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ESL Students' Technical Challenges in Web-Based Learning: A Bibliometric Analysis

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Abstract. Web-based learning has transformed the educational environment in recent years. A key question that requires specific contextual answers is how technological advancements have influenced teaching and learning practices in language education across all levels. Consequently, research underscores the need for ongoing investigations to help discover solutions and prevent pedagogical issues resulting from technological factors. Therefore, this study aimed to identify the most used relevant terms and recurring topics regarding the technical challenges of English as a Second Language (ESL) students in web-based learning and their frequency over time. The study focused on a 10-year bibliometric analysis of 19,725 research articles on the technical challenges of ESL learners in the web-based learning environment. The analysis used "ESL learners", "technical challenges", and "web-based learning" as keywords. An internet-based search was performed to locate recent and relevant articles published between 2014 and 2024 from the Web of Science database. The findings revealed contributions from 41,124 authors. A total of 5,771 of these documents were single-authored. On document featured 2.85 co-authors, average, each suggesting collaborative efforts among researchers. In particular, 21.72% of these documents were internationally co-authored, which reveals a degree of global collaboration. The analysis also showed sustained interest in issues regarding foundational language learning among ESL students, with a significant focus on key terms such as "language", "English", and "acquisition". The emerging trends highlighted the increased relevance of learner engagement and artificial intelligence. This study could direct future research in exploring dominant themes to help educators and researchers develop effective instructional strategies to enhance the learning experiences of ESL students in digital environments.

Keywords: bibliometric analysis; English as a second language; learner engagement; technical challenges; web-based learning

1. Introduction

Education is crucial in human development, encompassing morals, values, beliefs, creativity, innovation, and talent. Advancing education contributes to sustainable development (Nasri, Husnin, Mahmud, & Halim, 2020). However, significant concerns have arisen regarding how web-based educational practices can be implemented across all levels. A key question that requires specific contextual answers is how technological advancements have influenced teaching and learning practices (Al Arif et al., 2024; Onojah & Onojah, 2020; Wen & Kim Hua, 2020). This inquiry underscores the need for ongoing research to help find solutions and prevent pedagogical issues resulting from technological factors. Consequently, this area has become a promising avenue for pedagogical research, particularly regarding second language teaching and learning. This renewed focus is accompanied by a keen interest in understanding the circumstances and methods through which technology affects the conduct of educational activities and students' academic achievements.

The outbreak of COVID-19 was a significant factor that augmented the implementation of web-based learning across the globe as governments implemented the movement control order. This condition resulted in the immediate closure of schools and universities. Consequently, teaching and learning were "instantaneously transformed into distant and remote formats" (Nasri et al., 2020, p. 546). Following this, teaching and learning shifted to the online environment, using pedagogical tools such as Webex, Zoom, and Google Classroom to ensure the continuity of pedagogical activities (Bunyan, 2020; Wen & Kim Hua, 2020).

Web-based learning has transformed the educational environment, particularly English as a Second Language (ESL). As institutions increasingly adopt online platforms to facilitate learning, ESL learners face unique technical challenges that can impede their language learning success. These challenges are particularly pronounced among ESL learners, especially those who may not have equal access to reliable internet connections or the modern devices that are necessary for effective online language learning (Zhang, 2022). Additionally, varying levels of digital literacy among students can exacerbate these issues, as some students may struggle to navigate online platforms effectively. Addressing these technical barriers is crucial for creating an inclusive learning environment to support students in achieving positive learning outcomes.

Additionally, language learning inherently requires interaction to facilitate effective communication, practice, and social engagement. However, web-based learning environments may limit these opportunities for ESL learners. Hence, while web-based tools offer flexibility and accessibility, they may inadvertently hinder the collaborative and interactive aspects that are essential for language acquisition. As web-based learning becomes critical, researchers have investigated technical challenges in English learning practices (Aiju & Abdullah, 2024; Clement & Yunus, 2021; Karuppannan & Mohammed, 2020; Wen & Kim Hua, 2020). Therefore, this study focused on a bibliometric analysis to examine the research trends over the 2014–2024 decade regarding the technical challenges

of ESL learners. This focus could be valuable in revealing how research on the technical challenges of ESL learners has evolved. Additionally, understanding trends in the research context could provide insights into emerging issues and shifts in research focus to help determine the direction of future research. Specifically, the analysis aimed to achieve the following objectives.

