ARTIFICIAL INTELLIGENCE BASED TUTOR

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ABSTRACT

AI-based tutors have the potential to revolutionize education sector and provide personalized learning experiences. It will encourage the implementation of artificial intelligence based algorithms and customized application to promote the development of cognitive and pedagogical skills in students.

Traditional education faces several challenges when compared to AI-based tutors. Here's a brief overview of some of these challenges, viz; limited personalization, time and resource constraints, lack of real-time feedback, limited access to expertise, lack of flexibility and adaptability & teacher workload.

AI based tutors leverage machine learning algorithms and natural language programming to analyse individual student needs and deliver tailored educational content and support. These tutors serve as virtual assistants, capable of adapting to each students learning style, pace and preferences. They provide individual attention to students, allowing students to access the content at their convenience, breaking down barriers of time and location.

It is important to note that while AI-based tutors offer potential solutions to some of the challenges in traditional education, they should not be seen as a complete replacement for human teachers. The ideal approach is to combine the strengths of AI with the expertise, guidance, and empathy of human educators to create a comprehensive and effective learning environment.

KEYWORDS*:* Artificial intelligence (AI), Neuro diversity, sensors, Natural Language Processing, Learning management system , Intelligent tutoring robots

I. INTRODUCTION

Artificial intelligence has rapid growth and is completely changing all aspects of life. It contributes towards learning and teaching methodologies too.

Literature study reveals the following; viz;

i. Student demand for flexible and convenient learning modalities is increasing.

ii. The focus on equitable teaching as well as learning has enhanced.

iii. The field of artificial intelligence in various sectors is growing

Intelligent tutoring using AI holds great promise in revolutionizing education by offering personalized, adaptive, and engaging learning experiences. These systems can complement traditional classroom instruction and provide additional support for individual students, enhancing their learning outcomes

II.BENEFITS OF AI BASED TUTORS

By immersing students in technology from initial stages of academics, we are likely to be giving give exposure for them a future workplace, where use of such technology will inevitably become more common. Indeed, AI-based tutors have the potential to address several challenges in conventional teaching. Here are some specific ways AI is already bringing numerous benefits to the students:

i. Analyse the gaps in learning: Specially designed AI based environment can analyse the past performance, and identify learning gaps.

ii. Personalisation: AI can create a personalised learning experience rather than a conventional uniform teaching approach.

iii. Just-in-time learning & feedback: Leaners can receive more frequent and timely feedback mechanism at the point of learning, and they will be open to learning.

iv. Student engagement: Learning with AI allows for gamification and other learning environments such as virtual reality with augmented reality, which can greatly increase student engagement, involvement and self-motivation.

v. Instant answers for Questions: With the help of AI , leaners can have any questions answered within seconds rather than waiting for a human tutor response. This has the further advantage of encouraging shy students to ask questions without fear of being judged.

vi. Optimising time : Using AI to help generate ideas, enhance the cognitive and pedagogical skills and frees up student time to focus on higher level skills such as creativity & analysis.

vii. Improved accessibility: Smart data gathering with personalised schedules and custom tasks, the gap between students, teachers can be bridged with the help of AI technologies. Barriers based on geographical location, money, language, can be overcome as we move closer to 24*7 access to everyone.

viii. Neuro diversity: Some neuro diverse students thrive in AI powered environments who use to struggle with traditional settings or learning methods.

III.COMPONENTS OF AI BASED LEARNING

i. Virtual tutors & assistants: Instead of interacting with real tutors, students shall get explanations & help in real time using virtual tutoring and assistance. The traditional student assistance in the Learning management system (LMS) relies on a preset list of questions and associated answers. With the inclusion of AI capabilities , LMS understand unusual requests, provide answers that are more relevant to the questions, and create an experience close to communication with a human tutors.

ii. Interactive voice recognition:. The voice assistance is important for learning new languages, teaching special students with writing and reading impediments, and teaching kids that can't write yet. To interact with such students, an LMS needs to be able to read the text with audibility and should be able to recognize a student's speech, assess it, and respond.

