

# Research Trends in Technology-Enhanced Language Learning: A Bibliometric Analysis

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## ABSTRACT

Using bibliometric methods allows a quantitative understanding of the growth of TELL, and analysis of topic trends provides insight into the evolution of research interests, including significant growth in topics such as "Deep Learning". Using the Scopus database, a search query was developed to limit the study to articles published in the last 10 years, from 2014 to 2023. Results show consistent growth in TELL research, peaking in 2022 with 88 publications. Analysis of publication distribution identified a global contribution, with the United States as the main contributor, followed by China and the Russian Federation. Dominant keywords, such as "Language Learning," "Engineering Education," and "Students," highlight the primary focus of research on enhancing the language learning experience through technology. The relationships between findings highlight how developments in one area of research often trigger changes in other areas, creating a dynamic and interconnected learning ecosystem. In conclusion, this research confirms that TELL is a field that continues to develop, demonstrating the importance of technology integration in language learning, especially the use of mobile technology.

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## 1. INTRODUCTION

In the era of rapidly growing globalization and digitalization, technology has gone beyond the role of just a tool. It has become an integral part of many aspects of our lives. One of the areas most affected by these changes is language education. Technology-Enhanced Language Learning (TELL) has metamorphosed from a learning support tool to a central component in the modern language curriculum (Kim et al., 2023; Shadiev & Yang, 2020). This transformation not only spurs innovation in teaching methods but also opens up opportunities for deeper exploration of how technology can be used optimally for effective language learning (Loewen et al., 2019; Zhao & Lai, 2023). Language education is a constantly evolving field, and in recent years, its transformation has been greatly influenced by the integration of technology. In an increasingly connected world, the demand for effective language learning tools and strategies has skyrocketed exponentially (Cohen & Henry, 2018; Mahmood, 2021; Sultanova et al., 2020). In response, educators, researchers, and technology experts have collaborated to create innovative ways to enhance language learning through technology (Dörnyei, 2020; Galynska et al., 2021; D. Zou et al., 2018). This technology has shifted language teaching from teacher-centered to student-centered, leading to increased engagement and successful learning outcomes (Gacs et al.,

2020; Kacetl & Klímová, 2019). This article draws attention to these developing dynamics by conducting an in-depth bibliometric analysis.

The current information era is characterized by rapid and widespread access to information and increasingly intensive interaction between technology and learners. In the context of language learning, this means that students and educators now have access to advanced tools such as mobile applications, online learning platforms, interactive language games, and virtual reality technologies that can enrich their learning experience (Shortt et al., 2023; Symonenko et al., 2020). However, despite the abundant availability of these technologies, the proper role and effectiveness of these tools in language learning is still an issue that has not been fully resolved and documented. Technology-Enhanced Language Learning (TELL) is an interdisciplinary discipline combining concepts from linguistics, education, and technology (B. Zou & Thomas, 2019). It covers various tools and methodologies, from language learning software to mobile apps, virtual reality, and artificial intelligence.

The use of bibliometric methods in this research allows us to quantitatively measure the growth of research in the field of TELL (Meyran-Martínez et al., 2022; Shen & Ho, 2020). By observing trends in publications, document types, countries of research origin, the most common keywords, and emerging topics, we can uncover valuable insights into the ever-evolving nature of technology-enhanced language learning. In an era where technology is constantly changing, understanding how TELL research adapts to these changes is critical for educators, policymakers, and researchers seeking to improve language education. The next sections of this analysis will explore specific aspects of TELL research, from examining the growth and distribution of publications over the years to understanding the most frequently occurring keywords and topics in the field. By identifying patterns, gaps, and opportunities in TELL research, we can make greater contributions to more effective language education strategies and better prepare students for an increasingly connected world. This bibliometric analysis is intended to be a valuable resource for all stakeholders in the field of language learning, offering a comprehensive overview of TELL research and its prospects.

