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REVIEW

Artificial Intelligence for the development of qualitative studies

Inteligencia artificial para el desarrollo de estudios cualitativos

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ABSTRACT

The integration of Artificial Intelligence (AI) is revolutionizing qualitative research by optimizing data collection and analysis. Tools such as machine learning and natural language processing enable the analysis of large volumes of information with precision and speed, facilitating the identification of patterns and trends. The adoption of virtual research methods, such as online focus groups and video interviews, has overcome geographical barriers, enabling the participation of diverse and representative samples, in addition to being more cost-effective and allowing real-time data acquisition. The incorporation of advanced biometric techniques, such as eye tracking, facial expression analysis, and neuroimaging, provides a more holistic and accurate understanding of consumers' emotional and subconscious responses. These innovations allow companies to adapt their marketing strategies and product designs more effectively, enhancing personalization and emotional resonance of the experiences offered.

Keywords: Artificial Intelligence; Qualitative Research; Data Analysis; Virtual Methods; Biometrics.

RESUMEN

La integración de la inteligencia artificial (IA) revoluciona la investigación cualitativa al optimizar la recolección y análisis de datos. Herramientas como el aprendizaje automático y el procesamiento del lenguaje natural permiten analizar grandes volúmenes de información con precisión y rapidez, por tanto, facilita la identificación de patrones y tendencias. La adopción de métodos de investigación virtuales, como grupos focales en línea y entrevistas por video, ha superado las barreras geográficas a la par que posibilita la participación de muestras diversas y representativas, además de ser más rentables y permitir la obtención de datos en tiempo real. La incorporación de técnicas biométricas avanzadas, como el seguimiento ocular, el análisis de expresiones faciales y la neuroimagen, proporciona una comprensión más holística y precisa de las respuestas emocionales y subconscientes de los consumidores. Estas innovaciones permiten a las empresas adaptar sus estrategias de marketing y diseño de productos de manera más efectiva, lo que mejora la personalización y resonancia emocional de las experiencias ofrecidas.

Palabras clave: Inteligencia Artificial; Investigación Cualitativa; Análisis de Datos; Métodos Virtuales; Biometría.

INTRODUCTION

In recent decades, qualitative research has undergone a significant evolution, driven by technological and methodological advances that have transformed the landscape of data collection and analysis. The emergence

of artificial intelligence (AI) has marked a turning point in this field as it provides advanced tools and techniques that enhance the ability of researchers to obtain and analyze information more efficiently and accurately. [1, 2, 3]

Qualitative research, traditionally focused on the in-depth interpretation of social phenomena and human behavior through techniques such as interviews, focus groups, observations, and content analysis, has benefited greatly from these technological advances. Although initially, qualitative research relied heavily on manual labor and subjective interpretation of data, this has evolved since the rise of artificial intelligence. [4, 5, 6]

With the advent of advanced software and AI-based tools, researchers can now handle large volumes of data more efficiently. This makes it possible to identify patterns and trends that were previously difficult to detect, as well as to examine complex relationships between codes and categories beyond manual network designs. These tools not only facilitate the collection and organization of data but also improve the accuracy and reliability of qualitative analyses by providing auxiliary procedures for their representation. [7, 8, 9]

The integration of AI in qualitative research manifests itself in several key dimensions. First, data collection has been optimized through the use of AI algorithms that can analyze text, transcripts, and multimedia content with speed and accuracy superior to traditional methods. Second, qualitative data analysis has been transformed with AI's ability to identify themes, coding associated with emotions and sentiments, as well as patterns in large datasets, allowing researchers to gain deeper and more nuanced insights. [10, 11, 12]

In addition, AI has facilitated the adoption of virtual research methods by overcoming geographic limitations and enabling the participation of a more diverse and representative sample. Examples include advanced biometric data analysis techniques, such as eye tracking and facial expression analysis, which have opened new avenues for understanding the emotional responses of participants, making it possible to achieve a deeper and more comprehensive view of human behavior. [13,14,15] Another particularly relevant scenario is the formation of international research teams due to the ease with which databases, findings, and other resources can be shared, which helps to alleviate infrastructural shortcomings in underdeveloped contexts.

