, and observed benefits**. Researcher examine how AI influences **learning experiences**, whether it enhances **interaction, cognitive development, and engagement**, or presents challenges like **screen dependency and reduced human interaction**. Additionally, we assess trust levels in AI tools and the primary reasons for their usage. By analyzing these factors, this report provides insights into the **opportunities and concerns associated with AI integration in education**, helping educators and stakeholders make informed decisions on AI adoption in learning


Workplace Type Distribution
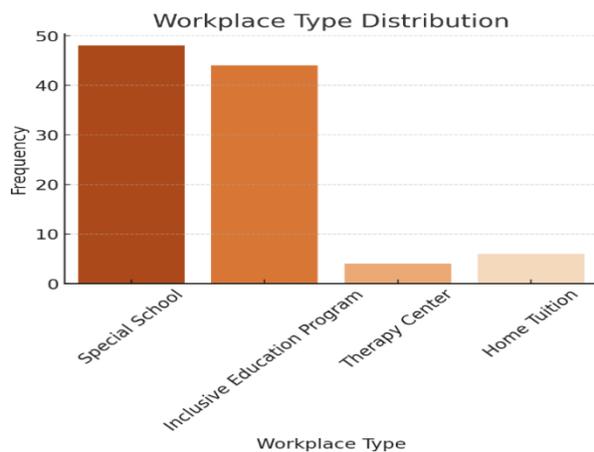
The demographic analysis reveals that most respondents (43.1%) fall within the 31-40 age group, followed by 29.4% in the 41-50 years category, while only a small percentage (7.8%) are 52 years old and above. The gender distribution is overwhelmingly female-dominated, with 90.2% of respondents being female. Regarding educational qualifications, a significant proportion hold a **B.Ed. in Special Education (33.3%)** or a **Master's Degree or higher (31.4%)**, while others possess a **Diploma (23.5%)** or a **Bachelor's Degree (11.8%)**. Experience in special education varies, with the largest group (39.2%) having **1-5 years of experience**, followed by **33.3% with more than 10 years**. Workplace distribution indicates that nearly half of the respondents work in **Special Schools (47.1%)**, while 43.1% are engaged in **Inclusive Education Programs**, with smaller groups working in **Therapy Centers (3.9%)** or providing **Home Tuition (5.9%)**. These insights highlight a predominantly female workforce with strong academic credentials and experience, primarily working within structured educational environments.

Comparison of AI Familiarity and AI Usage

Trust Level in AI-based Assistive Technologies
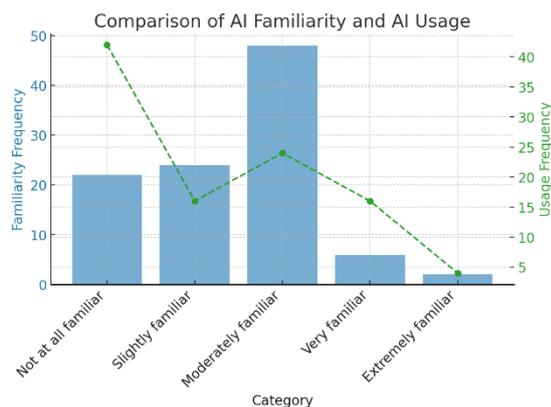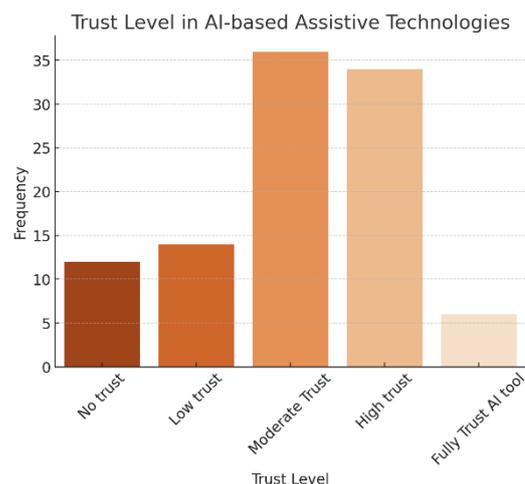
The analysis explores **familiarity, usage, trust, and learning sources** related to AI-based learning tools. A significant **47.1% of respondents** reported being **moderately familiar** with AI tools, while **21.6% were not familiar at all**. Despite this, **41.2% of respondents never use AI tools**, and only **3.9% use them daily**, indicating a gap between awareness and practical implementation.

Regarding the **primary reasons for using AI tools**, the majority cited **enhancing student engagement (37.3%)** and **providing personalized learning experiences (37.3%)**. Trust levels in AI-based assistive technologies varied, with **35.3% expressing moderate trust** and **33.3% having high trust**, but **25.5% reported low or no trust**, reflecting a mixed perception.

For AI awareness, **27.0% of respondents had never heard about AI-based tools**, while **22.2% learned through online research**, and **15.9% from media**. The **most commonly used AI tools** were **AI-based**

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communication apps (23.9%), followed by **AI-powered speech therapy tools (14.9%)**, while a significant **44.8% reported not using any AI tools**.