- 1. To identify the most used relevant terms for the technical challenges of ESL students in web-based learning and their frequency over time.
- 2. To ascertain the recurring topics and trends in research regarding the technical challenges of ESL students in web-based learning over time.

2. Benefits and Technical Challenges in Web-Based ESL Education

One of the most contentious areas of growing interest is the field of web-based learning and its associated benefits and challenges (Abd Rahman & Razali, 2024; Aiju & Abdullah, 2024; Baber, 2020; Du et al., 2022; Krishnan et al., 2020). Recently, studies have focused on how online technologies are applied in ESL teaching and learning. The studies employed various research approaches, including surveys (e.g., Al Arif, Kurniawan, & Handayani, 2024; Wen & Kim Hua, 2020), interviews (e.g., Abd Rahman & Razali, 2024), literature reviews (e.g., Aiju, & Abdullah, 2024; Karuppannan & Mohammed, 2020), and mixed methods (e.g., Clement & Yunus, 2021). The findings illustrate how ESL instructors and students perceive, adopt, and use web technologies. For example, Onojah and Onojah (2020) examined the role of online technologies in addressing the learning gaps created by COVID-19 and students' willingness to engage with these technologies. The study concluded that tools such as Google Classroom, Zoom, and mobile learning can enhance students' academic performance and improve teachers' job effectiveness.

Moreover, Krishnan et al. (2020) employed quantitative and qualitative approaches to explore the perceived usefulness of online resources among pre-elementary intensive English students. According to the findings, online resources are perceived to be valuable tools for learning English, especially reading, conversation, and vocabulary development. As a result of the shift of educational activities toward the online environment, some studies have focused on the perceived quality of teaching and learning outcomes. For example, Baber (2020) examined the determinants of perceived learning benefits and their impact on learners' satisfaction among undergraduates in India and South Korea. The study found that interaction, course structure, teachers' knowledge, resources, and motivation positively influence students' perceived learning outcomes and satisfaction. Similarly, another study established that learners' attitudes and experiences are likely to have contributed moderately to the success of the "transition from face-to-face to online learning" (Johnson et al., 2021, p. 1).

The literature, however, highlights the significant challenges that ESL learners face in a web-based environment. In this regard, Hassan et al. (2021) explored the challenges and benefits of Web 2.0-based learning among international students in Cyprus. According to the findings, students face challenges such as a lack of engagement and technological barriers. Similarly, Wahas (2023) conducted a case study that identified the various difficulties that ESL learners encountered, including technological barriers, lack of social interaction, and decreased

motivation, and these hindered their language acquisition during web-based learning. In addition, Sornasekaran et al. (2020) proposed a conceptual framework that addresses the specific challenges associated with web-based learning among ESL undergraduates in Malaysia. The research outlines factors that contribute to the challenges faced by students in adapting to web-based learning, such as inadequate access to technology and insufficient instructional support.

The technical challenges ESL learners face in web-based environments have been extensively documented in recent literature, revealing a complex interplay of factors that hinder effective language acquisition. Sornasekaran et al. (2020) outlined a conceptual framework that identifies key obstacles such as inadequate technological infrastructure, limited digital literacy among students, and the lack of interactive learning experiences, all of which contribute to the difficulties students encounter in Malaysia. Ying et al. (2021) added to this discourse by revealing how the abrupt shift to e-learning necessitated the integration of social media and video-conferencing tools. In this situation, many learners struggled with speaking skills due to anxiety and lack of confidence in virtual settings. Wahas (2023) further emphasized these challenges during the COVID-19 pandemic, highlighting issues such as reduced social interaction and engagement. The foregoing studies underscore the pressing need for targeted interventions to address the technological barriers that ESL learners face in online environments.

