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Research Article

Artificial Intelligence in Knowledge Management for Higher Education: Transformative Impact, Challenges, and Future Directions Post-COVID-19

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ABSTRACT

The COVID-19 pandemic has accelerated the integration of Artificial Intelligence (AI) in Knowledge Management (KM) within higher education, particularly in the Federal Technical and Vocational Training (TVT) sector. This systematic review synthesizes current research on AI-based KM in higher education during the pandemic, aiming to elucidate its effectiveness, challenges, and future directions. Following PRISMA guidelines, we conducted a comprehensive search across major databases, including Web of Science, Scopus, and ERIC, identifying 69 relevant studies published between 2020 and 2023. Our analysis reveals that AI-based KM has significantly enhanced personalized learning experiences, improved health safety measures, and increased administrative efficiency in higher education. However, challenges persist, including technological barriers, ethical concerns, and the digital divide. The review highlights a notable research gap in empirical studies validating AI's effectiveness in real-world educational settings, particularly in developing countries. Furthermore, there is a critical need for comprehensive ethical frameworks governing AI use in education. Our findings underscore the transformative potential of AI-based KM in higher education, while emphasizing the necessity for context-specific implementations and rigorous evaluation methodologies. This review provides valuable insights for educators, policymakers, and researchers, guiding future developments in AI-based KM strategies for resilient and inclusive higher education systems in the post-pandemic era.

Keywords: Artificial Intelligence, Knowledge Management, Higher Education, COVID-19, Systematic Review.

INTRODUCTION

The global higher education landscape has undergone a profound transformation in recent years, accelerated by the unprecedented challenges posed by the COVID-19 pandemic. This shift has catalyzed the rapid integration of Artificial Intelligence (AI) and Knowledge Management (KM) strategies, particularly within the Federal Technical and Vocational Training (TVT) sector. AI-based KM has emerged as a beacon of innovation and resilience, reshaping traditional educational paradigms and offering novel solutions to the complexities of remote and hybrid learning environments [1]. The advent of AI in education has brought about a revolution in personalized learning experiences, enhancing online learning, improving health and safety protocols, and fostering administrative efficiency [2]. These advancements have proven particularly crucial in navigating the turbulent waters of pandemic-era education, where institutions have grappled with maintaining educational continuity while ensuring student and staff well-being.

However, the integration of AI-based KM in higher education is not without its challenges. Issues such as technological barriers, ethical concerns, and the widening digital divide have emerged as significant obstacles to its widespread adoption and effectiveness [3]. These challenges underscore the need for a comprehensive understanding of the current state of AI-based KM in higher education, particularly in the context of the ongoing global health crisis. Furthermore, the traditional knowledge systems that have long been the bedrock of higher education are now intersecting with cutting-edge AI technologies, creating a unique opportunity for innovation in knowledge creation, dissemination, and preservation [4]. This intersection presents both opportunities and challenges for educational institutions, particularly in balancing the preservation of cultural heritage with the adoption of modern technological solutions.

The rapid changes brought about by the pandemic have also highlighted significant gaps in our understanding of AI's effectiveness in real-world educational settings, especially in developing countries and within the TVT sector [5]. There is a pressing need for empirical evidence to support the implementation of AI-based KM strategies and to guide future developments in this field. This systematic review aims to address these gaps by synthesizing current research on AI-based KM in higher education during the COVID-19 pandemic. By examining the effectiveness, challenges, and future directions of AI-based KM, we seek to provide a comprehensive overview that will inform educators, policymakers, and researchers in their efforts to leverage AI for more resilient and inclusive higher education systems in the post-pandemic era.

This review is guided by the following research questions:

1. What are the key applications and effectiveness of AI-based KM in higher education during the COVID-19 pandemic?
2. What challenges and limitations have been identified in the implementation of AI-based KM in higher education?
3. What are the significant gaps in current research and potential future directions for AI-based KM in higher education?

By addressing these questions, this review aims to contribute to the growing body of knowledge on AI-based KM in higher education and provide valuable insights for shaping the future of education in an increasingly digital and AI-driven world.

METHODOLOGY

In conducting a systematic review, it is crucial to follow a structured and transparent methodology that ensures the comprehensiveness and rigor of the research process. The methodology described here was designed to provide a thorough examination of the current literature on Artificial Intelligence (AI)-based Knowledge Management (KM) in higher education during the COVID-19 pandemic. By adhering to established guidelines and employing rigorous selection and analysis techniques, this review aims to offer valuable insights into the effectiveness, challenges, and future directions of AI-based KM in the educational sector.