Ultimately, artificial intelligence redefines the field of qualitative research by providing powerful tools that enhance researchers' ability to explore and understand social phenomena more deeply and accurately. Therefore, this article aims to explore these trends in the use of artificial intelligence and their impact on the development of qualitative studies. Special relevance is given to the analysis of how AI transforms traditional methodologies and approaches in this field.

METHODS

For the preparation of this article, an exhaustive documentary review focused on current trends and applications of artificial intelligence (AI) in qualitative research was carried out. [16,17,18] The documentary review was conducted using a rigorous methodology, which was structured in stages predefined by the authors in a semi-systematic review protocol. These stages ensured the quality and validity of the information collected while contributing to guaranteeing the soundness of the research process.

Stage 1. Selection of bibliographic sources

To carry out this review, academic sources, specialized journal articles, and online publications relevant to the topic were selected. Scopus was used as the primary database, with the Google Scholar engine and the ScimagoJR portal as tools to speed up the search and ensure the relevance of the sources. Priority was given to sources published in journals specialized in technology and innovation in qualitative research.

Stage 2. Search and data collection process

The search and data collection process was carried out through previously defined steps, as shown in Figure 1. These steps allowed for a rigorous search and data collection process, ensuring the completeness and validity of the information collected.

Stage 3. Data analysis process

The data collected were organized and synthesized to provide a comprehensive and up-to-date view of how AI transforms qualitative research. Recurring themes and categories were identified, relevant data were extracted, and the information collected was organized to highlight the benefits, challenges, and practical applications of AI in qualitative research.

Stage 4. Ethical considerations

In this documentary review, copyright was respected, and proper referencing of the sources used was performed. Integrity and transparency were ensured in the presentation of the results and information collected. In addition, the documentary approach made it possible to offer a clear and detailed perspective on the use of artificial intelligence in the development of qualitative studies without requiring the handling of sensitive data or violating deontological principles but in accordance with the purposes outlined.[19,20,21]

