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Research Paper

Modeling and Mapping the Effects of Generative AI on Student Readiness for Exams in Auchi Polytechnic: An Empirical Study

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A b s t r a c t
With the continuous intervention of AI tools in the education sector, new research is required to evaluate the viability and feasibility of extant AI platforms to inform various pedagogical methods of instruction. The current manuscript explores the cumulative published literature to date in order to evaluate the key challenges that influence the implications of adopting AI models in the Education Sector. The researchers present works both in favor of and against AI-based applications within the academic milieu. A total of 69 articles from a 618-article population was selected from diverse academic journals between 2018 and 2023. After a careful review of selected articles, the manuscript presents a classification structure based on five distinct dimensions: user, operational, environmental, technological, and ethical challenges. The current review recommends the use of ChatGPT as a complementary teaching-learning aid, including the need to afford customized and optimized versions of the tool for the teaching fraternity. The study addresses an important knowledge gap as to how AI models enhance knowledge within educational settings. For instance, the review discusses, inter alia, a range of AI-related effects on learning from the need for creative prompts, training on diverse datasets and genres, incorporation of human input, and data confidentiality and elimination of bias. The study concludes by recommending strategic solutions to the emerging challenges identified while summarizing ways to encourage wider adoption of ChatGPT and other AI tools within the education sector. The insights presented in this review can act as a reference for policymakers, teachers, technology experts, and stakeholders, facilitating the means for wider adoption of ChatGPT in the education sector.

Keywords: *ChatGPT**,** Artificial intelligence**,** Challenges**,** Strategies**,** Education sector*

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I. Introduction

1.1 Background

Educational and academic practices have been exposed to significant and far-reaching technological advancements in recent times, exemplified by the intervention of Artificial Intelligence (AI) (Tuomi, 2018). The swift technological research and embedded innovation in machine learning sciences have accelerated the introduction of language generation models (Dwivedi et al., 2021). This has led to the advancement of content generation technologies and innovation pertaining to digital content development and script development using embedded AI technologies such as the ChatGPT generative model (Hu, 2023).

The progression and integration of deep learning (DL) and reproducible AI technologies have led to the creation of digital artifacts that systematically integrate audio-visual inputs, movable graphics, and other digital and script commands. This is achieved by scrutinizing training inputs and synchronizing between various data patterns and designs (Abukmeil et al., 2021; Gui et al., 2023). Contemporary published literature acknowledges two main generative technologies: AI – Generative Adversarial Network (GAN) and Generative Pre-trained Transformer (GPT) (Vaswani et al., 2017; Abukmeil et al., 2021; Brown et al., 2020; Hu, 2023; Gui et al., 2023).

Presently, GAN is a GAI-enabled technology that uses dual neural networks (Karras et al., 2021). While the discriminator network aids in evaluating the genuineness and authenticity of the generated content, the generator network, which is an assemblage of GPT and GAN, can generate complex data such as the graphics of a human face. This iterative verification and the corroborative protocols continue until the discriminator network can discriminate between the synthetic and real content, with the synthetic then acknowledged as genuine and authentic (Jovanović and Campbell, 2022). GAN technology is primarily reliable for generation, graphics, and video (Hu, 2023). Generative-modeling artificial intelligence (GAI) such as ChatGPT is an unmonitored or moderately monitored machine learning framework that integrates manmade content artifacts with the intervention of statistics and probabilities (Jovanović and Campbell, 2022).

At its most basic, however, what is completely unclear with the revelation of generative AI models is how they can be used in ways that are not only innovative but also safe, ethical, and reliable (Jain et al., 2023). These important oversights in AI generative model innovation suggest that scholars have stopped short in reviewing the assortment of challenges that can be identified in extant research, particularly within educational settings. With these facts in mind, this review paper has the following objectives: First, the authors appraise the existing literature by identifying complex patterns and challenges that remain unresolved in the science and practice of ChatGPT generative models. Second, the manuscript evaluates the for and against arguments in using AI generative models.Generative AI models and ChatGPT in particular use Natural Language Processing (NLP) to recite and yield human-like transcripts in diverse dialects. These dialects are enabled to exhibit creative content while scripting texts. The AI platform is capable of creating voluminous content from a few lines to ballads and couplets, to a complete research article. Such content is convincing in almost all the themes that have substantial content on web-public platforms. Additionally, these models are empowered to engage clients in conversations resembling human dialogue; illustrations include customer-support chatbots or fictitious charismatic plots in computerized/electronic games (Pavlik, 2023; Rese and Tränkner, 2024).

A more erudite, better-trained, and advanced GPT-3 has been introduced recently (Brown et al., 2020). This AI version has 175 billion constraints and criteria (Cooper, 2021), wherein it can boost task-specific and objective features that can become highly efficacious through modern calibration (Brown et al., 2020). Brown et al. (2020) opined that GPT-3 is ten-fold sophisticated compared to any preceding non-sparse language model. This version is developed as the foundational NLP engine that improves the earlier language-enabled model of ChatGPT, which has fascinated many diverse fields of ontology inter alia from academic education (Qu et al., 2022; Williams, 2023), to engineering (Qadir, 2022), to broadcasting and journalism (Pavlik, 2023), across different fields of medicine (García-Peñalvo et al., 2020), and in many business domains related to money transactions, finance, and economics (Fallahi et al., 2022; Alshater, 2022; Terwiesch, 2023).

Sizable language models such as GPT-3 garner substantial progressions in NLP where prototypes are proficient in processing colossal transcripts and script data that can yield texts, answers, questions, and a bouquet of script-related tasks; these outcomes are achieved with the similar proficiency and intelligence of a human being (Floridi and Chiriatti, 2020). Notably, key developments in the sphere of transformer architectures and their usage (Devlin et al., 2018; Tay et al., 2023), and fundamental responsive machinery (Vaswani et al., 2017), significantly enrich the capacity of auto-regressive, self-controlled language schemas to leverage long-term adjuncts in natural-language scripts. The transformer architecture presented in GPT-3 (Vaswani et al., 2017) relies on the self-attention apparatus to resolve the consequence of the whole input mechanism while engendering prognosis. The architecture thus empowers the model to enhance the association among texts, their articulation to a context, and the script, irrespective of their locus and location.

