Design of Teaching and Learning Support Software Integrating Artificial Intelligence for High School Students

Hanh Dinh Thi My[1], Hung Tran Van[2]

[1]The University of Danang - University of Science and Education, Danang, Vietnam

[2]University of Science and Education, Danang, Vietnam

ABSTRACT: The remarkable progress of artificial intelligence (AI) is driving significant innovations in education, particularly in enhancing the effectiveness of teaching and learning at the high school level. In the era of digital transformation, the integration of AI in education facilitates personalized learning experiences and improves students' knowledge acquisition efficiency. However, traditional teaching methods exhibit several limitations, especially in providing individualized content and accurately monitoring learning progress.

This study proposes a teaching and learning support system using AI technology with the aim of optimizing the learning process of high school students. The research synthesizes information to analyse existing smart educational systems and employs the system design approach to identify key functionalities. The suggested solution includes the functions such as learning content personalization, chatbot AI, automated grading, and learning progress tracking. The system operates on a web-based platform with flexible customization capability to cater to modern learning needs.

Corresponding Author:
Hung Tran Van

1. INTRODUCTION

AI is playing an increasingly important role across various domains, especially in education. Its rapid advancement has offered new opportunities to enhance teaching and learning methodologies, contributing to improving educational quality through teaching content personalization and learning experience optimization (Chen, L., Chen, & Lin, 2020; Hinojo-Lucena et al., 2024). Many countries worldwide have actively integrated AI into education system, from developing smart learning platforms, virtual teaching assistants to deploying automated assessment tools to enhance student's learning outcomes (Davis & Lee, 2024; Garcia & Johnson, 2024).

In Vietnam, digital transformation in education is progressing rapidly, particularly at the high school level, to align with the demand of innovative teaching methodology. The application of digital technology not only enables teachers to adopt advanced teaching methods but also empowers students with self-directed learning, fostering creativity and improving knowledge acquisition (Nguyen & Do, 2022; Popenici & Kerr, 2024). However, integrating AI into the high school education faces several challenges, including the lack of curriculum-aligned solutions, low student-software interaction levels, and difficulties in personalizing the learning process (Chen & Wang, 2024; Johnson & Brown, 2024).

Given the increasing demand for intelligent, flexible, and efficient teaching support tools, the development of AI-integrated educational softwares has become an inevitable trend. Such platforms can tailor learning pathways to individual needs, deliver content suited to each student, and assist teachers in tracking study progress and precisely assessing learners' abilities (Kumar & Patel, 2024; Boulanger, Perret, & Liu, 2024). The combination of AI and education not only contributes to enhancing teaching quality, but also fostering students' proactive engagement in learning, thereby optimizing educational effectiveness in ongoing educational innovation and modernization (Luckin, 2018; Rudolph et al., 2023).

Although traditional teaching methods have played an important role in the education system, this model has revealed many limitations in the context of digital transformation and the increasing demand for personalized learning. One of the core problems is applying general teaching content to all students without considering differences in ability, acquisition speed, and individual learning style. This may cause some students to struggle with the program, while high-ability students lack opportunities to expand their knowledge and develop advanced thinking (Nguyen & Pham, 2024; Zheng et al., 2022).

In addition, limited class time makes it difficult for teachers to monitor each student's learning progress in detail and provide personalized feedback. This affects learners' self-learning ability and development of independent thinking skills (Smith et al., 2022; Watters, 2023). Accessing to learning materials is also not flexible, causing obstacles in the process of acquiring knowledge and improving personal capacity (Chen & Wang, 2024; Kumar & Patel, 2024).

With these challenges, many studies have shown that the application of AI in education can solve most of the limitations of traditional teaching methods. AI helps personalize the learning experience, providing content tailored to each student while supporting teachers to monitor and e accurately valuate learners' learning progress (Garcia & Johnson, 2024; Davis & Lee, 2024). AI-based learning systems not only help students be more proactive in the process of acquiring knowledge but also create a flexible learning environment, allowing content to be adjusted to the specific needs of individuals (Chen, Y. & Wang, 2024; Nguyen & Pham, 2024).

