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TECHNICAL COMMUNICATION

AI in Education

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Introduction and Background

Artificial Intelligence Overview

Artificial Intelligence (AI) refers to the simulation of human intelligence processes by machines. In education, AI can personalize learning, automate administrative tasks, and provide data-driven insights for educators.

Application in Education Sector

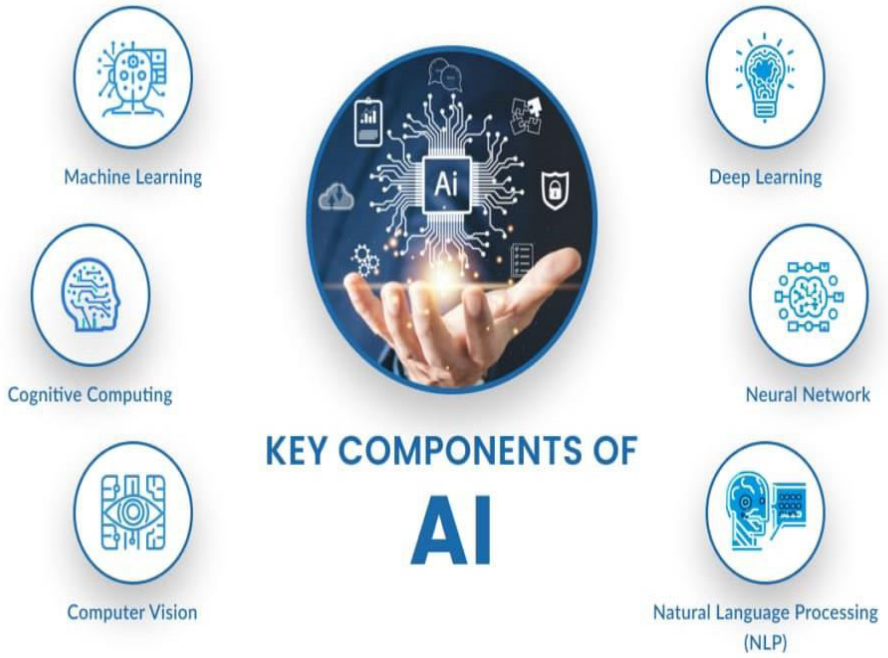
AI in education involves adaptive learning platforms, intelligent tutoring systems, and smart content recommendations. It aims to enhance student engagement, improve outcomes, and streamline teaching processes.

What is AI

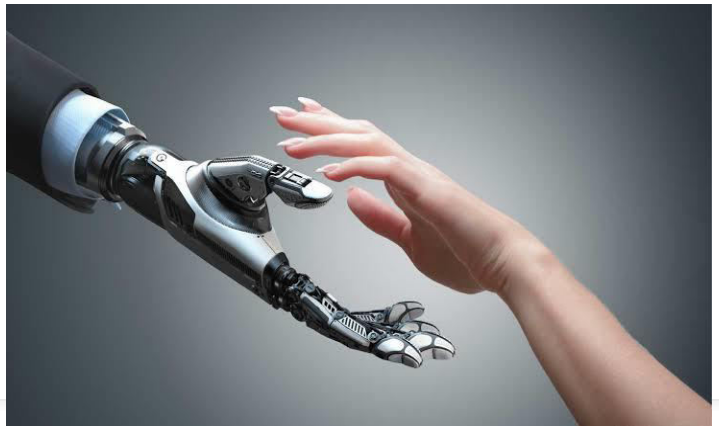
Artificial intelligence is a field of science concerned with building computers and machines that can reason, learn, and act in such a way that would normally require human intelligence or that involves data whose scale exceeds what humans can analyze.

AI is a broad field that encompasses many different disciplines, including computer science, data analytics and statistics, hardware and software engineering, linguistics, neuroscience, and even philosophy and psychology.

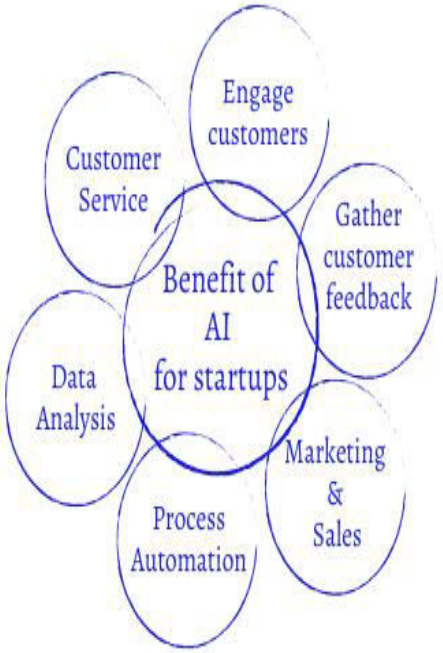
On an operational level for business use, AI is a set of technologies that are based primarily on machine learning and deep learning, used for data analytics, predictions, natural language processing, recommendations, and more.

