# Development of an AI-Powered System for Thesis Advisor Consultations

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***Abstract*—This research highlights the creation and assessment of an AI-powered system for thesis advisor consultations, aiming to enhance the academic advisory process for graduate students. The system delivers efficient, accessible, customized support in essential areas such as research design, literature review, research tool development, and statistical analysis. Evaluation results revealed that the system achieved a "Very Good" rating across key metrics, including functionality, accuracy, usability, performance, and security, with an overall average score of 4.76. Quantitative assessments of thesis progress among 42 graduate students demonstrated significant improvements, particularly in research tool development and quality assessment, with 88–95% achieving "Good" progress. Qualitative feedback highlighted the system's strengths in clarifying research objectives, guiding hypothesis formulation, and facilitating data analysis. Furthermore, a strong positive correlation ($r$ = 0.608, $p$ < 0.001) between research knowledge and thesis progress underscores the system's effectiveness in fostering academic growth. While no significant differences were observed in research knowledge among students with varying experience levels, the system showcased its ability to provide equitable support. These findings highlight the transformative potential of AI in academic advisory processes, offering reliable and accessible consultation services. Future development efforts will aim to enhance the system's capabilities in statistical analysis to meet advanced research needs better.**

***Keywords*—thesis consultation, thesis progress, artificial intelligence, research knowledge development, digital technology**

## I. Introduction

The integration of Artificial Intelligence (AI) into national strategies has become a significant focus globally, aiming to leverage technological advancements for sustainable development. In Thailand, the 20-Year National Strategy (2018–2037) emphasizes using technology and innovation to achieve stability, prosperity, and sustainability. AI plays a crucial role in enhancing entrepreneurial capabilities, developing the younger generation, and adapting business models to market demands. The strategy highlights the potential of AI to create new income streams, generate employment, and support education and research, fostering workforce readiness for the future [1].

Similarly, the 13th National Economic and Social Development Plan (2023–2027) prioritizes ecosystem development to support the digital industry. It underscores the importance of integrating AI into education to uplift workforce skills, adapt to emerging technologies, and align academic curricula with the demands of AI-driven industries. These initiatives are critical for producing a high-performing workforce capable of meeting future development challenges [2].

AI's transformative potential extends to academia, particularly in higher education. The National Education Plan (2017–2036) underlines the importance of AI in enhancing educational quality and efficiency. By aligning student skills with labor market requirements, AI supports the creation of value-added research and innovation, ensuring competitiveness in the 21st century [3].

A critical area of AI application lies in academic advisory systems. Effective thesis consultation between advisors and graduate students significantly impacts academic success, particularly at the doctoral level. Regular and structured interactions contribute to better academic outcomes, enhanced student satisfaction, and reduced dropout rates. Conversely, inconsistent or unstructured consultations can lead to frustration and hinder academic progress. Advisors with expertise and supportive interpersonal skills foster students' confidence and research capabilities, ultimately shaping them into competent researchers [4, 5].

The challenges of traditional academic advisory systems are amplified in the digital era. With large, diverse student populations and time constraints, traditional methods struggle to provide consistent and personalized support. AI-driven systems, such as intelligent multimedia answering platforms and chatbots, have emerged as promising solutions to address these limitations. These systems offer real-time, accurate, and efficient support, improving students' ability to navigate their academic journey and complete their theses successfully [6, 7].

This study aims to develop and evaluate an AI-powered advisory platform to support thesis consultations between graduate students and advisors. The platform employs advanced AI technologies, including natural language processing and interactive multimedia, to facilitate structured and effective communication. By bridging gaps in accessibility and availability, the system enhances collaboration, streamlines the advisory process, and ultimately contributes to students' academic success.

## II. Literature Review

### A. Thesis Consultation by Advisors

#### 1) The importance of thesis consultation

Thesis consultation is a critical component in supporting the success of doctoral students. High-quality consultation ensures students gain a comprehensive understanding of their research and conduct it effectively. This leads to enhanced academic satisfaction and lowers the risk of attrition [8].

Advisors play a vital role in equipping students with essential knowledge and research skills, enabling them to achieve success in their thesis work [9]. Effective consultation requires accessibility, timely guidance, and the ability to address the challenges faced by students. Additionally, fostering strong advisor-student relationships bolsters students' confidence and motivation to pursue their academic goals.

Research in Thailand highlights the importance of advisors with expertise and a deep understanding of the student's research area. Such advisors are more likely to guide students toward success [10]. Beyond academic support, advisors also provide encouragement and foster creativity, enabling students to refine their research skills systematically. By offering practical advice on research methodologies and thesis writing, advisors ensure that students comprehend the research process thoroughly, plan systematically, and address emerging challenges effectively. Comprehensive support and quality guidance significantly enhance students' research capabilities and overall academic achievement [11].

*2) Roles and responsibilities of advisors*

The roles and responsibilities of advisors are foundational to supporting and developing students' research capabilities. Advisors are pivotal in guiding students through their research journey by clearly defining their roles and responsibilities. These include providing academic support, mentoring, coordination, feedback, and resource management. Effective advisors guide students in selecting appropriate research topics, planning their methodologies, and writing their reports to meet scholarly standards [12].

Advisors also mentor students by encouraging and helping them overcome obstacles while fostering confidence and professional growth [13]. They coordinate resources and interactions between students and key individuals or organizations, such as thesis committees or research experts, to facilitate smooth research processes [12]. Additionally, advisors monitor students' progress, provide constructive feedback, and help them refine their research [14]. Effective time and resource management by advisors ensures students maintain productivity and manage stress effectively [15]. These multi-dimensional responsibilities underscore the importance of advisors in shaping students' research paths.

*3) Factors influencing graduate student success*

Several interrelated factors influence graduate student success in thesis completion. Foremost among these are the students' attributes, such as determination, confidence, and responsibility, which strongly correlate with research success [16]. Research skills, particularly in academic writing and presentations, are equally critical yet often underdeveloped among students [17].

Advisor support remains a key determinant of success, as regular guidance and academic assistance help students navigate the complexities of research. Additionally, self-management skills, including time planning and prioritization, are essential for students to balance academic responsibilities effectively [18]. Institutional resources, such as libraries, research support, and administrative guidance, also contribute significantly by facilitating access to essential academic tools and technical assistance [19]. Addressing these factors holistically can maximize the likelihood of thesis completion and academic success for graduate students.

*4) Building advisor-student relationships*

The relationship between advisors and students profoundly affects academic success, extending beyond academic consultation to encompass emotional and professional support. Effective advisor-student relationships include clear communication and mutual understanding. Advisors provide academic and career guidance, helping students develop research plans, write their theses, and prepare for postgraduate opportunities [20].

Furthermore, fostering accessibility and empathetic interactions strengthens students' confidence and academic commitment. Advisors also support students in managing personal challenges, stress, and well-being, contributing to overall academic productivity. By creating a supportive and collaborative environment, advisors empower students to overcome obstacles and excel academically. A strong advisor-student relationship is essential for building students' research capabilities and ensuring successful thesis completion [21].

