The Model of Improving College Students' Critical Thinking Ability based on Artificial Intelligence

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Abstract
With the deep application of artificial intelligence technology in higher education, the teaching methods of higher education are constantly changing. Critical thinking is an important ability for college students. As one of the cores of higher-order thinking ability, critical thinking is of great significance to the training of talents in the 21st century, and its research is of great significance and valuable. This paper aims to explore the improvement mode of critical thinking ability of college students based on artificial intelligence. Firstly, this article analyzes the characteristics of artificial intelligence technology, the components of critical thinking, and the relationship between artificial intelligence technology and critical thinking. Secondly, combined with the needs of college students to improve their critical thinking ability, this article puts forward a model of improving college students' critical thinking ability based on artificial intelligence. Finally, this study presents the future opportunities and challenges of critical thinking training for college students based on artificial intelligence.
Keywords: Artificial Intelligence, College Students, Critical Thinking Ability, Improvement Model, Information Literacy

Introduction

The fast advancement of artificial intelligence technology in the twenty-first century has extremely changed the numbers of industries including higher education. College students need critical thinking, a necessary part of high-order thinking to solve their complicated problems, come to judge wisely, and be creative. Conventional teaching approaches frequently fail to develop these abilities. To improve critical thinking skills, AI must be incorporated into educational frameworks.

In ways that traditional approaches might not be able to effectively give AI can offer individualized learning experiences, immediate feedback, and access to a wealth of materials (Dwivedi et al., 2021). Furthermore, Manyika et al (2017) stated that artificial intelligence (AI) technologies are finding their way into educational settings and providing creative alternatives to conventional pedagogical approaches. In this regard, it's vital to comprehend how AI might improve college students' critical thinking abilities.

This study is based on the features of AI technology and the elements of critical thinking. Russel and Norvig (2021) define artificial intelligence (AI) as a collection of technologies that mimic human cognitive functions, from natural language processing systems to machine learning algorithms. Similarly, Ennis (2015) defined critical thinking as a multifaceted combination of cognitive abilities essential for well-organized problem-solving, judgment, and analytical reasoning.

The study's significance also incorporates its implication for educational policy and practice. Teachers may develop a peer group of students with the cognitive flexibility and analytical skills required to successfully negotiate challenging situations in the twenty-first century by figuring out efficient ways to include AI in critical thinking training (OECD, 2019). Furthermore, by using these findings to guide curriculum development and budget allocation, policymakers may make sure that educational systems continue to adjust to the changing desires of the digital age (UNESCO, 2020).

Recently AI seems a continuous development like the use of AI tools such as Chat GPT and so on has been widely used in various fields of education and health (Bilad et al., 2023). After entering the field of educational research, AI has deeply integrated into education and intelligence which has changed the previous pattern and shape of the education system (Linhuber et al., 2023). Higher education plays an important role in the construction and development of education powerhouses (Naidoo, 2011). Therefore, higher education institutions must play an active role and take steps to adapt to this change and fully utilize the benefits of AI technology, and focus is needed to further enhance the development and innovation in education and research (Xia & Li, 2022).

The new period of AI has brought the latest needs to strengthen student abilities and their qualities. Those students who are taught to use critical thinking skills will be enable to examine critically the issues, make their own ideas, and establish their own logical decisions (Rusandi et al., 2023). There is a huge need for critical thinking in their new era of digital literacy and intelligence (Kouzov, 2019). For example, the use of Chat GPT is more valuable compared in terms of human mastery knowledge and associated knowledge (Fulbright & Morrison, 2024)

Malchukova attentions that one needs to deliberate the effects of digitalization on critical thinking in the greater context of human survival (Malchukova, 2023). With human reasoning capabilities, we can fit AI into a tool. Chen emphasized the importance of critical thinking as a creative and productive skill and offered methods for developing it (Chen & Yu, 2019). According to Xiaomi (2013); Fang (2010) specific models and practices for helping college

students fortify their critical thinking abilities. All of these research opinions to the need for focused interventions to increase college students' critical thinking.