The development and integration of AI tools into education is becoming an inevitable trend to improve teaching efficiency, improve student's learning ability, and optimize learning experiences in the context of current educational innovation (Garcia & Johnson, 2024; Watters, 2023).

The application of artificial intelligence (AI) in education opens up breakthrough solutions to overcome the above limitations. AI can support the personalization of learning content, building learning paths suitable for each student, and provide tools to support teachers in assessing and monitoring learning progress (Holmes, Bialik, & Fadel, 2023; Zawacki-Richter et al., 2024). Advanced technologies such as educational chatbots, smart lesson suggestion systems, and automatic grading not only help optimize teaching methods but also create a flexible learning environment, increasing acquisition efficiency, and improving the quality of education (Chen, L., Chen, & Lin, 2023).

Research Objectives

This study aims to develop an AI-based learning support system for high school students, personalizing learning progress and teaching efficiency enhancement. The software integrates the features such as AI-driven lesson recommendations, chatbot-based learning support, and automated assessment mechanisms. Besides, the research also suggests solutions to optimize AI application in education.

Research Questions:

Q1: How can AI be effectively integrated into educational software?
Q2: What are the core features required for an AI-powered learning platform?
Q3: How can AI applications enhance teaching and learning quality?

2. RESEARCH CONTENT

Artificial intelligence applications in education: potentials and challenges

Artificial Intelligence (AI) is increasingly important in education, especially in personalizing learning paths and improving teaching effectiveness. Many research projects worldwide have focused on exploiting AI's potential to build smart learning systems, helping learners acquire knowledge in a way that suits their individual abilities and knowledge acquisition speed. According to Holmes, Bialik, and Fadel (2023), AI can analyze learning data, thereby making recommendations to optimize the learning process based on each student's specific needs.

Advanced technologies such as natural language processing (NLP), deep learning, and computer vision have been integrated into modern educational platforms. Zawacki-Richter et al. (2024) emphasize that AI not only supports learning content personalization but is also applied in the tasks such as automated grading, monitoring exam integrity, and assisting teachers in developing lesson plans. In addition, the AI-integrated online learning platforms such as Coursera, Khan Academy, and Duolingo have demonstrated the effectiveness of technology in providing flexible and highly interactive learning content (Brown & Green, 2021; Lee & Choi, 2021).

However, the intergration of AI in education also faces many challenges. Research by Chen, Chen, and Lin (2022) shows that the quality of input data dramatically influences the accuracy of AI systems, while issues related to privacy and security of learner data are still controversial. Furthermore, access to AI technologies in education in many developing countries remains challenging due to infrastructure limitations and a lack of well-trained human resources (Wang & Liu, 2021; Kumar & Patel, 2024).

Davis and Lee (2024) emphasize that while AI has a great potential to improve the quality of education, careful consideration needs to be given to how this technology is integrated into teaching practices. Johnson and Brown (2024) also suggest that AI can improve student engagement with lessons through customized learning systems. However, it is necessary to ensure that this technology does not diminish the role of teachers in the teaching process.

Adaptive Learning

Adaptive learning is an educational approach that uses technology to adjust the content and pace of learning to each student's need, ability, and learning style. According to Johnson & Brown (2024), the personalized learning system is based on the data which analyses learner's behavior and accordingly, providing appropriate suggestions and exercises. This model helps optimize

the learning process, enhance acquisition, and facilitate students' learning according to a path suitable to their individual abilities. On the other hand, artificial intelligence (AI) has made great strides in education thanks to the technologies such as Machine Learning, Natural Language Processing (NLP), and Learning Chatbots. Machine Learning helps analyze learning data to predict and suggest appropriate content. NLP is applied in building educational chatbots, supporting students in answering questions, providing documents, and guiding learning in real time. According to Chen & Wang (2024), chatbots AI not only enhance self-learning ability but also help teachers reduce teaching workload.