Additionally, a significant structural progress is the practice of primarily training the model system on a considerable dataset before calibrating it for a particular task. This pre-sequencing has been pivotal for enhancing the functioning of an array of linguistic syntactical functions (Hughes et al., 2016; Alzubaidi et al., 2021). Moreover, Bi-directional Encoder Representations from Transformers (BERT) is a pre-trained transformer-based encoder model commissioned on distinct and diverse NLP tasks, with the capability of producing sentence cataloguing, queries, and answers and termed entity recognition (Devlin et al., 2018). Indeed, GPT-3 and ChatGPT comprise contemporary evolutions and specific advancements where they have been instructed on much larger datasets and data availability. Advancements include scripts and amassing information from the web which have proven to be efficient on a spectrum of natural-language tasks oscillating from an array of tasks such as question-answering, to scripting comprehensive and writing essays based on the nature and peculiarity of commands received (Floridi and Chiriatti, 2020). Furthermore, contemporaneous functions have aimed at calibrating these NLP technologies on smaller datasets where transfer learning applications have been rendered to new pertinent challenges (Kasneci et al., 2023; Baidoo-Anu and Ansah, 2023).

The recent past has witnessed the advancement and adoption of large language models. However, the advancement in AI tools foregrounds the embedded challenges of these technologies (Dwivedi et al., 2023a; Dwivedi et al., 2023b; Kasneci et al., 2023; Kshetri et al., 2023; Baidoo-Anu and Ansah, 2023; Richey Jr et al., 2023). Some of these include the inability to decipher the complex and challenging nexus of predictions made

by these models in the background. Further, moral contagions embody these complex systems which exhibit both predictable and unprecedented consequences across diverse contexts and industry milieus. For instance, the abuse of AI technology for immoral and unethical purposes has to be systematically anticipated and the consequences taken into consideration in model design. Taken together, such technologies will broaden the horizons, applications, relevance, and recognition of NLP. However, there has to be a systematic intervention addressing these challenges and related ethical considerations. This becomes increasingly germane when applying AI tools as learning aids for increasing know-how within relevant academic fields. Scholars suggest that consolidated and synergized research by the academic and professional fraternity is required to address such ethical and application-oriented challenges (van Dis et al., 2023). While some literature is generated in the public domain (viz. open forum posts), third-party information is unreliable and unauthentic. Thus, unanimous scrutiny of the AI concept and its consequences can only be accepted when it is an outcome of empirical and systematic research deliberations.

Similar to earlier language-driven models, the current review identifies a number of research gaps and challenges that need to be explored before ChatGPT users can be confident about the knowledge produced. Following a detailed and thorough review of contemporary scholarly studies, this review asks the following main research question: What are the key challenges of harnessing ChatGPT NLP applications in the education sector and what strategies can be implemented to address them?

The manuscript is structured as follows: Section 2 explores the background and the technological features of ChatGPT. This is followed by Section 3, where the authors outline a detailed discussion of the research methods used to conduct the review. Next, the challenges to the technology are discussed in Section 4. In Section 5, various educational strategies are identified that help to address the challenges presented. Future research directions are discussed in Section 6, including recommendations by which the scientific community can better support the progression of generative models. The limitations of the study and the conclusion to the review are discussed and outlined, respectively, in Section 7.

1.2 Objectives

This study aims to model and map the effects of generative AI on student readiness for exams in Auchi Polytechnic. The objectives include:

- Evaluating the impact of AI tools on student learning outcomes.
- Identifying challenges and strategies associated with the integration of AI in education.
- Providing recommendations for effective use of AI tools in academic settings.

II. Literature Review

2.1. Artificial Intelligence Overview

AI, or artificial intelligence, refers to the field of computer science where machines are designed to perform tasks that typically require human intelligence (Dwivedi et al., 2023c; Tsang et al., 2020; Ali et al., 2023; Pan and Nishant, 2023). These tasks include understanding, analyzing, and learning from data using specifically designed algorithms (Sasubilli et al., 2020; Richey Jr et al., 2023). Modern AI technologies enable applications such as facial recognition by cameras and language translation by computers (Sasubilli et al., 2020).AI as an academic discipline dates back to the 1950s and has since been extensively researched in areas such as natural language processing (NLP), learning, reasoning, and various knowledge domains. More recently, AI research has expanded beyond computer science to include contributions from psychology, linguistics, and philosophy (Ali et al., 2023). As a result, AI applications have spread across diverse sectors including education, e-commerce, robotics, navigation, healthcare, agriculture, military, marketing, and gaming.

Widely adopted AI applications include search engines like Google, recommendation systems such as Netflix, self-driving cars like Tesla, and speech recognition systems such as Siri and Alexa. AI methods can be broadly categorized into areas like machine learning (Bernardini et al., 2021), robotics, NLP (Murray et al., 2019), computer vision (Jahan and Tripathi, 2021), and big data (Hossen and Karmoker, 2020).Two major techniques in AI machine learning are classification and clustering. These algorithms process data such as numbers, text, images, and videos (Jahan and Tripathi, 2021). Classification algorithms, including neural networks, decision trees, and Bayesian networks, use large training datasets and can be categorized into supervised and unsupervised learning (Uddin et al., 2019). Supervised learning uses labeled data vectors during training, whereas unsupervised learning does not. Both methods use class labels during testing. Clustering algorithms, used for unsupervised learning, do not need class label data, whereas prediction algorithms develop forecasting models based on historical data (Libbrecht and Noble, 2015).AI and its subfields, such as robotics, the Internet of Things (IoTs), and machine learning, significantly impact society by improving quality of life, making tasks easier, safer, and more productive (Chaturvedi et al., 2023; Malik et al., 2021; Hradecky et al., 2022). Applications include face recognition for security, industrial automation, language translation, and home robotics (Herath and Mittal, 2022). AI has driven the Industry 4.0 revolution, characterized by IoTs, cloud

computing, robotics, cyber-physical systems, and machine-to-machine communication (Votto et al., 2021). Smart automation and interconnectivity, when used effectively, save time, enable flexible work management, and increase collaboration (Ahsan and Siddique, 2022).

2.2. Generative AI Types

Generative AI is defined as technology that leverages deep learning models to generate human-like content (e.g., images, text) in response to complex and varied prompts (Lim et al., 2023). These models generate various outputs based on massive training datasets, neural networks, deep learning architectures, and user prompts (Nirala et al., 2022). Depending on the model type, generative AI can produce images, translate text into images and vice versa, synthesize speech and audio, create original video content, and generate synthetic data (Porkodi et al., 2022).

The primary designs of generative AI models are Generative Adversarial Networks (GANs) and transformer-based models. GANs consist of two neural networks: the generator, which creates content based on user inputs and training data, and the discriminator, which evaluates the generated content against real examples to determine accuracy (Gonog and Zhou, 2019). Transformer-based models use encoders and/or decoders to process content segmented by user inputs (Li et al., 2022).