*B. Digital Technology in Education*

*1) Transformation of technology in the digital era*

The digital era has profoundly transformed education, introducing technologies that enhance teaching and learning while opening new avenues for effective academic advisory systems. Digital tools, such as computers, tablets, and internet-based platforms, have revolutionized the accessibility and flexibility of learning, enabling students and educators to engage anytime, anywhere [22].

Artificial Intelligence (AI) has increasingly become an essential tool in education, offering innovative capabilities to enhance student learning experiences. Research highlights the potential of gamification in fostering creativity and innovation by integrating elements such as problem-solving, exploration, risk-taking, brainstorming, and diverse perspectives [23]. These approaches empower students to develop critical skills, showcasing the importance of incorporating gamification into AI-powered educational systems. Such systems promote active engagement, skill development, and personalized learning, paving the way for transformative educational practices. Additionally, multimedia technologies, such as video streaming and online communication platforms, have significantly improved academic consultations and research guidance, making these processes more efficient and accessible [24].

Integrating Learning Management Systems (LMS), such as Moodle and Blackboard, further systematizes course management and tracks student progress effectively [25]. Emerging technologies like Virtual Reality (VR) and Augmented Reality (AR) create immersive learning experiences, enabling students to engage with simulations and experiments in realistic environments. In Thailand, digital technology has gained support in subjects like science and mathematics, improving comprehension through engaging multimedia communication tools [26]. This transformation emphasizes the critical role of digital technology in modern education while highlighting the need for educators and learners to adapt and enhance their

technological skills for optimal use.

*2) The role of websites, social media, and applications in education*

Websites, social media, and educational applications have become integral to modern education, enhancing teaching, learning, and communication. Websites serve as vital repositories for academic resources, facilitating access to online courses, research databases, and evaluation tools [27]. Social media platforms, such as Facebook, Twitter, and YouTube, foster collaborative learning by enabling students to form study groups, share insights, and access instructional content quickly [28]. Meanwhile, applications like Google Classroom, Microsoft Teams, and Zoom streamline online teaching, promoting effective communication and collaboration between students and educators [29].

Specialized applications, including Duolingo for language learning and Khan Academy for diverse subjects, cater to targeted educational needs. These tools allow for personalized learning experiences, encouraging skill development in specific areas [30]. However, the successful implementation of these technologies requires users to acquire essential skills and adapt to new modes of interaction. While these platforms offer immense benefits, challenges such as information security, digital addiction, and the appropriateness of online content must be addressed to ensure a productive and safe learning environment [31].

*3) Communication and collaboration through digital technology*

Communication and collaboration are fundamental to effective education, and digital technologies have significantly improved these processes. Platforms like Zoom, Google Meet, and Microsoft Teams facilitate real-time communication, enabling dynamic interactions for classes, group discussions, and individual consultations [32]. Collaborative tools, including Google Drive, Microsoft OneDrive, and Dropbox, allow students and educators to share documents and work on projects simultaneously, enhancing productivity and teamwork [33]. Project management tools, such as Trello and Slack, further streamline group work and facilitate efficient task coordination [29].

Blended learning models, combining traditional teaching with digital tools, have proven effective in fostering collaboration and communication between students and educators. Problem-based learning, supported by digital media, enhances engagement and develops critical thinking skills, while specialized applications enable safe, inclusive, and participatory learning environments [34]. Digital technologies have thus emerged as essential enablers of effective communication and teamwork in educational settings, particularly in an era dominated by online learning [35].

*4) Enhancing educational efficiency through digital technology*

Digital technology has not only transformed traditional teaching methods but also introduced innovative ways to enhance learning efficiency. Platforms like LMS enable efficient course management and progress tracking, ensuring flexibility and comprehensive access to educational content [36]. Additionally, structured learning models and the integration of digital tools, such as VR and AR technologies, simulate real-world scenarios and create dynamic, interactive learning environments. These approaches enhance student understanding, foster engagement, and support the development of critical skills necessary for success in the digital age [37].

AI technologies analyze learning patterns, automate repetitive tasks such as grading, and provide real-time guidance, thereby reducing the workload on educators and increasing the accuracy of assessments [38]. Multimedia platforms, including intelligent chatbots and AI tutors, ensure continuous support for students by delivering precise and timely information. Cloud-based technologies facilitate seamless data storage and sharing, allowing educators and learners to access resources anytime, enhancing collaborative learning experiences [39].

In conclusion, digital technologies play a critical role in modernizing education by improving teaching methodologies, fostering collaboration, and creating flexible learning opportunities. From immersive VR simulations to intelligent advisory platforms, these innovations have enriched the educational experience, empowering students and educators alike to achieve academic excellence in a connected and dynamic learning environment.

### *C. Artificial Intelligence (AI)*

*1) Definition and importance of artificial intelligence*

Artificial Intelligence (AI) refers to technologies that enable computers to perform tasks that typically require human intelligence, such as learning, data analysis, problem-solving, and decision-making [40]. AI applications span various domains, including language processing, image recognition, big data analysis, and deep learning, allowing systems to enhance their capabilities and continuously improve their performance.

AI's importance lies in its ability to increase efficiency and speed across diverse sectors. For instance, in business, AI supports market data analysis, sales forecasting, and inventory management. In medicine, it aids in disease diagnosis, outbreak prediction, and personalized treatment recommendations [41]. In education, AI facilitates personalized learning, enabling students to engage with material tailored to their abilities and interests. It also enhances teaching processes by analyzing learning behaviors, refining curricula, and providing precise assessment tools [42]. These capabilities demonstrate AI's potential to revolutionize and optimize various systems and services.

*2) Trends in artificial intelligence technology*

AI technology continues to evolve rapidly, influencing multiple sectors significantly. A key trend is the development of AI systems with enhanced learning and adaptability. Technologies such as deep learning and machine learning underpin this evolution, allowing AI to process large datasets and deliver highly accurate analyses [43]. Another significant trend involves the improvement of Natural Language Processing (NLP) and conversational AI, exemplified by chatbots and virtual assistants. These systems interact fluidly with users, offering applications in customer service, consultation, and sales support [44].

AI's role in big data analytics is also expanding, with

systems capable of uncovering complex patterns and relationships within vast datasets, thereby informing strategic decision-making in business and management. Moreover, advancements in AI for image and video analysis continue to gain traction, particularly in areas like healthcare, where AI is used for accurate and expedited disease diagnosis through tools like X-ray and MRI image analysis [45]. In education, personalized learning systems driven by AI are becoming increasingly prevalent, adapting to individual student needs and providing targeted support to enhance learning outcomes.

