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REVIEW

Relevance and Impact of Generative AI in Vocational Instructional Material Design: A Systematic Literature Review

Relevancia e Impacto de la Inteligencia Artificial Generativa en el Diseño de Materiales Instruccionales para la Educación Vocacional: Una Revisión Sistemática de la Literatura

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ABSTRACT

This study examines the relevance and impact of Generative Artificial Intelligence (GenAI) in the design of instructional materials for vocational education through a systematic literature review following the PRISMA guidelines. The review draws from reputable databases, including Scopus, Web of Science (WoS), and ERIC, to identify peer-reviewed articles published between 2019 and 2024. After applying inclusion and exclusion criteria, 28 eligible articles were analyzed. The findings highlight that GenAI significantly enhances instructional material design by supporting personalized learning, automating content creation, and improving accessibility. It enables the development of adaptive and high-quality resources tailored to diverse learner needs in vocational education. Furthermore, the study visualizes research trends using bibliometric analysis, providing insights into the evolution and distribution of GenAI-related research across time, regions, and themes. However, challenges such as the need for digital competency development among educators, ethical concerns regarding bias and content quality, and the potential over-reliance on AI tools are identified. This study underscores the importance of balancing AI-driven innovation with human-centered instructional design to ensure effective and sustainable educational practices. Practical recommendations include targeted professional development programs and ethical frameworks to guide the integration of GenAI into vocational education.

Keywords: Generative AI; Vocational Education; Instructional Material Design; Systematic Literature Review; AI in Education.

RESUMEN

Este estudio examina la relevancia y el impacto de la Inteligencia Artificial Generativa (GenAI) en el diseño de materiales instruccionales para la educación vocacional mediante una revisión sistemática de la literatura siguiendo las pautas PRISMA. La revisión se basa en bases de datos de prestigio, como Scopus, Web of Science (WoS) y ERIC, para identificar artículos revisados por pares publicados entre 2019 y 2024. Tras aplicar criterios de inclusión y exclusión, se analizaron 28 artículos elegibles. Los hallazgos destacan que la GenAI

mejora significativamente el diseño de materiales instruccionales al apoyar el aprendizaje personalizado, automatizar la creación de contenido y mejorar la accesibilidad. Permite el desarrollo de recursos adaptativos y de alta calidad, adaptados a las diversas necesidades de los estudiantes en la educación vocacional. Además, el estudio visualiza las tendencias de investigación mediante un análisis bibliométrico, proporcionando información sobre la evolución y distribución de la investigación relacionada con la GenAI en el tiempo, las regiones y los temas. Sin embargo, se identifican desafíos como la necesidad de desarrollar competencias digitales entre los educadores, preocupaciones éticas relacionadas con los sesgos y la calidad del contenido, y la posible dependencia excesiva de las herramientas de IA. Este estudio subraya la importancia de equilibrar la innovación impulsada por la IA con un diseño instruccional centrado en el ser humano para garantizar prácticas educativas efectivas y sostenibles. Las recomendaciones prácticas incluyen programas de desarrollo profesional específicos y marcos éticos que guíen la integración de la GenAI en la educación vocacional.

Palabras clave: IA Generativa; Educación Vocacional; Diseño de Materiales Instruccionales; Revisión Sistemática de la Literatura; IA en la Educación.

INTRODUCTION

The rapid development of Artificial Intelligence (AI) has significantly impacted education, with Generative AI emerging as a transformative tool in instructional material design.[1] Its ability to create personalized and adaptive content is particularly relevant in vocational education, where industry-aligned, skill-oriented learning materials are urgently needed to meet the demands of an evolving labor market.[2] Traditional instructional design methods often lack the flexibility required to address these challenges, underscoring the importance of innovative solutions like Generative AI.