iii. Attendance logging system: This will monitor the attendance of the student at remote lectures takes time and effort. Some students may also cheat by attending only at the start of an online class. By using the biometric checks it can be ratified. But this solution is rather expensive, since all students will need aces to the biometric scanner. With a library of data collection of student photos as a dataset, AI can detect students' faces in a video feed. It will calculate the attendance time, making it impossible for students to cheat. Such solutions are already widely used in 47,500 public schools in India.

iv. Customised training sessions: The educational process is more efficient when it adapts to the needs and requirements of a specific student. While a traditional LMS provides only limited choices and options when choosing a training course, AI makes this process more flexible and personalized.

v. Smart dashboards: Post data collection, comparison of gathered data with defined set of library and classifying with an LMS, users will interact and find improvement opportunities. For example, you can create dashboards with students' performance, the most requested training courses, the average length of a training session, the most common questions and issues, etc.

vi. Learner engagement assessment: The level of a learner's engagement may indicate effectiveness of the content of training course, quality of educational materials, issues associated with a tutor, knowledge level, imbibing capability etc. But this metric is particularly hard to assess in online education.

The deep learning algorithms can estimate the engagement based on a learner's history of interactions with the LMS and the educational curriculum content. They can also compare these interactions to the peer group, suggest reasons for changes in engagement, and propose for improvement if any.

IV. INTELLIGENT TUTORING SYSTEMS

Intelligent tutoring systems (ITS) will utilize the AI based platforms and algorithms provide personalized and adaptive instruction to students. These systems use AI algorithms and techniques to analyze learner data, understand their learning requirements, prerequisites, and provide customized educational content. The salient features of intelligent tutoring using AI are the following;

i. Personalized Learning: By understanding the strengths and weaknesses of each learner, the system shall deliver the student specific content, task and activities that align with their specific needs. The algorithms used in AI in intelligent tutoring systems shall analyze individual student data viz; performance, preferences, and learning style, and will deliver personalized learning experiences.

ii. Knowledge mapping: AI algorithms can map the learner's knowledge imbibe over time, identifying concepts they have grasped and areas where they require special attention and additional care. This knowledge tracing enables the intelligent tutor to provide interventions , targeted feedback and, customizing the understanding capability to the individual student's.

iii. Adaptive Instruction: Based on real-time student performance the custom built Intelligent tutoring systems can adapt their instructional strategies. AI algorithms can monitor the students' progress, identify gaps, students areas of difficulty, and dynamically adapt and correct the content as well as difficulty level to optimise the learning methodology. This adaptability helps ensure that students are optimally challenged and engaged.

iv. Natural Language Processing: AI based intelligent tutoring system will leverage natural language processing (NLP) capability to interact with leaners using legacy interfaces. This allows learners to ask questions, seek doubts, engage in conversation, simulating the environment of human tutor interactions.

v. Scalability and Accessibility: AI-powered intelligent tutoring systems have the potential to reach a wide range of learners, regardless of geographical location or time constraints. They can be accessed remotely and provide on-demand instruction, making education more accessible to diverse populations.

vi. Data-Driven Insights: Intelligent tutoring systems generate large quantum of data on learners performance, interactions, imbibe capability and learning patterns. AI based algorithms in applications of machine learning and data mining, can analyze these set of information's to provide valuable insights for educators. These insights can help to nullify common misconceptions, optimise teaching philosophy, and improve the overall learning culture.

vii. Continuous Assessment & Feedback: Intelligent tutoring systems shall give students the immediate feedback on their responses, allowing learners to take corrective actions on mistakes and reinforce their basics and subject fundamentals.

v. INTELLIGENT TUTORING ROBOTIC UNIT

In order to bridge the gap between the education domain and artificial intelligence domain, the subsequent paragraph explains the relationship model by explaining the learning process, into the well-established perception planning action model in the area of artificial intelligence.