## 2. LITERATURE REVIEW

### 2.1 Language Learning

Language acquisition and learning have been an integral component of human society for centuries, evolving to meet the needs of a world experiencing rapid globalization. In recent decades, technology integration has significantly changed the language learning landscape (Gilakjani, 2017). Technology-Enhanced Language Learning (TELL) is a dynamic field at the intersection of linguistics, education, and technology, where digital tools, online resources, and immersive experiences are leveraged to enhance the process of acquiring a new language or improve existing language skills (Y. Chen, 2022; Zhang et al., 2023; D. Zou et al., 2018). TELL's roots can be traced back to early applications of multimedia, audiovisual materials, and language laboratories. However, with the advent of the internet and digital technology, this field is experiencing a paradigm

shift. Innovation at TELL is now driven by artificial intelligence, virtual reality, mobile applications and natural language processing systems (Y. L. Chen et al., 2022; Pokrovska et al., 2020). TELL offers a variety of methodologies and tools designed to meet learners' individual needs, providing them with a flexible and engaging language learning experience. One of TELL's main contributions is its ability to make language learning more accessible and interactive. Learners can acquire language at their own pace, in various contexts, and across geographic boundaries. Online platforms, language learning apps, and interactive software have democratized language learning, making it available globally (Taghizadeh & Ejtehad, 2021; Zhang & Zou, 2022). Additionally, TELL facilitates the incorporation of authentic materials, real-life interactions, and culturally relevant content, which is important in developing practical language skills.

## 2.2 TELL Challenges and Opportunities

Although the TELL field has experienced significant progress, technology in language learning presents challenges and opportunities. Mobile technology, for example, can potentially enhance language learning, but its accessibility and use may be limited (Bachore, 2015). Issues related to access and equity, ensuring that technology reaches all students, are still a concern (Ghavifekr & Rosdy, 2015). Data privacy and security are also important in digital learning environments. Additionally, the effectiveness of specific technologies and the need for trained educators to facilitate TELL experiences remains debatable (Richards, 2015; Zhao, 2013). This literature review provides context for our analysis, setting the stage for an in-depth exploration of research trends in TELL over the past decade. As we delve into bibliometric analysis, we aim to uncover valuable insights into this transformative field's growth, focus, and future direction, which plays a critical role in equipping students with the language skills needed in an increasingly interconnected world.

## 3. RESEARCH METHODOLOGY

### 3.1 Data Collection and Search Strategy

The foundation of this bibliometric analysis rests on a collection of academic literature (Donthu et al., 2021). We utilize the Scopus database, a comprehensive platform that includes a wide range of academic journals, conference proceedings, books, and patents (Zupic & Čater, 2015). The search query used was designed to be broad enough to capture most of the literature but remain specific to the topic of Technology Enhanced Language Learning (TELL). The search string was defined as “technology AND language AND learning”. To ensure the relevance and quality of the retrieved publications, certain inclusion and exclusion criteria were applied: We focused on the last 10 years, including articles published from 2014 to 2023, to provide a contemporary analysis regarding research trends in TELL. The Exclusion Criteria used are (1) Duplicate Publications: Any duplicate records have been removed to maintain the integrity of the data set; (2) Non-academic Sources: Non-academic sources, such as news articles and blog posts, were excluded from the analysis; and (3) Irrelevant Content: Publications that are not directly related to Technology Enhanced Language Learning are excluded.

### 3.2 Data Capture and Processing

Search queries were executed in the Scopus database, and the resulting publications were exported in bibliographic format. This dataset includes the title, abstract, author information, year of publication, document type, keywords, affiliations, and references for each publication. After the data is collected, it is subjected to comprehensive bibliometric analysis with the help of biblioshiny (Zafrullah et al., 2023). This methodology ensures a systematic, complete, and ethical approach to analyzing research trends in TELL over the past decade.

Research Question:

1. What are the publication trends in Technology-Enhanced Language Learning research by year?
2. What is the distribution of publications in Technology-Enhanced Language Learning research based on document type?
3. How does the number of Technology-Enhanced Language Learning research publications compare based on the author's country of origin?
4. What keywords often appear in Technology-Enhanced Language Learning research?
5. How is WordCloud Analysis Technology-Enhanced Language Learning?
6. What are the Trend Topics in Technology-Enhanced Language Learning?