#### *3) Successes and limitations of AI in communication and consultation*

AI has demonstrated notable success in communication and consultation tasks. The diversity of student abilities and the large numbers in modern education often make it challenging for advisors to provide comprehensive support. This challenge can lead to a decline in students' statistical analysis skills and time constraints that push them to seek additional knowledge outside the classroom. Therefore, high-quality tutoring systems and automated teaching management using Artificial Intelligence (AI) have become essential. These AI systems enable more effective consultations by providing personalized and timely support, allowing students to practice statistical analysis and efficiently enhance critical skills such as decision-making, problem-solving, and lesson planning [46]. However, despite these advancements, AI still faces limitations. For instance, its ability to process complex language structures and interpret nuanced human emotions remains challenging in conversational contexts. Furthermore, the success of AI systems heavily depends on access to high-quality data and rigorous training, without which their functionality may be significantly hindered. Additionally, concerns about data privacy and security persist, particularly in applications involving sensitive personal information, highlighting the need for robust safeguards to ensure user trust and safety [47]. Similarly, AI-powered systems support professional consultations by tailoring recommendations based on user-specific needs.

However, AI still faces limitations. As detailed in Table 1, challenges in processing complex language structures and interpreting nuanced human emotions can hinder its effectiveness in some conversational contexts [48]. The success of AI systems relies on high-quality data and sufficient training, which, if inadequate, may limit their functionality. Additionally, concerns about data privacy and security remain critical, especially in applications involving sensitive personal information [49].

Table 1. Successes and limitations of AI in communication and consultation

| Aspect | Success | Limitation |
|---|---|---|
| Customer Service | Chatbots provide 24/7 assistance, increasing speed and efficiency. | Difficulty in processing complex language and interpreting emotions. |
| Educational Guidance | AI delivers personalized learning recommendations, improving efficiency. | Requires high-quality data and extensive training for effective operation. |
| Career Counseling | AI offers tailored advice based on user preferences and abilities. | Data privacy and security concerns persist. |

AI continues to be a transformative force across sectors, with ongoing advancements addressing its current limitations while enhancing its capabilities. These developments pave the way for broader AI applications in communication, consultation, and beyond, contributing significantly to innovation and efficiency in various domains.

### *D. Application of AI Technology in Educational Consultation*

#### *1) Development and use of Chat AI in education*

The integration of Chat AI into education exemplifies the application of artificial intelligence to enhance teaching, learning, and academic advising. Chat AI leverages Natural Language Processing (NLP) and Machine Learning (ML) technologies to interact with users and respond to inquiries effectively [50].

Natural Language Processing (NLP): NLP technology enables Chat AI to process and understand user inputs by breaking down sentences, analyzing grammar, and identifying key phrases. This facilitates precise and meaningful responses, forming the foundation of effective communication in Chat AI systems [51].

Machine Learning (ML): Machine learning, particularly deep learning, is a pivotal element in Chat AI development. By training neural networks on extensive datasets, ML enhances the system's ability to recognize patterns and improve its responses continuously. For instance, neural networks enable Chat AI to answer complex questions with increasing accuracy [52].

Tools and Applications for Developing Chat AI: Several tools support the creation and training of Chat AI systems [53]:

- TensorFlow: An open-source library for deep learning models, TensorFlow supports NLP tasks and enables efficient training of neural networks for Chat AI.
- Keras: Known for its simplicity, Keras integrates seamlessly with TensorFlow to develop neural network-based Chat AI systems swiftly.
- Dialogflow: A platform for building conversational interfaces, Dialogflow simplifies the creation of conversational intents and responses.
- Microsoft Bot Framework: Facilitates the integration of Chat AI into applications, enhancing conversational capabilities.
- IBM Watson Assistant: This platform leverages advanced NLP and deep learning for dynamic and adaptive AI conversations.
- ChatGPT: Developed by OpenAI, ChatGPT combines deep learning and contextual understanding to deliver efficient and context-aware interactions.

The selection of tools is crucial for developing effective Chat AI systems tailored to specific educational needs. ChatGPT, for instance, demonstrates strong capabilities in academic consultation, enabling personalized and dynamic interactions.

#### *2) Effectiveness and benefits of Chat AI in thesis consultation*

The use of AI in academic consultation has demonstrated several advantages:

Enhanced Accessibility and Efficiency: AI systems like ChatGPT make academic advising more accessible and

efficient, fostering educational equity by providing reliable support regardless of geographical or temporal constraints [24].

Motivation and Creativity: Incorporating ChatGPT in academic writing stimulates creativity and helps improve language skills, particularly for non-native speakers [54].

Effective Communication and Engagement: Chat AI facilitates real-time communication, increasing student engagement and providing timely support [55].

Content Creation and Research Assistance: ChatGPT supports brainstorming, structuring, and refining academic content, proving valuable for research and thesis development [56].

Support for Education and Research: Chat AI aids in assessment, teaching innovation, and individualized guidance, improving both educational outcomes and research efficiency [57].

#### *3) Application of machine learning in Chat AI development*

Machine learning is integral to developing Chat AI systems that are capable of dynamic and intelligent interactions. By employing advanced models such as neural networks, ML enables Chat AI to analyze inputs, learn from interactions, and enhance decision-making capabilities [48].

For example, ML-driven chatbots assist in language learning, providing flexible and interactive platforms for skill acquisition [58]. Additionally, they are used in higher education to support teaching assistants and enhance student engagement [59]. Tools like TensorFlow and Keras facilitate the creation of efficient and scalable AI models tailored to educational purposes [60].

The research underscores the effectiveness of ML in improving chatbot interactions across various domains, including education, customer service, and small business support. By training these systems on context-rich data, developers can enhance their adaptability and responsiveness, ensuring alignment with user needs [61].

The adoption of AI technologies, particularly Chat AI, in education marks a transformative shift in academic consultation and support. Through tools like ChatGPT and platforms such as TensorFlow and Dialogflow, AI facilitates personalized, accessible, and efficient educational interactions. Leveraging ML further enhances these systems' capabilities, positioning them as indispensable assets in modern education. Continued innovation and research promise to expand the potential of AI in educational consultation, driving advancements in teaching, learning, and academic support.

### *E. Development and Evaluation of AI Systems for Consultation*

#### *1) Development process of AI systems for consultation*

Developing AI systems for consultation involves multidisciplinary knowledge spanning Machine Learning (ML), Natural Language Processing (NLP), and user interface design. The process includes several critical stages [62]:

- Data Collection: High-quality, diverse datasets are collected to train the AI model, ensuring coverage of various scenarios relevant to consultation tasks.
- Data Preprocessing: Raw data undergoes cleaning and formatting to remove redundancies and ensure consistency, creating structured inputs for the AI model.
- AI Model Design: The model is tailored to the problem, employing supervised or unsupervised learning techniques based on the dataset and intended outcomes.
- Model Training: The model is trained using the processed data, leveraging high-performance computing resources for efficient processing and accurate learning.
- Testing and Refinement: The trained model is tested with unseen data to evaluate its performance, with adjustments made to optimize accuracy and reliability.
- Deployment and Monitoring: The system is implemented in real-world scenarios, with continuous monitoring to ensure it meets user expectations and remains effective.

#### *2) Design and development of intelligent response platforms*

The creation of intelligent response platforms enhances interaction between users and AI systems. ChatGPT, a tool exemplifying advanced conversational AI, is widely used in such platforms for its contextual understanding and versatile response capabilities. The design process incorporates user feedback and iterative refinement, ensuring alignment with user expectations and practical usability [63].