The perception planning action model with intelligent tutoring robots percepts students' activities & will collect the student related information for analysis & planning. It will further reshape the social and physical surrounding culture for students learning, before initiating the new trial run of perception.

Intelligent tutoring robots architecture (ITR) is mentioned pictorially in Fig1 below;

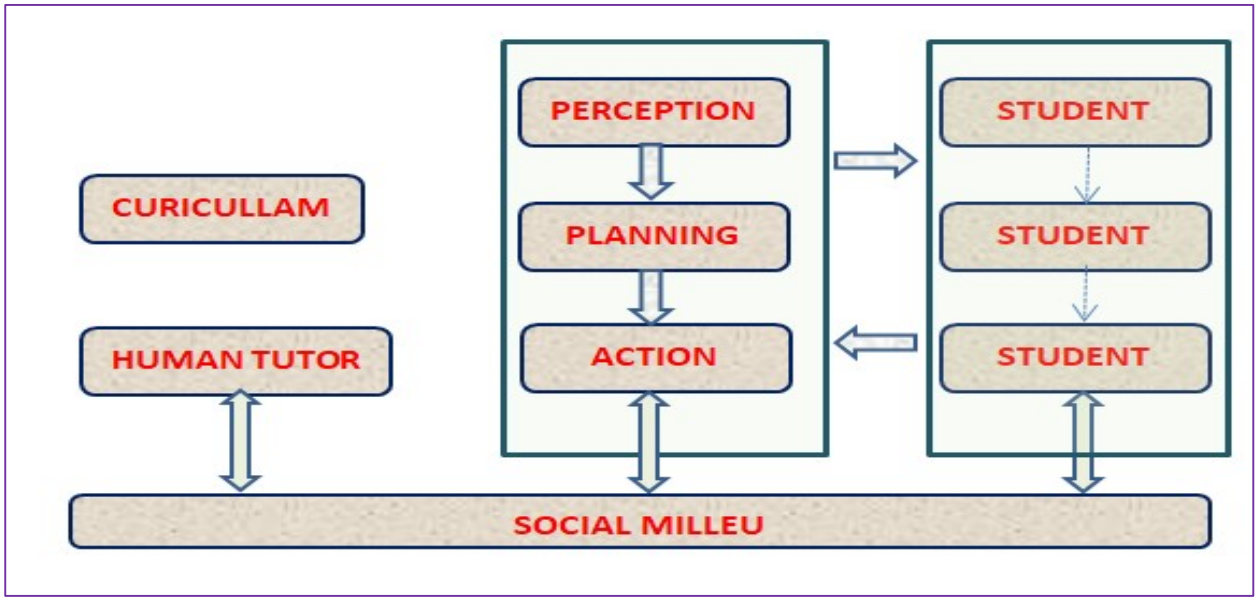

Fig1: INTELLIGENT TUTORING ROBOT

The perception module uses multi-modal sensors to observe the students' activity patterns & uses artificial intelligence techniques for learning and associated knowledge mastery analysis, which will be used as the primary source of the planning module. The planning module in turn will build the internal models for the students & evaluates teaching outcomes for different teaching methodologies before making a decision. According to the teaching decision, the action module constructs teaching-learning scenes to generate associated mapping of social & physical surrounding culture for students learning It also uses multi-modal communication channels for providing the teaching contents.

Continuous feedback unit will enable the perception, planning & action looping system to perform the online adaptation and will enable the intelligent tutoring robotic unit to learn. It is advisable to go for a hybrid model with human intervention to mitigate the risk associated with the complexity cum ethical issues of teaching pedagogy. The human intervention can be proposed to happen during the in the perception, planning & action loop either during the designing or runtime processes. Also adaptively a new model also can be evolved after lots of academic session of human interventions.