## 4. FINDINGS

### 4.1 Result

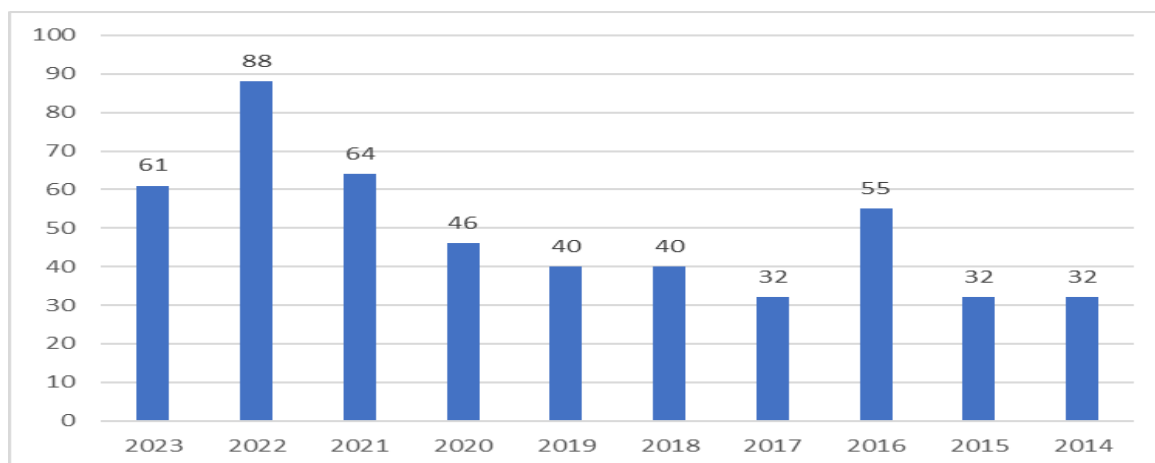
#### 4.1.1 Publication of technology-enhanced language learning research according to years

Figure 1 data provides an overview of the number of research publications in the field of Technology-Enhanced Language Learning by year. A total of 490 articles were found over 10 years. The following is a description of the data:

- 1) In 2022, there will be 88 research publications, the highest number in the year range provided. This indicates a strong interest in the field and possible research growth that year.
- 2) 2023 saw 61 publications, which, although slightly lower than the previous year, still reflect continued attention to language-assisted learning technology.
- 3) 2021 and 2016 also recorded high publications, with 64 and 55 publications, respectively. This represents a period when research in this area received significant attention.
- 4) 2020 and 2019 had a relatively high number of publications, namely 46 and 40, indicating continued interest in language-assisted learning technology research.
- 5) 2018 also recorded 40 publications, showing that research in this field was still relevant that year.
- 6) 2017 had 32 publications, showing consistency in research interest in recent years.
- 7) In 2015 and 2014, 32 publications were recorded, indicating that research interest in language-assisted learning technology has existed for several years.

This data shows that Language Assisted Learning Technology is a growing research field, with 2022 recording the highest number of publications in this data, indicating a growth trend. This reflects the importance of technology in language learning and the ongoing interest in exploring new ways to improve the language learning process.

Figure 1. Publication of technology-enhanced language learning research according to years



#### 4.1.2 Publication on technology-enhanced language learning research according to document type

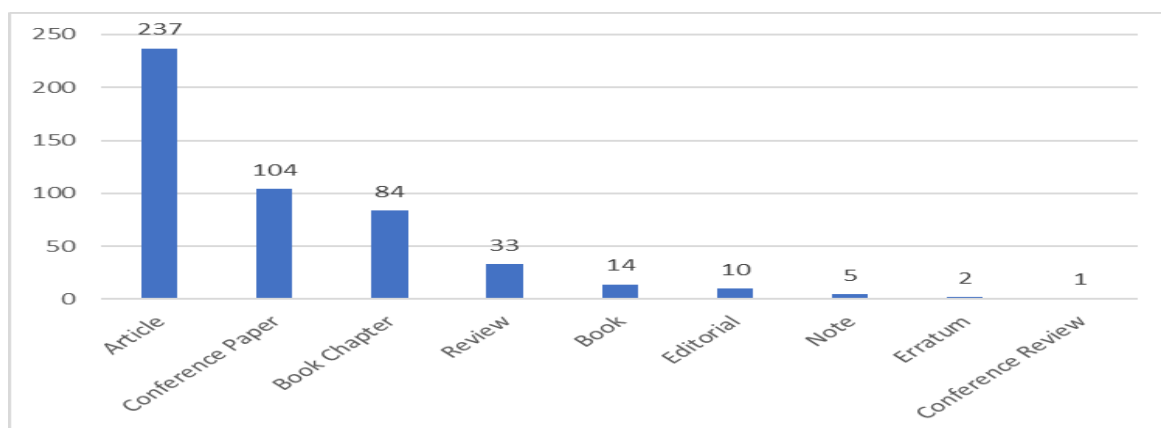
This data provides an overview of the number of research publications in the field of Technology-Enhanced Language Learning based on document type. The following is a description of the data:

- 1) Article: There are 237 published articles, the most common type of document in scientific research. This shows that research articles are the most widely used form of publication in documenting research in the language-assisted learning technology field.
- 2) Conference Paper: 104 conference papers have been published. Conference papers are generally a place where research in recent developments is often introduced and discussed.
- 3) Book Chapters: There are 84 book chapters covering research in this field. This shows the contribution of book literature to knowledge in Language Assisted Learning Technology.
- 4) Reviews: 33 research reviews have also been published, containing analysis and synthesis of previous research in this field.
- 5) Books: 14 books containing in-depth information or guides in language-assisted learning technology have been published.
- 6) Editorials: 10 editorials reflect comments, views, or introductions to special issues of particular journals or conferences.
- 7) Notes: There are 5 notes containing short information or observations in this research area.
- 8) Erratum (Erratum): Only 2 erratums were found, indicating improvements or corrections to previous publications.

9) Conference Review: Only 1 conference review was recorded, a summary or thinking of a conference related to Language Assisted Learning Technology.

These data provide insight into the different types of publications used in documenting research in the language-assisted learning technology field. Articles are the most common publication type, followed by conference papers and book chapters. This reflects the diversity of information sources available in this field.

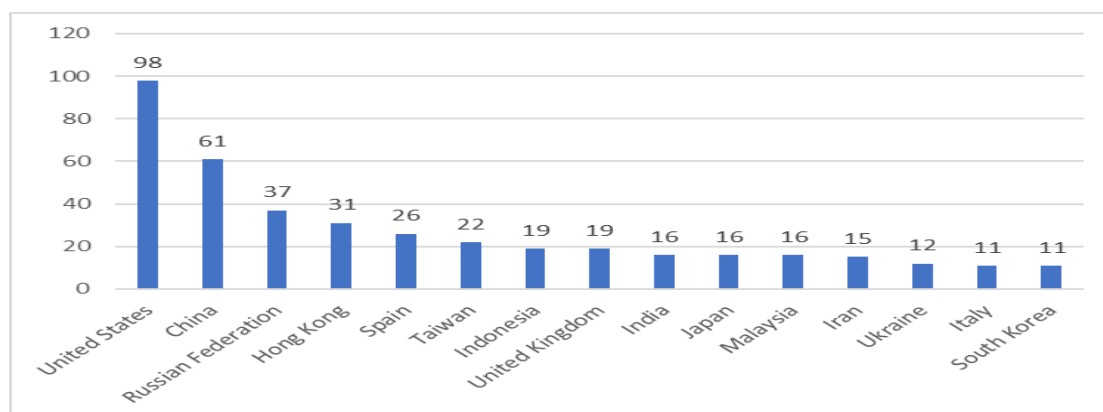
Figure 2. Publication on technology-enhanced language learning research according to document type



#### 4.1.3 Publication of technology-enhanced language learning research according to countries

This data provides an overview of the number of research publications in the field of Technology-Enhanced Language Learning based on the author's country of origin. The United States dominates with the largest publications, followed by China and the Russian Federation. This reflects these countries' important role in producing research in this field. In addition, Hong Kong, Spain, and Taiwan also made significant contributions to this research. Countries such as Indonesia, the UK, India, and Japan are also active in language-assisted learning technology, creating diversity in global donations. These data demonstrate continued interest in language-assisted learning technology research worldwide and cross-national collaboration in developing knowledge in this field.