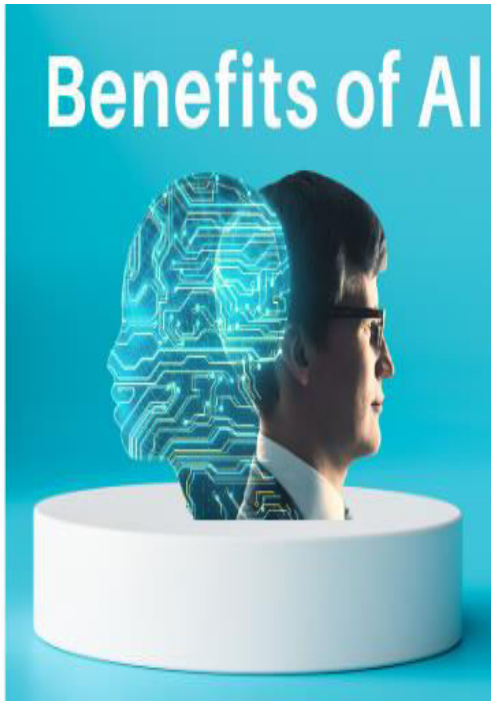


Benefits of AI

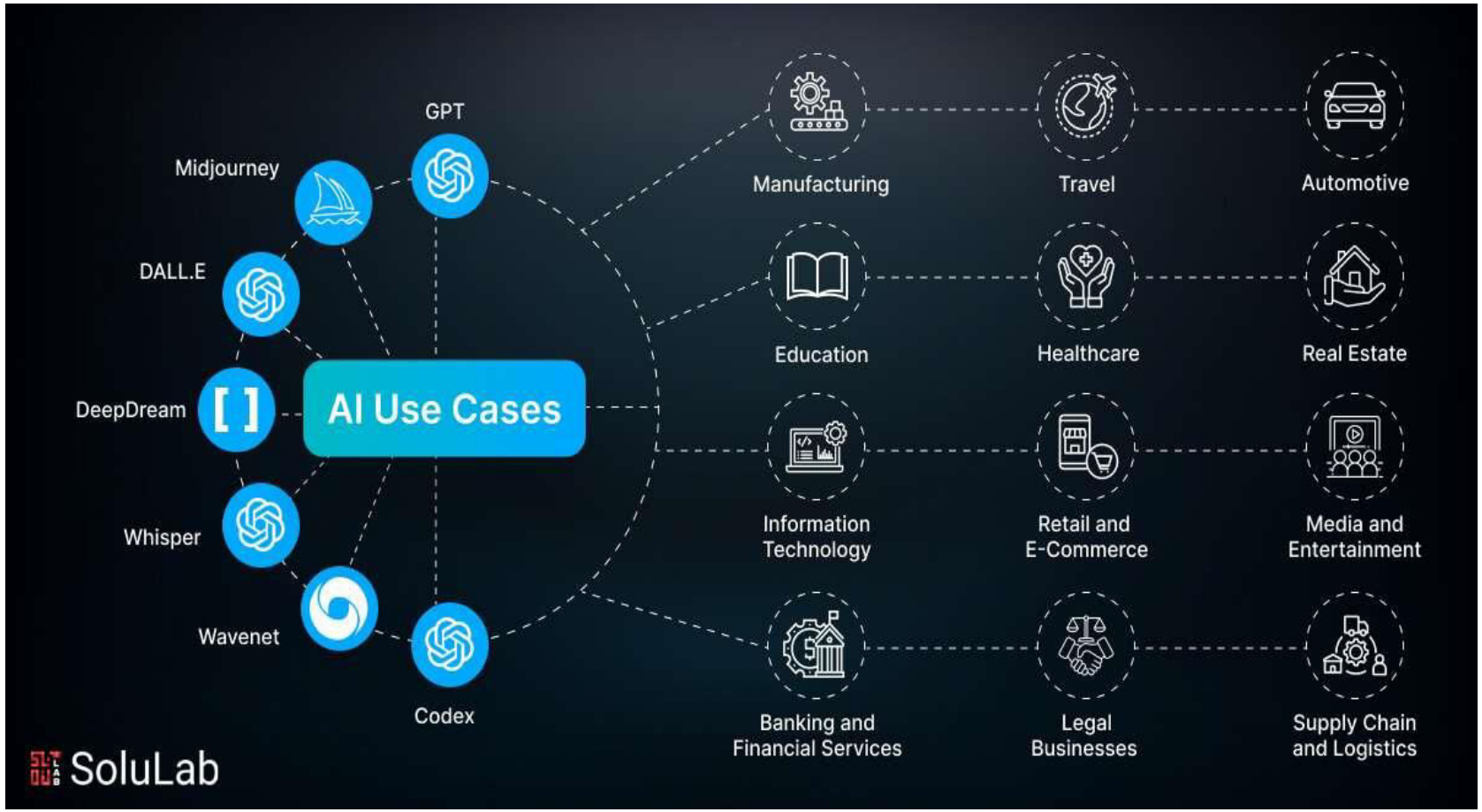


- **Automation** : AI can automate workflows and processes or work independently and autonomously from a human team.
- **Reduce human error** : AI can eliminate manual errors in data processing, analytics, assembly in manufacturing, and other tasks through automation.
- **Eliminate repetitive tasks** : AI can be used to automate processes, like verifying documents, transcribing phone calls, or answering simple customer questions.
- **Infinite availability**: When running in the cloud, AI and machine learning can be “always on,” continuously working on its assigned tasks.





Sectors in which AI is being used



- ✓ Healthcare
- ✓ Retail and e-commerce
- ✓ Banking and financial services
- ✓ Supply chain and logistics
- ✓ Travel
- ✓ Real estate
- ✓ Media and entertainment
- ✓ Manufacturing
- ✓ Pharmaceuticals and biotechnology
- ✓ Education
- ✓ Fashion
- ✓ Private equity and principal investment
- ✓ Information technology
- ✓ Hospitality

Intersection of AI and Education

Education has welcomed the introduction of AI to improve standards, accessibility and innovation in the sector to enhance learning and teaching around the world.

AI in education can personalize learning experiences, redefine teaching practices, offer real-time feedback, and support educators with advanced tools and insights, leading to more effective and engaging educational environments.

It holds immense potential to address the gaps that global education systems are struggling with and revolutionize the entire industry with its diverse use cases.

Fig. The SDG4 target progress chart

How AI is changing the education landscape

- The 2030 Agenda for Sustainable Development, adopted by all United Nations members in 2015, created 17 world Sustainable Development Goals in which SDG 4 is the goal for quality education
- It aims at ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all.
- AI has become an effective tool for addressing challenges in education and accelerating progress towards SDG 4.
- AI has the potential to transform education by optimizing teaching and learning processes through personalized learning algorithms.