Generative models differ from discriminative models in that the former can create new content while the latter classifies existing data through supervised learning (Van Engelen and Hoos, 2020). For example, a protein classification tool operates on a discriminative model, while a protein generator uses a generative AI model. Generative models create new content, whereas predictive models forecast based on existing data (Thomas et al., 2023).

Variational Autoencoders (VAEs) are another type of generative model used for text and audio generation. VAEs encode data into an embedded space and decode it to reconstruct original content, using distinct probabilistic combinations of input data (Yadav et al., 2021). Autoregressive Models (ARMs) generate content one unit at a time, using cues from the previously generated element to create contextual and coherent content (Bai et al., 2021). Recurrent Neural Networks (RNNs) process sequential data by predicting the next unit from the previous one, though they struggle with long sequences and are being improved to overcome these limitations (Chen et al., 2019). Transformer-based models are widely accepted for handling long output sequences by creating elaborate, coherent content.

Generative AI's power lies in its ability to generate content in response to user inputs, beyond the predefined responses typical of conversational AI (Lim et al., 2022). Some AI models, like ChatGPT, combine generative and conversational AI to enhance capabilities (Dwivedi et al., 2023a).

2.3. Generative AI Models and Background to ChatGPT

ChatGPT, developed by OpenAI, is a prominent example of generative AI. It synthesizes human-like text based on a variety of input commands, useful for tasks such as script generation, comprehension, conversation, and translation (Kirmani, 2023). Launched on November 30, 2022, ChatGPT quickly gained popularity, achieving one million users within a week (Altman, 2022; Mollman, 2022; Hu, 2023). Its sophisticated and human-like intelligence garnered attention from social media, news outlets, and research platforms like Nature (Stokel-Walker, 2022; Metz, 2022).ChatGPT can perform multiple complex tasks, including drafting articles, summarizing content, scripting emails, and debugging code, which has led to varied reactions from academic and educational experts due to its disruptive yet revolutionary impact on scholarship and pedagogy (Williams, 2023). It has dramatically increased the ability to create and access knowledge (Lucy and Bamman, 2021). However, opponents highlight ethical dilemmas and concerns about compromising human ingenuity and the quality of the teaching and learning process (Williams, 2023).

Generative AI's ability to create content in diverse formats has made it valuable across many fields. Its origins trace back to the 1960s with the invention of chatbots, and it became more pervasive around 2014 with the advent of GANs (Behrad and Abadeh, 2022). Transformer technology, based on machine learning, enables the training of AI models without the need for pre-labeled content, creating connections across vast datasets.ChatGPT utilizes transformer architecture to enhance NLP capabilities. This architecture processes input commands and generates comprehensive outputs linked to previous units in the sequence, customized to the input received (Baidoo-Anu and Ansah, 2023). The application can be tailored for specific tasks, languages, and dialects by customizing input datasets or prototyping with specific language codes (Kasneci et al., 2023).The COVID-19 pandemic significantly disrupted education, leading to a shift towards electronic, remote, and online learning to comply with social distancing guidelines (Chatzipanagiotou and Katsarou, 2023). This transition required rapid adoption of technology-enabled teaching methods, including virtual platforms like Google Classroom, Teams, and Zoom, as well as e-books, videos, and interactive activities (Chatzipanagiotou and Katsarou, 2023). Learning management systems like Moodle and Google Suite further empowered education with new teaching aids.

The pandemic emphasized the need for self-dependence and asynchronous learning systems, where learners have greater control over how and when they learn. Generative AI models like ChatGPT address these needs by providing flexible, personalized learning experiences. However, this transition also highlighted issues such as the digital divide, restricted interaction, lack of academic readiness, and ethical concerns (Baidoo-Anu and Ansah, 2023; Nguyen et al., 2023; Yan et al., 2023; Stahl and Eke, 2024).In summary, while generative AI like ChatGPT has revolutionized various fields, including education, it also presents new challenges and ethical considerations. The technology's rapid evolution underscores the need for ongoing research and adaptation to address these emerging issues.

III. Methodology

Watson (2015) and Ali et al. (2018) were seminal in establishing protocols and processes for conducting systematic and scoping reviews. These protocols have been designed to ensure that the review process is resourceful (Tranfield et al., 2003), systematic, independent, and rigorous (Boell and Cecez-Kecmanovic, 2015). Following the methodologies outlined by Kitchenham and Charters (2007) and Ali et al. (2018; 2020b), this manuscript is structured into three main stages: planning, execution, and summarizing.In the planning stage, the need for a comprehensive review on the effects of generative AI, specifically ChatGPT, on education is established. Despite numerous studies on critical challenges in using ChatGPT, academic investigations and systematic reviews of this generative AI tool remain underdeveloped. Consequently, this paper aims to investigate the existing literature on generative AI and ChatGPT's research and practice. A research question was formulated: What are the key challenges of harnessing ChatGPT NLP applications in the education sector and what strategies can be implemented to address them?

The researchers employed an automated search strategy complemented by a manual review process. The initial search included an exploration of various electronic databases and repositories using specific research terms. Databases such as Science Direct, Web of Science, IEEE, Emerald, Scopus, and ACM Digital Library were scanned for relevant data. To ensure relevance, a systematic approach was employed to filter non-relevant publications (McLean and Antony, 2014). Each article's title and abstract were read, followed by a complete reading of the article to confirm its relevance (Golder et al., 2014). This review protocol laid the foundation for developing practical and theoretical views on generative AI models.

3.3 Execution Stage

The execution stage involved a three-stage review process to filter relevant articles. The methodology included:

1. Identifying search terms and text: Exclusive and distinctive technical terms were used. Keywords included: “challenge(s)”, “issue(s)”, “barrier(s)”, “obstacle(s)”, “consideration(s)”, “ChatGPT”, “AI”, “NLP”, “education”, “university”, and “school” (Hu and Bai, 2014).
2. Database scrutiny with filtering tools: The search was constrained to the years 2018 to 2023 to enhance relevance (Zhang et al., 2014).
3. Manual review of titles and abstracts: Titles and abstracts were scanned to further specify the configuration of results (Pucher et al., 2013).
4. Full-text article review: Articles were read in full, filtering relevant knowledge, information, and theory related to the discipline (Shea et al., 2007).
5. Quality assessment: A Quality evaluation standard was applied to ensure all screened articles met the minimum quality criteria (Hu and Bai, 2014). Criteria included a statement of research objectives, sequential embedding of research questions and challenges, description and availability of review data, comprehensive explanation of research methods, and relevance of research outcomes (Sadoughi et al., 2020; Ali et al., 2018, 2021).