#### *3) Methods and tools for evaluating AI systems*

Evaluating AI systems is a crucial step to ensure efficiency, accuracy, and user satisfaction. The evaluation typically includes quantitative, qualitative, and benchmarking approaches.

The development and evaluation of AI systems for consultation require meticulous planning, robust design, and ongoing refinement. By employing structured methodologies and advanced tools, such systems can deliver reliable, context-aware, and efficient consultation solutions. Continuous feedback loops and performance tracking are vital to maintaining high-quality outcomes and adapting to evolving user needs.

## III. METHOD STUDY

This study employed both qualitative and quantitative research methods to assess the effectiveness of an AI-powered thesis consultation system in supporting graduate students. The research was conducted with graduate students from the Department of Industrial Education and Information Technology, Faculty of Industrial Education, King Mongkut's University of Technology North Bangkok (KMUTNB), during the 2024 academic year. The research design, data collection, and analysis methods are outlined below:

The study involved a purposive sample of 42 graduate students enrolled in the Technological Education and Digital Technology Education programs at KMUTNB. These students were selected based on their enrollment in courses such as Advanced Research Methods, Vocational and Technical Education Research, Digital Technology Education Seminars, and Applied Research in Digital Technology Education. All participants were actively engaged in thesis or dissertation work during the study

period.

The collected data were analyzed in two main parts: quantitative and qualitative.

*1) Quantitative analysis*

Analysis of Variance (ANOVA): Used to compare students' knowledge of research processes before and after using the system, highlighting any statistically significant improvements.

Pearson Correlation: Applied to determine the relationship between students' thesis progress and their research knowledge.

*2) Qualitative analysis*

Content Analysis: Employed to analyze responses from interviews, surveys, and observations. Key themes and insights about students' experiences, satisfaction, and challenges were identified and summarized.

## IV. Research Tools

The research tools employed in this study were meticulously developed to assess the AI-powered thesis consultation system delivered through an intelligent multimedia Q&A platform. These tools were integral to evaluating both the progress of students' thesis development and their understanding of the research process. The tools, along with their development and implementation processes, are outlined below:

### *A. Thesis Progress Assessment Form*

This form was developed to measure students' progress at different stages of thesis development, both before and after using the AI consultation system. Key features include:

- Focused on essential aspects, such as clarity of research objectives, data analysis skills, literature review quality, and communication of research findings.
- Designed with detailed criteria to evaluate progress in critical thesis development areas.
- Tested with master's and doctoral students to verify its validity and reliability.
- Refined based on feedback from educators and field experts.
- Students assessed their progress using a Likert scale aligned with the evaluation criteria.

### *B. Research Knowledge Assessment Tool*

This quiz was created to evaluate students' knowledge and understanding of the research process, addressing both theoretical and practical components. Key features include:

- Covered all stages of the research process, including problem identification, research design, data collection, and statistical analysis.
- Questions were divided into three levels of difficulty: basic, intermediate, and advanced.
- Tested with graduate students to ensure the questions were relevant and of high quality.
- Question difficulty was analyzed using statistical methods, such as difficulty index analysis, to ensure a well-balanced distribution.
- Delivered through the Quizizz platform for an engaging and user-friendly assessment experience.
- Administered both before and after using the AI consultation system to measure changes in students' knowledge.

## V. Findings

The AI-powered thesis consultation system was developed to enhance the efficiency and accessibility of thesis guidance for students through an intelligent multimedia Q&A platform. Key findings include:

### *A. Needs Assessment and System Design*

A needs assessment identified challenges in thesis consultation, guiding the system design. The system integrates AI to provide tailored support in areas such as research topic selection, methodological guidance, scheduling, and feasibility assessment. As illustrated in Fig. 1—Diagram illustrating the interactions between students, AI systems, and advisors during thesis consultations—the design clarifies the roles and interactions of each component.

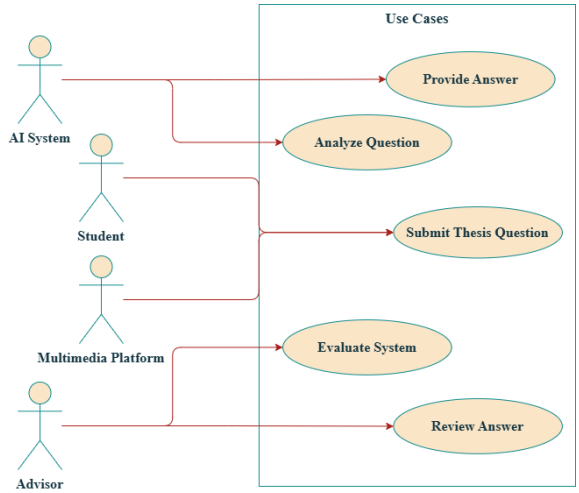


Fig. 1. Diagram illustrating the interactions between students, AI systems, and advisors during thesis consultations.

### *B. Key Components and Use Cases*

Actors:

1) AI System: Provides thesis-related guidance.
2) Student: Uses the platform for consultation.
3) Advisor: Reviews and evaluates AI responses.
4) Multimedia Platform: Supports text, audio, and video interactions.

Use Cases:

1) Students submit thesis questions.
2) The AI system analyzes questions and generates responses.
3) Advisors review and evaluate system-generated answers.

### *C. System Implementation*

The system enabled seamless interactions between students, AI, and advisors. Initial evaluations showed its potential to streamline academic consultations, improve response accuracy, and facilitate efficient communication.

This system demonstrates how AI can support thesis development, providing flexible and accessible consultation as shown in Fig. 2. Interface design showcasing the question submission section and AI-generated feedback for students, while laying a foundation for future enhancements based on user feedback.

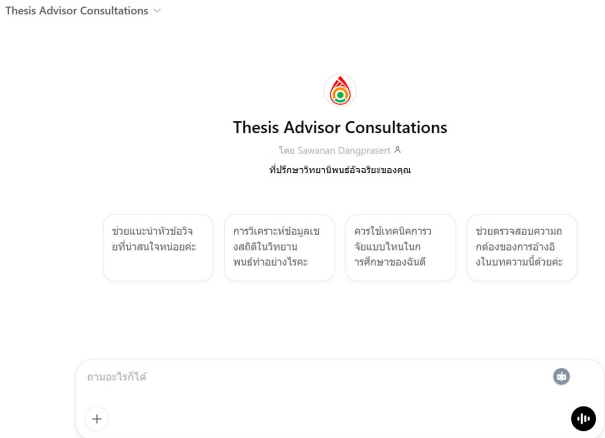


Fig. 2. Interface design showcasing the question submission section and AI-generated feedback for students.