The **comparative analysis** suggests that **while AI awareness is increasing, its practical usage remains limited due to trust issues, lack of exposure, and potential barriers in education settings**.
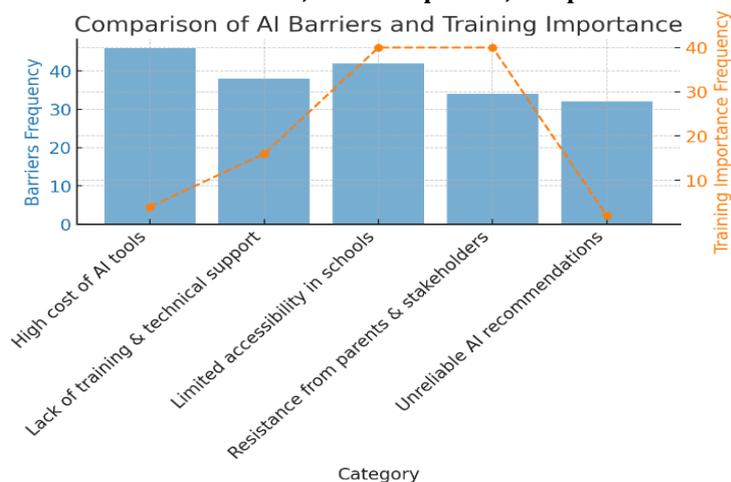

The analysis highlights the importance of **additional AI training** and the **barriers to AI adoption** in education. Regarding training, a significant **78.4% of respondents** consider it either **moderately (39.2%) or very important (39.2%)**, indicating a strong demand for AI training among educators. However, **only 2% consider it extremely important**, while **3.9% believe it is not important** at all.

In terms of **barriers to AI adoption**, the most significant challenges include **high costs of AI tools (24.0%), limited accessibility in schools (21.9%)**, and **lack of training & technical support (19.8%)**, reinforcing the need for more affordable and accessible AI solutions. Resistance from parents & stakeholders (17.7%) and concerns over unreliable AI recommendations (16.7%) also pose hurdles.

The combined analysis suggests that **enhancing AI training and addressing key barriers—particularly cost and accessibility—can significantly improve AI adoption in education**.
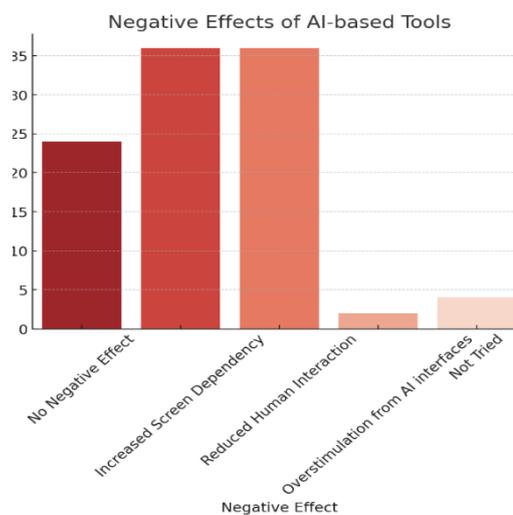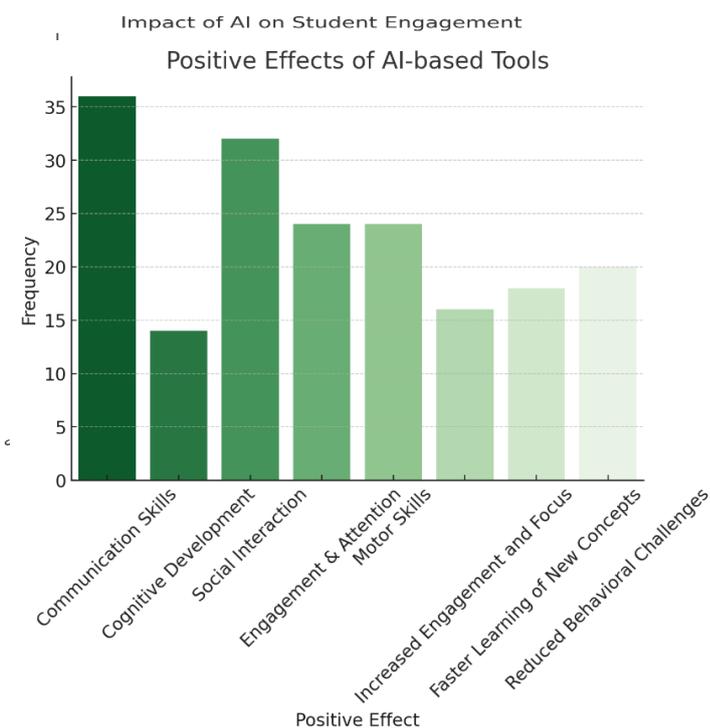
The analysis explores the **impact, positive contributions, and potential negative effects of AI-based learning tools** in education.

Regarding **student engagement**, 43.1% of **respondents reported a slight increase**, and **11.8% saw a significant increase** when using AI-based tools. However, **13.7% felt that AI significantly decreased engagement**, while **11.8% noted a slight decrease**, highlighting mixed perceptions about AI's effectiveness.