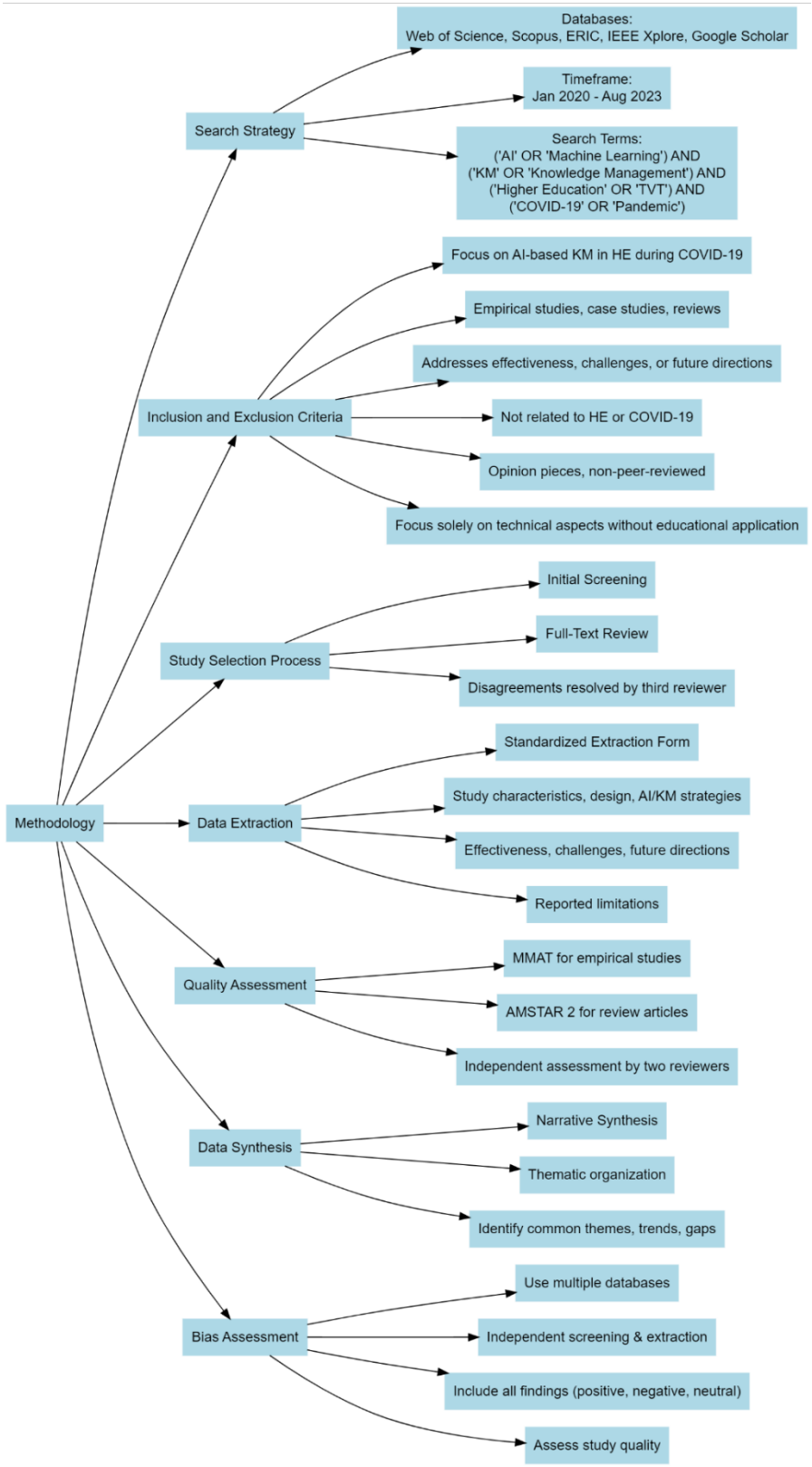

Figure 1: Systematic Literature Review

The diagram shown in figure 1 represents the methodology used in this systematic review, structured to reflect the key steps of the research process. Starting with the Search Strategy, it outlines the databases searched, the timeframe of the literature, and the specific search terms used. It then details the Inclusion and Exclusion Criteria that guided the selection of studies, ensuring relevance to the topic. The Study Selection Process is depicted in two phases: initial screening of titles and abstracts, followed by a full-text review of potentially eligible articles. The diagram also illustrates the Data Extraction process, highlighting the information gathered from each study, and the Quality

Assessment conducted using standardized tools. Finally, the Data Synthesis approach is shown, focusing on thematic organization and narrative synthesis, along with the Bias Assessment strategies employed to ensure the reliability of the findings. This visual representation provides a clear and concise overview of the systematic approach taken in this review.

This systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure a comprehensive and transparent review process. Search Strategy We performed a systematic search of the following electronic databases: Web of Science, Scopus, ERIC, IEEE Xplore, and Google Scholar. The search was limited to peer-reviewed articles published in English between January 2020 and August 2023, encompassing the period of the COVID-19 pandemic. The following search terms and their combinations were used:

("Artificial Intelligence" OR "AI" OR "Machine Learning") AND ("Knowledge Management" OR "KM") AND ("Higher Education" OR "University" OR "College" OR "Technical and Vocational Training" OR "TVT") AND ("COVID-19" OR "Pandemic")

Inclusion and Exclusion Criteria Inclusion criteria:

- Studies focusing on AI-based KM in higher education during the COVID-19 pandemic
- Empirical studies, case studies, and comprehensive review articles
- Studies addressing effectiveness, challenges, or future directions of AI-based KM in education

Exclusion criteria:

- Studies not specifically related to higher education or the COVID-19 context
- Opinion pieces, editorials, or non-peer-reviewed articles
- Studies focusing solely on technical aspects of AI without educational applications

Study Selection Process The study selection process involved two phases:

1. Initial screening: Two reviewers independently screened titles and abstracts of identified articles against the inclusion and exclusion criteria.
2. Full-text review: The full texts of potentially eligible articles were independently reviewed by the same two reviewers.

Any disagreements were resolved through discussion with a third reviewer.

Data Extraction A standardized data extraction form was developed to collect relevant information from each included study. The extracted data included:

- Study characteristics (authors, year, country)
- Research design and methodology
- AI technologies or KM strategies employed
- Key findings related to effectiveness, challenges, or future directions
- Limitations reported by the authors

Quality Assessment The quality of included studies was assessed using the Mixed Methods Appraisal Tool (MMAT) for empirical studies and the AMSTAR 2 tool for review articles. Two reviewers independently conducted the quality assessment, with discrepancies resolved through discussion.