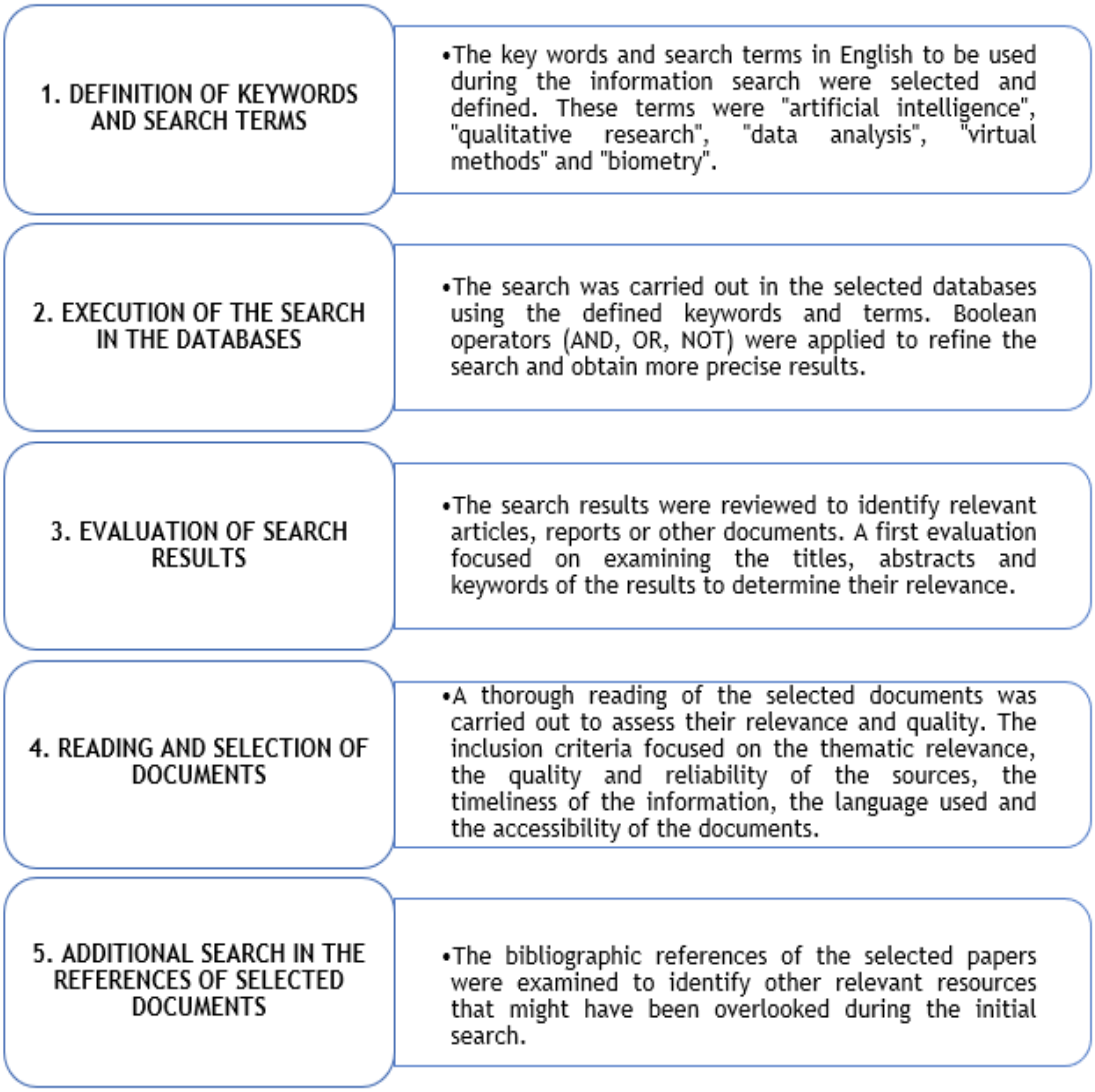

Figure 1. Phases of the search and data collection process

RESULTS AND DISCUSSION

The analysis carried out supports the main notion of the article: Artificial intelligence perfects the qualitative research process. By offering tools that not only increase the efficiency and accuracy of data analysis but also allow a deeper and more detailed understanding of the phenomena studied, the use of AI also contributes to standardized practices that, in positivist and post-positivist cultures, are pointed out as inadequacies of traditional qualitative research. This technological advance evolves traditional methodologies while opening new possibilities for qualitative research and has opened a complex debate on whether it represents a new avenue, the implementation of one more tool, or a scenario of a gnoseological revolution.

The analysis of the theory presented in the sources laid the foundations for the elaboration of a mind map that seeks to visualize and relate the different contents addressed (see Figure 2). This mind map aims to graphically represent the interconnections and relationships between the advances in technology-driven qualitative research.

The mind map was structured around three main branches:

- the incorporation of artificial intelligence into qualitative research
- the adoption of virtual research methods
- the integration of biometric techniques into qualitative research

These branches represent the technological advances currently influencing the field of qualitative research and provide new opportunities for deeper and more actionable insights.

Within each branch, key aspects and implications of each technological advance were identified.

Consequently, connections and relationships between the concepts were established to highlight how artificial intelligence, virtual research methods, and biometric techniques complement and enhance each other in the context of qualitative research.