On the **negative effects of AI-based tools**, the most commonly cited concerns were **increased screen dependency (35.3%)** and **reduced human interaction (35.3%)**, which may raise issues regarding social skills and physical activity. **23.5% of respondents reported no negative effects**, while **only 2% mentioned overstimulation** from AI interfaces.

In terms of **positive effects**, AI was most recognized for **enhancing communication skills (18.9%)**, **improving social interaction (17.4%)**, and **boosting engagement & attention (13.0%)**. Additionally, respondents noted

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improvements in **motor skills (13.0%)**, **reduced behavioral challenges (10.9%)**, and **faster learning of new concepts (9.8%)**.

These findings suggest that while AI can improve **student engagement, communication, and learning outcomes**, concerns over **screen dependence and reduced interpersonal interactions** must be addressed to maximize its benefits.

Recommendations for AI Integration in Education

1. Orientation & Awareness Session: Before integrating AI into the learning environment, educators and students should undergo an **awareness session** highlighting the **capabilities, limitations, and ethical considerations** of AI-based tools. This session should focus on **dispelling misconceptions**, introducing AI-powered learning platforms, and explaining how AI can assist rather than replace traditional teaching methods. Additionally, educators should be introduced to **successful AI implementations in education** to foster confidence in its use.

2. Training & Professional Development for Educators: To maximize AI's effectiveness, **educators must be adequately trained** in its application. Training sessions should cover **personalized learning approaches, adaptive AI-driven assessments, and AI-assisted communication tools**. Educators should also receive **technical support and guidelines on responsible AI usage** to mitigate concerns such as **over-reliance on AI and reduced human interaction** in the classroom.

3. AI Implementation in Classroom Activities: Once trained, educators can begin **phased AI integration** by incorporating AI tools into lesson plans. Initial sessions should focus on **engaging students with AI-assisted interactive learning tools** such as **gamified quizzes, virtual tutors, or speech recognition applications**. Educators should ensure AI is used as a **complementary tool** rather than a replacement for **direct teacher-student engagement** to avoid the issue of **screen dependency**.

4. AI for Personalized Learning & Student Engagement: AI should be leveraged in **targeted learning sessions** to provide **personalized instruction** tailored to individual student needs. Since **37.3% of respondents** cited AI's ability to enhance **student engagement and personalized learning experiences**, sessions should focus on AI-driven tools that **adjust difficulty levels, offer tailored recommendations, and track student progress in real-time**. This will ensure students receive **individualized attention without over-relying on AI-generated responses**.

5. Monitoring & Evaluation Sessions: Regular **feedback sessions** should be conducted to **assess AI's effectiveness** in improving student engagement and learning outcomes. Educators, students, and parents should provide insights on the **positive and negative aspects of AI integration**. Special focus should be placed on monitoring **screen time, human interaction levels, and trust in AI-driven recommendations**. These insights should then guide further **policy improvements and AI tool refinements**.

6. Ethical AI Usage & Digital Well-being Sessions: Given concerns about **increased screen dependency (35.3%)** and **reduced human interaction (35.3%)**, AI sessions should include discussions on **responsible technology usage**. Schools should introduce **digital well-being strategies**, emphasizing **balanced screen time, ethical AI practices, and the importance of human interaction**. AI developers should also be involved in sessions to address **privacy, security, and transparency concerns**, ensuring AI systems remain **trustworthy and unbiased**.

7. Future Prospects & Continuous Improvement Sessions: To sustain AI adoption, periodic sessions should be conducted to explore **emerging AI innovations** and their potential applications in education. Schools should collaborate with **AI developers and policymakers** to refine AI learning tools based on **real-world classroom experiences**. Additionally, **peer-sharing workshops** where educators discuss their AI successes and challenges can help create a **community-driven approach to AI integration**

CONCLUSION

Artificial Intelligence (AI) continues to redefine education by bridging gaps in accessibility, fostering personalized learning, and enhancing instructional methodologies. This study underscores the dual nature of AI's influence—offering substantial benefits while also presenting challenges that require strategic intervention. AI's integration into education has demonstrated improvements in engagement, cognitive development, and communication skills, particularly for children with Autism Spectrum Disorder (ASD). However, factors such as screen dependency, ethical concerns, and the necessity of teacher training remain critical considerations.

The global movement toward AI-driven education, supported by UNESCO and national policies like India's **National Education Policy (NEP) 2020**, signifies the growing acceptance of AI as a transformative tool. Tamil Nadu has taken proactive steps to implement adaptive AI learning platforms, yet issues like affordability, accessibility, and implementation complexities persist, highlighting the need for infrastructure development and policy refinement.

For children with autism, AI-driven assistive technologies provide meaningful support in communication and learning, yet their widespread adoption is hindered by technical, ethical, and infrastructural barriers. Ensuring the responsible and inclusive application of AI in education requires a collaborative effort from policymakers, educators, and technologists.

To move forward, AI implementation must be aligned with ethical frameworks, extensive educator training, and student-centered learning strategies. Future research should explore AI's long-term impact, address digital equity challenges, and enhance adaptive learning models to create a more inclusive and effective educational environment.

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