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Revealing Education's Digital Frontier of E-learning Among Rural Students

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E-learning has revolutionised education and attracted educators and scholars, particularly those passionate about enhancing e-learning for rural students. This study aims to conduct a bibliometric analysis to characterise the descriptive parameters of e-learning and rural student publications. The present study employed VOSviewer software and Scopus datasets to identify the most active scientific sources, prominent references, keywords, and trending topics on e-learning and rural students. The results disclosed that an increasing trend began in 2019 with 22 publications, and the highest number of publications was recorded in 2022, with 39 articles. This study has identified a rising tendency in the usage of keywords such as "education", "ICT", "rural school", "rural students", "online education", "online learning", "remote learning", "pandemic", "COVID-19", and "digital divide" since 2018. Therefore, using social intervention strategies to ameliorate e-learning is anticipated to assist educators and education professionals in mitigating educational inequalities among students residing in rural areas.

Keywords: e -learning; rural student; learning system; digitalisation; computer instruction; digital divide

I. INTRODUCTION

Within the dynamic realm of education, e-learning has emerged as a catalyst for change, fundamentally altering how knowledge is obtained and shared (Encarnacion *et al.*, 2021). Significantly, this educational framework has garnered the interest of educators, policymakers, and scholars alike, particularly in its implementation among students dwelling in rural regions (Sfenrianto *et al.*, 2018). The increasing attention and scholarly investigation on e-learning in rural settings exemplify its capacity to address the educational disparity and empower marginalised populations by providing them with high-quality learning opportunities (Haque *et al.*, 2023). According to Reeves *et al.* (2017), e-learning offers several advantages, including enhanced cost-effectiveness, flexibility, convenience, and the ability to reach a diverse audience irrespective of geographical barriers.

Scintillating e-learning is widely regarded as the most efficient and cost-effective approach to training in times of pandemic crises. Anwar and Wahid (2021) stated that e-learning during a pandemic had been identified as a cost-effective and efficient method for acquiring knowledge. E-learning, co-jointing with internet technologies, has facilitated the implementation of digital literacy competencies, thereby creating novel prospects within the global education market (Chohan & Hu, 2020). Vainshtein *et al.* (2019) asserted that implementing an individual educational trajectory in adaptive e-learning courses offers significant benefits for organising education in the electronic environment, benefiting both students and teachers. E-learning, an innovative training approach, has existed since the early 21st century. Promoting e-learning as a long-term strategy in education is crucial (Alyoussef, 2021) and finding

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practical solutions to facilitate its implementation in current and future conditions (Liao *et al.*, 2022).

The successful implementation of e-learning programs requires a supportive environment and the resolution of significant challenges national education systems face (Teo *et al.*, 2018). Nevertheless, many students have voiced dissatisfaction regarding insufficient internet connectivity, which has a detrimental effect on their academic performance (Anwar & Wahid, 2021). Rather than ascribing social change solely to broad concepts such as education, market, and technology, it is necessary to adopt a new collective perspective that explicitly recognises the role of researchers, teachers, and students as the valid drivers of future work (Peters *et al.*, 2019). Formal education needs to adapt to the characteristics of the information age by adopting innovative methods to address the social opportunities and challenges arising from the information revolution. Glassman (2019) argues that digital platforms have the potential to enhance access to information, promote online communities that challenge local norms, and empower individuals by giving them a voice and decentralised power. This involves promoting the participation and involvement of all students, including those in remote areas or facing academic disadvantages. Rural communities encounter challenges related to limited hardware facilities and inadequate internet access, which hinder the establishment and implementation of electronic education (Alabdali *et al.*, 2023; Castillo *et al.*, 2022; Wei *et al.*, 2022). Expanding education can be facilitated by utilising expansive communication facilities like distance education. Nevertheless, the expansion of regional facilities is constrained by their geographical dispersion and distribution, which poses a particular challenge in rural areas (Bozkurt, 2019).

Multiple reasons exist for implementing e-learning in rural areas, such as the insufficiency of secondary school classrooms in specific villages and the geographical distance obstacles (Agbabiaka *et al.*, 2020; Setiawan & Iasha, 2020). Other concerns included transportation issues for attending secondary school classes in different regions (Machado, 2018), limited enrolment in boarding schools (Howley, 2021), and physical disabilities of some students. Additional challenges were early marriages of rural girls (Fitzgerald *et al.*, 2002; Kamal Elden *et al.*, 2019), teacher shortages (Wei, 2022), and local conflicts among neighbouring villagers, which prevented children from continuing their secondary education (Barnes, 2022; Mukuna, 2021). Rural families' businesses also played a role in disrupting education.

However, the use of distance education has helped to a large extent in addressing these challenges and providing education to rural students. Education, being universally applicable, can create a specific direction and guide objectives systematically when pursued with purpose. Consequently, the mental capacities of the villagers have been transformed through motivational training following the optimistic mindset of rural management. This transformation will result in an enhancement of rural areas. It has decreased isolation and promoted open and inclusive education to enhance opportunities in rural areas (Carrete-Marn & Domingo Peafiel, 2023).