At the same time, the development of AI technology offerings hindrances and stresses on higher education (Zawacki-Richter et al., 2019). A real-world condition for raising creative skills in the new age is how to stand in learners' critical thinking and advanced abilities to familiarize them with a society where intelligent machines cohabit (Chu et al., 2021). In light of this, this article determines to investigate the influence that AI technology can have on the development of college students' critical thinking skills (Mohamed, 2024). It also aims to develop a systematic and scientific approach to doing so, offering assistance in the development of creative and critical thinking talents (Suter, 2011).

Definition of AI and Critical Thinking

Even though we are not able to define AI thinking exactly in this modern age. A common definition of AI is that it is a technology that enables machines to imitate various complex human skills (Sheikh et al., 2023). Different scholars' reviews revealed that there is an extensive arrangement to describe critical as an ability and trait. People in the psychological state assess the cognitive things with from prosperity of an individual. Whenever there is a discussion about the issues or points of view, this disposition must create difficulties for people to think about them specifically. According to John Dewy, the active, continued, and full care consideration of any belief or expected form of knowledge with insight into the information that supports it and the conclusion also (Xinghua & Ruohan, 2023).

Robert Ennis, a renowned expert in the field of critical thinking research, defines critical thinking as mature and reasoned reasoning that takes place when making decisions about what to believe or do. Although definitions vary widely among professionals and scholars, they always entail "analyzing evidence," "judging and evaluating," "making decisions," and "making inferences using inductive-deductive reasoning (Zhong & Song, 2024). In general, critical thinking refers to how people analyze and assess the benefits and drawbacks, truth, and falsity of a particular thing or phenomenon; in other words, it involves analyzing, challenging, and debating cognitive objects to create distinct, related, and accurate insights (Marin & De, 2017). Analyzing, assessing, and reconstructing issues as well as actively challenging information and looking for proof, taking into account viewpoints from all angles, and reevaluating one's thought processes are all components of critical thinking (Thayer-Bacon, 2000). Critical thinking is an ongoing process that necessitates well-defined cognitive objectives to address particular issues or arrive at particular conclusions (Halpen, 2014).

The relationship between artificial intelligence and higher education

Researchers are always focusing on developing and enhancing technology-supported critical thinking skills. Researchers will investigate how new technologies—like network, visualization, and virtual reality technologies apply to critical thinking whenever they are used in the teaching and learning process. Barakbaevich underlines once more how crucial the socio-pedagogical concept that underpins pedagogical technology is, especially for the growth of critical thinking (Barakbaevich, 2023).

John McCarthy put forward the AI idea in 1956. This field covers so many fields contained computer science, physiology, psychology, philosophy, and information science. The use of AI in education quickly changes the way that is taught in traditional education (Shao & Zhou, 2021).

AI, especially the technology related to this has strong data and information processing capabilities, which play a great role in transmitting the teaching methods and promoting deep learning for students (Xia & Li, 2022). The constant repetition and promotion of general AI has enabled AI technology to reach and exceed the level of different areas and involve human tasks, reasoning, and knowledge like vision, understanding, abstraction and so on that can be adapted to different types of issues and situations (Dwivedi, 2021). It has strong powerful processing data that help students to filter their information (Pariser, 2011). Retrieving this information, students can bitterly search and broaden their deep insights towards critical thinking (Lau, 2011). During decision-making, we can get help with AI to stimulate the decision process and make provision for various set-ups analyses, and possible guesses which help them to know about the difficulty of the problem and therefore, employ critical thinking to assess and select various possible solutions during the decision-making process (Purdy, 2023). Recently, AI has provided tools and other platforms for students which are helpful in their learning process (Fitria, 2021). Furthermore, students can get feedback, ask questions, and use them to enhance their learning and find the best solution to the problems they face (NGUYEN, 2023).