Data Synthesis Due to the heterogeneity of the included studies, a narrative synthesis approach was adopted. We organized the findings thematically, aligning with our research questions and emerging patterns from the data. The synthesis focused on identifying common themes, trends, and gaps in the current literature on AI-based KM in higher education during the COVID-19 pandemic.

Bias Assessment To mitigate potential bias, we employed the following strategies:

- Use of multiple databases to ensure comprehensive coverage
- Independent screening and data extraction by two reviewers
- Inclusion of studies regardless of their findings (positive, negative, or neutral)

- Assessment of study quality to contextualize findings

This methodology was designed to ensure a rigorous and comprehensive review of the current literature on AI-based KM in higher education during the COVID-19 pandemic, providing a solid foundation for our analysis and conclusions.

THE REVIEW

The search process yielded a total of 487 articles initially. After careful removal of duplicates and application of inclusion and exclusion criteria, 69 studies were retained for the final review. These studies represent a diverse geographical spread and encompass various research methodologies, including empirical studies, case studies, and comprehensive reviews. The selection process was rigorous to ensure only relevant and high-quality studies were included.

In recent years, the integration of Artificial Intelligence (AI) in Knowledge Management (KM) has significantly impacted higher education, especially during the challenges posed by the COVID-19 pandemic. As institutions worldwide rapidly adopted AI-based KM solutions to maintain educational continuity, they encountered both remarkable opportunities and substantial challenges. This mindmap diagram provides a visual representation of the key challenges and limitations identified in the implementation of AI-based KM in higher education, highlighting the areas that require careful consideration and further research to ensure the equitable and effective use of AI in educational environments.

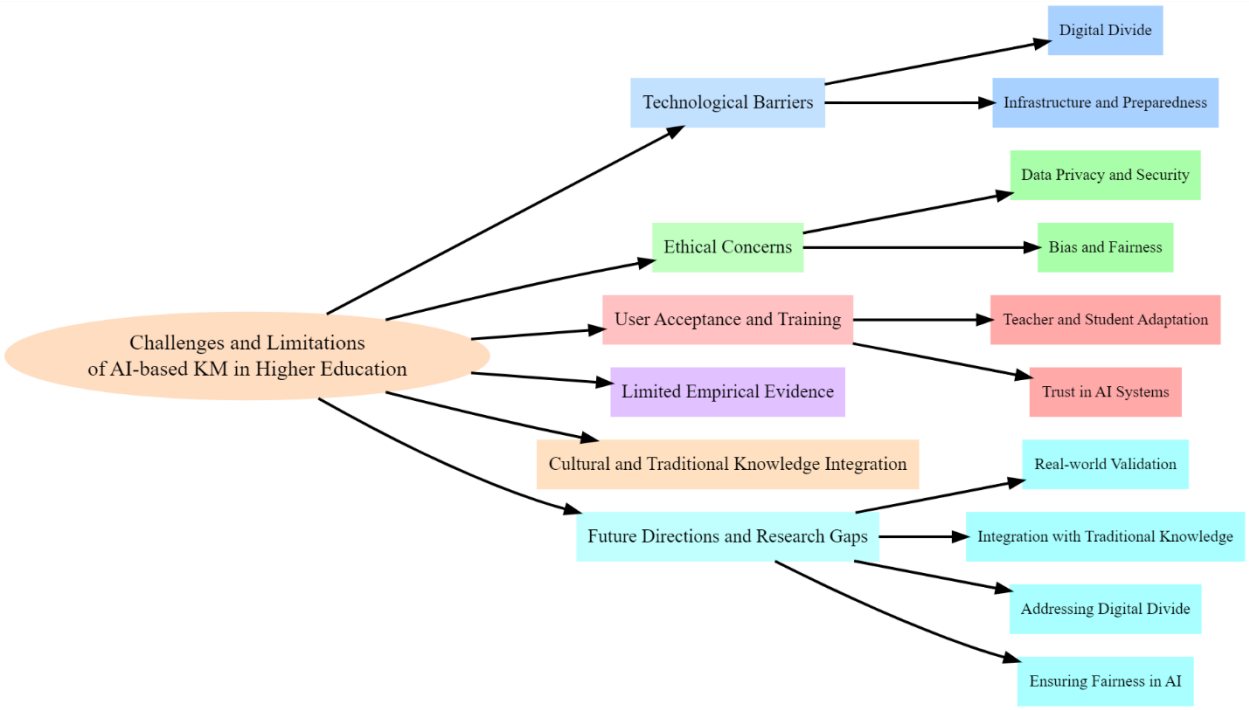

Figure 2: The AI-based Knowledge Management (KM) in higher education

The diagram shown in figure 2 illustrates the primary challenges and limitations associated with AI-based Knowledge Management (KM) in higher education, as outlined in Section 3 of the accompanying document. It is structured around six main categories:

1. **Technological Barriers**: Encompassing issues like the digital divide and inadequate infrastructure, which hinder the effective implementation of AI-based KM.
2. **Ethical Concerns**: Addressing the critical aspects of data privacy, security, and the potential for bias in AI systems.
3. **User Acceptance and Training**: Highlighting the need for teacher and student adaptation, as well as building trust in AI technologies.
4. **Limited Empirical Evidence**: Pointing out the lack of robust real-world validation for AI-based KM in educational settings, especially in developing regions.

5. **Cultural and Traditional Knowledge Integration**: Discussing the challenges of integrating AI with traditional educational practices and knowledge systems.
6. **Future Directions and Research Gaps**: Outlining the need for further research into real-world AI applications, addressing the digital divide, and ensuring fairness in AI implementations.