The research on e-learning and its impact on rural students has a relatively brief historical background. However, since the onset of the 21st century, there has been a noticeable upward trajectory in the publication of studies related to this subject matter. However, numerous research gaps still can be identified in this area. The study by Hamlin *et al.* (2023) on the academic achievement of students enrolled in virtual schools located in rural regions of Oklahoma from 2016 to 2019 revealed a discernible decline in academic advancement among the participants. The academic performance of students enrolled in virtual schools located in rural areas has declined, particularly in primary schools compared to secondary schools. According to Makalima *et al.* (2023), it was found that stakeholders demonstrate a willingness to engage and make valuable contributions to digital educational platforms. The user prefers a straightforward design that considers their perspectives and input, facilitating their ease of use and utilisation of the designed platform.

Based on research conducted by Carrete-Marín and Domingo Peñafiel (2023), increasing educational outcomes in rural areas requires actively promoting classroom transformation through technology, new learning environments, and resources. In contrast, Xu and Chen (2023) have presented evidence indicating that rural students' utilisation of media technologies to assert their agency and resistance can harm their educational achievement, amplifying the gap between rural and urban

students. As a result, this sustains the system that these students articulate discontent with the adopted approach. Wei (2022) posited that attaining academic success in rural schools is contingent upon various factors that pertain to the fundamental principles of education, the dynamic between teachers and learners, language proficiency in English, and the extent of parental involvement in pedagogy. In contrast, the subjects taught, the work environment, genetic traits, and environmental conditions can significantly influence rural institutions' teaching and learning processes. Sivo et al. (2018) discovered that the constructs of perceived resources, perceived usefulness, perceived ease of use, attitude towards using, behavioural intention to use, and actual system use adequately explained the data in both surveys conducted, thereby providing insights for enhancing students' persistence and retention in online learning courses.

The existing literature suggests an opportunity for more comprehensive research to explore the various dimensions of e-learning, particularly among rural students. Hence, it is imperative to employ bibliometrics to comprehend the publication trends of the nexus between e-learning and rural students. Bibliometric is a precious study tool that empowers researchers to present summaries of significant trending knowledge, ultimately assisting future researchers in exploring a topic more deeply (Abdullah & Abd Aziz, 2021). This paper presents a bibliometric analysis that delves into the landscape of e-learning research focused on rural students, aiming to identify key trends, gaps, and potential avenues for future exploration, ultimately shedding light on the transformative impact of technology-based education beyond traditional classroom settings.

By undertaking this study, the subsequent four research questions will be attained:

1. How has the research on e-learning among rural students evolved?
2. Which publications have the most significant influence on e-learning and rural students?
3. What are the nascent research trends and gaps in the literature on e-learning and rural students?
4. How does the geographic distribution of research on e-learning and rural students vary across countries?

II. MATERIALS AND METHODS

A. Datasets Analysis and Search Strategy

The datasets in this study were analysed using bibliometric analysis methods. Bibliometric analysis is regarded as a method for analysing publication statistics, encompassing statistical values and techniques for visualising information, such as mapping (Abdullah, 2022). Information visualisation is a commonly employed technique for effectively presenting bibliometric data (Abd Aziz *et al.*, 2022). This method enables the comprehension of complex structures and interconnections between multiple documents, which is a challenge for those who wish to investigate a particular topic in depth (Abdullah, 2021). Utilising specialised tools and visualisation techniques that rely on bibliometric data can be instrumental in acquiring a comprehensive understanding of the literature on intricate research topics (Beylik & Palteki, 2022). VOSviewer is a specialised tool designed to assist researchers in processing datasets to conduct bibliometric analyses; that is a freely available software developed by Ludo Waltman and Nees Jan van Eck in 2010 (Abdullah & Aziz, 2022). This software application is utilised to generate and visualise bibliometric networks and enables the creation of maps using network data and facilitates the visualisation and exploration of these maps (Sofyan *et al.*, 2022).

Bibliometric research typically relies on citation and indexing databases, which typically do not retain the original documents but instead store the abstracts and associated keywords. The database is designed to systematically document and evaluate citation statistics, which are essential in scientific discourse, information retrieval, and bibliometrics. Numerous endeavours actively advocate for the widespread adoption of unrestricted and accessible citation data (Lauscher *et al.*, 2018). In this study, Scopus is preferred due to its ability to offer a broader scope of data analysis and more precise results, thereby providing increased utility for academic purposes and citation analysis (Merdan & Etiz, 2022). In addition to the abstract, this repository also references the texts. Hence, it is feasible to compute the number of citations attributed to each article. Initially, a comprehensive search using specific keywords related to e-learning yielded over 100,000 articles. Subsequently, the search was refined by incorporating

additional keywords, such as rural student, resulting in the selection of 282 cases as a representative statistical sample. The search process was conducted without limiting the time frame and languages. Table 1 displays the search string that has been employed. The data were obtained from the Scopus database in a single RIS file format.

Table 1. Keyword searching

Information	Clarification
Retrieval Date	11/07/2023
Database	Scopus
Search Field	Title, Abstract, Keywords
Keywords	("e-learning" OR "online learning" OR "virtual learning" OR "distance education" OR "digital education" OR "blended learning" OR "remote learning" OR "mobile learning") AND ("rural student" OR "rural education" OR "rural school")

III. RESULTS

This section presents the findings relevant to the four research questions outlined in the introduction. The four research questions have guided the analysis to gain insight into the research patterns and trends of e-learning among rural students.