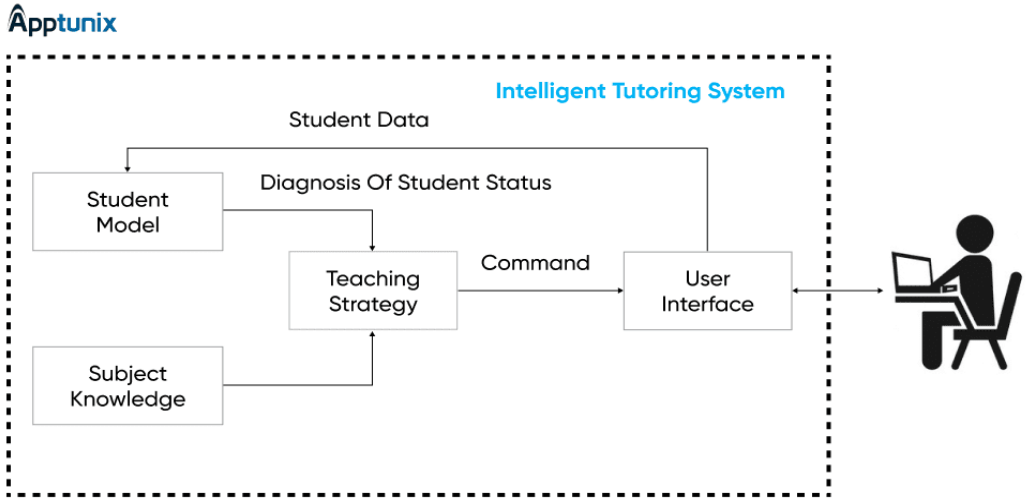
Some AI tools in Education

- By now, you've probably heard about **ChatGPT**, the AI chatbot developed by OpenAI..
- **Duolingo**: a language learning app that uses AI to personalize lessons for each user
- **ALEKS**: an AI-powered math learning platform that provides adaptive assessments and personalized learning plans
- **Coursera**: which uses AI to recommend courses to students based on their interests and previous learning history.
- Coursera has used AI for language translations, making their courses available in 17 languages, including Greek, Ukrainian, and Kazakh.

coursera

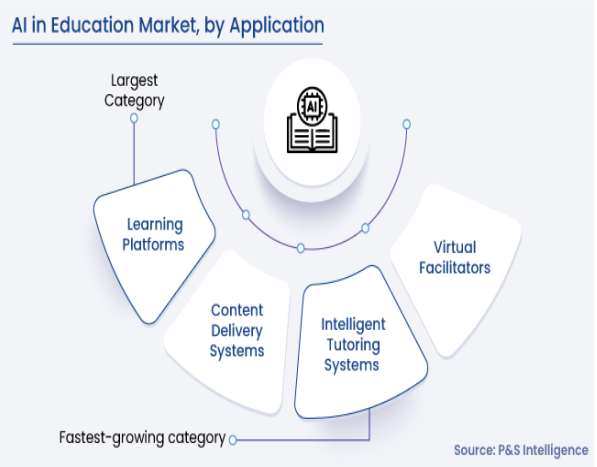
ALEKS

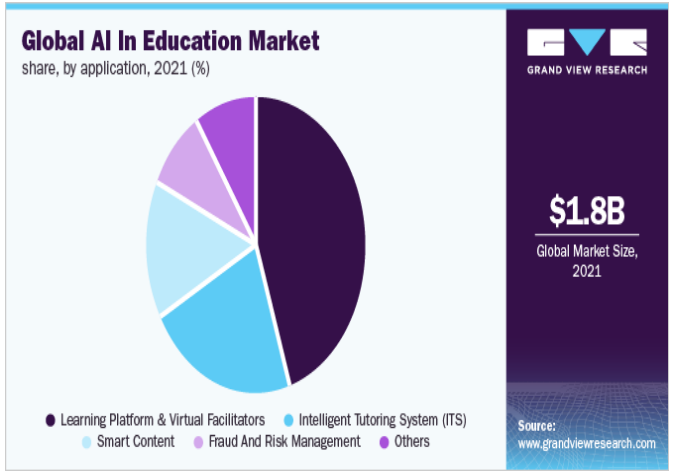
duolingo



Market Potential of AI in Education

- Top AI use cases in education aim at leveraging AI-assisted learning methodologies for education.
- The investments for use cases of AI in education amounted to $2 billion in 2020.
- UNESCO has claimed that the market capitalization of AI in education will reach $6 billion by 2024. Market research reports also suggest that the market size for artificial intelligence in education might reach $12 billion by 2027.





Significance

Transformation of Educational Landscape

AI has the potential to revolutionize education by enhancing accessibility, inclusivity, and effectiveness. It can address individual learning needs, promote lifelong learning, and prepare students for future workforce demands.