V.1 Student Model and Teaching Outcome Prediction

This model utilizes a dimension of topics, affective characteristics, student experiences, misconceptions and stereotypes, and also will be represented by operational student modules. Hence, the intelligent tutoring robotic unit shall evaluate the outcome from the potential teaching actions in its own brain / processing units, before performing actions in the real world. The student model and teaching outcome prediction is mentioned pictorially in Fig2 below;

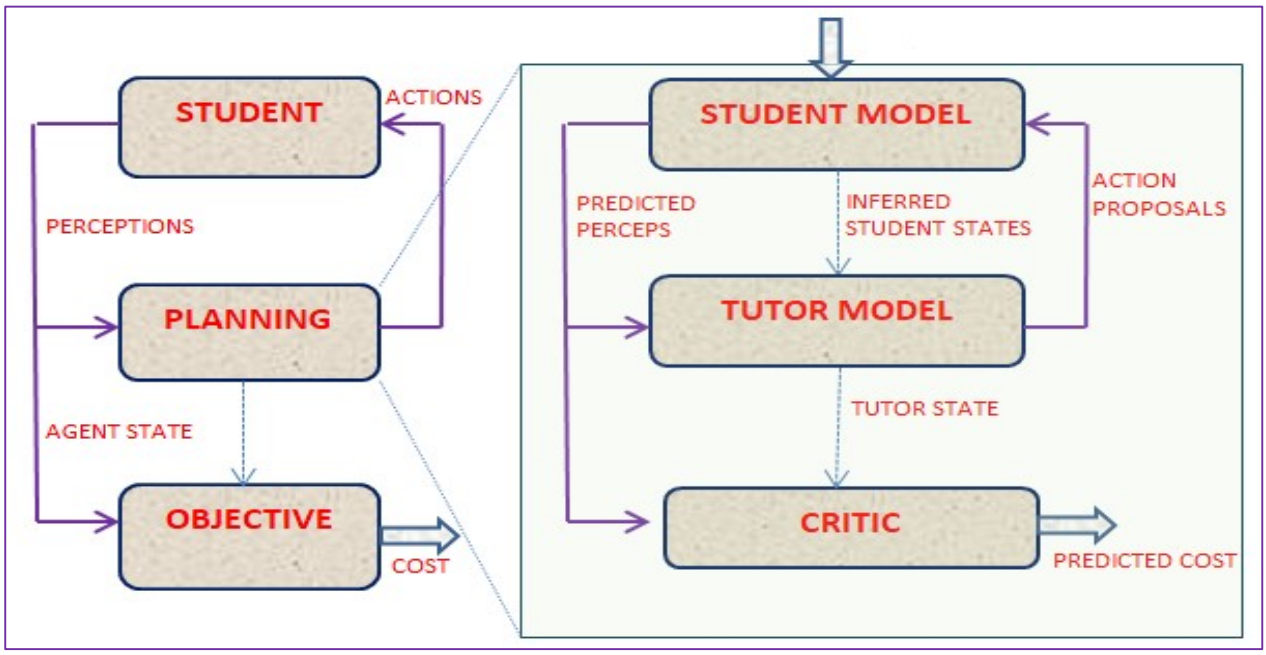

Fig2: STUDENT MODEL & TEACHING OUTCOME PREDICTION

V.2 Multi-Modal Perception of Students

For the human tutor, the basics for the effective teaching are to recognize an individual student's learning style and level of knowledge. The Students and multi model perception is mentioned pictorially in fig3. The intelligent tutoring robotic unit may be equipped with visible light, acoustic, infrared, tactile, and other needful sensors. First, the proposed model

shall utilize the multi-modal sensors to collect data of the external environments, from which the students' activities may be captured.