A. How has the research on e-learning among rural students evolved?

The first research question seeks to elucidate the metamorphosis of research on e-learning concerning students from rural areas, as depicted in Figure 1. Also, research question one proffers valuable enlightenment into the current research areas and source titles of the domain (see Table 2 and Table 3). Employing this investigation, scholars can contribute to comprehending the influence of e-learning on rural students and potentially pinpoint areas where further research or interventions may be warranted.

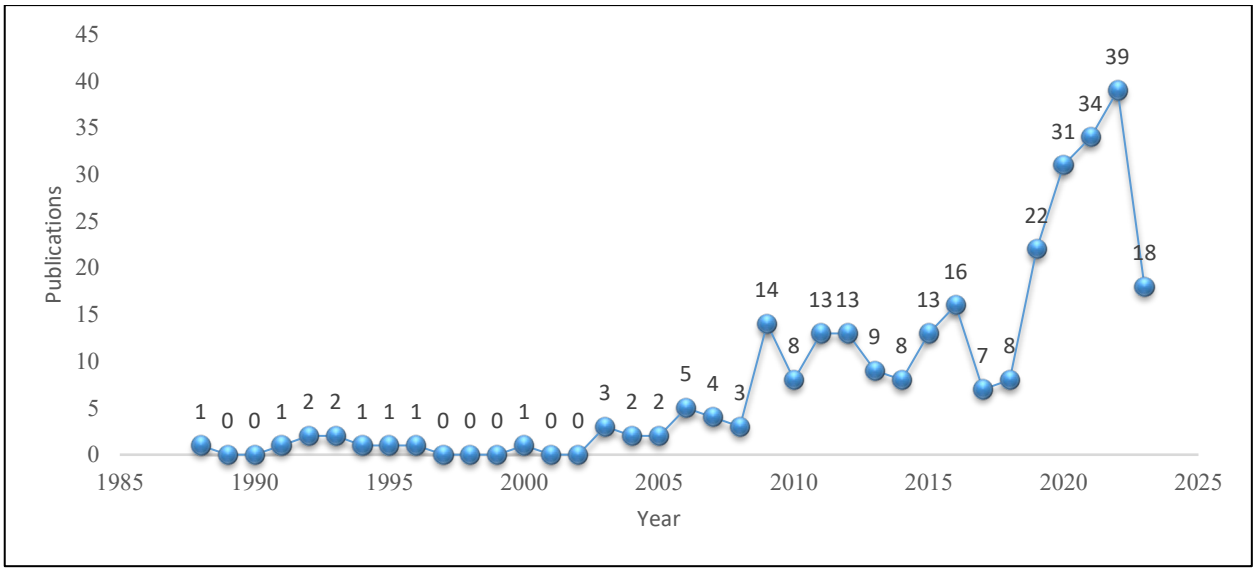

Figure 1. Global trend of publications

Figure 1 describes the overall growth of publications on e-learning among rural students. Notably, investigations on e-learning and rural students have been investigated since 1988, but in the years 1989, 1990, 1997, 1998, 1999,2001, and 2002 there were no articles published. Furthermore, until 2006, the number of articles did not reach five, indicating a period characterised by minimal research activity concerning e-learning among rural students. From 2006 to 2018, the number of articles published with less than 20, and from 2018 to 2023, research on e-learning and rural students gained attention, with more than 20 papers have been published. The number of publications peaked with an average of 39 articles in 2022. Inclusively, there is an upward trajectory in the publication of articles, leading to a positive outlook on this matter.

The interdisciplinary nature of e-learning among rural students is charted in Table 2. Based on Table 2, the field of social sciences was ranked first with 176 articles. The second

field in the ranking pertains to the field of computer science, encompassing a total of 141 articles. This input suggests that the implementation of successful e-learning initiatives in rural areas necessitates addressing challenges such as reliable internet access, electricity, and adapting content to local contexts. These challenges require further research in the field of computer science. The third field comprises 45 articles in the engineering domain, while the fourth field focuses on psychology, encompassing 16 articles. Psychology was notably ranked among the top four disciplines due to its significant contribution to investigating e-learning among rural students. This field of study examines both the mind and behaviour, which mutually reinforce one another in understanding the complexities of e-learning in rural settings.

Table 3 presents the top ten source titles that have conducted research on the topic of e-learning and rural students since the year 1988. The top-ranking category on the list is "Computers and Education", with a total of seven papers, which share the same position as "Distance Education" (7 papers). The lists were followed by "Rural Special Education Quarterly" (6 papers), ACM International Conference Proceeding Series (5 papers), "Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics" (5 papers), and have published more articles with at least three publications. Howbeit, concerning the number of obtained citations, it is depicted that "Education Science" (161 citations), "Computers and Education" (156 citations), "Computers in Human Behavior" (141 citations), "Education and Information Technologies" (139 citations), "Distance Education" (85 citations), and "International Review of Research in Open and distance learning" (75 citations) have garnered the highest number of citations.