Furthermore, Aljuaid (2021) examined the difficulties encountered in English language courses via platforms such as Blackboard at Saudi universities. In addition to identifying challenges, recent research also points toward potential opportunities for enhancing ESL learning through technology. Hanafiah and Aziz (2022) reviewed the literature and highlighted innovative pedagogical approaches that could improve language mastery despite existing obstacles. They argue that while challenges persist, integrating technology offers unique opportunities for personalized learning experiences and greater accessibility to educational resources. Aljuaid's (2021) study suggested that training for instructors and students on these technologies could mitigate some of the identified challenges. These findings illustrate that understanding the multifaceted nature of technical challenges can inform future research and pedagogical practices and enhance ESL education in web-based environments. By addressing the challenges and opportunities presented by technology, educators can better support ESL learners in achieving their language acquisition goals.

Additionally, previous studies have explored the factors and perceived usefulness of web technologies among ESL learners. For instance, Karuppannan and Mohammed (2020) investigated the factors affecting web-based learning among English language learners in Malaysia. According to the study, there is increasing concern over web-based ESL learning, particularly regarding language proficiency. In summary, previous studies have focused on various aspects regarding web-based technical challenges in ESL education, including access to resources, infrastructure, and technological competence. Technical challenges in the learning process have always been a major priority (Baber, 2020) and thus, researchers have keenly explored how educational activities are conducted in the web-based learning environment (Baber, 2020; Krishnan et al., 2020; Wen & Kim Hua, 2020). Hence, to investigate this research context more comprehensively, this study focused on a bibliometric analysis of 19,725 studies regarding technical challenges in ESL learning.

2.1 Pedagogical Impact of Web-Based Learning in the ESL Context

Web-based learning has emerged as a transformative force in ESL education (Dewi et al., 2024). Recent studies have demonstrated how this advancement influences ESL pedagogical practices across various language skills such as grammar, speaking, reading, and writing (e.g., Ahmadnejad et al., 2024; Dewi et al., 2024; Jassni et al., 2024; Yazid et al., 2024). For instance, Yazid et al. (2024) conducted a systematic review that examined the intersection of web-based learning, particularly grammar, and digital pedagogies. The outcomes suggest that web-based learning can enhance grammar education. According to the findings, while digital tools can facilitate language acquisition, educators must adapt effective teaching strategies to engage students and address specific learning needs.

Moreover, Mohammed and Yaakoub (2024) employed a qualitative method to explore how web-based technologies improve students' speaking skills in Algeria. The findings indicated that web-based learning enhances speaking proficiency. However, the study highlighted concerns regarding technical challenges and the need for adequate training. Similarly, Dewi et al. (2024) emphasize that web-based learning is crucial for ESL education. Their study underscores the importance of understanding learners' experiences and attitudes toward technology to foster effective language learning environments.

Furthermore, Jassni et al. (2024) investigated how web-based technologies contribute to the development of 21st-century skills among ESL learners in Malaysia. The findings showed that web-based learning enhances language proficiency and fosters critical thinking and collaboration skills that are essential for success in the digital world. Likewise, Ahmadnejad et al. (2024) examined the effect of Web 2.0 technologies on language achievement and self-regulated learning among English learners. The findings indicate that these technologies significantly improve student engagement and motivation. The study also highlighted the importance of incorporating user-friendly digital tools into language curricula. Additionally, Hassan et al. (2023) employed a cross-sectional survey to examine ESL undergraduates' engagement with web-based tools at a Malaysian public university. According to the findings, web-based tools facilitate active participation and improve ESL students' language skills.

In essence, previous research findings illustrate that while web-based learning offers substantial benefits for ESL education, certain challenges must be addressed through effective pedagogical strategies. This outcome suggests the need for ongoing research to explore innovative approaches that enhance instructional practices and learner outcomes in web-based learning environments. Therefore, the current study focused on a bibliometric analysis to

explore research trends regarding ESL students' technical challenges and to suggest proactive measures and future research directions.