Evaluation of the Effectiveness of the AI Thesis Consultation System

The evaluation aimed to assess the performance and quality of the AI-powered thesis consultation system delivered via an intelligent multimedia Q&A platform. Five experts participated in the evaluation, using a Black Box Testing Technique. The results are summarized in Table 2:

Table 2. Evaluation results of the AI-powered Thesis consultation system

| Evaluation Criteria | Mean | SD | Efficiency Level |
|---|---|---|---|
| 1. System functionality suitability | 4.60 | 0.55 | Good |
| 2. System Accuracy | 4.60 | 0.55 | Good |
| 3. Ease of use and user-friendliness | 4.80 | 0.45 | Very Good |
| 4. System performance | 5.00 | 0.00 | Very Good |
| 5. Security | 5.00 | 0.00 | Very Good |
| Overall Average | 4.76 | 0.44 | Very Good |

The findings presented in Table 2 demonstrate that the AI-powered thesis consultation system achieved a high level of performance across all evaluation criteria. The system received an overall average score of 4.76, classified as "Very Good". Specifically, functionality and accuracy were rated as "Good," each receiving a score of 4.60, which reflects the system's strong capability to address thesis-related tasks. Ease of use and user-friendliness achieved a score of 4.80, also classified as "Very Good," emphasizing the platform's intuitive design and accessibility. Moreover, performance and security were both rated with perfect scores of 5.00, indicating exceptional reliability, robustness, and the ability to safeguard user data. These results confirm the system's comprehensive efficiency and effectiveness in supporting thesis consultations. Detailed labels in Table 2 further clarify these evaluation criteria, making the data more comprehensible and easier to interpret.

The evaluation highlights that the AI-powered thesis consultation system consistently meets high standards of functionality, accuracy, usability, performance, and security. The system achieved an overall "Very Good" rating, showcasing its ability to effectively support academic consultation needs and meet user expectations. Enhanced labeling in figures and tables ensures that users can easily understand how these criteria were assessed, providing additional clarity for potential applications in academic advisory contexts.

The evaluation of thesis progress involved a sample of 42 graduate students in the Digital Technology in Technical Education program using the AI-powered thesis consultation system. The findings, supported by clearer figures and detailed labels, are presented both quantitatively and qualitatively, ensuring transparency and improved comprehension of the system's impact on students' academic progress.

Table 3. Thesis progress assessment results

| Evaluation Criteria | Mean | SD | Percentage (Good/Fair) |
|---|---|---|---|
| Research Design | 1.86 | 0.32 | Good: 93% / Fair: 7% |
| Literature Review | 1.81 | 0.36 | Good: 90% / Fair: 10% |
| Research Process | 1.78 | 0.38 | Good: 88% / Fair: 12% |
| Research Tool Development | 1.88 | 0.30 | Good: 95% / Fair: 5% |
| Instrument Quality Assessment | 1.83 | 0.34 | Good: 91% / Fair: 9% |
| Statistical Analysis | 1.76 | 0.40 | Good: 88% / Fair: 12% |

From Table 3, the mean scores for all evaluation criteria ranged between 1.76 and 1.88, reflecting "Good" progress. The highest score was in Research Tool Development (Mean = 1.88), indicating students' significant advancement in this area. The Standard Deviation (SD) ranged from 0.30 to 0.40, showing consistency in responses. Additionally, the "Good" percentage ranged from 88% to 95%, highlighting satisfactory results across all evaluated aspects.

**Qualitative Findings**

Feedback from students provided deeper insights into the system's effectiveness, categorized as follows:

1) *Research design*

- The system clarified research objectives and questions, enhancing precision in research planning.
- Guidance on hypothesis formulation was deemed effective, aiding students in structured planning.

2) *Literature review*

- The system effectively summarized relevant literature for thesis topics.
- Suggestions on citation and referencing reduced errors in documentation.

3) *Research tool development and quality assessment*

- The system provided practical guidance for designing and refining research tools.
- Quality assessment tools were appreciated for their focus on validity and reliability.

4) *Statistical analysis*

- The system assisted students in selecting appropriate statistical methods for their data.
- Recommendations for statistical software reduced learning time and streamlined analysis.

The AI-powered thesis consultation system demonstrated high effectiveness in supporting students' thesis development. Notable strengths were observed in research design, tool creation, and instrument quality assessment. However, enhancements in statistical analysis guidance are recommended to better support advanced research needs. These findings affirm the system's value in facilitating academic progress and improving the research process for graduate students.

This section presents an analysis of research knowledge and its relationship with thesis progress. This study compares research knowledge scores among students with different levels of research experience

Table 4. Comparison of research knowledge scores (ANOVA)

| Research Knowledge Area | Source of Variation | SS | df | MS | F | Sig. |
|---|---|---|---|---|---|---|
| Problem Identification | Between Groups | 3.710 | 2 | 1.855 | 0.282 | 0.755 |
| | Within Groups | 256.194 | 39 | 6.569 | | |
| | Total | 259.905 | 41 | | | |
| Data Analysis | Between Groups | 6.865 | 2 | 3.433 | 0.396 | 0.676 |
| | Within Groups | 338.278 | 39 | 8.674 | | |
| | Total | 345.143 | 41 | | | |
| Statistical Method | Between Groups | 6.389 | 2 | 3.194 | 0.559 | 0.576 |
| | Within Groups | 222.944 | 39 | 5.717 | | |
| | Total | 229.333 | 41 | | | |
| Instrument Development | Between Groups | 5.917 | 2 | 2.958 | 0.516 | 0.601 |
| | Within Groups | 223.417 | 39 | 5.729 | | |
| | Total | 229.333 | 41 | | | |
| Technology Integration | Between Groups | 6.508 | 2 | 3.254 | 0.558 | 0.577 |
| | Within Groups | 227.611 | 39 | 5.836 | | |
| | Total | 234.119 | 41 | | | |

The findings presented in Table 4. show no statistically significant differences in research knowledge levels among students with low, moderate, and high research experience across all evaluation criteria, as evidenced by the ANOVA results. For example, Problem Identification ($F$ = 0.282, $P$ = 0.755), Data Analysis ($F$ = 0.396, $P$ = 0.676), and Statistical Method Selection ($F$ = 0.559, $P$ = 0.576) all yielded P-values greater than 0.05. Similarly, no significant differences were observed in Research Tool Development ($F$ = 0.516, $P$ = 0.601) and Integration of Digital Technology ($F$ = 0.558, $P$ = 0.577). These results indicate that students, regardless of their prior research experience, displayed comparable levels of knowledge in research processes across the assessed criteria.

**Correlation Between Research Knowledge and Thesis Progress**

Table 5. Correlation between research knowledge and thesis progress (99% confidence intervals)

| Variable | Pearson Correlation | Sig. (2-tailed) | 99% Confidence Intervals (2-tailed)[a] | |
|---|---|---|---|---|
| | | | Lower | Upper |
| Research Knowledge—Thesis Progress | 0.608 | <0.001 | 0.285 | 0.807 |

a. Estimation is based on Fisher's r-to-z transformation.

As shown in Table 5, the Pearson correlation analysis revealed a moderate to strong positive relationship between research knowledge and thesis progress, with a correlation coefficient of 0.608 ($p < 0.001$). The 99% confidence interval ranged from 0.285 to 0.807, further validating the positive association.