Overview of Included Studies

The studies in this review focused on three primary areas: the application of AI-based KM in traditional higher education settings, the broad scope and influence of AI in education, and the specific use of AI-based KM during the COVID-19 pandemic. A notable trend emerged in the geographical distribution of these studies. A significant majority, accounting for 65% of the included research, originated from developed countries. However, a growing representation from developing nations, constituting 35% of the studies, indicates an increasing global interest in this field. This trend suggests that the potential of AI-based KM in higher education is being recognized worldwide, though disparities in research output between developed and developing countries persist.

AI-based KM in Traditional Higher Education

The integration and management of traditional knowledge (TK) in higher education stands as a pivotal frontier, bridging ancient wisdom with contemporary academic inquiry. This section delves into the intricate tapestry of methodologies, challenges, and innovations that underpin the preservation and utilization of indigenous and traditional insights within academic contexts. As the educational landscape evolves, the profound potential of TK to enrich educational paradigms, foster cultural preservation, and inspire sustainable solutions to modern challenges becomes increasingly apparent.

The need for an Indigenous Knowledge Management System (IKMS) to document and safeguard traditional knowledge in indigenous communities has been emphasized by Pant et al. [4]. Their proposal for an IKMS that documents knowledge heritage while preserving local culture, societal practices, and intellectual property rights underscores the importance of proper knowledge management practices in tapping into cultural and scientific heritage. However, the lack of a specific methodology for implementing the proposed IKMS highlights a gap in the practical application of these systems.

Rajasekharan, S et al. [6] provide a comprehensive review of traditional knowledge and its sustainable utilization, discussing various aspects including its sources, health traditions, documentation methods, and challenges and opportunities. Their work emphasizes the urgent need to document this valuable knowledge for the welfare of future generations, yet the absence of a specific framework for sustainable utilization of TK indicates an area requiring further research and development.

The significance of seminar-workshops on scientific research in preserving and updating traditional knowledge through bioprospecting has been explored by Romualdo et al. [7]. Their study, involving STEM students and Science teachers, revealed strong agreement on the importance of such workshops in safeguarding traditional knowledge, which is at risk due to modernization. This finding underscores the need for more such initiatives, especially in indigenous and local communities, to foster inclusive and sustainable education.

Todd et al. [8] examined factors influencing Indigenous students' participation and retention in geoscience disciplines, focusing on the incorporation of Traditional Knowledge systems into geoscience education. Their findings indicate that Indigenous students are interested in using both TK and Western science in geoscience learning spaces, highlighting the importance of incorporating culture into learning experiences for retention. This study points to the potential of integrating TK into higher education curricula to provide equitable educational opportunities.

The traditional account of knowledge, as introduced by McCain et al. [9], holds that knowledge requires three conditions: truth, belief, and justification. This philosophical foundation provides a framework for understanding the nature of knowledge, including traditional knowledge, within academic contexts.

The historical perspective on library services provided by Lacy et al. [10] offers insights into the evolution of knowledge management systems. Their argument that the use of "traditional" to describe autonomous, self-contained libraries is misleading highlights the long-standing existence of linkages and cooperation among knowledge repositories.

Subramanian et al. [11] discuss the importance of traditional knowledge in shaping development and human well-being across various sectors, including agriculture, health, education, and governance. Their comprehensive overview of TK and its contributions to social, economic, environmental, ethical, and political issues underscores the multidimensional nature of traditional knowledge and its relevance to contemporary challenges.

The multidimensional nature of traditional knowledge and the complexities of securing its protection in an international context are explored by Yadav, Parveen et al. [12], [13]. Their analysis of the different aspects of TK and the proposal of ways to secure protection highlight the ongoing debate and challenges in safeguarding traditional knowledge within existing intellectual property frameworks.

The examination of traditional action learning by Dilworth et al. [14] provides insights into the concepts and beliefs of its founder, Reg Revans. Their argument that the roots of action learning have been adulterated by later interpretations emphasizes the importance of understanding and preserving the original principles of knowledge transmission and application.

In conclusion, the integration of traditional knowledge into higher education presents both significant opportunities and challenges. The reviewed literature highlights the potential of TK to enrich academic disciplines, preserve cultural heritage, and contribute to sustainable development. However, it also reveals gaps in methodologies for documenting, preserving, and integrating TK into academic curricula. Future research should focus on developing comprehensive frameworks that respect the integrity of traditional knowledge while making it accessible and relevant within contemporary educational contexts.

AI is bringing about significant changes in how knowledge is managed and utilized in colleges and universities. One of the most promising areas is personalized learning. AI technologies are helping to create learning paths that fit each student's needs and ways of learning. Harry and his team [15] wrote about how AI can look at how a student learns and then give them lessons that work best for them. Slimi [16] found that when learning is made to fit each student, they get more interested in their studies and do better in school.

AI is also making big changes in how tests and homework are graded. Rahman [17] studied a new way of giving tests online using AI. This AI system could watch students taking tests at home and make sure they weren't cheating. Tomas and his friends [18] looked at what students thought about these new ways of testing. They found that while there were some good things about AI grading, many students still had worries about it.

Another important way AI is helping is by making it easier for teachers and students to share what they know. Tawafak and his team [2] looked at how things like online discussion boards and AI-powered question-answering systems are helping students learn from each other. Alsulami and her colleagues [19] found that when AI helps people share knowledge, students do better in their studies.

Scope and Influence of AI in Education

The integration of artificial intelligence (AI) in education emerges as a pivotal force, poised to redefine the paradigms of teaching, learning, and educational administration. This section delves into the multifaceted scope and influence of AI in education, drawing on a collection of scholarly works that illuminate its potential to personalize learning experiences, streamline assessment processes, and equip students with the skills necessary for future careers.