3. Methodology

3.1 Search Procedure and Inclusion Criteria

A bibliometric analysis of 19,725 research articles on the technical challenges of ESL learners in the web-based learning environment was conducted. The rationale for choosing a bibliometric analysis lies in its ability to analyze a large number of documents systematically to identify trends, patterns, and gaps (Ab Rashid, 2023). Previous studies have successfully employed bibliometric analysis (e.g., Chen, 2023; Bulut et al., 2023; Levidze, 2024). This bibliometric analysis was envisaged to uncover trends regarding the technical challenges of ESL students and to determine critical areas requiring attention. The bibliometric analysis sought to suggest future research directions by identifying underexplored topics.

An internet-based search was performed to locate recent and relevant articles published between 2014 and 2024. The search keywords included "ESL learners", "technical challenges", and "web-based learning. These keywords were selected based on their relevance to the study's focus since they reflected the primary themes in the literature regarding ESL education in digital contexts. Additional words such as "ESL students" and "technical issues" were considered during the preliminary searches to ensure comprehensive coverage.

Criteria	Inclusion	Exclusion		
Population	ESL learners in various	Non-ESL learners or studies		
	educational settings	not focused on ESL		
Publication Type	Empirical and review articles	Opinion pieces, editorials,		
		conference abstracts		
Language	Articles published in English	Articles published in		
		languages other than English		
Timeframe	Studies published between	Studies published outside		
	2014 and 2024	this timeframe		
Focus Area	Technical challenges in web-	Studies not addressing		
	based learning environments	technical challenges		

Table 1: Inclusion and exclusion criteria

As shown in Table 1, only empirical and review articles focusing on the technical challenges of ESL learners and published in English within the mentioned period were considered for analysis. The articles were collected from the Web of Science database. This is because relevant, reliable, and up-to-date information can be sourced from this database. The Web of Science database has extensive coverage and rigorous indexing criteria that ensure high-quality peer-reviewed literature that is relevant to ESL learning research. These potentials made the chosen database an ideal resource for collecting relevant documents for bibliometric analysis. The literature search was inclusive within the data pool consisting of empirical and review papers from various academic research journals. The following figure depicts information on the article selection process.



Figure 1: Search procedure

Figure 1 shows that the search process commenced with an initial open search that yielded 306,138 articles. A subsequent refinement specifying the period of 2014 to 2024 resulted in 230,328 articles. Further narrowing down the results to include only empirical and review papers led to 183,819 articles. Additionally, applying discipline-specific filters reduced this number to 20,166 articles. Finally, excluding articles published in languages other than English resulted in 19,725 articles being considered for analysis. This systematic approach ensured that the selected literature was both relevant and focused on the technical challenges faced by ESL learners in web-based learning environments.

3.2 Analysis Procedure

A quantitative analysis of 19,725 documents was conducted using RStudio software, which facilitated a comprehensive bibliometric evaluation of research trends regarding the technical challenges faced by ESL learners. The research systematically quantified trends, patterns, and relationships within the literature. The data were initially imported into RStudio. Subsequently, various bibliometric packages were used to generate descriptive statistics to assess publication trends, citation counts, and author contributions over the specified period of 2014 to 2024. This technique helped to generate key metrics such as annual growth rates and

co-authorship patterns (Ab Rashid, 2023; Bhat et al., 2023). Additionally, term frequency analysis was performed to identify and quantify recurring themes in the literature. This systematic approach provided insights into critical areas that required further exploration.

4. Findings

The analysis included contributions from 41,124 authors. A total of 5,771 of the documents were single authored. On average, each document featured 2.85 co-authors, suggesting collaborative efforts among researchers. In particular, 21.72% of these documents were internationally co-authored, which reveals a degree of global collaboration. These data provide a comprehensive overview of the research context and collaborative publications over the specified period.

SN	Description	Results
1	Timespan	2014-2024
2	Documents	19,725
3	Annual growth rate (%)	-46.31
4	Authors	41,124
5	Single-authored documents	5,771
6	Co-authors per documents	2.85
7	International co-authorships (%)	21.72
8	Average citations per document	9.765

Table 2: Main information of the data

As shown in Table 2, the bibliometric analysis spanned the decade of 2014 to 2024 and consisted of 19,725 documents related to the technical challenges of ESL students in web-based learning. Each document averaged approximately 9.765 citations, which shows a moderate impact within the academic community. The dataset revealed a significant annual growth rate of -46.31%, indicating a decline in the volume of published research in recent years. This decrease in research on ESL technical challenges may stem from a shift in focus toward other emerging areas within language education such as the integration of artificial intelligence or personalized learning approaches. This outcome suggests a potential gap in addressing the ongoing technical difficulties among ESL students.