3.4 Summarizing Stage

The review was conducted from February 2nd to April 3rd, 2023. The initial database search yielded 618 articles. After applying filters, the number of articles was reduced to 233. A manual review excluded 109 articles, leaving 124. Full article reviews further reduced the count by 37, resulting in 87 articles. Finally, a quality assessment excluded another 18 articles, leaving a total of 69 articles for the review.

Summary of Article Selection and Results

Stage	Actions	Result
Stage 1	Search the literature using specific terms or keywords	618
Stage 2	Applied filtering tools within the database	233
Stage 3	Exclusion of articles based on title and abstract	124
Stage 4	Exclusion of articles based on full-text review	87
Stage 5	Exclusion of articles based on quality	69

The final number of articles selected for this review was 69. These articles were analyzed to identify and categorize the key challenges of using ChatGPT in the education sector, such as poor human-AI interface, restricted understanding, bias in training input-data, stifling of creativity, data privacy and security, cost of training and maintenance, and sustainable usage. Each of these challenges is detailed in subsequent sections of this review.

3.5 Categorization Framework

The challenges associated with ChatGPT are categorized into four primary domains: User Challenges, Operational Challenges, Environmental Challenges, and Technological Challenges. Each domain is further divided into categories and sub-categories, providing a detailed description and examples from various sources.

Domain	Category	Sub-category	Description	Examples	Sources
ChatGPT Challenges	**User Challenges**	Absence of human interaction	The lack of human interaction during the use of such an AI platform renders the user experience excessively mundane and mechanical.	- Increasing use of technology - Decrease in face-to-face communication - Lack of social interaction	Gong et al. (2018); Rapanta et al. (2020); Baber (2021a, 2021b); Gao (2021); Bernius et al. (2022); Diederich et al. (2022); Kasneci et al. (2023)
	Restrained understanding	This AI-based assistance tool works on the data that it has been trained on and that might lead to its limited understanding of the contexts being discussed.	- Difficulty in understanding natural language - Limitation in content knowledge	Perelman (2020); Wang et al. (2020); Buhalis and Volchek (2021); Bernius et al. (2022); Omoge et al. (2022); Raković et al. (2022); Kim et al. (2022); Sheth et al. (2022); Kasneci et al. (2023); Baidoo-Anu and Ansah (2023)	
	Little creativity	The absence of imaginative stimulus owing to the nature of this tool manifests in an explicit lack of creativity.	- Limitations in learning approaches - Lack of novelty - Potential for overreliance	Pappas and Giannakos (2021); Chen and Wen (2021); Xia (2021); Stevenson et al. (2022); Placed et al. (2022); Kasneci et al. (2023); Biswas (2023); O'Connor (2023); Lund et al. (2023)	
	Restrained contextual understanding	The data fed into ChatGPT is collated from a wide variety of sources and hence may lack contextual background.	- Ambiguity in language - Lack of background knowledge - Inability to interpret non-verbal cues - Limited ability to adapt to new contexts	Niño (2020); Simkute et al. (2021); Miao and Wu (2021); Liu et al. (2021); Diederich et al. (2022); Atlas (2023); Floridi (2023); Dwivedi et al. (2023a); Kasneci et al. (2023)	
Operational Challenges	Cost of training the model	The success of this AI tool is dependent on its recency and training, and the perennial need for such training data can be an expensive input.	- Expertise - Training data - Computational resources - Ongoing maintenance	Chen et al. (2020); Okonkwo and Ade-Ibijola (2021); Hu (2021); Bogina et al. (2022); Dwivedi et al. (2023a); Kasneci et al. (2023)	
	Cost of maintenance	The data used by large language models has to be regularly updated and vetted for accuracy. Such data maintenance tasks are also high-cost tasks.	- Technical maintenance - Data - User feedback - Model re-training	Gao (2021); Bernius et al. (2022); Haleem et al. (2022); Agomuoh and Larsen (2023); Kasneci et al. (2023); Baidoo-Anu and Ansah (2023); Sigalov and Nachmias (2023); Polak and Morgan (2023)	
	Inadequate ability to personalize instruction	ChatGPT in its present form appears to lack personalization and adequate customization options. However, ChatGPT	- Limited information about student - Inability to provide feedback - Limited flexibility - Limited interactivity	Dehouche (2021); Gao (2021); Ahsan et al. (2022); Kasneci et al. (2023); Baidoo-Anu and Ansah (2023); Eysenbach (2023); Gilson et al. (2023); Cotton	

		will become more customizable in the near future.		et al. (2023); Kasneci et al. (2023)	
Environmental Challenges	Sustainable usage	The growing popularity of this large language model creates the need for huge computing and processing capacity. The need for servers and processors for this purpose poses a new challenge to sustainable computing.	- Energy consumption	Patterson et al. (2021); Kasneci et al. (2023)	
Technological Challenges	Data privacy	Since ChatGPT is gaining popularity as a 'go-to' solution for a wide variety of problems from content generation to coding, users are required to share details that may potentially compromise their privacy.	- Data breaches - Privacy policies - Consent - Data collection and use	Bundy et al. (2019); Breidbach and Maglio (2020); Williamson and Eynon (2020); Stahl (2021); Okonkwo and Ade-Ibijola (2021); Belk (2021); Irons and Crick (2022); Selwyn (2022); Dwivedi et al. (2023a); Kasneci et al. (2023)	
	Data security	With the exponential growth of its user base, this AI platform is likely to attract the attention of malicious players seeking to benefit from the vulnerabilities in the system.	- Cyberattacks - Compliance - Data storage - Authentication	Geko and Tjoa (2018); Okonkwo and Ade-Ibijola (2021); Stahl (2021); Deng and Lin (2023); Dwivedi et al. (2023a); Kasneci et al. (2023)	

4. Assessment Criteria and Article Distribution

The review process applied stringent assessment criteria to ensure the selection of high-quality articles. These criteria included the objectives of the research, the research questions, the description of the collected data, the methodology applied, the technique used to analyze the data, and the presentation of the results. Applying these criteria led to the exclusion of 18 articles, resulting in a final selection of 69 articles.

4.1 Article Distribution by Publication Year

The distribution of selected publications over the years is depicted in Figure 2. The analysis revealed that the majority of the articles were published between 2021 and 2023, with 21 articles, highlighting a recent surge in interest. In contrast, only one article was published in 2019, indicating minimal engagement with the topic in that year.

4.2 Comprehensive Examination of Challenges

The review study presented and discussed the results of a comprehensive examination of the challenges associated with using ChatGPT in education and scientific journal papers. The categorization framework included five key categories: user challenges, operational challenges, environmental challenges, technological challenges, and ethical concerns. This systematic approach enabled the identification of the most significant challenges of adopting and using ChatGPT.