Large data technology and the internet deliver a lot of data sources, which bring a huge change in the economy and society. So, the application of this technology in the field of education and management in universities and colleges has attracted high attention. The use of AI helps bring new ideas and techniques to teachers' teaching methodologies and students' learning even in colleges or at the school level. In China, the use of AI in the management of teaching and delivering education in universities and colleges has achieved the foundation, but still with some other industries it is at the primary position. Through this, the application of AI will enhance the level of management according to the new demand (Zhenxing & Ying, 2020).

The improvement model of critical thinking ability based on AI

AI has carried out the new demands to improve talent. Goes away from knowledgeable and skillful talents with higher-order thinking. The repeated demand that abilities with the skills of higher-order thinking power can be developed. Searching and examining the fundamental meaning of critical thinking and its style is very essential and valuable since it is the base of higher-order thinking. The usage of AI technology can boost human potential is a persistent subject of the study, and mostly those teachers are involved in educational technology. Furthermore, it is also important to explore how information technology brings up critical thinking (Rai, 2023).

Researchers have investigated the development of critical thinking from a variety of viewpoints. Critical thinking development is significantly facilitated by information literacy. Digital literacy has been greatly influenced by information literacy, which is a need for information and communication technology. Digital literacy incorporates not only proficiency with computers but also the critical thinking skills necessary for accurately evaluating the importance of information and making appropriate use of it over the internet (Amin, 2023).
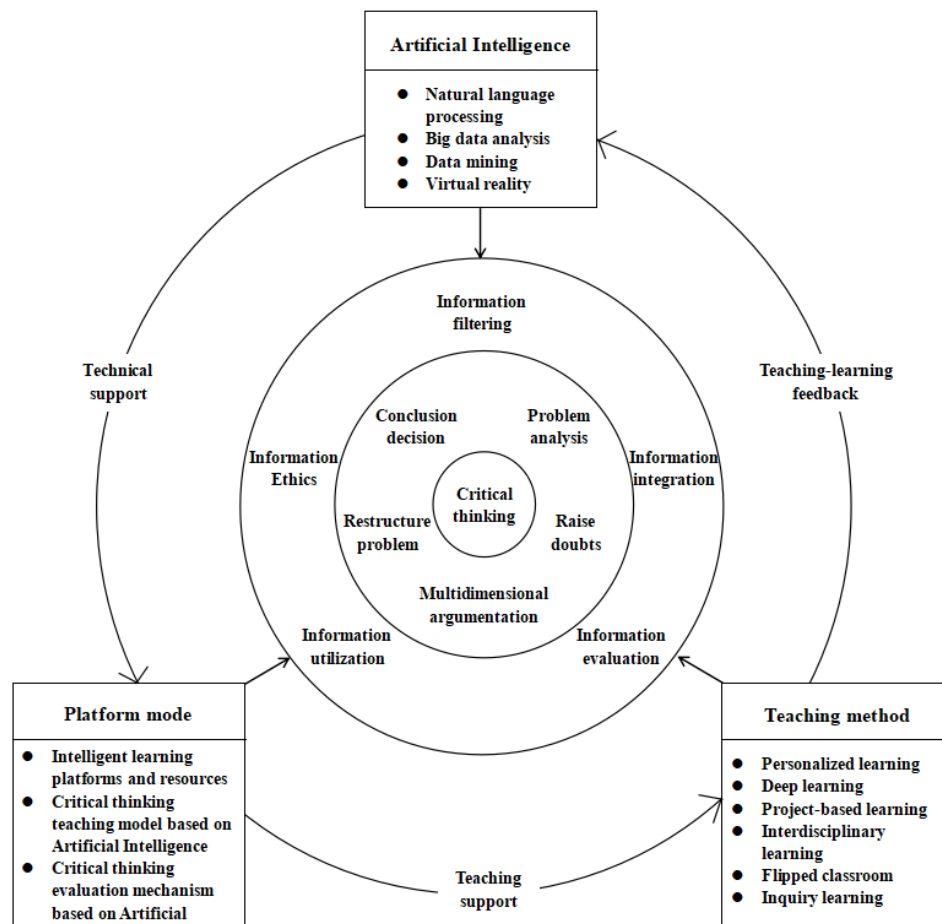
Figure 1. The improvement model of critical thinking ability based on AI