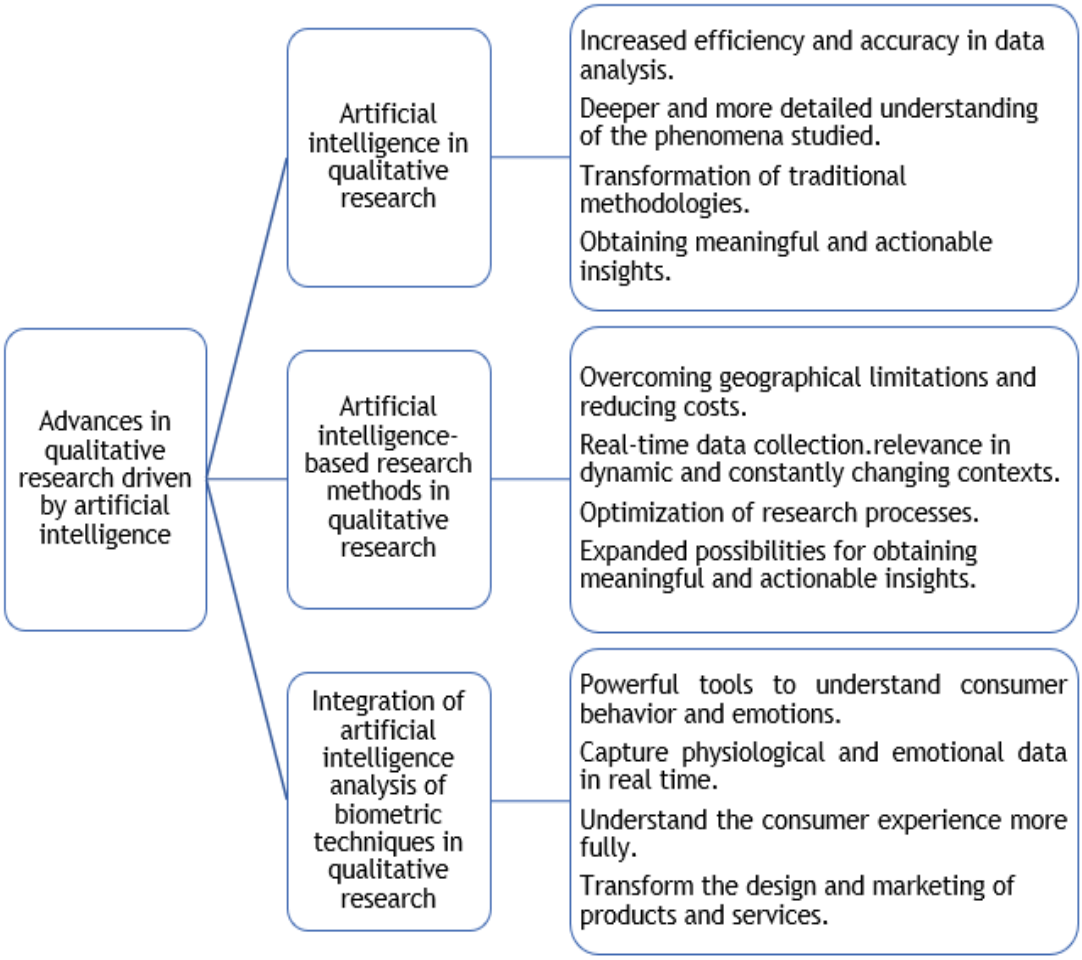

Figure 2. Artificial intelligence-driven advances in qualitative research

Adoption of Advanced Technologies

Qualitative research methodologies are undergoing a remarkable evolution as more and more artificial intelligence (AI)-driven tools, such as machine learning and natural language processing, are integrated. These technologies refine the way qualitative research is conducted by optimizing data collection and automating the analysis, allowing researchers to efficiently draw more accurate and insightful conclusions.[22,23,24]

The application of AI in qualitative research not only improves process efficiency but also has a significant impact on the work of researchers. By freeing them from repetitive and potentially tedious tasks, such as manually labeling data or sorting information, AI technologies allow them to focus on more important aspects of the research, such as interpreting results and deriving meaningful conclusions. This encourages more rigorous analysis and enriches the understanding of the phenomena studied. [25, 26]

Furthermore, the automation of qualitative data analysis using AI provides an additional advantage by enabling a more thorough exploration of the data. Machine learning algorithms can identify subtle patterns, hidden relationships, and emerging trends in large qualitative data sets. This advanced analytic capability broadens the scope of qualitative research and enables the discovery of new perspectives and dimensions in the data. [27, 28] This does not imply the replacement of human data management, as AI can produce mannerisms or overly stilted text patterns that affect the clarity and transparency of analysis.