IV. Results

4.1 Impact on Student Readiness

The results indicate that students who used generative AI tools for exam preparation showed improved performance and increased confidence. The AI tools provided personalized learning experiences, helping students identify and focus on their weak areas.

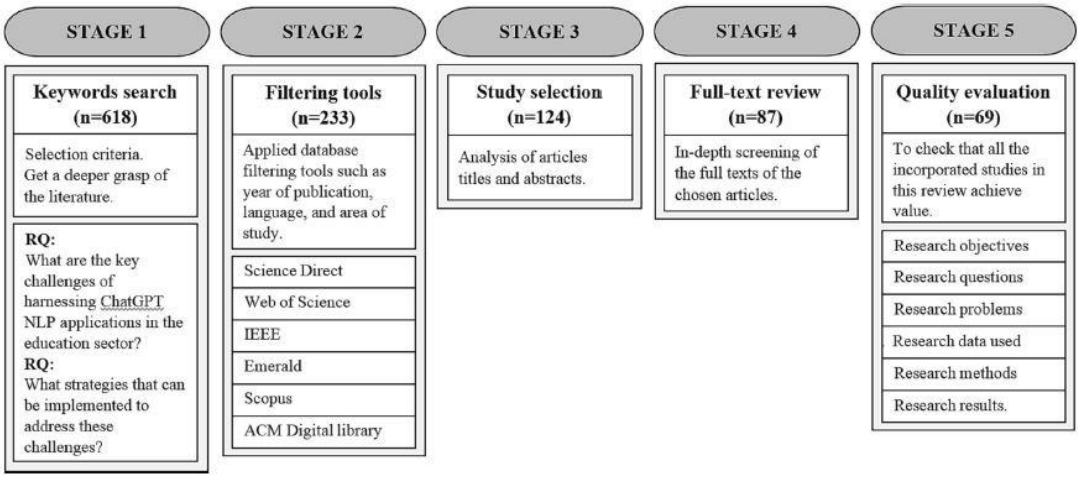

Fig. 1. Research process of this review

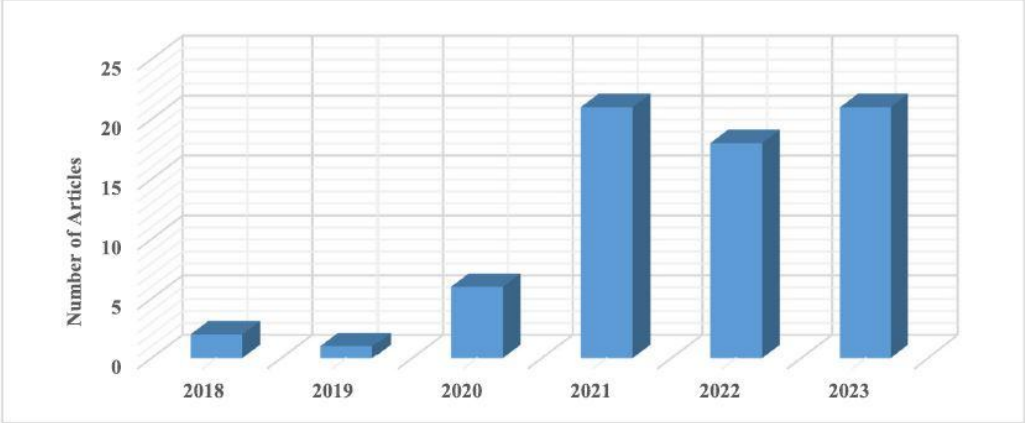

Fig. 2. Publications by year.

While ChatGPT presents numerous benefits for educational institutions, several significant downsides and potential challenges must be addressed. This section delves into the identified themes from the categorization framework in Table 2.

4.1. User Challenges

One major challenge of ChatGPT is the lack of human interaction. Generative AI models, such as ChatGPT, lack the adeptness to provide the nuanced human interaction that traditional education models offer. This shortcoming is significant as human instructors play a crucial role in the teaching-learning process by providing personalized feedback and support, which has been shown to enhance educational outcomes (Diederich et al., 2022; Kasneci et al., 2023; Rapanta et al., 2020). The lack of in-person communication and collaboration can lead to inferior educational results, as indicated by research showing that students in traditional classroom settings often outperform their peers in online courses (Baber, 2021a, 2021b). Blended learning environments, which combine face-to-face and online learning, have been found to foster greater commitment and academic satisfaction among students (Gong et al., 2018).

4.1.2. Restrained Understanding

ChatGPT's reliance on statistical patterns in training data limits its understanding of the knowledge concepts it helps students with (Perelman, 2020; Kasneci et al., 2023). Generative models should ideally be specific to students' needs and capable of understanding and responding to individual requirements. However, challenges include difficulties in understanding natural language, limitations in content knowledge, and an inability to provide personalized encouragement and support (Buhalis and Volchek, 2021; Omoge et al., 2022; Sheth et al., 2022). Misinterpretations and incorrect outputs can create confusion and diminish the technology's educational value (Raković et al., 2022).

Another significant challenge is ChatGPT's lack of innovative output quality. The generative models rely heavily on their training data, leading to monotonous and non-creative content. This limitation affects the system's ability to produce novel and unique responses, which are essential for fostering critical thinking and problem-solving skills in students (Pappas and Giannakos, 2021; Biswas, 2023; Chen and Wen, 2021). Additionally, the potential for overreliance on AI can inhibit students' self-dependence and creativity (Stevenson et al., 2022; Placed et al., 2022).ChatGPT's performance is heavily dependent on the quality and quantity of its training data. Insufficient or poor-quality input data can result in inaccurate and inappropriate outputs. Ensuring the authenticity and relevance of training data is crucial to maintaining the model's effectiveness (Roumeliotis and Tselikas, 2012; Shen et al., 2021). Continuous data updates and infrastructure for data collection and processing are also necessary, posing additional challenges (Ouyang et al., 2022).

Generative models like ChatGPT often struggle with contextual understanding, which is essential for various academic disciplines. The inability to interpret the context accurately can lead to irrelevant or incorrect responses. This challenge is exacerbated by the lack of background knowledge and the novelty of the technology, which may result in significant limitations in educational settings (Diederich et al., 2022; Miao and Wu, 2021; Liu et al., 2021). Ambiguities in natural language and differences in background knowledge between AI and human tutors further complicate the issue (Niño, 2020).Addressing these user challenges is critical for leveraging the full potential of ChatGPT in education. Ensuring human interaction, improving understanding and creativity, managing data dependency, and enhancing contextual comprehension are essential steps in integrating AI effectively into educational systems.