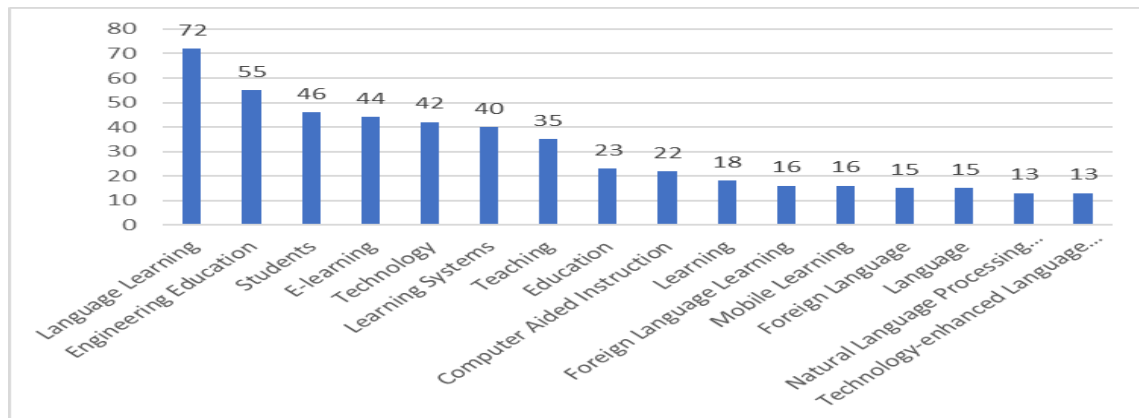
Figure 3. Publication of technology-enhanced language learning research according to countries



#### 4.1.4 Keyword Analysis

This data results from keyword analysis reflecting the most common topics in research or publications on language-assisted learning technology. The keyword "Language Learning" dominates with 72 occurrences, indicating that language learning is the main focus of this research. Additionally, "Engineering Education", with 55 events, highlights engineering education's important role in learning technology. The keyword "Students" appears 46 times, showing attention to students or teaching participants. "E-learning" also reflects the important role of technology in learning with 44 occurrences. "Technology" and "Learning Systems", with 42 and 40 events, respectively, emphasize technology's role in learning systems. "Teaching" and "Education", with 35 and 23 occurrences, highlight teaching and education's role in this research. Other keywords such as "Computer-aided instruction," "Foreign language learning," "Mobile learning," "Foreign language," and "Natural language processing systems" also reflect the diversity of topics in language-assisted learning technology research. This data provides insight into the focus and importance of various aspects of this field.

Figure 4. Keyword analysis



#### 4.1.5 WordCloud Analysis

In Figure 5., WordCloud's data provides a rich and varied picture of important education and learning technology topics. Engineering Education dominates with the highest frequency of 54, showing the importance of education in engineering. In addition, Students also stand out with high-frequency numbers, reflecting the main focus on students in the educational context. Learning Systems has a significant frequency, indicating great interest in learning systems development. The technology-based education trend is also strongly seen through e-learning, which has a frequency of 39.

Language learning is an important aspect of education, as demonstrated by Language Learning. Teaching reflects the role of teaching in education, although its frequency is lower. Computer Aided Instruction highlights the importance of computer-aided instruction in the learning process, and Education in general shows the central role of education in this data. Foreign Language Learning, Machine Learning, Natural Language Processing Systems, and Deep Learning reflect the complexity of education in the

technological era. Language and Learning show the important role of speech and the learning process.

Natural Language Processing and Computational Linguistics focus on language processing in education, while Educational Computing discusses the role of computing in educational contexts. Foreign Language and Sign Language highlights foreign languages and sign languages in education. Technology shows that the use of technology is an important aspect of learning. English Languages underline the importance of English in education, while Surveys highlight the use of surveys in educational research. Humans show the role of humans in the academic context, and learning technology and digital technologies emphasize the role of technology in learning.

This data reflects the complexity and diversity of topics relevant to modern education, focusing strongly on technology and language learning.