The global shift toward automation and digitalization further highlights the necessity for adaptive workforce training. Reports from organizations such as the World Economic Forum indicate that many existing jobs will be redefined by technology, creating a pressing need for vocational education systems to prepare learners effectively.[3] Additionally, the COVID-19 pandemic accelerated the digital transformation of education, exposing limitations in conventional materials and emphasizing the potential of Generative AI to provide high-quality, scalable, and customized content tailored to diverse learner needs.[4,5]

Despite its potential, the application of Generative AI in vocational education remains fragmented and underexplored. This study aims to systematically examine existing literature to assess the relevance, opportunities, and challenges of integrating Generative AI into vocational instructional material design, bridging the gap between technological innovation and practical implementation.

To address these issues comprehensively, this study formulates the following research questions to guide the systematic review: 1) RQ1: How can Generative AI be integrated into educational practices to enhance personalized learning experiences?, 2) RQ2: What are the main challenges and opportunities in implementing Generative AI for instructional design in vocational education?, 3) RQ3: How does the use of Generative AI influence the development and accessibility of learning content in vocational education?, 4) RQ4: What pedagogical models are most effective when integrating Generative AI into classroom instruction?, 5) RQ5: How do educators perceive the role of Generative AI in improving the teaching and learning process?. This study general objectives is To explore the relevance, challenges, opportunities, and pedagogical integration of Generative Artificial Intelligence (GenAI) in vocational education, focusing on its impact on instructional material design, personalized learning experiences, and educators' perceptions to enhance teaching and learning processes.

METHOD

This study employs a Systematic Literature Review (SLR) approach designed to systematically identify, analyze, and synthesize relevant literature. This approach is chosen to provide a comprehensive understanding of the relevance and impact of Generative AI in the design of instructional materials for vocational education. Additionally, a bibliometric analysis is conducted to visualize research trends, including author collaboration, topic distribution, and the evolution of publications related to Generative AI.

The research framework adheres to the PRISMA guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) to ensure the transparency, rigor, and replicability of the research process.[6,7] By employing PRISMA, this study incorporates clear and systematic steps, including document identification, screening based on inclusion and exclusion criteria, and both thematic and quantitative analyses. This approach enables the collection of comprehensive data while presenting reliable findings to address the formulated research questions effectively.[8]

The integration of bibliometric tools further enhances the study by mapping out the existing research landscape. This visualization provides valuable insights into key contributors, prominent themes, and gaps in the literature, thereby strengthening the foundation for future research and practical applications of Generative AI in vocational education

Data Collection

Data collection in this study was conducted through a structured literature search process utilizing three leading academic databases: Scopus, Web of Science (WoS), and ERIC. These databases were chosen for their extensive coverage of high-quality, peer-reviewed publications, ensuring the reliability and relevance of the collected data.

The search strategy employed advanced search queries specifically designed to capture articles aligned with the research focus, namely Generative AI, vocational education, and instructional material design. The search queries incorporated a combination of targeted keywords such as "Generative AI," "Artificial Intelligence," "vocational education," "instructional design", and other related synonyms to ensure comprehensive coverage of the literature.

To enhance precision, filters were applied to limit results based on the publication year (2019–2024) and document type (journal articles). These filters ensured that the selected studies reflected current and relevant findings in the field. The detailed breakdown of the search strategy and advanced query parameters is presented in the table below.

Table 1. Advanched Searching query for databases

Indexer	Query code
Scopus	(TITLE-ABS-KEY("Generative AI" OR "Artificial Intelligence" OR "AI") AND TITLE-ABS-KEY("instructional design" OR "learning materials" OR "teaching materials") AND TITLE-ABS-KEY("vocational education" OR "higher education") AND PUBYEAR > 2019)
WoS	TS=("Generative AI" OR "Artificial Intelligence" OR "AI") AND TS=("instructional design" OR "learning materials" OR "teaching materials") AND TS=("vocational education" OR "higher education") AND PY=(2020-2024)
Eric	("Generative AI" OR "Artificial Intelligence" OR "AI") AND ("vocational education" OR "higher education") AND ("instructional design" OR "learning materials") AND (published_date: 2019 OR published_date: 2020 OR published_date: 2021 OR published_date: 2022 OR published_date: 2023 OR published_date: 2024)