While many benefits appear on the surface level for educational institutions, numerous downsides and potential challenges need to be addressed. This review now addresses each of the themes identified in the categorization framework from Table 2.

4.1 User Challenges

ChatGPT and similar generative AI models have sparked global interest, but they face significant challenges due to the lack of human interaction (Diederich et al., 2022; Kasneci et al., 2023). Unlike human instructors, these models cannot replicate the nuances of personal communication and interaction. The increased use of AI in education raises concerns about the diminishing value of in-person communication and collaboration, which are central to effective learning systems. Research by Rapanta et al. (2020) demonstrated that students who received personalized human feedback performed better and were more engaged than those relying on automated programs (Gao, 2021; Bernius et al., 2022). Baber (2021a, 2021b) also found that online learners achieved inferior results compared to their classroom peers, emphasizing the need for collaborative learning and social interaction. Blended learning environments, combining face-to-face and online learning, have shown greater student commitment and satisfaction (Gong et al., 2018). Therefore, while technology supports the educational process, it cannot replace the essential human elements of personalized instruction and interaction (Diederich et al., 2022).

Generative AI models like ChatGPT are trained on statistical patterns in data, making them unaware of the knowledge they provide (Perelman, 2020; Kasneci et al., 2023). Ideally, these models should be tailored to specific student needs, but current technology lacks the sophistication to deliver personalized outputs (Wang et al., 2020; Bernius et al., 2022; Baidoo-Anu and Ansah, 2023). Challenges include difficulty in understanding natural language, leading to potential misunderstandings and confusion (Buhalis and Volchek, 2021; Omoge et al., 2022). Moreover, the models have limited content knowledge and cannot offer the same personalized encouragement and consideration as human instructors (Sheth et al., 2022). This limited understanding hampers the quality of educational support provided by AI.

ChatGPT faces challenges in producing innovative and creative outputs due to its reliance on training data (Lund et al., 2023; Kasneci et al., 2023). This dependency leads to monotonous and non-creative content, restricting the model's ability to address creative problem-solving and critical thinking (Pappas and Giannakos, 2021; Biswas, 2023). Generative AI struggles with contextual problem solving and innovation, making it less effective in fostering a critical mindset (Mantelero, 2018; Kasneci et al., 2023). Overreliance on AI could also inhibit students' self-dependence and creative problem-solving abilities (Stevenson et al., 2022; Placed et al., 2022).ChatGPT's effectiveness is heavily dependent on the quality and quantity of its training data (Tlili et al., 2023; Dwivedi et al., 2023a). Inaccurate or incomplete data can lead to poor-quality outputs (Shen et al., 2021). The continuous need for high-quality training data requires significant investment in data collection, annotation, and maintenance (Roumeliotis and Tselikas, 2012). Additionally, the model needs ongoing training to stay relevant, which can be economically inefficient and time-consuming (Polak and Morgan, 2023).

Generative models often fail to contextualize inputs accurately, leading to irrelevant and confusing responses (Diederich et al., 2022). Ambiguities in language and a lack of background knowledge can further exacerbate these issues (Niño, 2020; Miao and Wu, 2021; Liu et al., 2021). The absence of contextual understanding limits the practical application of ChatGPT in diverse educational disciplines, requiring greater substantiation and continuous data input from various specialized fields (Kasneci et al., 2023).

4.2 Operational Challenges

The adoption of large language and generative technologies imposes significant infrastructure and economic burdens on educational institutions, especially those with limited financial resources (Kasneci et al., 2023). High computational requirements, the need for specialized expertise, and the cost of quality training data pose substantial challenges (Okonkwo and Ade-Ibijola, 2021; Hu, 2021; Bogina et al., 2022).Ongoing maintenance is crucial for the optimal performance of generative models like ChatGPT (Agomuoh and Larsen, 2023). This includes software updates, bug fixes, and performance optimization, all of which can be costly and time-consuming (Baidoo-Anu and Ansah, 2023). Additionally, continuous data maintenance and the need for regular user feedback and model retraining further increase maintenance costs (Gao, 2021; Polak and Morgan, 2023).Generative models currently lack the capability to personalize instructions and cater to individual student needs (Kasneci et al., 2023). This limitation questions their effectiveness as educational tools, as they cannot provide personalized feedback or adapt to the evolving needs of students (Ahsan et al., 2022; Gilson et al., 2023; Cotton et al., 2023). Limited interactivity further diminishes the potential for personalized learning experiences (Dehouche, 2021).

4.3 Environmental Challenges

The sustainability of AI applications in education is a significant concern, particularly regarding high energy consumption and environmental impact (Kasneci et al., 2023). The need for energy-efficient infrastructure and eco-friendly energy sources is critical for sustainable operations in educational settings (Patterson et al., 2021). Addressing these environmental challenges requires collaborative efforts from educators, institutions, policymakers, and administrators to reduce the technology's carbon footprint and ensure its ethical implications in the classroom (Kasneci et al., 2023).

4.4 Technological Challenges

Data privacy is a significant challenge for generative AI models in education (Irons and Crick, 2022). Issues include data breaches, the need for robust privacy policies, and gaining informed consent from students and guardians (Williamson et al., 2020; Stahl, 2021). Ensuring the security of student data and addressing regulatory and policy challenges are essential for the safe adoption of ChatGPT in educational settings (Williamson and Eynon, 2020). Continuous Professional Development (CPD) for Educators: Training and development programs for educators on the use of ChatGPT can be implemented. These programs can help educators understand the capabilities and limitations of the technology and how to integrate it effectively into their teaching practices (Dwivedi et al., 2023a). Regular workshops and training sessions can be organized to keep educators updated with the latest advancements and best practices.Clear guidelines and documentation: Providing educators with clear guidelines and documentation on how to use ChatGPT effectively in the classroom can mitigate misunderstandings and misuse. These guidelines should include ethical considerations, best practices, and troubleshooting tips (Agomuoh and Larsen, 2023).Case studies and success stories: Sharing case studies and success stories of institutions that have effectively integrated ChatGPT into their educational practices can serve as examples and inspiration for other institutions. These case studies can highlight the benefits, challenges, and solutions, providing a practical framework for implementation (Gao, 2021).

4.5 Strategies Related to Operational Challenges

To address the operational challenges associated with the adoption of ChatGPT in educational settings, several strategies can be implemented:

• Cost-effective solutions: Institutions with limited financial resources can explore cost-effective solutions such as leveraging cloud-based services, open-source tools, and shared infrastructure. Partnerships with technology providers and government grants can also help alleviate financial burdens (Okonkwo and Ade-Ibijola, 2021).