Table 2. Top ten subject areas

Subject area	**Documents**	**Percentage (%)**
Social Sciences	177	37.30
Computer Science	142	30.00
Engineering	45	9.50
Psychology	16	3.40
Business, Management, and Accounting	13	2.70
Mathematics	12	2.50
Medicine	12	2.50
Decision Sciences	11	2.30
Arts and Humanities	8	1.70
Physics and Astronomy	7	1.50%

Table 3. Top ten source titles

Source	Documents	Citations
Computers and Education	7	156
Distance Education	7	85
Rural Special Education Quarterly	6	67
Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics	5	4
ACM International Conference Proceeding Series	5	2
International Review of Research in Open and Distance Learning	4	75
Perspectives In Education	4	36
Lecture Notes in Networks and Systems	4	1
Computers in Human Behavior	3	141
Education and Information Technologies	3	139

B. Which publications have the most significant influence on e-learning and rural students?

The second research question examines the consequences of publications on e-learning and rural students. By addressing this research question, scholars can learn about the primary contributions and influential literature in e-learning among rural students. This comprehension can be employed by policymakers, educators, and stakeholders to effectuate well-

informed determinations and conceive efficient e-learning resolutions specifically tailored to satisfy the unique demands of students in rural areas.

Table 4 displays a compilation of seven papers that have garnered significant attention, each having received a minimum of four citations. On top of the list was an article by Hannum *et al.* (2009) discussing the topic of "distance education use in rural schools". Hannum *et al.*'s (2009) study covers the use of distance education in rural schools, which frequently suffer from infrastructure and geographic limitations. The study demonstrates how, despite obstacles including inadequate internet connectivity, technical assistance, and insufficient teacher preparation, technology may provide access to high-quality education in rural locations. The study also discovered that to optimise the advantages of remote learning in rural schools, teachers should receive more training and improve the technology infrastructure. Students can also profit from taking courses that are not offered locally.

The academic work by Dube (2020) holds the second-highest number of citations. In a scholarly article, Dube (2020) analysed the implementation of online learning in rural areas of South Africa during the COVID-19 pandemic, focusing on promoting inclusive education. The second-ranked position was shared with a paper written by Hobbs (2004) titled "The Promise and the Power of online learning in Rural Education". Notably, the publications in Table 4 garnered considerable citation counts and noteworthy attention from the scholarly community, underscoring their impact on electronic learning and rural education. These papers delve into various topics, including but not limited to web-based instruction, all-encompassing learning, instructor retention, institutional overhaul, and the predicaments confronting rural schools. Scholars, legislators, and educators frequently allude to these seminal works to shape their practices, policies, and future research endeavours within this domain.

Table 4. The most cited references

Author	Title	Source	Citations
(Hannum *et al.*, 2009)	"Distance education use in rural schools."	Journal of Research in Rural Education	12
(Dube, 2020)	"Rural online learning in the context of COVID-19 in South Africa: evoking an inclusive education approach."	Multidisciplinary Journal of Educational Research	6
(Hobbs, 2004)	"The promise and the power of online learning in rural education."	ERICV Hobbs Rural School and Community Trust	6
(Barbour & Reeves, 2009)	"The reality of virtual schools: a review of the literature."	Computers and Education	5
(Hobbs, 2004)	"Learner-centred psychological principles: a framework for school reform and redesign"	ERICV Hobbs Rural School and Community Trust	5
(Moore & Kearsley, 2011)	"Attracting and retaining teachers in rural areas."	Belmont University	5
(Jimerson, 2006)	"Breaking the fall: cushioning the impact of rural declining enrolment."	Rural School and Community Trust	4

C. What are the nascent research trends and gaps in the literature on e-learning and rural students?

Research question three aims to identify new trends, gaps in the literature, and domain-specific issues that need more study concerning e-learning and rural students. Thus, addressing this issue can develop e-learning solutions for rural students and close the educational gap between urban and rural areas. Utilising VOSviewer for mapping analysis can comprehensively comprehend the relationships and patterns among author keywords in research related to e-learning and rural students. The visualisation depicted in Figure 2 illustrates the overlay of authors' keywords co-occurrence, considering a minimum keyword occurrence of five. As a result, among the 826 keywords, 24 of them have met the threshold criteria.

According to the data presented in Figure 2, the keywords "education", "ICT", "rural school", "rural students", "online education", "online learning", "remote learning", "pandemic", "COVID-19", and "digital divide" have been observed to trend after 2018. The keyword "online learning" appears closely linked to "educational technology" and "blended learning". Online learning extensively depends on

using educational technology to disseminate educational information via digital platforms and applications. Educational technology comprises a wide range of software, applications, and digital resources that are utilised to aid and augment learning. Blended learning, a pedagogical approach incorporating both online and face-to-face training, also depends on educational technology to effectively merge these learning modalities among rural students.

Several noteworthy new themes are emerging from research on e-learning for students in rural locations. The primary issues frequently brought up are the constraints of the technology infrastructure, namely inconsistent and sluggish internet connectivity and the supply of suitable devices. This study trend also emphasises the significance of promoting digital inclusion, whereby e-learning platforms are created to meet rural students' low digital literacy and technological constraints. Additionally, as infrastructural issues and a lack of social support impact students' engagement, attention is focused on student motivation and retention in online learning. One possible way to close these disparities is through community-based approaches in which families, teachers, and students collaborate.

While these developments are encouraging, the literature still has significant holes. For instance, more research is still needed on particular and efficient instructional strategies for pupils in rural regions. Additionally, research does not thoroughly examine the function of local communities and parents—frequently more critical in rural than metropolitan areas. Moreover, little research has been done on the long-term effects of e-learning on the socioeconomic advancement of rural pupils. These results indicate that e-learning in rural areas has much potential. Still, a more contextual and cooperative strategy involving many stakeholders, including the Government, educational institutions, local communities, and technology suppliers, is crucial to its success.