Significance

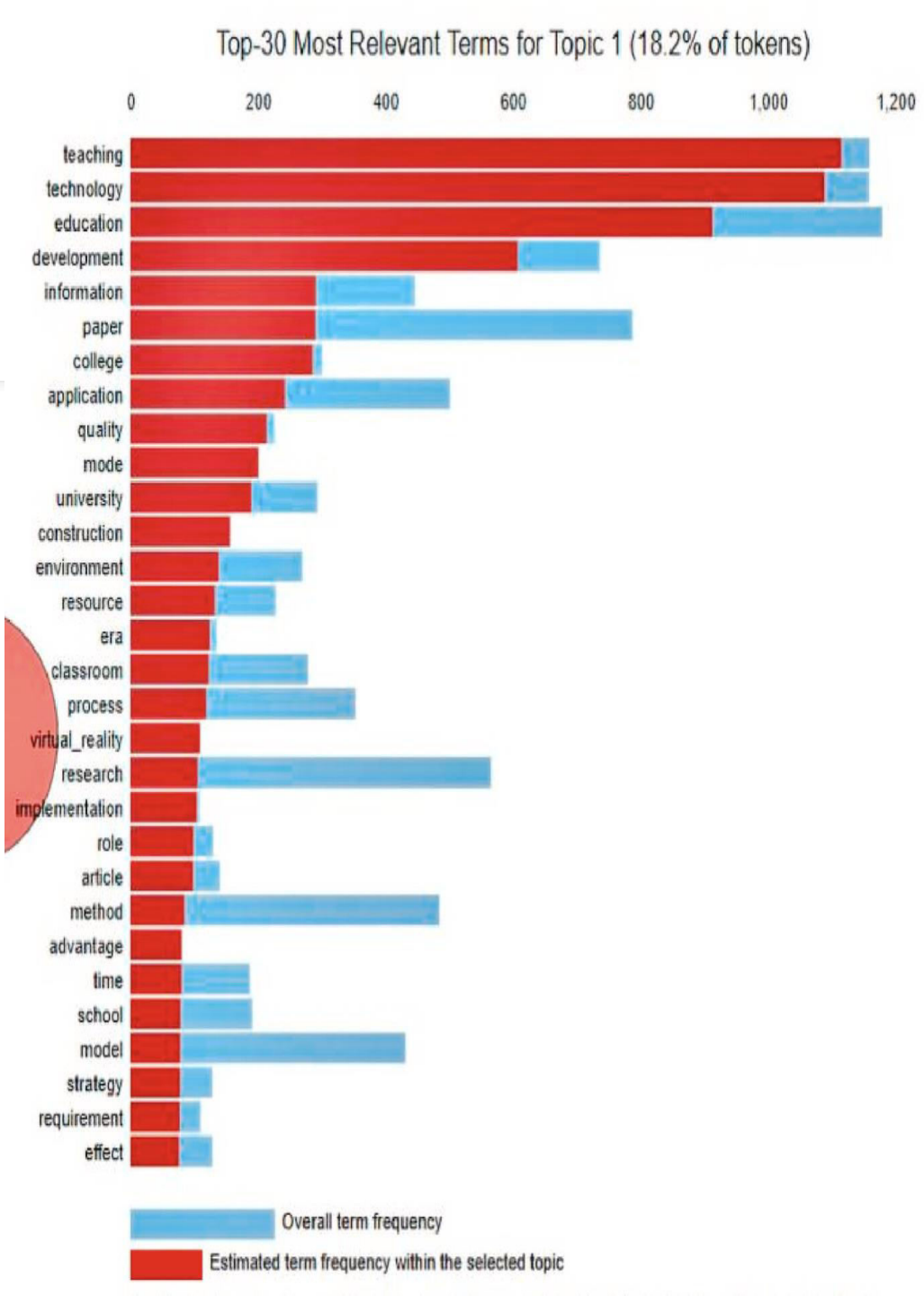
1. Personalized Learning

- A study was performed approach using topic modeling, to analyze the abstracts of 1709 papers and identify key themes. This process revealed ten topics, of which three were pertinent to their research .

A subsequent LDA model was applied to these abstracts to explore more nuanced sub-topics for further investigation in which the topic that was found to be most applicable is studying personalized education and the use of AI in it .

- It also provided customized lessons , exercises based on the individual performance and preferences

AI do so by implementing a reinforced learning algorithm which is based on real time performance feedback It adapts it's recommendations based on user progress and success rates.



Significance

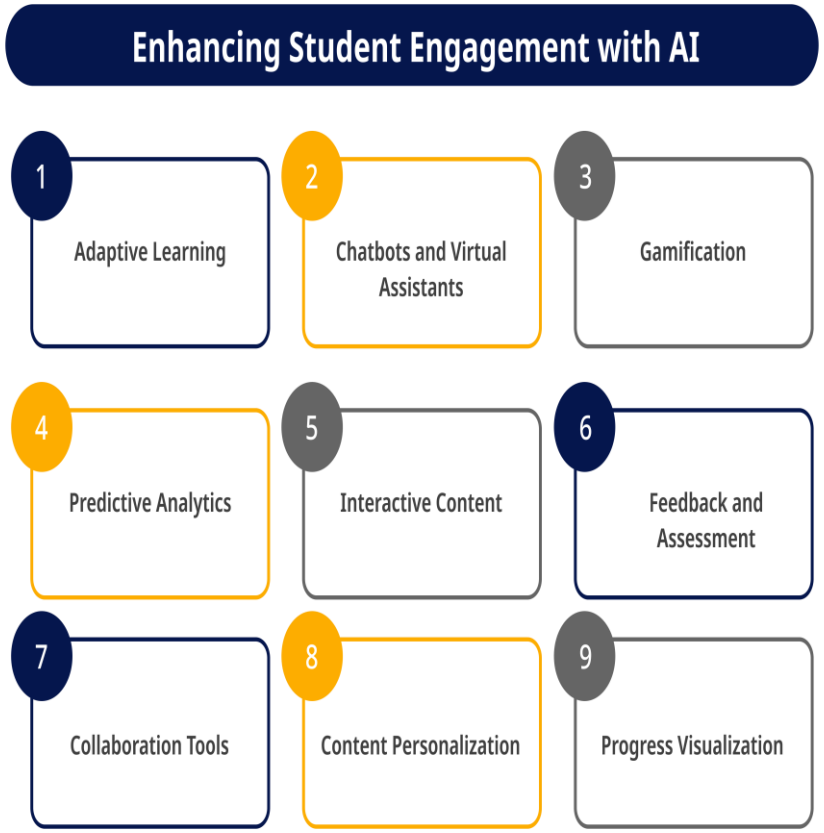
2. Enhanced Student Engagement

- It promotes a positive environment among students and recognizes their achievements, which boosts their motivation to learn and improve.
- It improves learning by providing opportunities to gain knowledge and skills through hands-on experiences in virtual environments that are safe and well-managed.

For e.g. Embodied Labs which utilizes various technologies to provide first class training experience to medical professionals. Central to this approach is VR, which allows users to experience patient scenarios from a first-person perspective.

The platform employs computer vision and motion tracking to monitor users' movements in real-time, enhancing immersion.