Methods of designing teaching support softwares

The design of teaching support softwares needs to follow modern pedagogical methods and technology. Popular design models include:

• The ADDIE model (Analysis, Design, Development, Implementation, Evaluation) helps build an effective teaching system.

• The UDL model (Universal Design for Learning) supports the creation of teaching content that many different types of students can access.

• The Agile Development model is used to develop flexible educational softwares that can be easily upgraded based on user feedback.

In the world, many educational platforms use AI to personalize learning, typically:

• Khan Academy: Provides personalized lessons based on student's progress.

• Coursera: Uses AI to recommend courses suitable for learners.

• Duolingo: Applying AI to language teaching through customized exercises.

In Vietnam, some digital education platforms have started applying AI, such as:

• VioEdu: Personalized learning system based on student's ability.

• Topica Edtech Group: Developing AI system to support online training.

Trends in integrating AI in online teaching and learning.

The trend of using AI in online teaching and learning becomes growing. Recent studies show that AI helps optimize learning content, personalize learning experience, and enhance interactions between learners and teachers. Notable trends include:

• AI tutor system: Providing virtual learning assistants to help students solve exercises and support review.

• AI-driven Assessment: An automated student assessment system that reduces the burden on teachers.

• Integrating AI into virtual reality classrooms (VR/AR): Creating a vivid learning environment, enhancing the learning experience.

Many studies have demonstrated the potential of AI in education, but some research gaps still need to be exploited. According to Kumar and Patel (2024), most current personalized learning systems only focus on content recommendation without profoundly exploring the ability to assess student's learning motivation and emotions. In addition, Lee and Choi (2021) also pointed out that implementing AI in education still faces many challenges regarding ethics, privacy, and teacher acceptance. Based on the above comparisons, this study will focus on developing an AI learning system capable of personalizing content and assisting teachers in monitoring learning motivation and providing appropriate feedback, thereby improving teaching effectiveness in the digital environment.

3. RESEARCH METHODOLOGY

This study employs a literature review approach to analyze existing AI applications in education and assess current smart learning systems. Additionally, the system analysis and design methodology is applied to define essential software functionalities, user interface elements, and AI integration strategies tailored to educational needs. Furthermore, the study proposes criteria to assess software's effectiveness, identifying challenges and opportunities for practical implementation to ensure high practice and application in education.

4. THE DEVELOPMENT OF AI-BASED TEACHING AND LEARNING SUPPORT SOFTWARES

4.1 System Requirements

Requirement 1: Alignment with the High School Curriculum

The AI-integrated teaching and learning support softwares must align with high school curriculum, ensuring compliance with the Ministry of Education and Training's requirements. The system must incorporate subject-specific teaching materials and provide tools for teachers to track students' learning progress (Nguyen & Le, 2024).

Requirement 2: Learning Pathways Personalization

AI algorithms must analyze each students's learning data to generate customized recommendations and adjust instructional pacing based on individual competencies. The system should be able to identify students' strengths and weaknesses to optimize learning

pathways. According to Johnson & Brown (2024), the application of AI in personalized learning helps increase learning motivation and facilitates students' development of self-learning skills.

Requirement 3: Interactive Teacher-Student Communication

The platform should integrate interactive tools, such as virtual assistants, automated response systems, and discussion forums to facilitate effective teacher-student interaction. According to Garcia & Johnson (2024), AI creates a more flexible learning environment, boosting interaction and enhancing learning experience. The tools like chatbot AI can assist to consult students, and help teachers save time in learning guide.

4.2 Key Features of the software

- Personalized learning recomendation: Based on each student's ability: The software uses AI to analyze students' learning data, thereby providing suggestions suitable for individuals' levels, learning styles, and acquisition speed. Based on previous learning results, the system can recommend lessons, supplementary exercises, or advanced content. According to Nguyen and Le (2024), AI helps improve learning efficiency thanks to its ability to adjust the learning path to suit each student, minimizing the situations where students encounter difficulties or get bored due to inappropriate content.