In this regard, in addition to improving the quality and efficiency of research, the integration of AI into qualitative methods also facilitates the adoption of virtual approaches. Conducting focus groups and interviews online, supported by AI tools, eliminates geographical limitations and allows for a more diverse and representative participation of study subjects. Researchers can connect with participants from different regions, which enriches the diversity of perspectives and enriches the validity and applicability of findings. [29, 30]

Additionally, advanced biometric data analysis techniques, such as eye tracking and facial expression

analysis, benefit from artificial intelligence by allowing researchers to more fully and thoroughly understand participants' emotional responses. AI processes and analyzes large amounts of biometric data efficiently and also identifies patterns and trends that cannot be perceived with the naked eye. These techniques provide new tools for understanding participants' emotional responses, offering a more complete and detailed view of human behavior. [31, 32, 33]

Virtual Research Methods

Como se mencionó en el tema anterior, la transformación digital ha acelerado notablemente la adopción de métodos de investigación virtuales, como los grupos focales en línea, las entrevistas por video y la etnografía virtual. Estos enfoques innovadores trascienden las barreras geográficas tradicionales y permiten a los investigadores acceder a una muestra más diversa y representativa de participantes, lo que enriquece la validez y la generalización de los hallazgos.[34,35]

Los grupos focales en línea permiten reunir a individuos de diferentes ubicaciones geográficas en una única sesión de discusión. Esto facilita la inclusión de perspectivas diversas y mejora la representatividad de los datos recolectados. Además de ampliar el alcance geográfico, estos métodos virtuales son significativamente más rentables en comparación con las técnicas tradicionales.[36,37]

Adicionalmente, la reducción de costos asociados con el desplazamiento, la logística y el alquiler de espacios físicos permite a las organizaciones invertir más en el análisis de datos y la interpretación de resultados. Este aspecto económico es particularmente beneficioso para proyectos de investigación con presupuestos limitados ya que favorecen una gestión más eficiente de los recursos disponibles.[38,39] En el campo de la investigación cualitativa esta oportunidad es crucial, pues frecuentemente es argüida como un factor que actúa en detrimento de proyectos cualitativos como los gastos asociados a la duración, la movilidad de los investigadores y otros similares.

Otra ventaja crucial de los métodos de investigación virtuales es la capacidad de obtener datos en tiempo real. Esta inmediatez es fundamental en contextos dinámicos donde las condiciones pueden cambiar rápidamente y la rapidez en la recolección y análisis de datos puede influir directamente en la relevancia y aplicabilidad de los resultados. Tal es el caso de las entrevistas por video, estas pueden ser grabadas y transcritas automáticamente mediante herramientas de inteligencia artificial. Ello que agiliza el proceso de análisis y permite una respuesta más rápida a los fenómenos estudiados, aspecto que alivia la pérdida de datos asociada a la gestión de la entrevista.[40,41] De acuerdo con la experiencia de los autores, este significa un importante avance, especialmente para investigadores noveles con dificultad para la toma de notas y la síntesis de información.

Además, las fuentes consultadas destacan la etnografía virtual, que implica la observación de comportamientos y culturas en entornos digitales, ofrece una perspectiva única sobre cómo las personas interactúan y se comunican en el mundo virtual. Este método es especialmente relevante en el estudio de comunidades en línea, redes sociales y entornos virtuales de trabajo y ocio. Además, proporciona una comprensión profunda de las dinámicas y prácticas que emergen en estos espacios y que no son reducibles a la aplicación de preceptos supuestamente universales, consideración fundamental para la sustentación de las nuevas tendencias en cuanto a investigación cualitativa se refiere. [42,43]

Biometric Data Integration

One particular line of data pointed to the application of AI as an auxiliary resource in the business world. According to articles consulted in this regard, to better understand consumer emotions and reactions, qualitative research incorporates biometric data such as eye tracking, facial expression analysis, and neuroimaging. These advanced techniques provide a more reliable view of consumer behavior, allowing companies to tailor their strategies based on the emotional engagement of their customers. [44, 45]

Eye-tracking allows researchers to determine what consumers' visual attention is focused on, how much time they spend looking at certain elements, and in what order they do so. This is crucial for understanding which aspects of a product, advertisement, or web page capture the most attention and how users visually interact with the content. [46,47]