Based on the present study, explains the concept of AI technology to enhance college students' thinking as mentioned in Fig 1. AI as a sign of cutting-edge technology, deals with systems, settings, and AI tools that increase the development of student critical thinking. Along with its persuasive power in the analysis of huge data mining, language processing, and other technologies, it builds a technological atmosphere that plays a role in fostering the development of critical thinking. With the solid distributed processing competencies of cloud computing, it may create experiences of virtual reality for college students as well as different learning platforms and resources for students. At the same time, it integrates the advantages of several technologies to give students a personalized and well-prepared learning practice. It is not difficult to achieve a method and assessment process of critical thinking by real-time response and content adjustment. This helps in exact evaluation and stimulating the progress of college students' critical thinking.

Critical thinking is the "ability to analyse and evaluate information" (Duron et al., 2006).The teaching-learning process is primarily responsible for the enhancement of critical thinking. The skills of critical thinking of the students are better improved through project-based learning, interdisciplinary learning, deep learning, flipped classrooms personalized learning and so many other approaches. Information literacy demands that students become able to collect, apply, and assess all the information significantly. Through critical thinking, we may be able to make accurate decisions and gather fair information. As a result, there is a relationship between the basic requisites of information literacy and critical thinking.

Teachers use continuous response and feedback on technology and learning environments to adapt their approaches and arrange resources that will best suit their students' desires and enrich their critical thinking power.

The potential of AI in improving Critical Thinking Ability about college students
To help in developing the critical thinking skills of college students, AI plays an important role. With the help of these resources and individualized paths, it enhances the incorporation of student deep learning and critical thinking. Concurrently, AI plays a major role in fostering the growth of college students' critical thinking. It means that for college students AI is the resource that improves and develops their thinking power as well as their critical capabilities. Furthermore, it also helps them strengthen their problem-solving skills and their screening analysis power. Moreover, in human development, the objectives of higher education obey the current tendencies and experience constant reform to improve the overall quality and foster the student's ability and power to adapt to society (Michelle, 2018 and Díaz-Melí et al., 2019).

AI plans personalized learning paths and aggregates learning resources
The introduction of AI into education marks a significant departure from conventional teaching methods, offering personalized learning and support for diverse educational requirements (Walter, 2024).The major three components of AI that individualized learning are the main path recommendations and resources: the first one is the additional use of resources. To support students in practical critical thinking, it can offer various tools that are related to intelligence, like debate training sessions and writing helpers (Administrator, 2023). All these tools can provide ideas for further enhancement. The student's critical thinking skills can be gradually improved by ongoing feedback and hands-on activities. The second one is that practices create concrete scenes. It is also mentioned that with the help of AI, students may be able to solve different kinds of problems they face and make their decisions according to the situation (Ibna Seraj, 2022).
Besides, it also helps the learners create a simulated environment that impersonates the work or real learning circumstances. While gaining a deep understanding of the nature and difficulty of the problems, students can practice and make its usage through simulation (Lateef, 2010). Students can practically experience so many solutions to the issues in a virtual environment and also can determine the best one through assessment and self-introspection. The third one is the progress of a classy system for feedback and evaluation has the power to analyze students' outputs and their learning process also as well as through evaluation reports and recommendations for further enhancement Piet (2005). Furthermore, helping students in their understanding of critical thinking skills can be more fruitful to help them in their issues and bring positive changes in their thoughts to do the essential corrections (Richmond, 2007).

AI improves learners' ability to deep learning
The secret to concluding deep learning tasks is the higher-order intellectual ability personified by critical and creative thinking. With characteristics such as analysis of learning and intelligent endorsements, it may motivate the students significantly to understand the ideas and completely reflect them from different positions. Once combined AI's recommendations will help the students broaden their understanding level and will remove their confusion. AI is also helpful in the analysis of student behaviors and explains it further to find out the misunderstandings and lack in their thinking power (Tan, 2021).