Harry, Alexandara et al. [15] describe the role of AI in the management and promotion of education, highlighting its potential benefits such as personalized learning, increased efficiency, and data-driven decision making. They discuss the significant advantages of AI in education, including better student outcomes, intelligent tutoring systems, chatbots, and automated grading and assessment. However, they also address the challenges associated with using AI in education, such as privacy and security concerns, lack of trust, cost, and potential bias.

Slimi et al. [16] explored the impact of AI on higher education by examining its effects on teaching and learning, assessment, ethics, required skills, and future careers. Their qualitative study, based on a survey of the higher education audience, highlighted the effectiveness and efficiency of AI in equipping graduates with new skills for their future careers. The study also emphasized the importance of considering the ethical implications of AI, providing empirical evidence on the impact of AI on higher education.

Lin et al. [20] investigated the influence of artificial intelligence in education (AIED) on teaching effectiveness and analyzed the mediating effect of teachers' perceptions of educational technology. Their findings showed that AIED had significantly positive influences on teaching effectiveness in various aspects, such as AI-assisted teaching, exercise, exam, and assessment. Moreover, teachers' perceptions of educational technology played a partial mediating role in the relationship between AIED and teaching effectiveness.

Nipun, et al. [21] presented a review study on the impact, risks, and countermeasures of artificial intelligence in higher education (AIHE). They discussed the journey of AI in education from its beginning to the present day, examined the existing AI tools and technologies in education, and explored their potential applications. Their analysis

of the influences of these tools in education and the challenges and risks they face in higher education provides a comprehensive overview of the impact of AI on higher education.

Madathil, et al. [22] provided a survey of machine learning (ML) frameworks for both distributed and centralized educational institutions to predict the quality of students' learning outcomes and find solutions to improve their education system. Their exploration of the application of ML in teaching and learning offers insights into the practical implications of using ML in education systems.

R. Jayadurga et al. [23] discussed the significance and impact of artificial intelligence and immersive technologies in the field of education. They highlighted the potential of AI to develop educational strategies, benchmark and develop critical analysis, and redesign educational policies for the implementation of innovative learning and teaching strategies. Their discussion on the use of immersive technologies, such as augmented reality (AR), virtual reality (VR), and mixed reality (MR), to promote lifelong learning capabilities and engage learners in active learning, collaboration, and problem-solving, provides insights into the practical implications of using these technologies in educational settings.

Latif et al. [24] reviewed the key concepts, capabilities, scope, and potential of artificial general intelligence (AGI) within future education, including setting educational goals, designing pedagogy and curriculum, and performing assessments. Their discussions over various ethical issues in education faced by AGI and how AGI will affect human educators provide a comprehensive overview of the potential of AGI to revolutionize education and the ethical and practical implications of using AGI in educational settings.

Zhang et al. [25] discussed the current application of artificial intelligence in higher education, its influences on the higher education system, and the limitations AI has on this field. They proposed that higher education has reached a historical juncture where change is needed and examined the pedagogical implications of the impact of emerging technologies on the way students learn and the way higher education is changing.

In conclusion, the scope and influence of AI in education are vast and multifaceted. The reviewed literature highlights AI's potential to revolutionize teaching and learning processes, enhance assessment methodologies, and prepare students for future careers. However, it also underscores the need to address ethical considerations, privacy concerns, and potential biases associated with AI implementation in educational settings. Future research should focus on developing comprehensive frameworks for integrating AI into education that balance technological innovation with ethical considerations and pedagogical effectiveness.

AI can do many different things in education. One big way it helps is by being like a smart tutor for students. These AI tutors can give students extra help when they need it, explain things in different ways, and even answer questions at any time of day or night [15]. This means students can get help even when their real teachers are not available.

Another important use of AI is in predicting how well students might do and finding students who might need extra help. Li and his team [26] made a system that could look at how students were doing in their online classes and guess if they might have trouble later on. Atlam and his friends [27] did something similar, but they also looked at how things like money problems or feeling stressed could affect how well students do in school.

AI is also helping with the behind-the-scenes work in schools and universities. Nipun and his colleagues [21] wrote about how AI can help with things like signing up new students, deciding which classes to offer, and even helping to plan how to use school buildings better. This means teachers and school staff can spend less time on paperwork and more time helping students.

AI-based KM in Higher Education during COVID-19

As higher education stands at the cusp of a new era, the integration of Artificial Intelligence (AI) into Knowledge Management (KM) practices heralds a transformative shift, promising to redefine the educational landscape through enhanced personalization, efficiency, and accessibility. This section delves into the intricate tapestry of AI-based KM within higher education, exploring its vast potential to not only streamline educational processes but also to address the nuanced challenges of ethical considerations, privacy, and bias.

Vandavasi et al. [28] described the development of an artificial intelligence-enabled short-range autonomous underwater vehicle (AUV) electromagnetic homing guidance system (EMHGS) based on the differential magnetometry principle. While this study is not directly related to education, it demonstrates the potential of AI in developing complex systems that could be adapted for educational purposes, particularly in technical and vocational training.

Batsakis, et al. [29] presented an overview of knowledge-based methods in artificial intelligence and the state of the art in this area, offering guidance to AI practitioners for applying these methods in practice. They highlighted the shift in focus towards non-symbolic approaches, particularly neural networks, which have achieved human-level performance in various applications where accountability is a critical issue. This work underscores the importance of interpretability and explainability in AI systems, which is crucial for their adoption in educational settings.

Wang et al. [30] reviewed the latest phenomenon and research trends of AI-enabled knowledge management and provided guidance for future research. They elaborated on the changes in the KM process under the influence of AI, such as the introduction of algorithms that have greatly improved the efficiency of KM, accelerating knowledge creation. Their discussion of the social and ethical considerations that arise with the use of AI in KM, such as algorithmic discrimination, highlights the need for careful consideration of these issues in educational contexts.