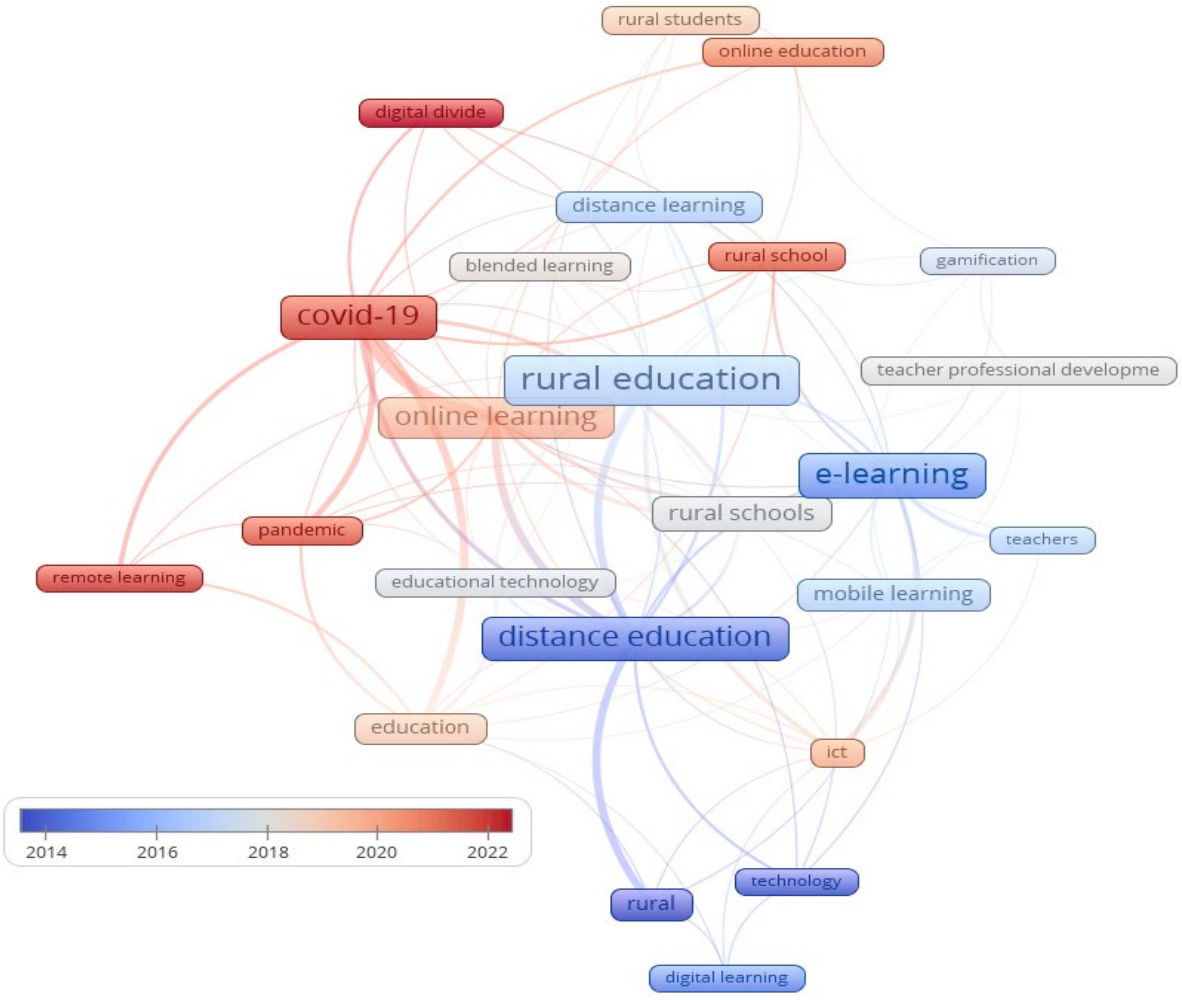

Figure 2. Overlay visualisation of the keywords

D. How does the geographic distribution of research on e-learning and rural students vary across countries?

The geographical distribution of research about e-learning and its impact on rural students exhibits considerable variation across different countries. Adopting a comprehensive strategy encompassing various aspects is essential to effectively tackle the disparities in research productivity. This includes fostering collaboration among researchers, appropriately allocating resources, and undertaking initiatives to enhance research awareness and capacity building in regions with limited output in this field. Figure 3 presents data indicating the number of countries that have published articles on e-learning initiatives targeted at rural students. The United States of America has the highest number of publications, with 63, followed by China with 40 publications, South Africa with 27 publications, India with 22 publications, and Australia with 17 publications.

Based on the findings, it can be concluded that there is a clear correlation between the dissemination of e-learning research articles and the level of technological advancement and accessibility of infrastructure in different countries. The United States, China, and Australia are renowned for their robust technological infrastructure, extensive internet connectivity and digital device penetration. Consequently, these countries have successfully facilitated the implementation of e-learning initiatives, even in remote rural regions. A confluence of technological infrastructure, educational investment, research funding, policy agendas, population size, and culture influences the allocation of e-learning research papers among various countries.