- Learning support Chatbot: Real-time question answering: AI chatbots can answer students' questions immediately, helping students access information quickly without waiting for teachers. Chatbot systems can use natural language processing (NLP) to understand questions and provide accurate answers according to the context. According to Chen and Wang (2024), chatbots AI in education help enhance self-learning ability, encourage students to ask questions and learn more deeply about the lesson content. In the article, the ChatGPT integrated system supports learning. ChatGPT-integrated chatbots can act as a virtual learning assistant, helping students to ask questions, answer questions, and interact with learning content flexibly. This helps students to be more proactive in the learning process. According to Zhai (2023), AI chatbots in education help improve self-learning ability and increase students' participation in lectures.

- Automatic grading system: Using AI to evaluate assignments: AI can assist teachers in automatic grading, especially for multiple choice exercises, short essays, or programming code. The system can accurately evaluate based on specific criteria and provides immediate feedback to students based on the KNN algorithm. According to Wang and Liu (2021), automatic grading tools not only help reduce teachers' workload but also ensure objectivity and consistency in the process of evaluating learning outcomes.

- Tracking learning progress: Based on the KNN algorithm, the system provides detailed reports on students' learning process, including the level of homework completion, study duration and performance at each stage. These reports help teachers and parents grasp learning progress and adjust teaching methods or provide timely support. According to Holmes, Bialik, and Fadel (2023), applying AI to learning tracking helps personalize the learning experience and supports students in maintaining learning motivation.

4.3 Technological Framework

The system employs:

Machine Learning (ML): The k-Nearest Neighbors (KNN) algorithm is used for students' personalized content recommendations. The system will analyze data on each student's learning performance, task completion speed, and learning style. When a new student joins, KNN will search for the student's closest learning characteristics to suggest appropriate learning content for him/her. According to Baker and Inventado (2024), this method helps personalize the learning path, increases the acquisition ability, and reduces students' difficulties. In addition, KNN can be used to classify students' level of understanding. When a student completes a test, the KNN algorithm will compare the results with groups of students with similar characteristics, from which it will classify them as "Excellent," "Good," "Average," or "Need support/weak." According to Zhai (2023), applying KNN to learning assessment helps teachers have a more accurate view of students' abilities and adjust teaching methods accordingly.

In addition, KNN can predict students' ability to score in the following tests, helping teachers identify groups of students who need more support. The system will be based on students' previous score data and compare with students with similar learning trends. According to Susnjak (2023), KNN is a useful method in predicting learning outcomes, helping to personalize teaching more effectively.

The language used to build the system includes Laravel Framework with PHP programming language due to its security and compatibility with MVC model. ReactJS is also used to support flexible UI, and MySQL database to store ample data.