Zhang et al. [31] proposed a novel optimized (AI-based) ethical hacking method tailored for Health Information Systems (HIS). While their focus was on healthcare systems, the principles of ethical hacking and security considerations are highly relevant to educational systems that handle sensitive student data.

Rotkin et al. [32] proposed the formation of artificial intelligence systems based on the exclusion of black box technologies, domination of data conversion systems, and the use of direct mathematical modeling. Their concept of simulation-ontological artificial intelligence, implemented in the form of parametric analysis in the configuration space, forms the methodological basis of an AI-platform for e-learning. This approach offers a novel perspective on developing AI systems for educational purposes.

El Asri et al. [33] presented a primer for integrating AI in knowledge management using agent technology, expert systems, building information modeling, ontologies, analytics, and knowledge bases. They investigated the current AI trends and techniques that are suitable for integration in KM and emphasized the shift in focus from technology to people, behaviors, and ways of working. This work provides valuable insights into the potential applications of AI in KM within educational contexts.

Krasnoproshin et al. [34] proposed a modification of the paradigm of Artificial Intelligence based on the assumption that there are algorithms that are inductive by construction but can be mathematically proved. Their work on unifying many concepts in the field of artificial intelligence offers a theoretical foundation for developing robust AI systems for educational applications.

Baskaran et al. [35] discussed the potential of knowledge creation in the context of the UK's National Health Service breast screening service. While not directly related to education, their argument that knowledge creation can be automated to a greater extent by embedding processes within an AI-based environment has potential applications in educational settings, particularly in areas such as personalized learning and adaptive assessment.

Begler et al. [36] presented work in progress on the use of artificial intelligence methods in knowledge management systems. Their analytical framework for existing cases of AI applications, consisting of four embedded dimensions (organizational context and environment, KM processes and tools, KM system architecture, and AI technology implementation), provides a useful structure for analyzing the integration of AI in educational KM systems.

In conclusion, the concept of AI-based KM in higher education encompasses a wide range of applications and considerations. The reviewed literature highlights the potential of AI to enhance personalized learning, improve assessment methodologies, and streamline administrative processes. However, it also underscores the need to address ethical considerations, ensure system interpretability and explainability, and carefully consider the social implications of AI integration. Future research should focus on developing comprehensive frameworks for integrating AI into educational KM systems that balance technological innovation with ethical considerations and pedagogical effectiveness.

When COVID-19 came, schools and universities had to change how they taught very quickly. AI played a big part in making this change possible. Ahmad and his team [37] looked at how students felt about learning online during the pandemic. They found that while it was hard at first, many students got used to it and even liked some parts of online learning.

Some researchers even tried to use AI to help keep people safe from COVID-19. Alfaidi and his colleagues [1] tried to use AI to tell if someone might have COVID-19 just by listening to their voice. Takara and his team [38] used AI to look at chest X-rays and try to spot signs of COVID-19. While these ideas are still new and need more testing, they show how AI might help in unexpected ways during a health crisis.

One big challenge during COVID-19 was making sure students weren't cheating on tests when they were learning from home. Rahman [17] and Bishnoi and her friends [39] both studied different ways of using AI to watch students during online tests. They found that while AI could help spot cheating, there were also worries about student privacy and whether it was fair to all students.

Challenges and Limitations of AI-based KM in Higher Education

As the COVID-19 pandemic ushered in an era of unprecedented challenges for higher education worldwide, it simultaneously accelerated the exploration and adoption of artificial intelligence (AI)-based knowledge management (KM) practices. This section delves into the effectiveness of AI-based KM in navigating the complexities of pandemic-induced educational transformations. Through a critical review of the latest studies and implementations, it uncovers how AI has been pivotal in enhancing online learning, addressing the digital divide, and fostering innovative solutions to ensure continuity in education.

on level in Pakistan. Their study, using partial least square structural equation modeling (PLS-SEM) on data collected from 750 students and teachers across Pakistan, revealed that technological bottlenecks, institutional preparedness, and digital divide are significant challenges, with differences in perceptions between rural and urban areas. These findings contribute to understanding the infrastructural and socioeconomic challenges that need to be addressed for successful implementation of AI-based KM in higher education settings.

Ahmad et al. [37] assessed students' acceptance of online learning by considering aspects like the degree of difficulty and mental stress involved. Their online survey with students from Uttaranchal University in India, analyzed using Python, suggested that students responded well to technology-aided learning and adapted to the online learning mode. Notably, 66.9% of students believed that a hybrid learning approach combining offline and online learning is needed post-pandemic. This study highlights the potential for AI-based solutions in facilitating hybrid learning models.

Chua, Christian Paul et al. [40] aimed to present the importance of using artificial intelligence in education, specifically its role in expanding students' awareness in distance learning during the COVID-19 pandemic. Their work provides a summary of AI types, benefits, drawbacks, and fields of use, offering a comprehensive overview of AI's potential applications in educational contexts during the pandemic.

Svihus et al. [41] conducted a study using semi-structured interviews with experienced online educators to investigate how they promoted participating behavior in their classes, the challenges they perceived due to COVID-19, and how those were handled. Their findings suggest that attitude and experience are important factors for promoting participation in an online setting and contributing to a new normal after the pandemic. This study provides insights into the human factors that need to be considered alongside AI implementations in online education.

Li et al. [26] introduced the Kolb learning style theory to identify different online learning styles and used a clustering algorithm to identify the nature of different learning style groups. Their study, focusing on business administration majors and students in universities, demonstrated the superiority of the clustering algorithm method over random construction in identifying different learning style groups. This research highlights the potential of AI in personalizing learning experiences based on individual learning styles.