Considering their robust technological infrastructure and extensive internet access, it is not unexpected that industrialised nations like the United States, China, and Australia produce most articles on rural e-learning. More intriguing, though, is the inclusion of growing nations like Malaysia and Thailand on this list. With Government programs like the "Malaysia Education Blueprint" and the "Thailand 4.0" project, which concentrate on expanding access to digital education in remote areas, both countries have created notable publications on rural e-learning. Their commitment to using technology to close the education gap between urban and rural communities is seen in these policies.

Malaysia and Thailand have been prosperous in this field due mainly to supportive regulations, increased access to technology in rural areas, and international collaboration. Despite ongoing infrastructure constraints, both nations have sought to expand telecommunications networks and deliver digital gadgets to distant regions. By collaborating with international research organisations, researchers from both countries can publish more and better works and offer significant insights into how e-learning might raise the standard of education in rural areas.

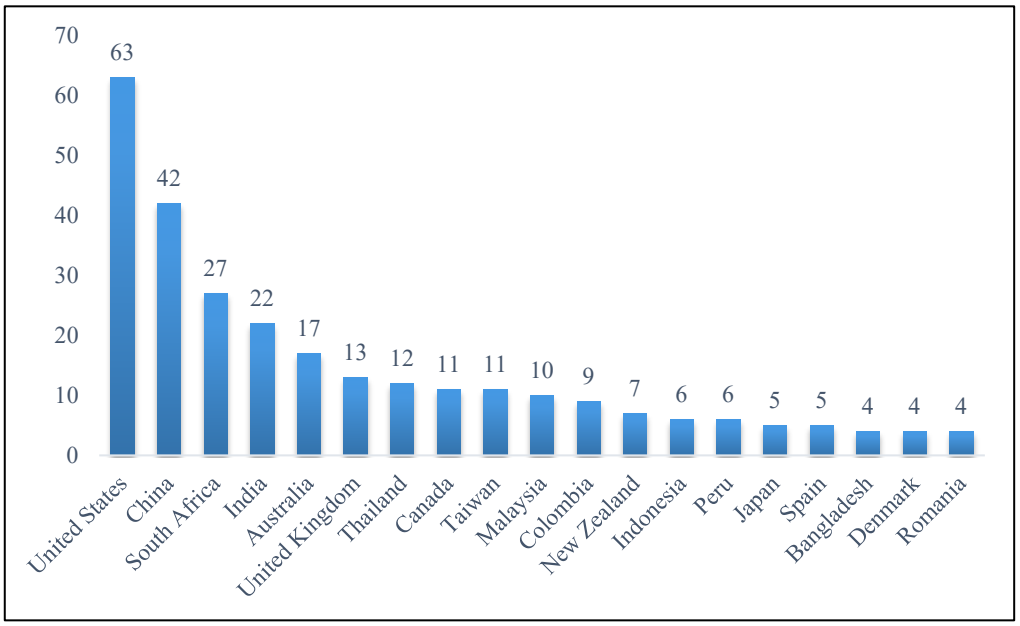

Figure 3. Active countries

IV. DISCUSSION

The results of the bibliometric analysis on e-learning and rural students offer significant contributions to the body of knowledge and practices in this research area. The study addresses four research questions, each shedding light on different research trends and patterns in e-learning among rural students.

The first research question delves into the research growth on e-learning among rural students. The level of research activity was limited prior to 2006; however, there has been a steady increase in published articles (see Figure 1). E-learning publications among rural students have increased, especially after 2018. This increase is likely due to technological advances, awareness of educational inequity, and the urgent need for alternative learning platforms, especially during the COVID-19 pandemic. The pandemic spurred online learning, driving educators and academics to find digital solutions for neglected rural communities. However, low research effort (1988–2006) suggests a lack of attention to rural e-learning, reflecting global academic discourse's systemic neglect of rural education challenges. After 2018, publications increased, peaking in 2022, demonstrating e-learning's capacity to close educational disparities. This growth also suggests that future research should optimise e-learning practices for rural students, who often face challenges like limited infrastructure and socio-economic barriers.

The increasing trend observed here indicates the significance and pertinence of e-learning in the context of rural education. This pattern is potentially corroborated by the assertion made by Stecuła and Wolniak (2022) that individuals with a strong familiarity with information technology and a keen interest in innovative e-learning tools are more likely to experience a higher level of ease when acquiring content through e-learning platforms, which prompted further research on this topic. Also, this observation suggests that the growing accessibility and cost-effectiveness of technology, such as internet connectivity and digital devices, have played a significant role in enabling the growth of e-learning initiatives (Salloum *et al.*, 2019). With the increasing accessibility of technology, researchers and educators are now more equipped to thoroughly investigate its potential to enhance educational outcomes for students residing in rural areas (Bianchi *et al.*, 2022).

The interdisciplinary nature of e-learning among rural students is highlighted, with social sciences and computer science emerging as the leading fields of study. This suggests that successfully implementing e-learning initiatives in rural areas requires addressing technological challenges and understanding the social contexts in which these interventions are deployed. Rural student e-learning publications have increased, especially after 2018. Technology, educational inequity awareness, and the necessity for alternative learning platforms, notably during the COVID-19 pandemic, may explain this growth. Online learning increased during the pandemic, encouraging educators and academics to find digital solutions for disadvantaged rural areas. Early years of little research effort (1988–2006) imply a lack of attention to rural e-learning, reflecting worldwide academic discourse's systemic neglect of rural education challenges. Publications increased post-2018, peaking in 2022, indicating e-learning's potential to close educational gaps. This growth suggests that future research should optimise e-learning practices for rural students, who often face challenges like limited infrastructure and socio-economic barriers.