Natural Language Processing (NLP) enables responsive interactions in conversational simulations,with virtual patients . Additionally, data analytics track user behavior to assess learning progress and adapt scenarios



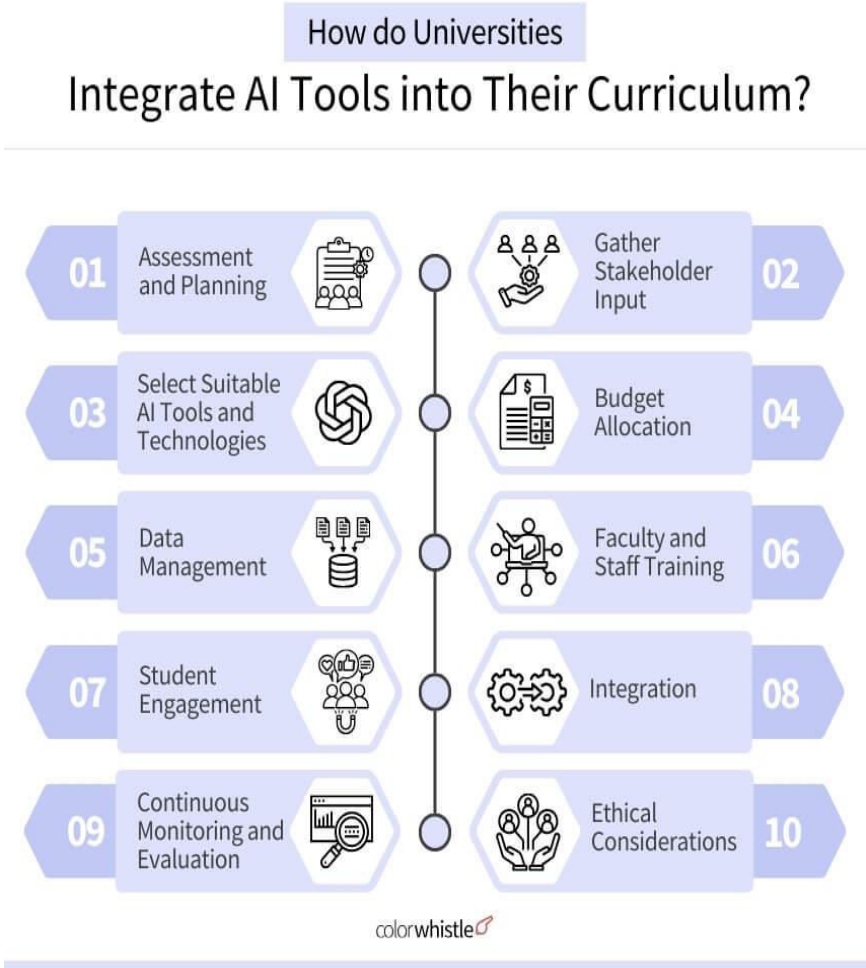
Significance

3. Curriculum Optimization

- It focuses on continuously improving educational courses by collecting and analyzing data and research results to improve decision-making.
- the curriculum is modified to accommodate the various cultural backgrounds, languages, and educational needs of different groups of students. This ensures that all students can understand and engage with the material effectively
- the educational content is regularly revised and improved to include the latest information and to meet current educational guidelines.

AI can be connected to **external databases and real-time data feeds** from trusted organizations, research institutions, and online journals. This allows the AI system to pull the latest information and incorporate it into its recommendations.

For instance, an educational AI system could use APIs from reputable sources like PubMed, IEEE Xplore, or government databases to access the latest scientific research and official guidelines.



Significance

4. Increase Accessibility

- AI-powered tools such as speech-to-text, text-to-speech, and screen readers help in assisting students with visual, auditory, or learning impairments.
- It provides quality education to students in remote areas, helping to remove the significant educational gap.
- Real-time translation services help people understand different languages instantly, allowing non-native speakers to access the material more easily.

These tools are developed by transforming the input format into a specified format suitable for the application of NLP techniques. Then these techniques which are based on RNN which are trained on huge amount of data make predictions which are very close to actual result

Challenges

With every great opportunity introduced by AI tools and capabilities, educators should be supported in overcoming the challenges that arise as well.

Challenges

- Lack of Basic Technological Infrastructure
- Lack of trained educators
- Data Privacy and Security
- Digital Divide
- Biased Information and hallucinations
- Ethical Considerations
- Cost and Budget Constraints
- Resistant to Change
- Overdependence of students as well as faculties on AI systems
- Compliance Issues
- Content Quality and Relevance
- Fear of losing jobs

Challenges

1. Biased Information and hallucinations

- Implicit or explicit bias in training data will lead to discrimination against certain groups of people
- Reinforce societal inequalities
- Undermine the principles of equal and fair distribution
- It is very easy for AI to create hallucinations or false content that look convincing.
- AI generated content can be unreliable, and faculties as well as students need to establish the ability to critically review these responses

Challenges

2. Data Privacy

- AI systems in education processes vast amount of data
- Unauthorized access or data breaches can lead to identity theft, academic dishonesty, and misuse of personal information
- Data collected must be used for its intended purpose
- Must not be shared with third party without consent
- Proper access controls, data collection, storage, and monitoring systems must be installed and maintained to mitigate the risks

Challenges

3. Compliance Issues

- Institutions are required to comply with data protection regulations
  - GDPR in Europe
  - FERPA in US
- These laws describes how personal information should be collected, stored, and shared to ensure data is kept secure and used only for specified purposes.
- Ensuring AI systems are designed and operated in compliance with these regulations can be complex and resource-intensive, requiring heavy monitoring and adjustment to maintain compliance.

Challenges

4. Digital Divide

- It refers to the gap between those who have access to digital technology and those who don't.
- Students in underfunded schools or low-income households may lack access to essential devices such as laptops, tablets, or smartphones. Without these tools, they cannot fully participate in AI-driven educational programs.
- It will affect the equitable and fair distribution of educational resources and opportunities.
- It can lead to unequal access to educational tools and resources, affecting student's learning experiences and outcomes.

Challenges

The digital divide in education results in four major outcomes, as identified by the Digital Divide Council:-

1. Low performance,
2. Diminished competitive edge,
3. Inconvenience in learning,
4. Disparate learning experiences.

Challenges

5. Cost and Budget Constraints

- The cost of developing or purchasing AI tools can be high, which can be a barrier for many educational institutions.
- Beyond the initial purchase, there are ongoing costs related to maintaining and updating AI systems, training staff, and ensuring data security.
- Schools need to plan for long-term financial sustainability.
- Financial planning and resource allocation are critical to sustaining AI initiatives over time.