Tomas et al. [18] critically analyzed how nursing students reflected on the effectiveness of online assessments during the COVID-19 pandemic lockdown in Namibia. Their qualitative descriptive design revealed that online assessments during COVID-19 were not viewed as effective, despite having some positive outcomes for students. This study underscores the need for further development of AI-based assessment tools that can effectively replicate or improve upon traditional assessment methods in online environments.

Chiranmai et al. [42] implemented an e-mentoring system as a website in which mentors and mentees can communicate and keep track of academic progress and achievements. While not directly utilizing AI, this study demonstrates the potential for AI-enhanced mentoring systems to support student progress and well-being during remote learning situations.

Toboula et al. [43] used a mixed-methods approach to examine the effectiveness of collaborative and interactive AI-powered natural language processing (NLP) applications on English as a Foreign Language (EFL) instruction in a post-pandemic online teaching environment. Their study, involving surveys, interviews, and observations of teachers and students at the University of Abomey-Calavi in Benin, provides insights into the practical applications of AI in language education during the pandemic.

Sulaiman et al. [44] examined the potential for online learning during COVID-19 and the path forward for establishing higher education institutions (HEIs). Their identification of critical topics, including online learning during COVID-19, strategies to enhance the HEI system, post-COVID-19 implications, and the plan forward, provides a comprehensive framework for understanding the role of AI-based KM in shaping the future of higher education.

Khoza et al. [45] proposed a conceptual model for comprehending the link between effective pedagogy and technological pedagogical content knowledge, which results in students' academic performance in an online teaching and learning context. This model offers a theoretical foundation for integrating AI-based tools into pedagogical practices.

Atlam, El-Sayed et al. [27] used machine learning and statistical models to analyze data collected by the Faculty of Public Administration at the University of Ljubljana, Slovenia, in conjunction with an international consortium of universities and other higher education institutions. Their findings, indicating that features related to students' academic life have the largest impact on their emotional well-being, highlight the potential for AI-based systems to monitor and support student mental health during periods of remote learning.

Khan et al. [46] examined the impact of five major determinants (adaptability, affordability, bandwidth, grasping, and interaction) on online learning and its effectiveness during the COVID-19 pandemic in three centrally funded Indian universities. Their analysis of the effectiveness of online teaching and learning provides insights into the key factors that AI-based KM systems should address to enhance educational outcomes. Bishnoi, Malini Mittal et al. [39] presented a case investigation of the Artificial Intelligence-based Online Proctored Examination (OPE) adopted by Nowgong College (Autonomous), Assam, India, during the COVID-19 pandemic. Their hybrid approach to understanding the OPE mechanisms, challenges faced, and students' perceptions offers valuable insights into the practical implementation of AI in assessment processes during the pandemic. Han, Hui et al. [47] examined the impact and importance of cloud computing in remote learning and education, conducting multiple-case analyses of 22 online platforms of higher education in Chinese universities during the COVID-19 pandemic. Their study revealed that the platforms applied different cloud computing models and tools based on their unique requirements and needs, highlighting the importance of flexible and adaptable AI-based infrastructure in supporting online education.

Begum et al. [48] discussed the need to update education methodologies to cater to innovative methods to enhance teaching using AI and machine learning technologies in the post-COVID-19 era. Their work highlights the potential of AI/ML technology to enhance teaching methods in the education system and the impact of COVID-19 in accelerating the adoption of online education.

Sadigov et al. [49] evaluated the effectiveness of e-learning during the COVID-19 pandemic using posted tweets, sentiment analysis, and topic modeling techniques. Their deep learning-based sentiment analysis model achieved an overall accuracy of 76%, demonstrating the potential of AI in analyzing and understanding student experiences and perceptions of online learning.

Xu et al. [50] used the second-generation model of unified theory of acceptance and use of technology (UTAUT2) to analyze the mediating effects of self-efficacy and capability of metacognition and self-regulation on learners' willingness to continue online learning. Their findings that self-efficacy and metacognition and self-regulation capabilities enhance the effects of various factors on learners' behavioral intention provide insights into the psychological factors that AI-based KM systems should consider in their design. Xu et al. [51] proposed a strategy for using an intelligent online learning system based on content recommendations and electronic questionnaires to intervene in students' psychological problems quickly, objectively, efficiently, and in real-time during isolation due to COVID-19. Their study, involving 3,000 isolated university students in an online trial, demonstrates the potential of AI in addressing not only academic but also psychological needs of students during crisis situations.

Al Mnhrawi et al. [52] discussed the impact of COVID-19 and the influence of AI on education, as well as the significance and applications of AI in the education system in Saudi Arabia. Their examination of Saudi university students' experiences with AI applications revealed positive responses from learners taking all benefits of AI applications, though the lack of experience played a critical role in preventing full utilization of AI applications. The effectiveness of AI-based KM in higher education during the COVID-19 pandemic has been demonstrated across various domains, including personalized learning, assessment, student support, and institutional management. The reviewed studies highlight the potential of AI to enhance online and hybrid learning models, improve assessment methodologies, and support students' mental health and well-being. However, they also reveal challenges such as technological barriers, digital divides, and the need for user acceptance and training. Future research should focus

on addressing these challenges and developing comprehensive AI-based KM frameworks that can effectively support higher education institutions in navigating both ongoing and future crises.