• Collaboration with technology providers: Educational institutions can collaborate with technology providers to access expertise, training, and resources. These collaborations can help institutions implement and maintain the necessary infrastructure and expertise required for ChatGPT adoption (Hu, 2021).

• Scalability and modular implementation: Adopting a scalable and modular approach allows institutions to implement ChatGPT in phases, starting with smaller-scale pilots and gradually expanding as resources and expertise grow. This approach helps manage costs and allows for iterative improvements based on feedback and experience (Bogina et al., 2022).

• Ongoing technical support: Providing ongoing technical support and maintenance is crucial for the successful implementation of ChatGPT. Institutions can establish dedicated support teams or collaborate with external service providers to ensure the model operates optimally and any issues are promptly addressed (Baidoo-Anu and Ansah, 2023).

4.6 Strategies Related to Data Privacy and Security

To address data privacy and security concerns associated with ChatGPT, institutions can implement the following strategies:

• Robust data protection measures: Implementing robust data protection measures, such as encryption, secure data storage, and access controls, can help safeguard student information from unauthorized access and breaches (Kasneci et al., 2023).

• Compliance with regulations: Ensuring compliance with relevant data privacy and security regulations, such as GDPR, is essential. Institutions should develop policies and procedures to meet regulatory requirements and regularly audit their data protection practices (Geko and Tjoa, 2018).

• User consent and transparency: Obtaining informed consent from students and their guardians regarding the use of ChatGPT is crucial. Institutions should provide clear information about data collection, usage, and storage practices, ensuring transparency and building trust (Stahl, 2021).

• Regular security audits: Conducting regular security audits and vulnerability assessments can help identify and address potential security risks. These audits should be performed by independent experts to ensure unbiased evaluations and recommendations (Deng and Lin, 2023).

5.5. Strategies related to ethical challenges.

To address ethical challenges associated with the use of ChatGPT in education, institutions can implement the following strategies:

• Diverse and inclusive training data: Ensuring that the training data used for ChatGPT is diverse and representative of different demographics, backgrounds, and perspectives can help mitigate biases and improve the quality of responses (Akter et al., 2021).

• Bias detection and mitigation: Implementing mechanisms to detect and mitigate biases in ChatGPT's responses is essential. Regular audits, bias detection algorithms, and user feedback can help identify and address biased outputs (Hamilton, 2022).

• Ethical guidelines and oversight: Establishing ethical guidelines and oversight committees can help monitor the use of ChatGPT in educational settings. These guidelines should address issues such as bias, fairness, transparency, and accountability (Krügel et al., 2023).

• Continuous monitoring and evaluation: Regularly monitoring and evaluating the performance and impact of ChatGPT in educational settings is crucial. Institutions should collect feedback from students, educators, and other stakeholders to identify areas for improvement and ensure ethical use of the technology (Kasneci et al., 2023).

In conclusion, while the adoption of ChatGPT in educational settings presents several challenges, implementing appropriate strategies can help address these issues and maximize the benefits of this technology. By focusing on blended learning, personalized learning, collaborative learning, pre-training on educational data, continuous professional development for educators, robust data protection measures, and ethical guidelines, educational institutions can harness the potential of ChatGPT to enhance the learning experience and outcomes for students.

V. Discussion

5.1 Strategies Related to Inadequate Human Interaction

Addressing the challenges of inadequate human interaction in the institutionalization of ChatGPT involves considering it as a complementary tool to existing teaching aids, rather than a replacement. Here are some strategies to enhance human interaction while using ChatGPT:

- **Blended Learning**: Combining online learning with face-to-face instruction can help maintain social engagement. ChatGPT can support in-person lectures, group discussions, and collaborative activities, ensuring students interact with peers and instructors (Gong et al., 2018).
- **Personalized Learning**: Using ChatGPT to provide individualized feedback and support can create a more tailored and engaging learning experience, catering to each student's needs (Dwivedi et al., 2023a).
- **Collaborative Learning**: ChatGPT can facilitate group discussions and collaborative activities, enhancing teamwork and social skills among students (Jalil et al., 2023).
- **Supplementary Learning Tool**: Teachers can use ChatGPT to complement traditional teaching methods, providing additional resources and feedback while ensuring human interaction remains a key component of the learning experience (Dwivedi et al., 2023a).

5.2 Strategies Related to Limited Understanding

To overcome limited understanding of ChatGPT in the education sector, the following strategies can be implemented:

- **Pre-training on Educational Data**: Training ChatGPT on educational texts, lectures, and videos can improve its accuracy and relevance in educational contexts (Sallam, 2023).

- **Knowledge Graphs**: Using knowledge graphs to store domain-specific knowledge can enhance ChatGPT's understanding and response accuracy in educational settings (Chicaiza and Valdiviezo-Diaz, 2021; Kasneci et al., 2023).
- **Fine-tuning on Specific Tasks**: Fine-tuning ChatGPT on specific educational tasks can improve its performance and relevance in those areas (Kasneci et al., 2023).
- **Human-in-the-Loop Approach**: Incorporating human feedback into the model training process can help improve ChatGPT's accuracy and relevance by allowing for error correction and continuous improvement (Wu et al., 2022).

5.3 Strategies Related to Absence of Creativity

Minimizing the absence of creativity in generative models like ChatGPT can be achieved through the following strategies:

- **Incorporating Creative Prompts**: Using creative prompts during training can encourage more imaginative responses from ChatGPT (Kasneci et al., 2023).
- **Training on Diverse Genres**: Training ChatGPT on a wide range of genres can help it generate more creative and varied responses (Haleem et al., 2022).
- **Incorporating Human Input**: Allowing humans to review and provide feedback on ChatGPT's responses can foster creativity and improve the quality of outputs (Cooper, 2023).

5.4 Strategies Related to Dependency on Data

To reduce ChatGPT's dependency on data, the following strategies can be employed:

- **Incorporating Domain-Specific Knowledge**: Providing domain-specific knowledge during training can reduce reliance on general data and improve relevance (Zhu et al., 2023).
- **Transfer Learning**: Using transfer learning to leverage pre-trained models can reduce the need for extensive data and training efforts (Kasneci et al., 2023).
- **Active Learning**: Iteratively training the model on small data chunks can improve performance and reduce data dependency (Budd et al., 2021).
- **Data Augmentation**: Generating new data from existing data can increase the amount of training data and reduce dependency (Maharana et al., 2022).