Main operating diagram of the system

This section proposes some AI technologies being developed and tested to improve education regarding research and learning for learners. Teachers can get help from AI as teaching assistants and become examiners by giving feedback to students in a short period using these technologies.
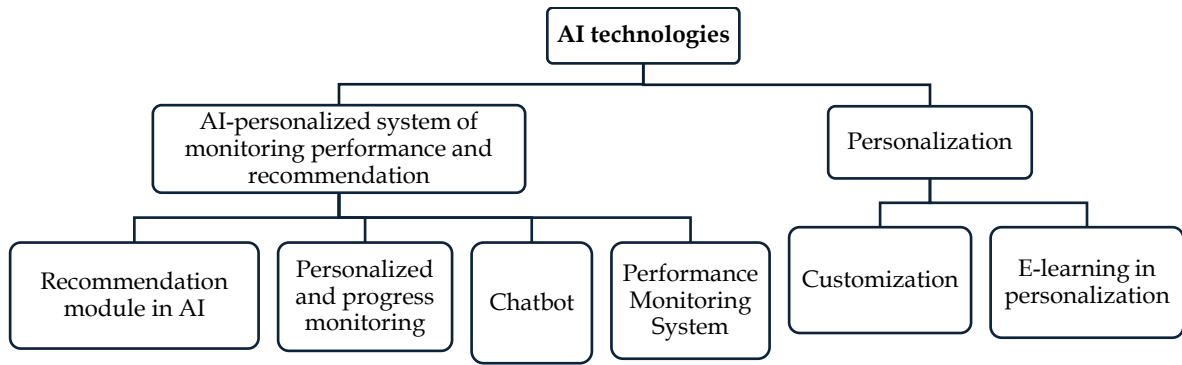
Figure 1: AI technologies
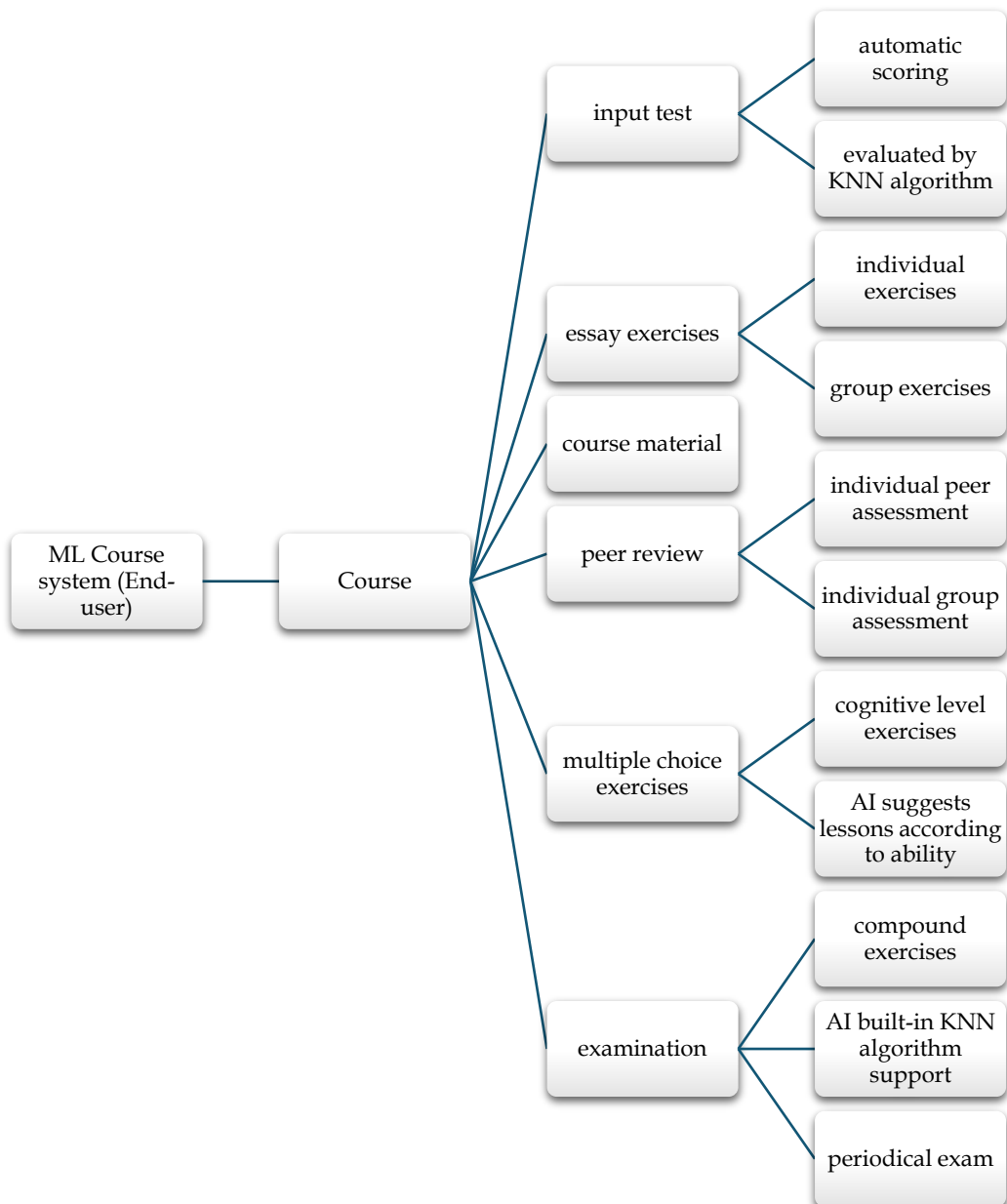
5. RESULTS
5.1. System overview diagram