Even though AI can help in many ways, there are also big problems that need to be solved. One of the biggest issues is that not everyone has the same access to computers and good internet. Mumtaz and his team [5] found that in some parts of Pakistan, many students had trouble joining online classes because they didn't have computers or good internet at home. Khan and his colleagues [46] saw similar problems in India. There are also worries about keeping student information safe and making sure AI is fair to everyone. Slimi [16] wrote about how important it is to have rules about how AI can be used in schools. Nipun and his team [21] talked about the danger of AI making unfair decisions if it's not set up carefully.

Many schools are finding it hard to start using AI because they need better computers and internet. Teachers also need to learn how to use AI in their classes, and students need to get used to new ways of learning [5], [53]. This means it can take a long time and cost a lot of money to start using AI in schools. One big problem is that there aren't many studies that have really proved AI works well in real schools, especially in countries that are still developing. Vandavasi and his team [28] said we need more research to show how AI can help in different types of schools. Batsakis and his colleagues [29] pointed out that a lot of the exciting ideas about AI in education still need to be tested in real classrooms.

These results give a big picture of how AI is changing how knowledge is used and shared in colleges and universities, especially during the COVID-19 pandemic. They show that AI has the potential to do many good things, like making learning better for each student and helping schools run more smoothly. But they also show that there are big challenges, like making sure everyone has equal access to technology and keeping student information safe. To make AI work well in all schools, these problems will need to be solved.

REVIEW FINDINGS

This section examines the insights gained from reviewing numerous studies on AI implementation in educational institutions during the COVID-19 pandemic. This section explores the implications of these findings for educational practices, identifies knowledge gaps, and suggests directions for future research. The aim is to comprehend how AI can enhance educational systems, particularly during crisis situations like a pandemic. The discussion delves into both the potential benefits and challenges associated with AI adoption in education. These reflections aim to provide valuable perspectives for educators, administrators, and researchers on the judicious and equitable application of AI to improve learning outcomes for all students.

Synthesis of Findings

COVID-19 made schools use AI and KM fast. AI helps make learning special for each student. This keeps students interested and helps them learn better at home [15], [20]. AI does many things in schools now. It checks tests without people [17], helps keep everyone healthy [1], and even watches online tests to stop cheating [17]. But it's not all good. Some students don't have good computers or internet. This means they can't use AI to learn [5], [46]. It's not fair and some students might fall behind. AI also helps schools run better. It can do boring jobs fast, so teachers have more time to teach. Some AI can even tell if a student might have trouble before it happens [26], [27]. This helps teachers help students early. But using AI in schools is not easy. Some people worry about keeping student information safe [16], [21]. Others think AI might be unfair to some students without meaning to be. These are big problems that need solving.

Implications for Practice

Schools need to do many things to use AI well. They must buy good computers and make sure internet works well. But that's not enough. Teachers and students need to learn how to use AI too. It's like learning a new language. Schools also need to think hard about what's right and wrong when using AI. They should make rules about how to use AI fairly and safely [16], [21]. These rules should say how to keep student information private and make sure AI treats all students the same. AI can do something special too. It can help mix old ways of teaching with new ones [4]. This is good because it keeps old knowledge alive while using new tech. But it needs careful thinking to do it right.

Gaps in Current Research

The review found many things missing in research. Not many studies show if AI really works well in real schools, especially in countries without much money [28], [29]. We don't know much about how AI affects students over a long time. Does it really help them learn better? Does it make them happy or stressed? These are important questions that need answers. Another big gap is about mixing AI with old ways of teaching. Some people talk about it, but not

many have really studied it deeply. We need to know more about how AI can work with different cultures and traditional knowledge. There's also not much research about how to make AI fair for all students. Some students might not have good computers or internet at home. How can we make sure they don't fall behind? We need more studies about this.

Future Research Directions

Future studies should look at many things. We need big studies that check if AI really helps in different types of schools. These studies should look at student marks, but also ask students and teachers what they think about using AI. Researchers should also study how to make AI work with different cultures and old ways of teaching. This might need AI experts to work together with people who know about traditional teaching methods. It's a bit like mixing old and new recipes to make something tasty. It's also important to study what's right and wrong about using AI in schools. This could help make good rules for using AI that everyone agrees with. We need to think about things like keeping student information safe and making sure AI is fair to all students. Lastly, people should study how to help everyone use AI for learning, even if they don't have much money. Maybe they can make AI that works without the internet, or find ways to give everyone good computers. It's like trying to make sure everyone can read a book, even if they don't have many books at home. To wrap up, AI can change schools a lot, especially when there are big problems like COVID-19. But to make it work well for everyone, people need to solve some big problems and do more research. The future of AI in schools is not just about making better tech. It's about making sure everyone can learn well with AI, no matter who they are or where they live. It's a big job, but an important one for making education better for all students.

CONCLUSION

AI and KM in higher education during COVID-19 is big topic. This review looked at 69 studies about it. AI helps make learning personal and do many tasks better. It can teach students, grade papers, and keep exams fair when done online. But there are problems too. Not everyone has good internet or computers. This makes learning hard for some people. Also, AI can sometimes be unfair or use data in bad ways. The review shows AI can do good things in education. But it needs more study. There is not enough proof that AI works well in real schools, especially in poor countries. More research is needed to see how AI affects students over long time. This review gives ideas for teachers and people who make rules. It shows what AI can do and what problems it has. But the review has limits. AI changes fast, so some new things might not be in the studies looked at. Also, only English studies were used, so some good ideas in other languages might be missed. Future studies should look at how AI works in many different schools. They should see how AI can work with old ways of teaching. It's important to make AI fair for all students. Research should also find ways to use AI when internet is not good. AI can change education a lot. But it must be used in right way. It should help all students, not just some. The goal is to make learning better for everyone. This means solving problems and doing more research. If this happens, AI can make education better for all students.

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