These findings indicate that students with higher levels of research knowledge tend to demonstrate greater thesis progress. This underscores the importance of enhancing research knowledge to support successful thesis development outcomes for graduate students.

## VI. Conclusion

This study presents significant insights into the integration of AI-powered systems in academic thesis consultations. The development and evaluation of the AI-powered thesis consultation system through an intelligent multimedia Q&A platform demonstrated its capacity to enhance thesis progress and research process knowledge among graduate students. The system, characterized by advanced AI functionalities, robust performance, and intuitive design, achieved "Very Good" ratings across all evaluated criteria, indicating its potential to meet diverse user needs effectively.

Key findings revealed that students using the AI system showed considerable progress in essential thesis development stages, such as research design, literature review, and research tool development. While ANOVA results showed no significant differences in research knowledge levels among students with varying research experience, a strong positive correlation ($r = 0.608$, $p < 0.001$) between research process knowledge and thesis progress emphasized the importance of fostering research competencies to achieve academic success. After ensuring the system's high standards of functionality, accuracy, usability, performance, and security, additional efforts were made to enhance clarity in presenting the evaluation results. This includes more detailed labeling of figures and tables, ensuring that readers can easily comprehend the findings and their implications for broader academic applications.

Before using AI tools, students must engage in in-depth discussions with their thesis advisors to fully leverage the benefits of AI-powered thesis consultation systems while fostering intellectual skills. These discussions enable students to analyze their research objectives, refine methodologies, and ensure clarity in their research direction. This collaborative process strengthens foundational knowledge and critical thinking skills. After utilizing AI tools, students should perform a creativity review to evaluate the originality and applicability of AI-generated outputs. This step encourages students to explore deeper insights, expand on AI suggestions, and incorporate innovative ideas into their work. By embedding these practices into their academic workflows, students can ensure that AI serves as a complementary tool, enhancing rather than replacing the intellectual and creative processes essential for academic growth.

This study has addressed the potential biases in the AI-powered thesis consultation system by implementing several measures to ensure fairness and equity. These measures include the use of diverse and representative training datasets, regular audits of the system's outputs, and the integration of user feedback into its ongoing development. By adopting these strategies, the system minimizes bias and provides inclusive support to students from diverse backgrounds. These efforts ensure that the AI system offers fair, equitable, and effective academic support for all users.

This research contributes new knowledge by demonstrating the practicality and efficiency of integrating AI into the educational consultation process. It underscores the role of AI in providing personalized academic guidance, bridging knowledge gaps, and fostering equal opportunities for research excellence. Additionally, the findings highlight actionable pathways for refining AI-based educational tools, such as enhancing statistical analysis support and integrating user-centric design improvements, to further empower learners and educators. These results establish a robust foundation for the broader application of AI in academic and professional advisory systems, paving the way for innovative, scalable, and equitable education solutions.

## Conflict of Interest

The authors declare no conflict of interest.

## AUTHOR CONTRIBUTIONS

Sawanan Dangprasert conducted the research, including designing the study, developing the AI-powered thesis consultation system, collecting data, performing the analysis, and drafting the manuscript. Parwapun Kamtab contributed by providing expert guidance on research methodology, refining the system's evaluation framework, and reviewing the manuscript for accuracy and coherence. Both authors reviewed and approved the final version of the manuscript.

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## REFERENCES

[1] Office of the National Economic and Social Development Council. (2018). *20-Year National Strategy (2018–2037).* [Online]. Available: https://pub.nstda.or.th/gov-dx/national-strategy-2561-2580/

[2] Office of the National Economic and Social Development Council. (2023). *The 13th National Economic and Social Development Plan (2023–2027).* [Online]. Available: https://www.nesdc.go.th/article_attach/article_file_20230615134223.pdf

[3] Office of the National Digital Economy and Society Commission. (2019). *National Digital Economy and Society Development Plan (2018–2037).* [Online]. Available: https://www.onde.go.th/view/1/Digital_Development_for_National_Economic_and_Social_Development/EN-US

[4] Office of the Education Council. (2017). *National education plan (2017–2036).* [Online]. Available: https://www.onec.go.th/us.php/home/category/CAT0001145

[5] P. Patel, S. Rios, A. Valentine, and E. A. Oliveira, "Enhancing automated peer code reviews in software engineering education with context-aware generative AI," *APUBS*, 2024. https://doi.org/10.14742/apubs.2024.1446

[6] S. Singh, S. Kumar, and V. Singh, "Parenting style and emotional intelligence as the predictors of academic buoyancy among senior secondary students," *Int. J. Adolesc. Youth*, vol. 30, no. 3, pp. 245–265, 2025. https://doi.org/10.11591/edulearn.v19i1.21283

[7] S. Antony and R. Ramnath, "A phenomenological exploration of students' perceptions of AI chatbots in higher education," *Int. J. Educ.*, vol. 11, no. 2, Article 01, 2023. https://doi.org/10.22492/ije.11.2.01

[8] A. Masek and M. Alias, "A review of effective doctoral supervision: What is it and how can we achieve it," *Universal J. Educ. Res.*, vol. 8, no. 6, pp. 2493–2500, 2020. https://doi.org/10.13189/ujer.2020.080633

[9] T. Hayes, L. Lindeman, and C. Lukszo, "The role of academic advisors in the development of transfer student capital," *NACADA Journal*, vol. 40, no. 1, pp. 49–63, 2020. https://files.eric.ed.gov/fulltext/EJ1260384.pdf

[10] D. Thipayakulphairoj, "Strategies to enhance the effectiveness of thesis advising tailored for learners in the digital era," Ph.D. dissertation, Dept. Educ., Chulalongkorn Univ., Bangkok, Thailand, 2018. https://digital.car.chula.ac.th/chulaetd/3301

[11] J. Sverdlik and N. C. Hall, "Not just a phase: Exploring the role of program stage on well-being and motivation in doctoral students," *J. Adult Cont. Educ.*, vol. 26, no. 1, pp. 97–124, 2020. https://doi.org/10.1177/1477971419842887

[12] K. Pearce, S. Alghowinem, and C. Breazeal, "Build-a-bot: Teaching conversational AI using a transformer-based intent recognition and question answering architecture," in *Proc. AAAI Conf. Artif. Intell.*, 2023, vol. 37, no. 13, pp. 16025–16032. https://doi.org/10.1609/aaai.v37i13.26903

[13] A. Afzal, A. Sami, and S. Munawar, "The role of academic advising and mentoring in promoting student success and retention," *Int. J. Human Soc.*, vol. 4, no. 1, pp. 110–123, 2024. https://www.researchgate.net/publication/377364849

[14] S. Pramjeeth and P. Ramgovind, "Generative AI tools in teaching and learning: An enabler to creating work-ready students in the 4IR," in *Proc. International Conference on Educational Research (ICER)*, 2024, vol. 1, no. 1, pp. 2725–2736. https://doi.org/10.34190/icer.1.1.2725