The first objective of this bibliometric analysis was to identify the most used relevant terms relating to the technical challenges of ESL students in web-based learning and their frequency over time. Figure 2 represents the most commonly occurring terms in research concerning ESL learners' technical challenges. The size of these terms suggests their high frequency and importance in the literature. The prominence of words such as "English", "language", "acquisition", "learners", and "students" indicates that they are central themes in the research context.



Figure 2: Most used terms

Figure 2 also shows other significant terms, including "comprehension", "communication", "knowledge", and "education", and these highlight key areas of focus within the field. The terms are crucial for identifying the main topics and trends in ESL research. The emphasis on "acquisition" and "learners" points to a strong interest in the processes and experiences of students learning English as a second language. The occurrence of terms such as "comprehension" and "communication" underscores the importance of understanding and effectively using the language. These findings indicate a broader trend within ESL research that prioritizes learner-centered approaches, emphasizing the importance of fostering effective communication skills alongside foundational language competencies. By highlighting these key terms, this research contributes to a deeper understanding of the multifaceted nature of ESL education, suggesting that effective teaching must address both linguistic proficiency and the contextual factors that have an impact on learners' experiences. Identifying these significant terms can guide future research endeavors to explore innovative pedagogical strategies and technological interventions that enhance comprehension and communication skills among ESL learners. Ultimately, by focusing on these critical areas, researchers can better inform educational practices that support the diverse needs of students in an increasingly interconnected world. Table 3 presents a bibliometric analysis of the frequency terms used over the decade of 2014 to 2024.

Year	Language	English	Students	Acquisition	Education	Learners	Knowledge	Performance	Children	2nd Language
2024	2193	1785	1410	1229	1176	948	831	694	674	647
2023	1923	1581	1242	1101	1002	824	740	612	600	575
2022	1614	1308	1008	957	817	673	626	518	517	491
2021	1317	1036	816	812	652	539	511	412	436	412
2020	1052	836	649	668	497	424	419	325	357	333
2019	840	657	507	526	365	331	319	252	297	266

Table 3: Frequency of terms over time

2018	580	461	375	407	276	236	235	194	237	192
2017	440	341	284	319	208	175	187	144	193	153
2016	339	246	198	235	152	126	133	90	134	96
2015	212	161	115	141	97	72	89	55	86	65
2014	110	61	64	50	47	27	50	26	35	22

Table 3 represents the frequency of key terms associated with the technical challenges of ESL students from 2014 to 2024. The term "Language" appeared most frequently each year, reflecting a strong and consistent focus on linguistic studies, and was followed closely by "English" and "Students", which suggested a particular interest in English language education and student-related research. The data revealed a marked increase in the frequency of terms such as "Language" (2,193), "English" (1,785), and "Acquisition" (1,230), indicating a sustained focus on foundational language learning issues within the research community. In particular, 2024 showed the highest frequencies for these terms, suggesting a growing recognition of their importance in web-based learning contexts. Additionally, a noticeable trend in the data was the significant increase in the use of all terms over time, indicating a growing interest and emphasis in these areas. The term "2nd Language" was less frequent but showed an expanding research interest in second language acquisition.

Additionally, the analysis revealed a noticeable trend of increasing usage across all identified terms over time, reflecting an expanding scholarly interest in language acquisition and its associated challenges. While "2nd Language" was mentioned less frequently, its use indicates an emerging research focus on second-language acquisition processes. This gradual shift toward recognizing the complexities of language learning further emphasizes the importance of understanding linguistic competencies and the contextual factors that influence learners' experiences. The steady increase in these key areas suggests that researchers are increasingly aware of the multifaceted nature of ESL education, particularly in view of technological advancements and changing educational paradigms. These findings highlight critical areas for future inquiry and intervention, reinforcing the necessity for ongoing research to enhance instructional practices and learner outcomes in web-based learning environments.