Additionally, AI help students develop self-reflection, critical thinking, and creative skills (Malik et al., 2019).It also helps the teachers to identify the concepts and approaches towards the learners' solving problems that they may not have completely guessed by collecting the data from the students during their learning process. As a result, the trainers the instructors, or the AI system can provide the information as advised. Instructions like this can help the learners to correct, inspire reflection and a high level of exploration, and empower the abilities of the students for critical thinking.

AI promotes problem-solving and innovation in students

To combine cutting-edge technology AI can be used for these purposes such as to generate an immersive environment for learning that meets the challenges related to the real-world circumstances (chernyshova, 2019). By the use of this virtual environment that can imitate the problems and issues in some situations, students can participate in simulated settings, refine their problem-solving competencies, and understand how to use critical thinking to assess, evaluate, and address difficult issues (Koukourikos, 2021). For assessing and recognizing problems, students can apply critical thinking to find the solution, make decisions, and bring balance in this kind of environment. In the meantime, AI can motivate students to test and get new ideas (Person & Pherson, 2020).

To conduct learning activities we can easily make it possible with the help of AI. Today is a need to provide students with practical use and approaches to using AI tools to enhance their capacity and solve their educational problems in a limited time,with students reporting that it helps them gain information and complete assignments more efficiently (Sarwari & Adnan, 2024). Arrangement of such kind of activities improves the student's techniques on how to overcome the issues they face. Additionally, the integration of technology and AI can provide the students with a peaceful environment of learning and increase their both critical thinking and problem-solving skills.

AI improves students' information literacy and critical skills

In this era of technology, effective searching and the analysis of information is very crucial. AI has the power to save students time and do a lot in a short period by providing them support to quickly extract the related content from huge data by the use of effective technology (Kamalov, 2023). It also helps in solving the biases of the students and assesses the elements like data sources, dependability, and efficacy and gives the learners a concept and framework free of biased judgment and evaluation (Little, 2009). Students can also use AI technology to think critically and examine the knowledge in more detail. Evidence may be evaluated for validity and worth by contrasting data from several sources, examining the information's constancy and logic, looking for proof to support arguments, and noticing any errors. Moreover, it also assists students to become more skillful or experts in finding out the related patterns and identifying the dissimilarities that fall among the data (Darwin, 2024).

The methods of AI improving Critical Thinking in college students

In several ways, AI can cultivate the critical thinking of the students (Jonassen, et al., 1998). All these include creating an environment that is digitalized, and informative and offering strong supporting tools and software for AI that processes numerous amounts of information and also helps in decision-making skills (Jarrahi, 2018). The evaluation system of AI is based on combining activity or project-based learning, individual learning flipped classroom, and so

on (Jarrahi, 2018). To develop the students' critical thinking power, it need increased information literacy (Bawden, 2001).

Develop intelligent learning system and provide learning resources
Establishing AI learning platforms and well-sourced libraries can help develop the critical skills of college students. It also plays an important role in facilitating the proper arrangement and displaying the learning resources, making them more available, understandable, and fruitful. To analyze the students' habits and needs, we provide them with good learning support and an intelligent system of recommendation using technology such as the natural learning process of language and deep learning (Maimela, 2024). Furthermore, for the creation of an extensive well well-equipped library, this platform can also integrate different kinds of brilliant resources for education like teaching cases, online courses, and so on (Barton & Haydn, 2006).

All these resources can be used for the satisfaction of different learning needs of the students and cover a variety of other fields (Luckin, 2016). Depending on their subject areas students can take part in self-directed learning and discovery anytime and anywhere. By selecting and using these materials, they can enhance their power of critical thinking and learning by themselves. Besides, this platform can also provide various kinds of collaborative resources such as virtual laboratories, question-answer sessions, and so many others, which can engage the students to participate in greater academic exchanges and partnerships (Tang, 2024). Through interaction with peers, colleagues, professionals, and other experts, students can improve their level of understanding about the related materials that make their problem-solving techniques and help in practicing critical thinking in social settings (Challa, 2021).