[15] G. Chuenchom, K. Jairak, and U. Kowan, "A model for developing digital literacy skills for students at Rajabhat Universities to enhance the quality of learning," *J. Inf. Sci. Res. Pract.*, vol. 39, no. 2, pp. 16–33, 2021. http://cmruir.cmru.ac.th/handle/123456789/2234

[16] W. Jantanukul, "Rajabhat University concept for local development: Strategies, implementation, and community impact," *J. Educ. Learn. Rev.*, vol. 1, no. 6, pp. 47–60, 2024. https://doi.org/10.60027/jelr.2024.789

[17] Y. R. Apzhaparovna, K. k. Kutbyby, T. k. Zarina, and I. D. Mukhtorovna, "Challenges in developing the academic writing abilities of adults learning English," *Library Prog. Int.*, vol. 44, no. 3, pp. 13582–13588, 2024. https://bpasjournals.com/library-science/index.php/journal/article/view/2472/1815

[18] S. Siripipattanakul, S. Chaivisit, and P. Sriboonruang, "ChatGPT smart chatbot technology for future learning," *J. Educ. Stud.*, vol. 52, no. 2, EDUCU5202012, 2024. https://doi.org/10.14456/educu.2024.29

[19] S. Soelistiono and Wahidin, "Educational technology innovation: AI-integrated learning system design in AILS-based education," *Influence*, vol. 5, no. 2, pp. 1–10, Aug. 2023. https://doi.org/10.54783/influencejournal.v5i2.175

[20] B. H. Roos and J. S. Schreck, "The role of faculty advising, mentoring, and gatekeeping as social support for undergraduate communication sciences and disorders students," *Perspect. ASHA Special Interest Groups*, vol. 6, no. 4, pp. 818–830, 2021. https://doi.org/10.1044/2021_PERSP-21-00007

[21] B. G. Gimbert, D. Miller, E. Herman, M. Breedlove, and C. E. Molina, "Social emotional learning in schools: The importance of educator competence," *J. Res. Leadership Educ.*, vol. 18, no. 1, pp. 3–39, 2023. https://doi.org/10.1177/19427751211014920

[22] A. Abulibdeh, E. Zaidan, and R. Abulibdeh, "Navigating the confluence of artificial intelligence and education for sustainable development in the era of industry 4.0: Challenges, opportunities, and ethical dimensions," *J. Cleaner Prod.*, vol. 140527, 2024. https://doi.org/10.1016/j.jclepro.2023.140527

[23] S. Dangprasert, "The impact of gamification on creative and innovative skills of graduate students," *J. Theor. Appl. Inf. Technol.*, vol. 101, no. 8, pp. 3077–3087, 2023. http://www.jatit.org/volumes/Vol101No8.php

[24] W. Strielkowski, V. Grebennikova, A. Lisovskiy, G. Rakhimova, and T. Vasileva, "AI-driven adaptive learning for sustainable educational transformation," *Sustainable Development*, 2024. https://doi.org/10.1002/sd.3221

[25] R. R. Aljad, "Analysis of development trends and experience of using LMS in modern education: An overview," *E-Learning Innov. J.*, vol. 1, no. 2, pp. 86–104, 2023. https://doi.org/10.57125/ELIJ.2023.09.25.05

[26] A. M. Al-Ansi, M. Jaboob, A. Garad, and A. Al-Ansi, "Analyzing Augmented Reality (AR) and Virtual Reality (VR) recent development in education," *Soc. Sci. Humanities Open*, vol. 8, no. 1, 100532, 2023. https://doi.org/10.1016/j.ssaho.2023.100532

[27] F. Prasetya, N. Ö. Uluçay, P. Jaya, and R. Hidayat, "Social media in education: Trends, roles, challenges, and opportunities for digital-native generations—A systematic literature review," *Asian J. Univ. Educ. (AJUE)*, vol. 20, no. 3, 2024. https://ajue.uitm.edu.my/wp-content/uploads/2024/10/1-Agariadne-Dwinggo-Samala.-Social-Media-in-Education-1-1.pdf

[28] A. Njuguna, "Social media technologies and blended learning: Promoting interactivity and collaborative learning in educational emergencies," in *Proc. EDULEARN22*, pp. 3933–3941, 2022. https://doi.org/10.21125/edulearn.2022.0952

[29] O. A. Ajiva, O. G. Ejike, and A. O. Abhulimen, "Advances in communication tools and techniques for enhancing collaboration among creative professionals," *Int. J. Front. Sci. Technol. Res.*, vol. 7, no. 1, pp. 66–75, 2024. https://doi.org/10.53294/ijfstr.2024.7.1.0049

[30] T. K. Vashishth, V. Sharma, K. K. Sharma, and B. Kumar, "Enhancing literacy education in higher institutions with AI: Opportunities and challenges," *AI-Enhanced Teaching Methods*, pp. 198–215, 2024. http://dx.doi.org/10.4018/979-8-3693-2728-9.ch009

[31] A. Haleem, M. Javaid, M. A. Qadri, and R. Suman, "Understanding the role of digital technologies in education: A review," *Sustain. Oper. Comput.*, vol. 3, pp. 275–285, 2022. https://doi.org/10.1016/j.susoc.2022.05.004

[32] D. Choukaier, "Enhancing English as a Foreign Language (EFL) instruction through digital teaching platforms: Analyzing the impact of microsoft teams, zoom, and google meet on communication and participation," *Educ. Admin. Theory Pract.*, vol. 30, no. 6, pp. 2404–2418, 2024. https://doi.org/10.53555/kuey.v30i6.5748

[33] M. F. Castro-Arquinigo *et al.*, "Collaborative tools for project management: A technological review," in *Proc. 2023 IEEE Colombian Caribbean Conf. (C3)*, Nov. 2023, pp. 1–6. https://doi.org/10.1109/C358072.2023.10436211

[34] A. Kumar *et al.*, "Blended learning tools and practices: A comprehensive analysis," *IEEE Access*, vol. 9, pp. 85151–85197, 2021. https://ieeexplore.ieee.org/abstract/document/9446138

[35] A. Jaedun, M. Nurtanto, F. Mutohhari, I. N. Saputro, and N. Kholifah, "Perceptions of vocational school students and teachers on the development of interpersonal skills towards Industry 5.0," *Cogent Educ.*, vol. 11, no. 1, 2375184, 2024. https://doi.org/10.1080/2331186X.2024.2375184

[36] P. Veluvali and J. Surisetti, "Learning management system for greater learner engagement in higher education—A review," *Higher Educ. Future*, vol. 9, no. 1, pp. 107–121, 2022. https://doi.org/10.1177/23476311211049855

[37] B. T. Familoni and N. C. Onyebuchi, "Augmented and virtual reality in U.S. education: A review—analyzing the impact, effectiveness, and future prospects of AR/VR tools in enhancing learning experiences," *Int. J. Appl. Res. Soc. Sci.*, vol. 6, no. 4, pp. 642–663, 2024. https://doi.org/10.51594/ijarss.v6i4.1043

[38] L. Chen, P. Chen, and Z. Lin, "Artificial intelligence in education: A review," *IEEE Access*, vol. 8, pp. 75264–75278, 2020.