Table 1 presents the advanced search queries used to retrieve relevant literature from the three main academic databases: Scopus, Web of Science (WoS), and ERIC. These queries were meticulously designed to identify studies exploring the application of Generative AI, Artificial Intelligence (AI), and related technologies in the context of instructional material design, particularly in vocational education and higher education. The query construction carefully included primary terms and their synonyms to ensure comprehensive search coverage.

Inclusion and Exclusion Criteria

In this study, inclusion and exclusion criteria were established to ensure that the analyzed documents are highly relevant to the research topic and meet rigorous academic standards. The application of these criteria aims to narrow the scope of articles to align with the research objective, which is to explore the relevance and impact of Generative AI in the design of instructional materials for vocational education. The criteria are presented in detail in the following table:

Table 2. Criteria for Inclusion and Exclusion

Inclusion criteria	Exclusion criteria
Articles published between 2019–2024.	Document Type: Books, conference proceedings, editorials, book reviews, and opinion articles that are not peer-reviewed.
Studies relevant to Generative AI, instructional material design, and vocational education.	Irrelevant Topics: Articles that mention Generative AI or vocational education broadly but do not explore their relationship with instructional material design.
Language: Articles written in English to ensure accessibility and consistency in analysis.	Restricted Access: Articles that are not fully accessible or available only in abstract form.