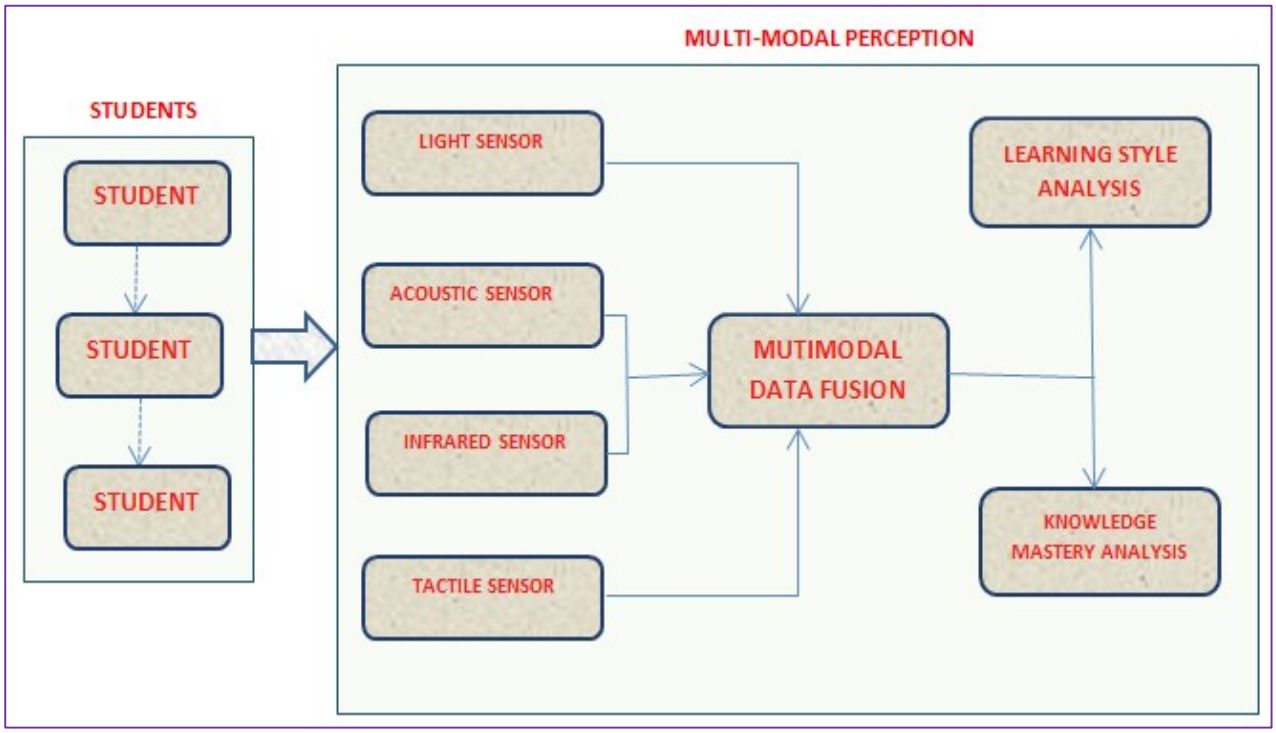

Fig3: STUDENT & MULTI MODEL PERCEPTION

Then, these multi-modal data fusion is implemented to reduce the environmental noise and associated neighboring data interference and align data from multi-modal channels. Then, the pre-processed data shall be fed to the learning style analysis module & knowledge mastery module, which may apply artificial intelligence based algorithms and proven off the shelf techniques to extract useful information concerning the students learning status, learning patterns, & the knowledge level.

The first phase of initiating an effective cognitive perception, planning & action loop is to capture the relevant data concerning the environments & the selected sets of students. As shown in Figure, the ITR may use multi-modal perception by utilizing multiple information channels, e.g., audio, visual, tactile, electromagnetic, and latest requirement specific sensory units. Pre-processing steps are demanded before extracting information from the raw signals. First, it is required to remove the environmental noise and associated neighboring data interference, to extract the needful information. Then the signals and data gleaned from multiple independent channels should be aligned in the spatial-temporal space to avoid incorrect correlations. Standard sets of beam forming algorithms will be used to get spatial-temporal coherence.

In the context of the intelligent tutoring robotic unit design, multi-modal data fusion is not specifically explored for this study. The fusion can be thought as integration of the sensor parameter data as per the needs. Periodicity of data sample depends on type of physical data variation. However, the topic is in the context of data-mining and robotics.