[39] S. Dangprasert, "The development of a learning activity model for promoting digital technology and digital content development skills," *Int. J. Inf. Educ. Technol.*, vol. 13, no. 8, pp. 1242–1250, 2023. https://doi.org/10.18178/ijiet.2023.13.8.1926

[40] L. Markauskaite *et al.*, "Rethinking the entwinement between artificial intelligence and human learning: What capabilities do learners need for a world with AI?" *Comput. Educ.: Artif. Intell.*, vol. 3, 100056, 2022. https://doi.org/10.1016/j.caeai.2022.100056

[41] M. Paramesha, N. L. Rane, and J. Rane, "Big data analytics, artificial intelligence, machine learning, internet of things, and blockchain for enhanced business intelligence," *Partners Univ. Multidiscip. Res. J.*, vol. 1, no. 2, pp. 110–133, 2024. https://doi.org/10.5281/zenodo.12827323

[42] M. Iqbal, "AI in education: Personalized learning and adaptive assessment," *Cosmic Bull. Bus. Manage.*, vol. 2, no. 1, pp. 280–297, 2023. https://doi.org/10.30574/gscarr.2024.18.2.0062

[43] N. L. Rane, M. Paramesha, J. Rane, and O. Kaya, "Emerging trends and future research opportunities in artificial intelligence, machine learning, and deep learning," *Artif. Intell. Ind. Soc.*, vol. 5, pp. 2–96, 2024. https://doi.org/10.70593/978-81-981271-8-1_1

[44] A. D. Samala *et al.*, "Unveiling the landscape of generative artificial intelligence in education: A comprehensive taxonomy of applications, challenges, and future prospects," *Educ. Inf. Technol.*, pp. 1–40, 2024. https://doi.org/10.1007/s10639-024-12936-0

[45] A. N. Mumuni, F. Hasford, N. I. Udeme, M. O. Dada, and B. O. Awojoyogbe, "A SWOT analysis of artificial intelligence in diagnostic imaging in the developing world: making a case for a paradigm shift," *Phys. Sci. Rev.*, vol. 9, no. 1, pp. 443–476, 2024. https://doi.org/10.1515/psr-2022-0121

[46] S. Dangprasert, "Effects on using tutoring application in integration with self-directed learning to improve statistical analysis skills," *TEM J.*, vol. 10, no. 1, pp. 63–68, 2021. https://doi.org/10.18421/TEM101-08

[47] A. Kasirzadeh and I. Gabriel, "In conversation with artificial intelligence: Aligning language models with human values," *Philos. Technol.*, vol. 36, no. 2, pp. 27, 2023. https://doi.org/10.1007/s13347-023-00606-x

[48] G. Bansal, V. Chamola, A. Hussain, M. Guizani, and D. Niyato, "Transforming conversations with AI—A comprehensive study of ChatGPT," *Cognit. Comput.*, pp. 1–24, 2024. https://doi.org/10.1007/s12559-023-10236-2

[49] A. Aldoseri, K. N. Al-Khalifa, and A. M. Hamouda, "Re-thinking data strategy and integration for artificial intelligence: Concepts, opportunities, and challenges," *Appl. Sci.*, vol. 13, no. 12, p. 7082, 2023. https://doi.org/10.3390/app13127082

[50] S. Tyagi, V. Gupta, and V. Mehndiratta, "Building smart campuses: Integrating AI in higher education," *Recent Trends in Artificial Intelligence Towards a Smart World: Applications in Industries and Sectors*, Singapore: Springer Nature, 2024, pp. 399–431. https://doi.org/10.1007/978-981-97-6790-8_15

[51] A. M. Sowjanya and K. Srividya, "NLP-driven chatbots: Applications and implications in conversational AI," *Conversational Artificial Intelligence*, 2024, pp. 713–725. https://doi.org/10.1002/9781394200801.ch39

[52] B. A. Alazzam, M. Alkhatib, and K. Shaalan, "Artificial intelligence chatbots: A survey of classical versus deep machine learning techniques," *Inf. Sci. Lett.*, vol. 12, no. 4, pp. 1217–1233, 2023.

[53] S. Acharya, "Study of the effectiveness of chatbots in customer service on e-commerce websites," Bachelor's thesis, Haaga-Helia Univ. Appl. Sci., 2023.

[54] C. Wang, "Exploring students' generative AI-assisted writing processes: Perceptions and experiences from native and nonnative English speakers," *Technol. Knowl. Learn.*, pp. 1–22, 2024. https://doi.org/10.1007/s10758-024-09744-3

[55] K. F. Hew, W. Huang, J. Du, and C. Jia, "Using chatbots to support student goal setting and social presence in fully online activities: Learner engagement and perceptions," *J. Comput. Higher Educ.*, vol. 35, no. 1, pp. 40–68, 2023. https://doi.org/10.1007/s12528-022-09338-x

[56] M. Khalifa and M. Albadawy, "Using artificial intelligence in academic writing and research: An essential productivity tool," *Comput. Methods Programs Biomed. Update*, 100145, 2024. https://doi.org/10.1016/j.cmpbup.2024.100145

[57] R. Sajja *et al.*, "Artificial intelligence-enabled intelligent assistant for personalized and adaptive learning in higher education," *Inf.*, vol. 15, no. 10, pp. 596, 2024. https://doi.org/10.3390/info15100596

[58] I. Gligorea *et al.*, "Adaptive learning using artificial intelligence in e-learning: A literature review," *Educ. Sci.*, vol. 13, no. 12, p. 1216, 2023. https://doi.org/10.3390/educsci13121216

[59] Y. Guo and Y. Wang, "Exploring the effects of artificial intelligence application on EFL students' academic engagement and emotional experiences: A mixed-methods study," *European Journal of Education,* vol. 60, no. 1, e12812, 2025. https://doi.org/10.1111/ejed.12812

[60] B. T. Chicho and A. B. Sallow, "A comprehensive survey of deep learning models based on Keras framework," *J. Soft Comput. Data Mining*, vol. 2, no. 2, pp. 49–62, 2021. https://doi.org/10.30880/jscdm.2021.02.02.005

[61] P. Suta, X. Lan, B. Wu, P. Mongkolnam, and J. H. Chan, "An overview of machine learning in chatbots," *Int. J. Mech. Eng. Robot. Res.*, vol. 9, no. 4, pp. 502–510, 2020. http://dx.doi.org/10.18178/ijmerr.9.4.502-510

[62] E. Nasarian *et al.*, "Designing interpretable ML system to enhance trust in healthcare: A systematic review to propose responsible clinician-AI-collaboration framework," *Inf. Fusion*, 102412, 2024. https://doi.org/10.1016/j.inffus.2024.102412

[63] A. Nazir and Z. Wang, "A comprehensive survey of ChatGPT: Advancements, applications, prospects, and challenges," *Meta-Radiology*, 100022, 2023. https://doi.org/10.1016/j.metrad.2023.100022


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