The second objective of this analysis aimed to ascertain the recurring topics and trends in research on the technical challenges of ESL students in web-based learning over time. Figure 2 illustrates the frequency of specific terms related to the technical challenges of ESL learners in web-based learning. The distribution of dots along the horizontal lines for each term indicates the number of times the term has appeared in the research context during a given year. The concentration of dots in certain periods suggests trends in research focus, highlighting how certain topics have gained or lost prominence within the field.



Figure 3: Topic trends

As shown in Figure 3, terms such as "artificial intelligence", "learner engagement", and "perceived ease" have been on trend over the years. The data show the prevalence of these terms in the research context over time. This outcome provides valuable insights into past and current research trends, which could help researchers understand the evolving research regarding the technical challenges of ESL learners in web-based learning and identify potential future areas of interest. Table 3 details topic trends related to the technical challenges of ESL learners and highlights the frequency of various topics over the decade (2014–2024).

Additionally, Table 3 further elaborates on topic trends related to the technical challenges of ESL learners, highlighting the frequency of various topics over the decade of 2014 to 2024. This comprehensive overview reinforces the importance of understanding technological integration in language learning and emphasizes the need for ongoing inquiry into how these elements interact with traditional language acquisition processes. The findings suggest that as technology continues to evolve, the pedagogical approaches employed by educators ensure that they effectively meet the diverse needs of ESL learners. By examining the intersection of technology and language education, this research contributes to understanding how to enhance instructional practices and improve learner outcomes in increasingly digital learning environments. Ultimately, these insights might inform future studies that are exploring innovative strategies for integrating technology into ESL curricula to foster more engaging and effective learning for students.

SN	Term	Frequency	Year (Q1)	Year (Median)	Year (Q3)
1	Perceived ease	8	2023	2024	2024
2	Learner engagement	10	2023	2024	2024
3	Artificial intelligence	18	2023	2024	2024

Table 4: Topic trends regarding technical challenges of ESL learners

4	Information technology	39	2021	2023	2024
5	Enjoyment	61	2022	2023	2024
6	Emotions	82	2021	2023	2024
7	Anxiety	204	2020	2022	2024
8	Experiences	208	2019	2022	2023
9	Engagement	220	2020	2022	2023
10	Students	1,410	2018	2021	2023
11	English	1,785	2018	2021	2023
12	Language	2,193	2018	2021	2023
13	Children	674	2017	2020	2022
14	Knowledge	831	2018	2020	2022
15	Acquisition	1,230	2017	2020	2022
16	Form	144	2017	2019	2022
17	Organization	149	2017	2019	2022
18	Discourse	226	2017	2019	2022
19	Duration	48	2016	2018	2022
20	Conversation	53	2016	2018	2022
21	Repair	58	2016	2018	2022
22	Language production	25	2016	2017	2020
23	Ambiguity	33	2015	2017	2021
24	Phonology	46	2015	2017	2022
25	Primary care	13	2015	2016	2021
26	Learning environment	13	2015	2016	2021
27	1st year	13	2015	2016	2022
28	Abuse	5	2015	2015	2018
29	Mortality	7	2014	2015	2016
30	Health professions	13	2015	2015	2021

As depicted in Table 4, the most frequently mentioned term is "Language", with a total frequency of 2,193. This outcome indicates the central role of language in discussions about ESL education. The term is followed by "English" (1,785) and "Acquisition" (1,230), suggesting a strong focus on language-learning processes. Notably, terms such as "Anxiety" (204) and "Experiences" (208) reflect significant emotional and experiential dimensions of the technical challenges in ESL learning. Nevertheless, "Learner engagement" and "Perceived ease", both recorded in 2023, indicate emerging concerns in recent years. The data also revealed a shift toward integrating technology in language learning, as evidenced by the increasing mentions of emerging terms such as "Information-technology" (39) and "Artificial intelligence" (18). Overall, the trends illustrate a dynamic research landscape that evolves to address both foundational language acquisition issues and contemporary challenges posed by technology and learner engagement.