The current study reveals the progression of e-learning implementation among rural students, highlighting significant milestones, such as the introduction of distance education tools, advancements in technology infrastructure, and the rapid adoption of virtual education due to the pandemic. Government responses to the pandemic and the potential for improving education are essential factors in this context. The findings indicate that the notable increase in the diffusion of this field began in 2006, which can be attributed to two main factors: the characteristics of distance education (Wei, 2022) and the more tremendous advantages that villages derive from the internet and digital devices (Pargman et al., 2016). The significant increase in publications is primarily attributed to the past three years, which can be linked to the COVID-19 disaster.

The second research question focuses on identifying influential publications in the field. By pinpointing the most cited papers, the study aids researchers, educators, and policymakers in understanding the pivotal contributions to the field. These highly cited articles serve as foundational resources for shaping policies, practices, and future research

endeavours in e-learning and rural education. This study emphasised that an article by Hannum *et al.* (2009) discussing distance education use in rural schools was first ranked among the most cited publications. The academic work by Dube (2020) authored holds the second-highest number of citations. These papers delve into various topics, including but not limited to web-based instruction, all-encompassing learning, instructor retention, institutional overhaul, and the predicaments confronting rural schools. Scholars and educators frequently allude to these seminal works to shape their practices, policies, and future research endeavours within this domain.

Bibliometric analysis can identify the top source titles consistently producing high-quality research in e-learning and rural education. This analysis contains data on the journals, authors, and organisations that publish on the topic. It also highlights the most referenced articles, which can point to authoritative sources. A study, for example, examined the scientific production of e-learning in journals indexed on Elsevier's Scopus and discovered that publishing rates are increasing (Sobral, 2021). Another study depicted the network of prominent authors, organisations, sources, and countries dedicated to online learning throughout the epidemic, which might serve as valuable references for scholars and practitioners (Yu, 2022). Furthermore, PubTrends was created to examine the intellectual structure of a research field and provide insights into influential authors, journals, and subjects (Shpynov *et al.*, 2021). By employing these resources, scholars and researchers can conveniently obtain relevant literature and stay current on the latest breakthroughs and findings in e-learning and rural education.

The third research question explores emerging trends and gaps in the literature. The visualisation of author keywords highlights keywords that have gained prominence in recent years, such as “online learning”, “remote learning”, and “digital divide”. These trends reflect the changing landscape of education, especially with the onset of the COVID-19 pandemic, which emphasises the importance of online and remote learning. Addressing these trends and gaps can aid in designing effective e-learning solutions tailored to rural students’ needs. Recent research trends revolve around "online learning," "pandemic," "digital divide," and "educational technology," which are significant themes in rural e-learning discourse. Using terminology like "COVID-19" implies that the epidemic affected current research, pushing a re-evaluation of traditional education approaches and highlighting e-learning. More concepts like "blended learning" indicate a growing understanding that a hybrid model may work better in rural areas, where face-to-face instruction is valuable but may be supplemented by online technologies. Despite these good tendencies, literature gaps exist. Local communities and families promote rural e-learning, although more needs to be studied. Rural life is generally communal. Thus, additional research is required to determine how these support networks can improve e-learning. E-learning's long-term socio-economic effects on rural students, such as employment chances and community development, still need to be discovered. These gaps indicate the need for interdisciplinary approaches considering educational outcomes and social and economic aspects of rural e-learning.

These trends reflect the changing landscape of education, particularly with the COVID-19 pandemic, which has highlighted the importance of online and remote learning (Razzaque & Hamdan, 2020). By exploring these trends and gaps, researchers can identify rural students’ specific challenges and develop strategies to bridge the digital divide and ensure equitable access to education (Roy *et al.*, 2021). This can involve addressing issues such as lack of infrastructure, low IT skills, self-disciplinary, content, policy, and social issues (Koi-Akrofi *et al.*, 2020). Additionally, future research can focus on specific e-learning situations, readiness, and adaptability through interdisciplinary empirical studies.

The fourth research question analyses the geographic distribution of research across different countries. The findings showcase that countries with advanced technological infrastructure tend to produce more research articles in this domain. This correlation between research output and technological advancement emphasises the role of infrastructure in enabling e-learning initiatives. However, addressing the digital divide and ensuring equitable access to quality education for rural students in less technologically developed regions is also essential. The most productive country in this study is the United States of America (63

cases), followed by China (40 cases), and South Africa (27 cases), which had the highest number of publications. African, European, and Latin American countries are on the sidelines, and Asian countries play an interactive role. One of the reasons for this can be the attention and tendency of Southeast Asian countries in recent decades to public education, along with rural education, and the presence of a larger rural population than in European and Western countries.

These countries have robust internet connectivity, educational investments, and digital education policies. Government-led initiatives to enhance rural education access through technology have also boosted research production in rising economies like Malaysia and Thailand. They demonstrate the necessity of political will and tailored policies in rural e-learning research and practice. These countries address educational inequality digitally despite infrastructure issues, showing how supportive Government and international engagement can lead to tremendous progress. The data also imply that rural e-learning research is scarce in many developing nations, particularly Africa and Latin America. To spread the benefits of e-learning worldwide, research capacity and international relationships must be increased. With initiatives to improve research and practice in these locations, rural kids in more technologically advanced areas can stay caught up.