Challenge in AI use	Description	f	Sample research
Limited reliability of AI algorithms	AI algorithms are not reliable enough to provide useful information to teachers	6	Schwarz et al. (2018)
Limited technical capacity of AI	AI may not be capable of processing specific features (e.g., graphics or images and text)	3	Ma et al. (2020)
Limited technical infrastructure in schools for AI	Technical infrastructure in schools are limited for AI-based teaching	2	Ozdemir and Tekin (2016)
Inapplicability of the AI system to multiple settings	An AI system cannot operate in multiple learning settings	2	Nikiforos et al. (2020)
Inefficiency of AI for assessment and evaluation	AI cannot properly evaluate text structure and content logic and coherence	2	Lu (2019)
Lack of technological knowledge of teachers on AI use	Teachers may not have the technological knowledge needed for AI-based teaching	1	Chiu and Chai (2020)
Lack of interest of teachers in AI	Teachers may perceive AI as uninteresting and unenjoyable for teaching	1	McCarthy et al. (2016)
Slow AI feedback	AI feedback may take longer than expected	1	McCarthy et al. (2016)
Limited AI adaptive feedback	AI may not provide comprehensive adaptive and personalized feedback	1	Burstein et al. (2004)

Source: Celik, Ismail, et al. "The Promises and Challenges of Artificial Intelligence for Teachers: A Systematic Review of Research."

Existing Approaches

Current AI Solutions

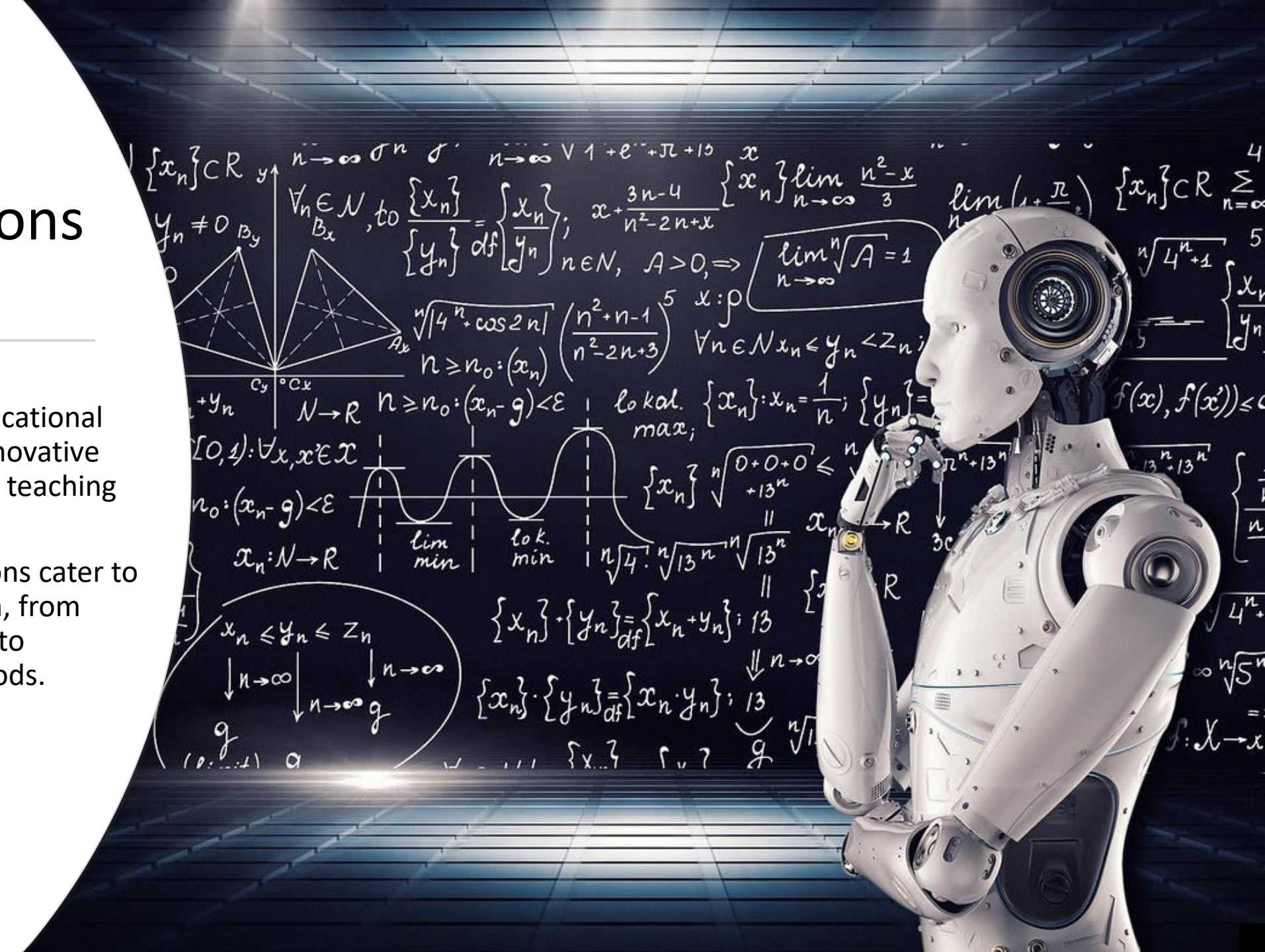
AI applications in education include virtual tutors, smart assessments, and learning analytics tools. These technologies aim to enhance student engagement, facilitate personalized learning, and improve academic outcomes.

Impact on Teaching Methods

AI tools can automate routine tasks, provide real-time feedback to students, and enable teachers to focus on individualized instruction. They also offer insights into student performance and learning patterns.

Current Solutions

- AI is transforming the educational landscape by introducing innovative solutions that enhance both teaching and learning experiences.
- These AI-driven applications cater to various aspects of education, from personalized learning paths to advanced assessment methods.