Facial expression analysis uses advanced algorithms to detect and classify the emotions reflected in participants' facial expressions. This technique allows researchers to capture immediate and spontaneous emotional responses to specific stimuli. Therefore, a more authentic measure of consumer reactions can be achieved than self-reported responses, which conscious or unconscious biases may influence. This methodology is especially useful in product testing, where emotional reactions may indicate the initial acceptance or rejection of a product or service because, in addition to offering identifiable scales, it offers a comprehensive view of behavior, as well as favoring the triangulation of qualitative data and their integration with quantitative data strands. [48, 49]

On the other hand, the interpretation by artificial intelligence of neuroimaging studies, which include

techniques such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), allows the observation of brain activity in response to different stimuli. These techniques provide data on how the brain processes information and reveal the neural basis of consumer decisions and preferences. For example, fMRI can show which areas of the brain are activated upon seeing a specific brand, which can indicate levels of emotional attachment and preference if they are properly triangulated. [50,51]

This innovative approach of incorporating biometric data into qualitative research offers a deeper and more accurate understanding of responses that are not fully conscious and voluntarily elaborated by participants. By capturing reactions that may not be verbalized or even conscious, companies can tailor their marketing and product design strategies more effectively. However, it also offers a panel of data that might need to be clearer for even seasoned observers to discern. This not only improves the alignment of products and services with consumer expectations and desires but also enables the creation of more personalized and emotionally resonant experiences. [52,53] Going forward, as these advances can be feasibly included in other disciplines, qualitative researchers may benefit from tools that are still inaccessible in most cases, with Large language models (LLaMA) the most widely employed.

Integrative analysis

However, qualitative analysis is much more complex than it is usually represented in the sources reviewed. Although the process is often depicted in a parceling for informational and didactic purposes, other stages that are fundamental to the discussion of the impact of IA on qualitative research are usually omitted. In addition, the epistemological and ethical implications of reducing qualitative analysis to flat textual analysis remain to be explored, an aspect that is partially resolved with the incorporation of advanced technologies but which is far from being accessible in all contexts and disciplines.

Although many researchers currently rely on transcriptions, the qualitative methodology has been strengthened and enriched considerably, especially when strong triangulation programs are designed, a weakness still to be overcome, in the authors' opinion. Finally, although it speeds up textual processing, there are two issues of concern that qualitative researchers frequently have to resolve during their research. First, the interpretation of the intertextual, of the unsaid, of the emotive and its representations, which could be favored by the "liberation" of note-taking and transcription, but which still requires further deepening and, ultimately, specialized training for researchers.

Second, the construction of categories and themes, from the analysis of the relationship between codes and triangulation, remains a metacognitive (rather than cognitive) exercise and requires stepping outside the narrow frameworks that this tool could provide. In short, the sources suggest that IA is a valuable tool, as valuable as the user intends its use, but that it should not, at least in the field of qualitative research, be presented as a messianic instrument.

CONCLUSIONS

The integration of artificial intelligence-based tools, such as machine learning and natural language processing, has revolutionized qualitative research by optimizing data collection and analysis. These technologies make it possible to analyze large volumes of information with unprecedented accuracy and speed. This automation frees researchers from repetitive tasks, allowing them to concentrate on interpreting results and deriving meaningful conclusions. The adoption of virtual research methods, such as online focus groups, video interviews, and virtual ethnography, has overcome geographical barriers and enabled the participation of more diverse and representative samples. These methods are not only more cost-effective but also allow for real-time data collection, which is crucial in dynamic contexts. Incorporations of advanced biometric techniques provide a deeper and more accurate understanding of consumers' emotional responses. These tools allow immediate and authentic reactions to be captured, providing valuable information that can be used to tailor marketing strategies and product design more effectively.

For future research, it is necessary to delve into the possibilities and limitations, the didactic requirements for training qualitative researchers in their appropriate use, the epistemological and experiential assessment of both issues and the exploration of the ethical dilemmas involved. An essential aspect in this sense will be the self-referential and external study during ongoing research since the richness of qualitative research is hardly replicable in experimental or simulated biased studies.

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None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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