Design a Critical Thinking teaching pattern based on AI
Create an AI-based critical thinking teaching pattern and integrate computer-generated coaches and intelligent teaching supporters to assist instructors in this way of teaching. Adapted learning support can be provided through intelligent teaching assistants who can wisely adjust lesson plans and content in response to students' remarks and their learning improvement (Fakhar, 2024). Learners can have interesting learning from virtual teachers who can stimulate real-world teaching situations. By the usage of simulated setups, instructors can guide their students in developing and applying critical thinking capacities, for instance, evaluating the consistency of opinions or the rationality of divergent positions. This intensification the students' contribution in the classroom and supports their understanding of and use of critical thinking techniques (Jawal & Behera, 2025).

Concurrently, teaching strategies, such as, flipped classroom and project based learning can assist the students to enhance their abilities of critical thinking. In the flipped classroom, the students can use their learning resources to gain more theoretical information about outside the class. Inside the class, students take part in discussion, ask questions and try to apply what they have learned. Students are motivated to energetically read, write and speak and think in this way (Khasawneh, 2023). Those students who are enrolled in the project based learning should to manage the study group and interact to complete the difficult assignment successfully well on time. In this process the students gain knowledge, about the collected data, putting out the theories and doing experiments and solution for it and at the end they present the findings. As a result of all these students are been able to improve their critical thinking abilities in solving the real world tasks and challenges they faces (Boss & Krauss, 2022).

Develope a Critical Thinking evaluation mechanism based on AI

To build up a critical thinking evaluation system based on the college students' critical thinking power, AI can precisely assess and evaluate their level. This mechanism can help in utilizing the heavy data analysis technology to profoundly and widely analyze the students' behaviors, completion of home task and performance in the class. To process and collect the student data with the help of AI we can determine and the weakness and strengths of their critical thinking and correctly assess and evaluate their critical thinking level. On the bases of the results gained through evaluation of the students learning situation, the feedback reports determine the issues and problems about the student critical thinking and help in providing the suggestions related to their results (Adlawan, 2024).

As a result student can gain vivid understanding about their learning process and improve their weak points. Besides, the evaluation also help the teachers to know about the level and needs of the students on behalf of their individual differences. Teachers may also provide special supports and arrange their teaching strategies for better learning environment. Furthermore, they can develop more activities on the bases of the results to improve the critical ability of the student (Prince, 2004).

Challenges and Suggestions for Countermeasures

The data security and ethical issues of AI in educational applications

However, AI technology is quiet in its early stages and has produced moral disagreement, requires careful consideration of potential biases and ethical concerns (Christou, 2023). There are a lot of potential uses of it in the field of education. This is one of the most important hindrances that stop AI technology from being used broadly. It means that with time, the use of AI will be more increased and more effective. To escape the students from the misled during the teaching-learning process, the use of AI plays an essential role in their steadiness, accuracy, and objectivity. Meanwhile, a noteworthy quantity of student data containing their grades, learning behavior records, and personal information will be used in the application of AI education. In the same way, the security of data and student privacy is also very important to guarantee it that students are safe and all institutions should make possible that all types of laws and regulations are applicable and also to ensure that all the personal information of the students are not leaked or abused (Filva, et al., 2021).

To enhance the flexibility and power of AI technology in education, policymakers, educational institutions, stakeholders and other influential should devote more and more in their research and development, and to build systematic procedures and standards to ensure equality, honesty, trustworthiness, and submission of AI application in education (Smuha, 2020). To reduce the danger of confidentiality leaks, it is imperative to implement rigorous privacy regulations and data management procedures that will control the range and intent of data gathering while also desensitizing student data. Huang emphasizes the need for systematic procedures and standards to ensure equality, honesty, trustworthiness, and submission of AI applications in education (Huang, 2023). Instantaneously, we will emphasize the ethical education surrounding AI and support the preservation of student privacy. We also need to elevate the students and teachers' ethical level of literacy regarding the use of AI and also to raise their comprehension of information security.