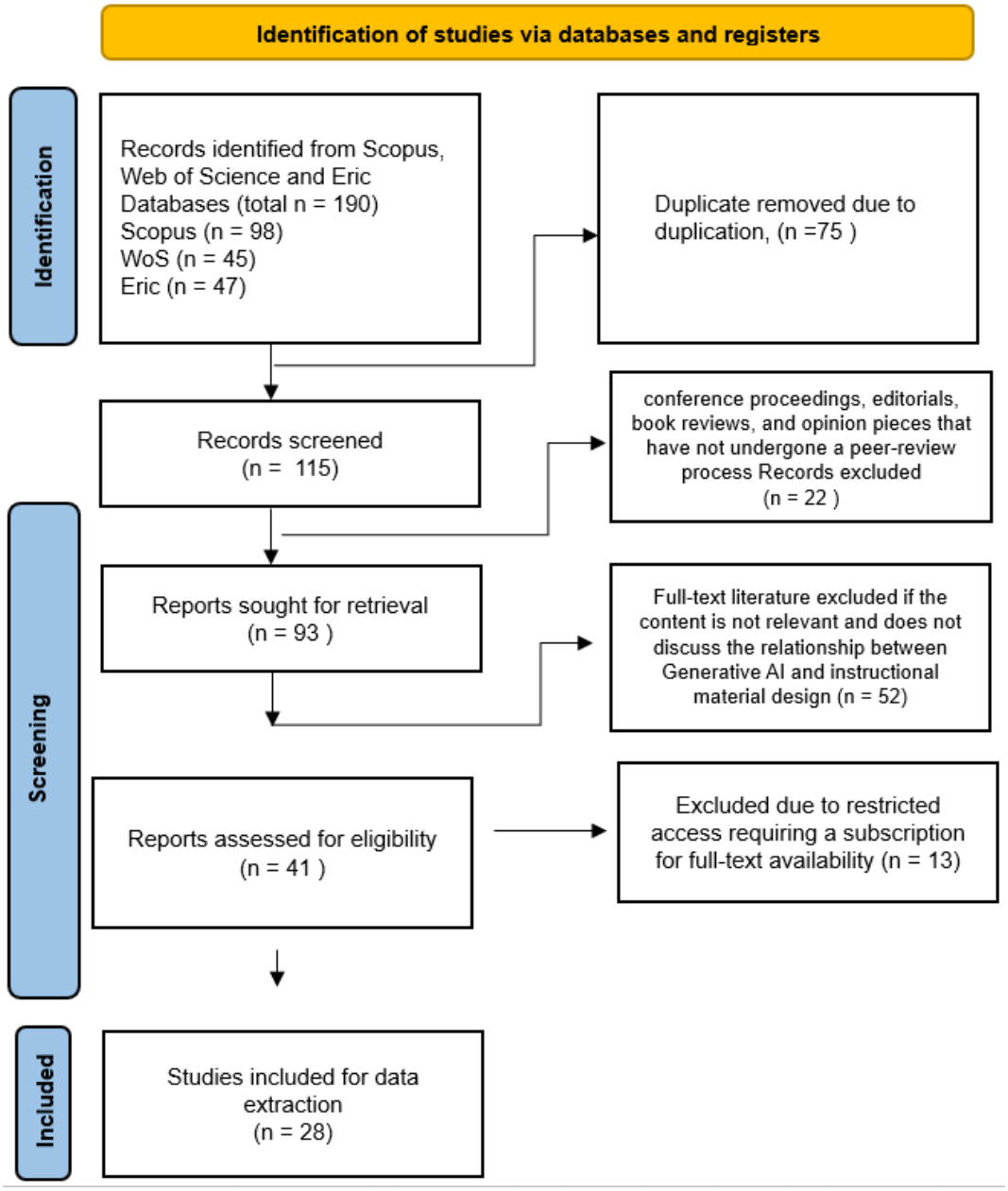

Figure 1. Search Flow using PRISMA Protocol

RESULTS

Data Collection Summary

The metadata obtained and filtered through the PRISMA procedure were analyzed using RStudio via the Biblioshiny platform to support an in-depth bibliographic analysis. The metadata encompass key elements such as abstracts, affiliations, authors, DOI, document type, journal name, language, year of publication, total citations, keywords, and other relevant details. The completeness of each metadata element was assessed based on the number of missing items (Missing) and the percentage of unavailable data (Missing %). Each element was then categorized into one of four statuses: Excellent, indicating minimal missing data and high reliability for analysis; Good, with a small proportion of missing data sufficient for reliable results; Acceptable, reflecting a moderate amount of missing data that requires careful interpretation; and Critical, signifying significant missing data that could limit the reliability of the analysis. This evaluation ensures transparency regarding the quality of the bibliographic data and highlights potential limitations, providing a robust foundation for conducting accurate bibliometric analysis and interpreting the trends effectively.

Based on the biblioshiny data quality result, most of the metadata elements exhibit excellent completeness, with a Missing % value of 0, including abstract (AB), affiliations (C1), author names (AU), DOI (DI), document type (DT), journal (SO), language (LA), publication year (PY), title (TI), and total citations (TC), all of which are categorized as Excellent. However, there are some metadata elements with inadequate completeness. The “Keywords Plus” (ID) element has a Missing % of 57,14 %, and the “Science Categories” (WC) element

has a Missing % of 60,71 %, both classified as Critical. Additionally, the completeness of metadata for the "Corresponding Author" (RP) element has a Missing % of 14,29 %, which is considered Acceptable, while the "Keywords" (DE) element, with a Missing % of 3,57 %, is categorized as Good.

The significant deficiencies in critical elements, such as "Keywords Plus" and "Science Categories," can impact the overall bibliometric analysis, particularly when identifying thematic trends or academic categories. Therefore, efforts to improve the data or implement compensatory strategies are necessary to ensure the quality and validity of the findings in this study.