Human action recognition may find its wide range of applications such as video analytics, robotics, and human machine interfaces. Actual scenario will need the sensors pertaining to complex tutoring scenario of much occlusion and moving objects, the inertial sensory data may complement the visual sensory data. This will need added modules with standard

proven application software' modules viz; support vector machine and hidden-Markov model.

VI. POTENTIAL CHALLENGES OF AI BASED TUTORS

AI-based tutoring system has the vast potential to enhance the education system and provide personalized learning experiences to students. They also face several challenges. Here are some potential challenges of AI-based tutors:

i. Lack of Emotional interface: AI tutors will not be able to establish an emotional connection with student community due to design limitations of the system.
ii. Limitations in critical thinking: AI tutors will be performing well in providing factual information & solving standard well-defined problems. However, AI based tutoring system has challenges due to lack of creativity & critical thinking skills to engage students in open-ended discussions, foster higher order cognitive skill sets & to encourage divergent thinking.
iii. Contextual Understanding limitations: AI based tutors will primarily depend on the collected data & algorithms to deliver instruction. However, system will have limitations to understand the context and nuances of each student, which can hinder their ability to customize the instruction to specific needs and to address the complex queries.
iv. Ethical Concerns: AI tutors have limitations mainly due to factors like privacy and data security. Data collection and analysis of each student data for personalized instruction can raise privacy issues if not handled meticulously. It is a prime requirement to safeguard student related information and ensuring transparent data practices for AI-based educational platforms.
v. Accessibility & Equality: By the introduction of AI based tutor system we will be able to break the barrier of existing inequalities for access to quality education. The issues due to lack of connectivity will lead students without access to the necessary technology and will make them left behind their society counterparts.
vi. Adaptability limitation: While AI tutors can adapt their instruction based on learners' responses, they may not possess the same level of adaptability as human tutors due to limitations in design model. Human tutors can dynamically adjust their teaching style, pace, content based on non-verbal cues, student engagement, and immediate feedback, which AI based tutors, will struggle to replicate effectively due to design limitations of the system.

These potential challenges need mitigations by finding ways to combine the strengths of AI based tutors with the expertise as well as empathy of human teachers to create a well-rounded and effective learning experience for students. It is mandatory to consider these benefits and limitations when integrating AI-based tutors into educational settings. Striking the right balance between AI and human involvement can lead to a comprehensive and effective learning culture.

VII. BALANCING APPROACHES TO MITIGATE POTENTIAL CHALLENGES:

To strike a balance, a hybrid learning model that combines AI-based tutors with traditional teaching methods is recommended.

i. Hybrid Learning Models: Implementing a hybrid learning model that combines AI-based tutors with legacy teaching models can optimally balance and mitigate the potential challenges. This approach allows for personalized instruction, immediate feedback, and adaptive learning while maintaining the benefits of human interaction and guidance. This will enhance the development of cognitive and pedagogical skills in students.

ii. Teacher Training & Collaboration: It is mandatory to provide training and professional development opportunities to teachers to have a better understanding to effectively integrate AI-based tutors in the classroom. Collaboration between AI systems and human tutor will help to optimize their use & ensure alignment with pedagogical goals.
iii. Ethical Frameworks & Guidelines: The concerns related to privacy, bias, and data security can be mitigated by suitably developing ethical frameworks and guidelines for the use of AI-based tutors. These guidelines should be updated periodically & informed based on the input from educators, researchers, and other stakeholders.
iv. Regular Evaluation & Feedback: In order to help identify strengths, weaknesses, and potential risks of AI-based tutors it is necessary to do continuous evaluation and feedback from teachers, students, and parents. This feedback should inform improvements, corrective actions and needful modifications to ensure a balanced and effective implementation.

By adopting a balanced approach, by combining the strengths of AI-based tutors with the expertise & guidance of human teachers, we can harness the benefits of AI and mitigate the potential threats & associated challenges with their use. This approach ensures that technology supports and catalysts, instead of replacement of the essential role of teachers in education field.