Current AI Solutions

1. **Virtual Tutors**
   - AI-powered systems that provide students with personalized support outside the traditional classroom setting.
   - Offer explanations, answer questions, and guide students through complex topics at their own pace.
   - 24/7 Available
   - Popular Examples : Knewton, Socratic (by Google)

2. **Smart Assessment**
   - AI-driven assessments are revolutionizing the way student performance is measured.
   - Offers real-time feedback, adaptive testing, and detailed analytics on student progress
   - This ensures that assessments are not just evaluative but also formative
   - Examples : Edulastic, Grammarly

Current AI Solutions (Continued)

3. Learning Analytics Tools

- Learning analytics tools leverage AI to collect and analyze data on student performance, engagement, and behavior.
- By analyzing patterns in data, AI can predict student success and even flag at-risk students, allowing for timely interventions.
- Popular Examples : BrightBytes, Cerego

4. Personalized Learning Platforms

- AI-powered personalized learning platforms adapt educational content to fit the needs, preferences, and pace of each student.
- Can create customized learning paths, ensuring that students focus on areas that require the most attention
- This personalized approach helps in bridging knowledge gaps and accelerates learning.
- Examples : DreamBox Learning, Duolingo.

Use Case of DreamBox Learning

1. What DreamBox Learning Does:

- DreamBox Learning is an online math education platform that personalizes learning using adaptive technology.
- It tailors math lessons to each student’s level, keeping them engaged and helping them master concepts over time.

AI Algorithms at work in DreamBox Learning

- **2. Algorithms in DreamBox**
- **Adaptive Learning Algorithm**: These algorithms use **decision trees** or **machine learning models** to determine skill level, detect patterns in mistakes, and decide the next best content.
- **Spaced Repetition**: Optimize review timing by predicting the best intervals for a user to revisit material. they Use **exponential decay models** or **algorithms like the SM2** (used by SuperMemo) to calculate when memory retention drops.
- **Error Pattern Analysis**: Technically, they use **clustering methods** or **rule-based systems** to recognize recurring error types (e.g., calculation mistakes or conceptual misunderstandings).
- **Engagement & Gamification Algorithms**: These algorithms use behavioral data—such as time spent on tasks, response speed, and consistency—along with **reinforcement learning** or **threshold-based models** to offer rewards strategically.

AI Algorithms in DreamBox Learning (Contd..)

3. How These Algorithms Work to Deliver Personalization:

- The **adaptive learning algorithm** continuously evaluates each student's responses in real time, adjusting the lesson sequence and difficulty based on their progress.
- **Error pattern analysis** helps pinpoint specific misunderstandings, while spaced repetition ensures timely reviews for memory reinforcement.
- **Engagement algorithms** provide achievements and rewards to sustain interest, balancing challenge and encouragement throughout the curriculum.

Impact of AI on Teaching Methods

- Offers educators powerful tools to enhance their effectiveness and transform the classroom experience.
- By automating routine tasks, providing real-time feedback, and offering deep insights into student performance
- AI allows teachers to focus more on individualized instruction and fostering a richer learning environment

Impact of AI on Teaching Methods (Continued)

1. Automation of Routine Tasks

- AI tools are revolutionizing the way teachers manage routine tasks, such as grading, attendance tracking, and administrative paperwork.
- Help in freeing up valuable time that teachers can redirect towards more meaningful interactions with students.
- Reduce the potential for human error.
- Example : Gradescope

2. Real-Time Feedback

- Can analyze student work instantly and offer immediate, actionable insights, helping students understand their mistakes and learn from them on the spot.
- For teachers, this means they can monitor student progress more closely and intervene promptly when a student is struggling, ensuring no one falls behind.
- Example : Grammarly

Impact of AI on Teaching Methods (Continued)

3. Individualized Instruction

- AI's ability to analyze vast amounts of data enables it to create highly personalized learning experiences for each student.
- Teachers can use AI-driven insights to design customized lesson plans, assign tailored homework, and provide differentiated support, ensuring that each student receives the guidance they need to succeed.
- Example : DreamBox Learning

4. Insights into Student Performance

- AI tools offer educators deep insights into student performance and learning patterns, which are critical for informed decision-making.
- These insights enable teachers to adjust their teaching methods dynamically, ensuring they are meeting the evolving needs of their students.
- Example : BrightBytes

Open Problems and Future Scope

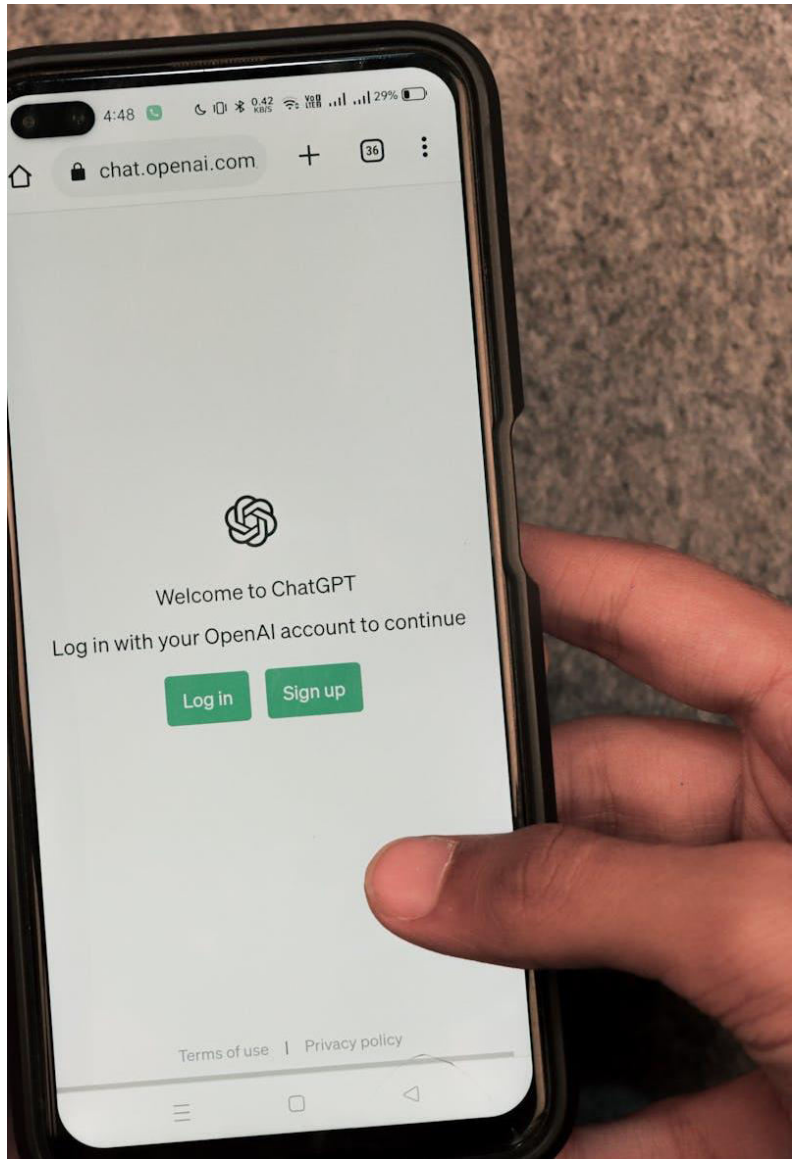
As AI continues to transform education, it brings both incredible opportunities and significant challenges.