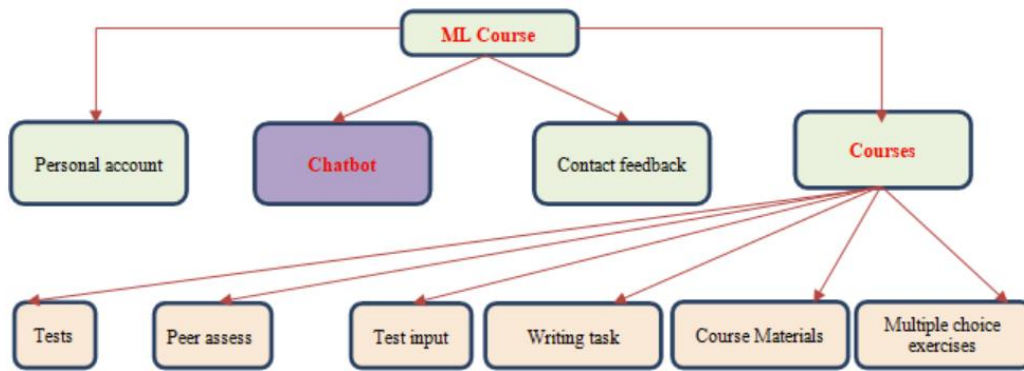**Figure 2. System architecture diagram (course organization hierarchy)**
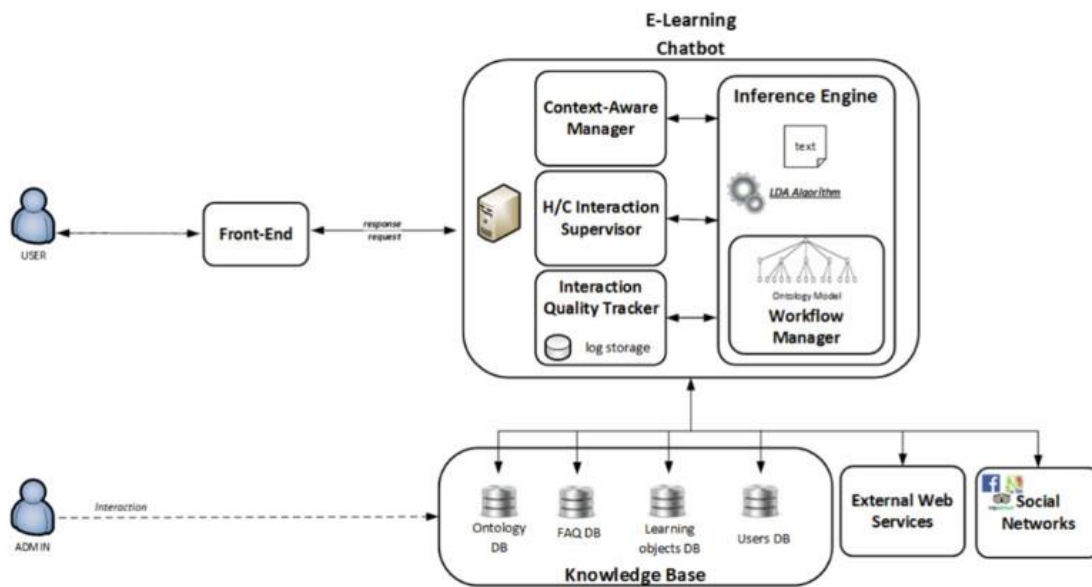
Figure 3. Structural diagram of the ML Course