VIII. AI-BASED TUTOR USEFUL FOR PRACTITIONERS

There are several examples of AI-based tutors that have been developed to enhance learning experiences. Here are a few notable examples relevant to practitioners and researchers for up gradations:

i. Duolingo is a popular language learning platform that utilizes AI algorithms to provide personalized language instruction. It customizes and will adapt its curriculum based on individual learner's strengths, weaknesses, and progress. It uses the concepts of machine learning to assess learners' proficiency, provide instant feedback, and optimize the learning curve.
ii. Cognii is an AI tutor focused on providing feedback and assessment in the field of writing as well as critical thinking. It uses natural language processing (NLP) to analyze students' written responses, assess their comprehension, and provide detailed feedback on coherence, grammar, analytical skills and critical thinking skills.
iii. SMART Learning Suite is an educational software suite that uses the AI based algorithms for tutoring capabilities. It offers interactive lessons, assessments & adaptive learning experiences. The platform uses AI algorithms to analyze student responses and provide customised feedback and needful recommendations for improvement.
iv. Thinkster Math is an AI based math tutor that combines human coaching with adaptive technology. It offers personalized math programs & uses AI algorithms to analyze students' problem solving capability, aptitude , skill sets and approaches. Human tutors review the work, provide feedback, as well as will adapt the curriculum to meet individual requirements.
v. Carnegie Learning is an AI-based math tutor designed to support classroom teaching. It incorporates change based learning technology that adjusts the various levels of difficulty & content based on students' performance. The platform provides personalized instruction, practice questions & assessments for students to improve their math skills.
vi. Knewton is an adaptive learning platform that uses AI algorithms to analyze student data & to provide customised student specific recommendations. The platform also provides adaptive assessments, content recommendations & adaptive sylabus in various

subjects. The system continually adjusts the learning path to match the individual student's needs and learning style.

These are just a few examples of AI-based tutors that uses artificial intelligence concepts are applied to enhance the learning experience. As technology growth continues, we can expect further innovation and development in this field.

IX. EXECUTIVE SUMMARY:

Artificial intelligence is growing in rapid rate and is completely changing all aspects of life. It contributes towards learning & teaching methodologies too. It concludes that present day teachers have more exposure and know how on common artificial intelligence products, such as sound aids , graphics, identity, fingerprint recognition, digital library, wikis, chatbots and smart classroom.

AI-based tutors are computer based systems that utilize artificial intelligence algorithms, and proven techniques to provide personalized instruction & support in modern educational settings. These tutors have the capability to mitigate the challenges in conventional teaching and enhance the learning experience for students.

The key benefits of AI-based tutors include personalized learning, immediate feedback, and access to resources, continuous support, adaptive instruction, enhanced engagement, and data-driven insights. By analyzing student data and adapting to individual requirements, AI tutors can customise the instruction, identify knowledge gaps, and can also provide targeted feedback, ultimately improving teaching methodology as well as learning outcomes.

However, it is important to consider the limitations and potential threats associated with AI-based tutors. The system creates new challenges and limitations due to the risk of overreliance on technology, establishing emotional connections, concerns regarding data privacy and security, issues of equality, limitations due to resource accessibility & ethical considerations related to bias in algorithms.

To strike a balance, a hybrid learning model that combines AI-based tutors with traditional teaching methods is recommended. This approach allows for personalized instruction along with custom build adaptive learning using the benefits of human interaction and guidance. Teacher training, collaboration, development of ethical frameworks and guidelines are critical in exploiting for the effective use of AI-based tutors in education system.

Further research and evaluation are needed to refine AI-based tutoring systems, address their limitations, and optimize their integration into educational settings. By harnessing the strengths of AI-based tutors while complementing them with human expertise, we can create a comprehensive and effective learning environment that meets the needs of unique and diverse learners to prepare them for the challenges of the future.

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