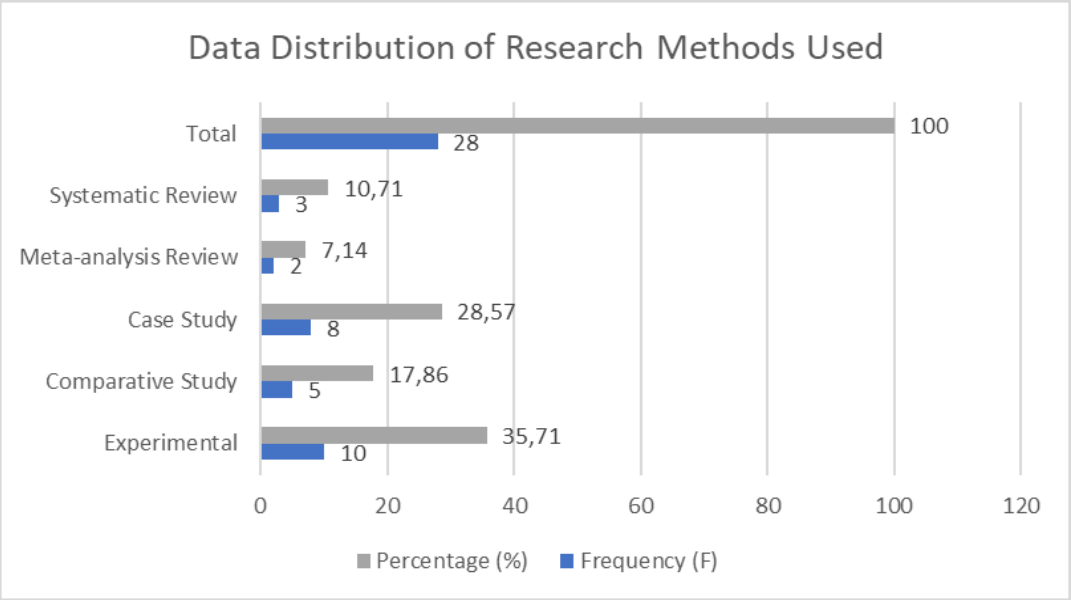

Figure 2. Distribution of Methods Used in data collection

DISCUSSION

How can Generative AI be integrated into educational practices to enhance personalized learning experiences?

Generative AI holds significant potential for integration into educational practices to enhance personalized learning experiences. Technologies such as AI chatbots, learning analytics, and AI systems for customized learning play crucial roles in addressing the individual needs of students.[9,10] According to Nizhenkovska et al.[11], AI chatbots support the principles of self-regulated learning by providing automated guidance and tailored feedback based on students' progress, enabling a more proactive and independent approach to learning.[9] Moreover, technologies like learning analytics allow for real-time performance prediction, helping educators adjust teaching strategies to improve effectiveness and student motivation.[12]

Generative AI also supports content-based learning where materials can be structured to match students' learning styles, comprehension levels, and specific needs.[13] In this context, the perspectives of students and educators are critical. Studies indicate that the integration of AI, such as ChatGPT, not only enhances student engagement but also helps in understanding the challenges of implementation, such as the reliability of generated content and ethical concerns.[14]

Overall, generative AI enriches the learning environment by providing access to adaptive materials, quick feedback, and in-depth analysis of students' progress. However, challenges related to technological readiness, teacher training, and data privacy must be addressed to ensure optimal implementation of AI across various educational contexts.[15]

What are the main challenges and opportunities in implementing Generative AI for instructional design in higher education?

One of the main challenges in implementing Generative AI in instructional design in higher education is the readiness of infrastructure and the skills of educators.[16] Many educators face difficulties in integrating AI tools into their teaching, particularly regarding technical limitations and the lack of training in using this technology. Perezchica-Vega et al.[17] noted that although educators recognize the immense potential of AI in learning, they feel inadequately supported in terms of training and guidance to fully leverage this technology in instructional design. Additionally, Titko et al.[18] suggest that the introduction of AI in education should be gradual, taking into account the readiness of instructors and the need for continuous training.