The foundational themes indicate shifting priorities in recent years and highlight an increasing concern for how students interact with digital learning environments and the importance of user-friendly technology in facilitating effective language acquisition. The data also reveal a notable shift toward integrating technology into language learning. This trend illustrates a dynamic research context that addresses longstanding issues related to language acquisition and embraces contemporary challenges posed by technological advancements. By examining these evolving trends, researchers can better understand how to create more engaging and effective ESL learning experiences that meet the diverse needs of students in web-based learning environments. The current study underscores the necessity for ongoing research to explore innovative pedagogical strategies and technological tools to enhance language proficiency and learner engagement.

5. Discussion

This bibliometric analysis of 19,725 documents relating to the technical challenges of ESL learners in web-based environments revealed significant insights into the evolving research in this field. The findings were centered around two main objectives. First, the analysis sought to identify the most used relevant terms for the technical challenges of ESL student in web-based learning and their frequency over time. This objective aimed to pinpoint specific concepts frequently discussed in the literature. Identifying these concepts will help establish a foundational understanding of the key issues in the research context. Second, the study was set to ascertain the recurring topics and trends in research regarding the technical challenges of ESL students in web-based learning over time. This objective focused on how discussions around the technical challenges of ESL students have evolved. Understanding the trends can provide insights into emerging issues and shifts in research focus.

The analysis revealed several significant outcomes. For instance, the findings indicate a decrease in the volume of published research in recent years. This decline in research output on the technical challenges of ESL learners in web-based learning environments may be attributed to shifting academic priorities and the emergence of other pressing topics within language education. For example, recent studies have increasingly focused on broader technological advancements such as artificial intelligence and blended learning, which may overshadow specific investigations into technical challenges (Jassni et al., 2024; Yazid et al., 2024). The COVID-19 pandemic prompted a surge in research on web-based learning, but as the immediate urgency subsided, attention may have shifted to other areas of educational innovation (Dewi et al., 2024). This decline suggests a potential gap in addressing ongoing technical issues in the ESL context such as digital literacy, which remains critical for equitable access to web-based education.

The implications of this trend are significant for future research and policy development. A reduced focus on the technical challenges of ESL students could hinder efforts to design inclusive digital learning environments that cater to diverse learner needs. Policymakers and educators must recognize the technical barriers of ESL students as highlighted in studies by Dewi et al. (2024) and Hassan et al. (2023). Addressing these issues requires targeted research funding and

policy development that prioritizes technology integration and educators' professional development. By reviving research in this area, future studies can provide actionable insights to enhance web-based ESL learning experiences and ensure that technological advancements benefit learners effectively.

Central to the findings is the prominence of key terms such as "Language", "English", and "Acquisition", which collectively indicate a sustained research focus on the technical challenges of ESL learners in language acquisition. The frequency of these terms reflects the critical importance of linguistic studies in the research context, particularly the increasing concern over language proficiency in the web-based learning environment (Abd Rahman & Razali, 2024; Aiju & Abdullah, 2024; Karuppannan & Mohammed, 2020). In addition, terms such as "Anxiety" and "Experiences" highlight the emotional dimensions of language acquisition. This outcome suggests that emotional factors are critical in ESL learners' engagement and success in web-based environments. Equally, Johnson et al. (2021) found that learners' attitudes affect the success of web-based learning.

Moreover, the data highlight trends in ESL research, particularly the increasing relevance of emerging technology-related terms such as "Learner engagement", "Perceived ease", "Information technology", and "Artificial intelligence". Specifically, the emphasis on these topics indicates a shift toward understanding how to foster active participation among ESL students in web-based contexts. This aspect in particular is discussed in previous research (Al Arif et al., 2024; Hassan et al., 2021; Wahas, 2023). This alignment with technological advancements suggests that researchers are increasingly interested in integrating innovative solutions to address students' challenges and enhance ESL education. In essence, the data indicate specific research attention toward foundational language acquisition issues while concurrently addressing contemporary technological challenges. This dual focus reflects a dynamic research context that adapts to the needs of ESL learners in the evolving digital environment. The year 2024 in particular, showed heightened frequencies for terms related to language acquisition and technology integration.