Figure 4. E-learning Interactive System Architecture (Clarizia et al., 2018)

5.2. Design analysis

a) System's target audience: The system is designed for target objects such as teachers, those who want to contribute online courses with charge or free of charge, students, people who need to learn..., and the users of the courses created by teachers and lecturers. The system administrator is the admin but does not have much power to intervene in the teaching of teachers and lecturers; mainly, the admin is only capable of operating the system.

   b) BFD diagram: The system ensures the needs of learning free or paid courses on the system, as well as tracking the learning process of learners from teachers. Specifically, the system provides functions to ensure the above. (The design analysis is given in the following link:
https://drive.google.com/drive/folders/1kd8IejbKH5fyOBtDsCl57ywRMXjKlJUH?usp=sharing)

5.3. Designed website and some illustrative images

   The software is designed and integrated on the domain web page: https://ailearn.com.vn/

Figure 5. Experimental courses

Available on: https://ijhrsss.com/index.php/ijhrsss

Figure 6. Course topics content

Figure 7. AI-assisted programming course

CONCLUSION

This study has developed a teaching and learning support software integrating artificial intelligence (AI), focusing on applying Machine Learning technologies with KNN algorithms and natural Language Processing (NLP) integrated with ChatGPT. The system is designed to personalize learning paths, provide virtual learning assistants, support automatic grading, and monitor students' learning progress. The application of AI helps optimize teaching content, enhance interaction, and support teachers more effectively (Chen, Zhang, & Zhao, 2023).

In addition, the software helps reduce administrative work for teachers by automating the process of evaluating and giving feedbacks on assignments while providing flexible teaching support tools. The ChatGPT-based virtual learning assistant helps students look up information quickly, improve their self-learning ability, and enhance learning efficiency (Holmes, Bialik, & Fadel, 2019). The system also facilitates students' learning at their own pace, increasing their learning motivation and knowledge acquisition efficiency (Nguyen & Do, 2022). Integrating AI into education is an inevitable trend, helping to promote digital transformation in teaching and learning (Luckin, 2018).

In the next phase, the research will focus on improving the AI algorithm to enhance the personalization of learning content, ensuring that the system can provide smart and adaptive learning suggestions for each student (Hwang & Fu, 2023). This helps to optimize teaching methods by accurately identifying students' strengths and weaknesses to adjust learning content accordingly.

In addition, pilot deployment of the software in various educational settings will be conducted to evaluate the actual effectiveness of the system. This process will help collect data on students' and teachers' acceptance of AI in teaching and improve the model based on real feedbacks (Boulanger et al., 2024).

Another important development direction is the integration of AI with virtual reality (VR) and augmented reality (AR) technology to create a more intuitive and vivid learning experience. This is especially useful for highly visual subjects such as science, technology, and mathematics (Bergmann et al., 2024).

Furthermore, the study also proposed the application of Blockchain to secure students' learning data, ensuring transparency and safety in storing and processing data. This technology can help minimize risks related to cheating in exams and learning assessments (Chen et al., 2024).

Finally, expanding collaboration with educational institutions and technology companies will play a key role in promoting the software development toward commercialization and expansion of AI application in education on a broader scale (Johnson & Brown, 2023).

Ethics Information to the manuscript

The authors declare that there is no conflict of interest related to this manuscript. All research procedures comply with ethical standards, and no financial, personal, or professional relationships influenced the study. The authors confirm that they have adhered to institutional and ethical guidelines throughout the research process.

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