Ethical considerations and policies are also major concerns in AI implementation, especially regarding student data management. The use of big data to personalize learning experiences and analyze student progress raises

concerns about privacy and the potential misuse of information. Drugova et al.[19] highlight the importance of clear policies on the use of personal data in AI systems, as well as the need for transparency in the algorithms used to prevent bias. Nevertheless, with proper management, AI can enhance the quality and accuracy of learning analytics, enabling instructional designers to tailor teaching materials more effectively. Pesovski et al.[20] mention that AI can provide more adaptive learning materials customized to individual student needs, which could potentially improve learning outcomes and student engagement.

Despite the challenges, the implementation of Generative AI also presents significant opportunities to enhance instructional design, particularly in the development of more flexible and personalized learning materials. Marchena Sekli et al.[21] emphasize that one of the key benefits of AI is its ability to generate teaching materials that meet individual needs, enabling a more inclusive and effective learning experience. Furthermore, Michalon et al.[22] suggest that AI can be used to develop enduring competencies such as critical thinking and problem-solving skills, which are crucial for students in higher education. Therefore, despite the challenges, the implementation of AI in instructional design in higher education opens up many opportunities to enrich the learning experience and enhance the quality of education.

How does the use of Generative AI influence the development and accessibility of learning content in higher education?

It is crucial to consider the impact of generative AI on enhancing the efficiency of instructional content creation and expanding accessibility for students in higher education. Generative AI, as seen in the use of tools like ChatGPT and other AI platforms, enables the creation of content tailored to individual learning needs, enhancing the student learning experience in a more personalized way.[23] This creates significant opportunities for providing more inclusive education, with materials that can be customized to suit various learning styles and the specific needs of students.

The use of generative AI in the development of instructional materials allows for content creation at a much faster pace and greater efficiency compared to traditional methods. For instance, Marchena Sekli[21] emphasizes how AI can facilitate the creation of text-based, audio, and visual content that is aligned with the student's level of understanding. Furthermore, Pesovski et al.[13] highlight that AI enables the automatic and responsive development of instructional materials based on actual student needs, such as generating practice questions or instructional videos tailored to the required level of difficulty. However, while AI can expedite content creation, the quality and accuracy of the generated information still need to be assessed by educators to ensure the materials remain relevant and meet the desired academic standards.

On the other hand, generative AI also facilitates improved accessibility to instructional content for diverse student groups. Perezchica-Vega et al.[24] demonstrate that AI enables the creation of more flexible and accessible materials for students with various needs, such as language or physical ability differences. Technologies like automated dubbing or automatic video translation using AI can allow content delivery in multiple languages and offer students with physical limitations the opportunity to access materials through text or subtitles. Additionally, Miquel-Vergés[25] highlights how AI technology can enhance educational accessibility by creating more inclusive and globally accessible content, overcoming geographical barriers or resource constraints.

What pedagogical models are most effective when integrating Generative AI into classroom instruction?

The urgency of understanding how pedagogical models can facilitate the integration of Generative AI (GenAI) in teaching to enhance student engagement and learning outcomes is crucial. With its ability to create adaptive and personalized learning content, Generative AI requires pedagogical approaches that can maximize its effectiveness in the classroom.[26,27]

Project-Based Learning (PBL) is one such model that is highly relevant for integrating GenAI. This model emphasizes problem-based learning, where students work on real-world projects, utilizing AI to generate ideas, solutions, or content relevant to the challenges at hand. According to Pesovski et al.[13], GenAI can serve as a tool that provides various resources and creative ideas, thus enhancing students' critical thinking abilities and collaborative skills in solving projects. PBL enables GenAI to act as an assistant in designing and developing solutions, increasing student engagement by giving them ownership of their learning journey.