While AI-powered tools have the potential to revolutionize learning experiences, there are still unresolved issues that need attention.

This section will explore the current open problems in integrating AI into education. We will also look ahead to the future scope, where advancements in AI could further enhance educational accessibility, and lifelong learning.

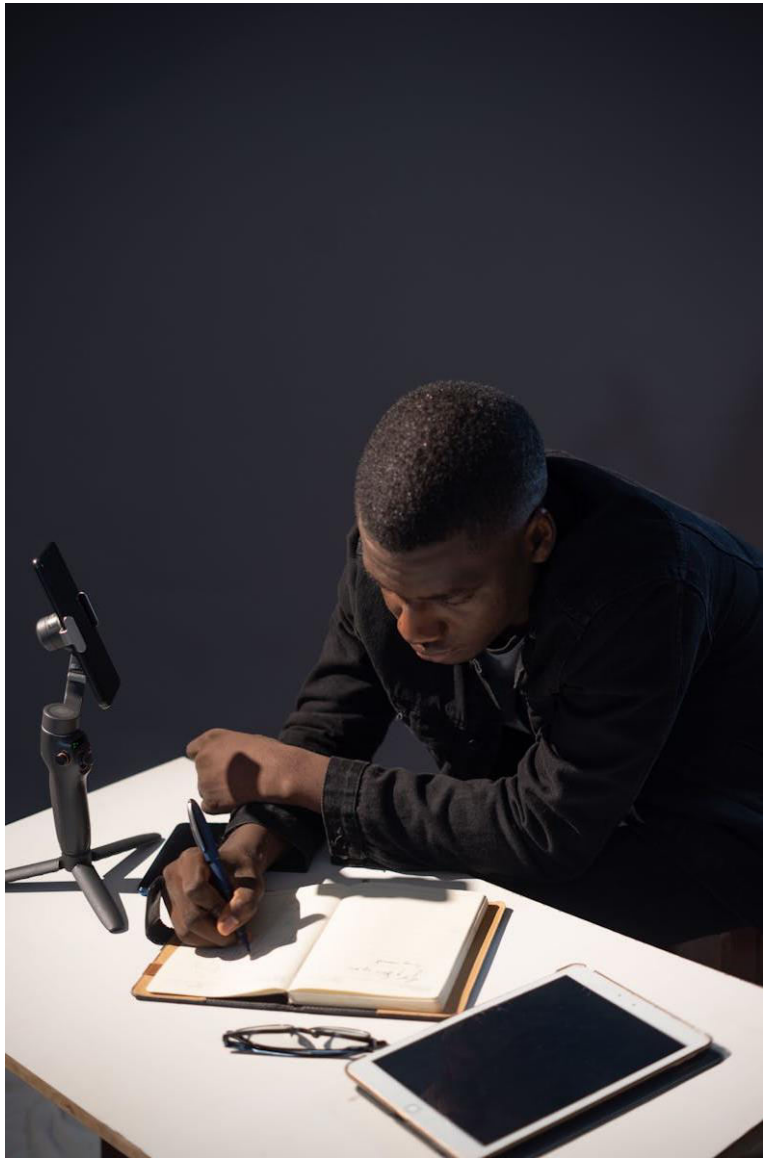
Open Problems

- **Personalization vs. Privacy** - AI can customize learning but raises privacy concerns around student data protection.
- **Teacher-AI Integration -** Teachers need training to use AI effectively; there's a risk AI could be viewed as replacing rather than assisting them.
- **Accessibility and Equity -** AI tools may be inaccessible in under-resourced areas, risking inequity in benefits across socio-economic groups
- **Ethical Considerations -** AI's role in educational content, assessments, and monitoring requires careful ethical consideration.



Open Problems

- **Effectiveness Measurement**: It’s challenging to gauge AI's impact on learning outcomes and compare it to traditional methods.
- **Dependence on Technology**: Over-relying on AI might hinder students' critical thinking and problem-solving skills.
- **Long-Term Impact**: The effects of AI on education, including roles of teachers and student learning, are not fully understood.



Future Scope

- **Intelligent Tutoring Systems**: AI tutoring offers real-time assistance, adapting feedback and support like one-on-one tutoring.
- **Automated Assessment and Feedback**: AI can assess complex tasks and provide personalized feedback, helping students improve.
- **Language Translation and Accessibility**: AI breaks language barriers and supports students with disabilities through tailored resources.

Future Scope

- **AI-Driven Content Creation**: AI can develop interactive, up-to-date educational content, keeping resources current and engaging.
- **Predictive Analytics for Student Success**: AI analyzes data to predict outcomes, enabling early intervention for at-risk students.
- **Virtual and Augmented Reality (VR/AR)**: AI-enhanced VR/AR provides immersive, adaptive learning experiences in virtual simulations.

Conclusion

In conclusion, AI holds immense potential to revolutionize the education sector by personalizing learning experiences, enhancing teacher efficiency, and improving student outcomes. Embracing AI in education requires addressing challenges and fostering innovation to create a more inclusive and effective learning environment for all learners.

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Thank You