According to Statista (2023d), the proportion of the global population residing in rural areas has declined from over 50% in 2007 to approximately 43% in 2021. The topic of interest pertains to the United States. According to Statista (2023e), the United States had an estimated rural population of roughly 57.47 million individuals, accounting for 18% of the total population in 2020. In contrast, the urban population was approximately 274.03 million individuals. Furthermore, China undoubtedly, one of the factors that made China rank second in the number of articles is its rural population, which will make up 30% of its population in 2022. Although according to the World Bank, the proportion of the Chinese population residing in urban areas was only 19.4% in 1980. Subsequently, China's urban population has experienced a significant and rapid increase (Statista, 2023b). As of December 2022, the internet users in China's rural areas amounted to around 308 million, accounting for 28.9% of the total online population in the country (Statista, 2023a). According to Jialing (2018), the Chinese central government allocated 10 billion yuan between 2004 and 2007 to construct and refurbish rural schools in the central and western regions of the country. According to the World Bank (2023), the percentage of the population in this country is projected to be 32% in 2023. The Department of Basic Education (DBE) has significantly contributed to the change and transformation of the rural education system in the nation. The Department of Basic Education (DBE) has successfully conducted a computerisation initiative to provide technological infrastructure to schools in rural areas. This initiative aims to enhance the presence of computers in rural educational institutions by establishing intra- and inter-departmental connections that facilitate efficient access to information communication technology (ICT). A comprehensive strategy has been devised, encompassing various aspects such as curriculum integration, teacher training, human resource allocation, and infrastructure development (Gina, 2015). In India, more than 909 million (34 %) people resided in rural areas in 2021, an increase compared to 2018 (Statista, 2023c). Nevertheless, there is no significant activity of researchers in this country.

V. CONCLUSION

The results of this study significantly contribute to understanding e-learning's impact on rural students. The findings offer insights into the historical growth, influential publications, emerging trends, and global distribution of research in this field. These insights can guide further research, policy formulation, and the development of effective e-learning strategies to bridge the educational gap between urban and rural areas.

This study adds to the literature on rural student e-learning by exposing rising research trends, key publications, and study gaps. From the late 1980s until the early 2000s, e-learning research paused. The frequency of articles increased significantly after 2018, demonstrating a growing awareness and attention to e-learning's role in alleviating rural educational gaps. Technological advances and the COVID-19 epidemic reinforced the significance of virtual education in remote locations.

This study also shows that e-learning is interdisciplinary, with social sciences, computer science, and psychology leading in identifying and addressing rural student difficulties. Cross-disciplinary collaboration is needed to build more accessible e-learning systems for technology infrastructure, teacher training, and local content adaptation. This study also highlights some critical gaps in the literature, including the need for in-depth studies on effective rural learning strategies, local community support for e-learning, and the long-term effects of digital learning on rural students' socio-economic development. This study suggests new research directions to address the urban-rural schooling gap. This study provides a comprehensive picture of rural students' e-learning development and challenges. It opens the door to more contextual and collaborative research involving government, educational institutions, local communities, and technology providers.

Based on four main research questions, 35 years of research in this field provides us with valuable information:

1. The trend of publishing articles has been on the rise since 2006, and 2022 had the highest number of articles, with 39. The field of the study depicted those social sciences published 176 articles and computer science 141 articles, which had a dominant aspect. The results of source titles explicitly rendered that Computers and Education issued seven papers, Distance Education with seven papers; they seem to have a high impact on the development of information about the latest data in this field which also shows the dominance of British magazines in the publication of this field.
2. On the top of the list was an article by Hannum et al. (2009) discussing distance education use in rural schools. The academic work by Dube (2020) authored holds the second-highest number of citations were prolific authors.
3. The keywords “education”, “ICT”, “rural school”, “rural students”, “online education”, “online learning”, “remote learning”, “pandemic”, “COVID-19”, and “digital divide” have been observed to trend after 2018.
4. The United States of America, followed by China and South Africa, were the most productive countries. Asian countries have performed well and are different from other countries in this respect. The United States of America and China are mediators between all countries and play a central role in the research system. According to the average publishing year, Malaysia, Peru, and Colombia are newbies in this field.

One possible downside of this study is the reliance on papers indexed in the Scopus database, which could introduce publication bias. Therefore, including publications from databases other than Google Scholar may be omitted from the analysis, potentially introducing bias to the findings.

Examining bibliometrics can reveal hidden and underappreciated aspects, illuminating promising avenues for future scholarly exploration. This study suggests an exciting opportunity to explore additional scientific databases, such as the Web of Science (WOS) and Google Scholar, alongside the citation database Scopus. By doing so, we can further enhance the comprehensiveness and robustness of our research findings. Furthermore, conducting comparative studies across different countries and regions to identify cultural factors that positively influence the success of e-learning initiatives in rural settings is highly valuable for future researchers to prioritise. Moreover, it is crucial to prioritise assessing the positive impact of e-learning on student engagement, motivation, and learning outcomes in rural settings for future research endeavours.

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VII. CONFLICT OF INTEREST

All authors declare that they have no conflicts of interest with anyone or any funder.

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