Furthermore, Personalized Learning models are particularly well-suited for integrating GenAI. This approach allows the use of AI to tailor learning materials to each student's needs and learning style. Perezchica-Vega et al.[24] suggest that using GenAI, instructors can create personalized learning experiences that accommodate varying levels of student comprehension, providing appropriate challenges and timely feedback. This model can enhance motivation and learning outcomes as students feel more valued in their personalized learning paths. Collaborative learning models also prove effective, where GenAI supports collaboration among students by providing tools that enable them to share ideas and work together on tasks. Xu Q[28] emphasizes the importance of student interaction using technology to foster collaborative skills, with GenAI offering instant feedback and enriching discussions with additional ideas. In this model, GenAI not only serves as an information source but also as a facilitator guiding students to think more deeply and broaden their perspectives. Thus, project-based,

personalized, and collaborative learning models are highly effective pedagogical strategies for integrating GenAI into classroom instruction. These approaches allow for more dynamic and adaptive teaching, optimizing the potential of AI to enhance student engagement and learning effectiveness.

How do educators perceive the role of Generative AI in improving the teaching and learning process?

Based on various studies, the use of Generative AI (GenAI) has the potential to bring significant changes to the teaching and learning process, offering numerous advantages in enhancing the quality of education.[29,30] Some studies indicate that educators view GenAI as a highly useful tool in supporting more personalized and interactive learning. For instance, Perezchica-Vega et al.[24] reveal that most educators believe that generative AI can assist them in quickly generating relevant instructional materials, allowing them to focus more on interacting with students. GenAI also enables the creation of more adaptive learning content, such as practice questions, quizzes, and learning modules tailored to the individual needs of students. This has the potential to increase student engagement and motivation in learning, while also supporting a more holistic and personalized learning experience.

However, concerns have also emerged regarding the use of AI in education. Miquel-Vergés[31] and Nizhenkovska et al.[11] highlight that while GenAI can accelerate content creation and provide automated feedback, educators are worried that over-reliance on these tools may reduce students' ability to think critically and independently. Some studies emphasize the importance of in-depth ethical considerations when using AI, including the potential risk of diminishing the quality of learning if not properly managed. Therefore, it is crucial for educators to carefully integrate GenAI into their curricula and ensure that this technology is used to support, rather than replace, their role in guiding and developing students' critical thinking abilities.

To enhance the acceptance and effectiveness of GenAI use, educators stress the need for continuous professional development. Marchena Sekli et al.[21] argue that effective training can help educators understand both the potential and limitations of GenAI, as well as how to integrate this technology appropriately into their teaching practices. Well-designed training allows educators to optimize the use of these tools while ensuring they retain control over the learning process in the classroom. This approach will encourage a more responsible and sustainable use of GenAI to improve teaching and learning processes.

CONCLUSIONS

This study emphasizes the importance of Generative AI in enhancing vocational instructional material design. The key findings indicate that Generative AI can significantly improve personalized learning experiences, enabling content adaptation according to individual student needs. Furthermore, the integration of Generative AI into instructional design can reduce administrative burdens on educators, providing them with opportunities to focus on more meaningful interactions with students. However, despite its many positive potentials, challenges in its implementation, such as concerns about over-reliance on AI and its negative impact on students' critical thinking abilities, must be addressed.

Additionally, the study identifies several pedagogical models that can be optimized with this technology, which may lead to the development of more inclusive and efficient learning materials. To support successful implementation, it is essential for educators to receive proper training on how to integrate Generative AI into the curriculum and to fully understand both the potential and limitations of this technology. Thus, Generative AI can be leveraged to enrich vocational education, improve teaching quality, and enhance learning outcomes. On the other hand, this study also has limitations. One of the limitations is the sample, which is confined to existing literature studies, meaning that the findings may not fully represent the entire context of global vocational education. Moreover, while the study identifies significant opportunities, further empirical research and broader case studies are needed to explore the long-term impact and sustainability of Generative AI in vocational education. These limitations highlight the need for further research to test practical applications and real-world evaluations of Generative AI across various educational institutions.

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CONFLICT OF INTEREST

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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