Teacher's Attitude and Training Needs for AI

Based on the competencies and disposition of teachers, the use of AI mainly depends on it. However, the enhancement and use of AI technology in education is still narrow because of

the inadequate understanding and application abilities of many teachers. All the teachers concerned with AI technology must receive effective training (Chichekian & Benteux, 2022). It needs to establish a platform for teachers to interact and negotiate among themselves and also to encourage and communicate about how to exchange practical skills. Moreover, teachers also need to actively participate in the project about the effective use of AI technology.

Uneven Distribution of AI Education Resources

The unsatisfactory delivery of learning funds limits the use of AI technology. Some other areas and educational institutions find it puzzling to implement and assume AI technology because of financial restraints and technological restrictions.to help students develop their critical thinking and problem-solving skills in an extra unbiased and contemporary learning environment, the struggle can be made to increase the technological research and advancement, develop hardware facilities in schools, provide necessary AI learning tools and platforms, and inspire the advancement of educational teaching methods with the help of multi-party cooperation between the government, business, and educational institutions (Dwivedi, et al., 2021).

Excessive reliance on AI may lead to decline in students' thinking abilities

When college students apply AI technology to their learning and everyday life an overreliance on ChatGPT can affect the development of their critical thinking abilities.AI's overutilization may lead to cognitive discrepancies in students (Banele, 2023). AI can regulate and process heavy amounts of data and carry out tasks automatically. The over-reliance on AI technology may cause the students' information-searching and evaluation abilities to worsen, which will impair their capacity for independent thought in college. But, this can also prevent the students from exploring novel approaches to problem-solving which will limit their capacity for creative and critical thinking. This is because AI gives students answers to problems based on specific procedures. It means that we should be careful while using AI technology.

College students' ability to think critically may be influenced to a certain degree by the prejudices and boundaries integrated into AI algorithms and representations. When using AI technology, we need to have a critical mentality and not trust carelessly the results and also to display that the outcomes are correct from a variety of viewpoints while accepting responsibility for their individual choices to escape the above-described concerns.

Conclusion and outlooks

AI has been shown to support the development of critical thinking skills in college students (Yang et al., 2020; Ge & Hu, 2020). Because AI creates platforms related to AI tools, it also provides students with greater learning opportunities to participate in this. Recommendations for learning resources can improve the outcomes and help the students in developing a deeper understanding of the use of resources. Students can also practice their critical thinking power through interpersonal communication by participating in cooperative communication activities.

Likewise, the application of AI technology in the shape of virtual reality, intelligent mentors, and educational robots supports the college students' development of AI skills. This technology helps the students to analyze problems, discover problems, get information, and use this information to solve the problems all of which practice and enhance the ability to think critically. Besides, they can also provide the students with guidance and cultivate their

literacy rates. AI is being used to build up critical models for the teaching and assessment process. This can help in effective support and in evaluating the students' learning and also helpful in time management to teach tactics and to encourage the growth of students' critical thinking.

In higher education, AI will likely be more cultivated in more asserted and reflective ways. It will be able to understand the student's learning needs better with the development of the new technologies and will provide them with a more classy and well-developed learning experience.

Additionally, AI will inspire the worldwide development and integration of multidisciplinary in higher education, as well as provide college students with a lot of learning opportunities and extensive development.

The future of education will see a significant emphasis on the development of AI, which will play a crucial role in fostering students' creative and independent thinking (Kataria et al., 2020; Li, 2022). This will be proficient by providing the students with ironic and difficult assignments that will motivate their critical thinking power. Besides this importance, it also gives the teachers more precise feedback on how well their students are learning and suggests lessons through the use of technologies such as data mining and analysis. By this, the teachers will be able to promote the thinking skills of their students bitterly.

Though AI is not stoppable and we always need it to be used in the right way (Dreyfus, 1992). Teachers also need to continuously practice attention and consideration when using AI technology, they also need to utilize these tools with great care and attention and also to support their instructions wisely and focus on the critical thinking skills of their students (Dene Poth, 2023).

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