Additionally, language learning inherently requires interaction to facilitate effective communication, practice, and social engagement; however, web-based learning environments can significantly limit these opportunities for ESL learners. The reliance on digital platforms often reduces face-to-face interactions, which are crucial for developing conversational skills and building confidence in language use (Baber, 2020). This lack of peer engagement can lead to feelings of isolation and anxiety, as indicated by the increasing frequency of terms such as "anxiety" and "engagement" (Table 4) that highlight the emotional challenges faced by learners in online settings. Consequently, while web-based tools offer flexibility and accessibility, they may unconsciously hinder the collaborative and interactive aspects that are essential for language acquisition. In this analysis, the data demonstrated that a specific focus on addressing technical barriers to enhance positive web-based learning outcomes is crucial, especially for second language (L2) acquisition.

6. Conclusion

This study focused on a bibliometric analysis concerning the technical challenges of ESL learners in web-based environments. The findings revealed critical themes and trends that define the current research context in this field. The themes particularly emphasized the challenges faced by ESL learners in language acquisition. This outcome underscores the significance of linguistic studies in ESL education. Concurrently, the emergence of technology-related terms indicated a notable shift toward understanding how challenges posed by digital tools and platforms affect the language acquisition of ESL learners. The findings suggest a dual focus within the research community that addresses both the challenges of language acquisition and the contemporary issues posed by technological integration. Additionally, the current study revealed a marked increase in research attention toward emotional factors. This outcome suggests that understanding learners' emotional dimensions is crucial for fostering effective web-based learning environments. The growing recognition of the relationship between cognitive, technological, and emotional factors calls for a more holistic approach to ESL research that considers how these variables influence learner outcomes in web-based contexts.

The significance of this research lies in its comprehensive bibliometric analysis of 19,725 documents concerning ESL learners' technical challenges in web-based environments, which elucidates critical trends and themes within the field. The findings highlight ESL learners' challenges and emphasize the importance of emotional factors such as anxiety and motivation in web-based learning contexts. Additionally, this study could serve as a valuable resource for educators and researchers aiming to develop effective instructional strategies that enhance the learning experiences of ESL students in digital environments. Educators and institutions could address the technical challenges of ESL students by providing targeted training programs for teachers and students' digital literacy to ensure the effective use of web-based tools. Additionally, implementing user-friendly platforms that facilitate interactive learning experiences can help engage learners and support their language acquisition more effectively. Ultimately, the contributions of this study underscore the necessity for ongoing exploration and innovation in ESL education to meet the evolving needs of learners in an increasingly digital world. This information could help researchers in quickly grasping the dominant themes and in identifying potential areas for further investigation in the research context.

6.1 Limitations and Future Research Directions

Acknowledging the limitations of this study is essential. For instance, the current study relied on the Web of Science database, which may not have captured all relevant literature, particularly non-English publications or journals indexed in other databases. Additionally, the focus on bibliometric analysis may have overlooked qualitative insights that could provide a deeper understanding of the technical challenges of ESL students. As mentioned in the conclusion, the contributions of this analysis underscore the need for continued research into the technical challenges of ESL learners in the web-based environment. To advance the field, future research should prioritize exploring the emotional dimensions of

ESL learning, particularly how anxiety and other psychological factors influence learner engagement and success in online environments. To develop effective support systems for ESL learners, further research could investigate strategies to mitigate anxiety and enhance positive web-based learning experiences.

Additionally, researchers could examine the role of technology in shaping these emotional experiences, focusing on how specific digital tools could be designed to foster a supportive and engaging learning atmosphere. Research could explore how adaptive learning technologies, artificial intelligence, and interactive platforms could create personalized learning experiences that cater to the needs of individual ESL learners. This research focus would provide valuable insights into best practices for integrating technology into ESL instruction. In addition, interdisciplinary approaches incorporating insights from psychology, education technology, and linguistics would enrich the experiences of ESL learners in web-based environments. Collaborative studies involving researchers in language education, technology, and psychology could yield comprehensive frameworks that could address foundational language acquisition issues and the contemporary challenges posed by technology. By pursuing these directions, researchers could contribute to developing innovative educational practices that enhance ESL learning outcomes in an increasingly digital world.

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