5.5 Strategies Related to Training and Maintenance Expenditures

To manage training and maintenance costs, the following strategies can be implemented:

- **Leveraging Open-Source Resources**: Using open-source ChatGPT models and code can reduce development costs (Kasneci et al., 2023).
- **Using Pre-Trained Models**: Pre-trained models require less training for specific tasks, reducing overall costs (Han et al., 2021).
- **Cloud-Based Services**: Outsourcing infrastructure management to cloud-based services can reduce maintenance costs (Ali et al., 2022).
- **Prioritizing Maintenance**: Regular maintenance can prevent costly issues and ensure long-term sustainability (Kasneci et al., 2023).

5.6 Strategies Related to Inadequate Contextual Understanding

Enhancing ChatGPT's contextual understanding can be achieved through:

- **Multi-Task Learning**: Training the model to handle multiple tasks simultaneously can improve its contextual understanding (Kasneci et al., 2023).
- **Pre-Processing Data**: Adding metadata and using named entity recognition can provide additional contextual information to the model (Dwivedi et al., 2023a).

5.7 Strategies Related to Limited Ability to Personalize Instruction

Improving ChatGPT's ability to personalize instruction involves:

- **Using Student-Specific Data**: Customizing teaching methods based on individual student data can enhance personalized learning (Kasneci et al., 2023).
- **Implementing Adaptive Learning Systems**: Using machine learning algorithms to adapt instruction in real-time based on student data can improve personalization (Zhou et al., 2021).
- **Using Natural Language Processing (NLP)**: Analyzing student writing with NLP techniques can provide tailored feedback (Bernius et al., 2022).
- **Incorporating Human Instructors**: Combining ChatGPT with human instructors can ensure personalized and supportive learning experiences (Kasneci et al., 2023).

5.8 Strategies Related to Sustainable Usage

Ensuring sustainable usage of ChatGPT in education includes:

- **Prioritizing Energy Efficiency**: Using energy-efficient hardware and software can reduce environmental impact (Qadir, 2023).

- **Developing Ethical Guidelines**: Creating ethical guidelines for ChatGPT's use in education can ensure responsible and sustainable practices (Mhlanga, 2023).
- **Encouraging Responsible Use**: Promoting responsible use among students and staff can minimize environmental impact (Michel-Villarreal et al., 2023).
- **Promoting Alternative Solutions**: Encouraging the use of complementary educational tools and practices can support sustainable usage (Dwivedi et al., 2023a).

5.9 Strategies Related to Data Security and Privacy

Addressing data security and privacy issues involves:

- **Implementing Strong Authentication and Access Controls**: Using multi-factor authentication and role-based access management can protect student data (Gupta et al., 2023).
- **Regularly Updating Security Systems**: Keeping security systems updated can prevent cyberattacks and ensure data safety (Gupta et al., 2023).
- **Monitoring and Logging**: Regular monitoring and logging can help identify security breaches and unauthorized access (Dwivedi et al., 2023a).
- **Educating Staff and Students**: Teaching users about data security and privacy can create a culture of cybersecurity (Alshaikh, 2020).
- **Conducting Regular Risk Assessments**: Timely risk assessments can identify vulnerabilities and prevent data breaches (Kasneci et al., 2023).

5.10 Strategies Related to Bias in Training Data

Addressing bias in training data involves:

- **Diverse Data Collection**: Collecting data from various sources can ensure that training data is representative and inclusive (Bogina et al., 2022).
- **Human-in-the-Loop Approach**: Allowing human feedback during training can help identify and correct biases in the data (Wu et al., 2022).
- **Regular Data Audits**: Reviewing training data regularly can help eliminate biases and ensure accurate outputs (Ayinde et al., 2023).

These strategies provide a comprehensive framework for integrating ChatGPT into the education sector while addressing the various challenges and ensuring its effective and sustainable use.

VI. Conclusion

ChatGPT, as a generative AI model, represents one of the most transformative innovations of recent times. This review has addressed the need for a more nuanced understanding of such models by exploring their potential impacts and challenges, especially in the educational sector. Our study highlights how AI-driven content generation has evolved and how ChatGPT exemplifies this evolution. We developed a classification framework to outline the key challenges associated with ChatGPT and proposed strategies to address these challenges effectively.

6.1. Limitations and Future Research Directions

Several limitations of the current review should be noted:

1. **Scope of Literature**: The review focused primarily on peer-reviewed journal articles and reputable databases, potentially omitting relevant information from books, book chapters, and unpublished data. Future research could benefit from a broader literature search, including these additional sources, and employing a more extensive longitudinal design.
2. **Methodological Constraints**: Our methodology was limited to a specific set of keywords and data repositories. Expanding the range of keywords and exploring different data sources could provide a more comprehensive understanding of ChatGPT and its applications.
3. **Interpretation of Themes**: The interpretation of emerging themes is subjective and could vary among researchers. Different studies might present alternative perspectives or highlight other aspects of generative AI that were not covered in this review.
4. **Generalization**: The review's findings are generalized to broader educational contexts. Future research could focus on specific educational institutions or aspects, such as personalized human tutoring, to provide more targeted insights.

Future Research Directions

1. **Detailed Studies**: Further research should delve into the specific effects of generative AI models like ChatGPT within distinct educational settings. Investigations could focus on how these models impact particular features of educational practice, including learner experiences and personalized instruction.
2. **Unified Theoretical Frameworks**: Developing a unified theoretical framework could help guide future research. This framework could integrate various theories of innovation and technology acceptance, such

as the Technology Acceptance Model (TAM) and the Transfer of Technology (TOT) model, to explore their relevance to generative AI.

3. **Sector-Specific Studies**: Research could extend beyond education to other fields where AI models are being implemented, such as healthcare, information systems, and organizational learning. Exploring how generative AI affects these areas could provide valuable insights into its broader applicability.

4. **Innovative Dimensions**: Future studies might investigate the promising dimensions of generative AI, including its potential to revolutionize educational practices and other sectors. This could involve empirical testing of the proposed framework and exploration of its effects on various theoretical and practical aspects.

5. **Cross-Theoretical Integration**: Researchers could explore how different theories of innovation and technology interact with generative AI. This approach could help understand the technical, operational, and organizational implications of AI models and their integration into various systems.

The swift adoption of generative AI across sectors suggests its potential to transform education and other fields significantly. As AI technology continues to evolve, its impact on various domains will likely become even more profound, emphasizing the need for ongoing research and adaptation.

Declaration of Competing Interest

There are no conflicts of interest associated with this manuscript.

Data Availability

No data was used for the research described in this article.

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