Figure 5. WordCloud Analysis



#### 4.1.6 Trend Topics

Data Figure 6. presents data on trends in educational technology and language research topics. Here is a brief description of each case:

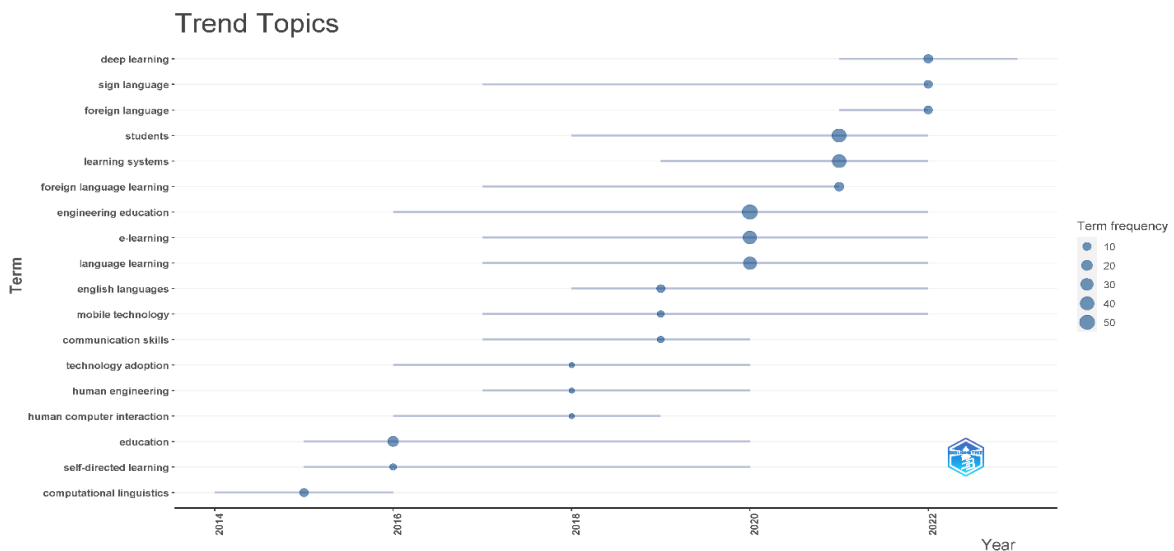
- 1) Computational Linguistics: Research frequency increased from 2014 to peak in 2016.
- 2) Education: Research trends in education have increased since 2015 and will continue to develop until 2020.
- 3) Self-Directed Learning: Research on self-directed learning experienced significant growth from 2015 to 2020.
- 4) Human-Computer Interaction: Research in human-computer interaction has experienced growth since 2016 and reached its peak in 2019.
- 5) Human Engineering: Research in the field of human engineering has experienced growth from 2017 to 2020.
- 6) Technology Adoption: Research trends on technology adoption continue to grow from 2016 to 2020.
- 7) English Languages: Research on English has experienced growth since 2018 and will continue until 2022.
- 8) Communication Skills: Research on communication skills has experienced growth since 2017 and will continue until 2020.



- 9) Mobile Technology: Research on mobile technology has experienced growth since 2017 and will continue until 2022.
- 10) Engineering Education: Research trends in the field of engineering education experience very significant growth from 2016 to 2022.
- 11) E-Learning: Research on e-learning has experienced growth since 2017 and will continue to grow until 2022.
- 12) Language Learning: Research on language learning has experienced growth since 2017 and will continue until 2022.
- 13) Students: Research on students has experienced growth from 2018 to 2022.
- 14) Learning Systems: Research on learning systems has experienced growth from 2019 to 2022.
- 15) Foreign Language Learning: Research on foreign language learning experienced growth from 2017 until it peaked in 2021.
- 16) Deep Learning: Research on deep learning has experienced significant growth since 2021 and will continue until 2023.
- 17) Foreign Language: Research on foreign languages has experienced growth since 2021 and will continue until 2022.
- 18) Sign Language: Research on sign language has experienced growth since 2017 and will continue until 2022.

This description provides a brief overview of how these topics have developed in educational technology and language research over recent years.

Figure 6. Trend topics



## 5. Discussion

Based on a graph of the number of research publications in Technology-Enhanced Language Learning (TELL) from 2014 to 2023, 2022 stands out as the peak with 88 magazines, reflecting the strong interest and potential for significant progress in TELL research. A consistent growth trend can be seen throughout the period, demonstrating the dynamic nature and ongoing attention to TELL. Despite these fluctuations, the number of

publications has remained relatively stable, with marked increases in certain years, characterizing the continued and strong interest in TELL research. The possible impact of the COVID-19 pandemic in the period around 2020 to 2022 appears significant in the increase in TELL research through the adoption of technology in education. Despite a decline in 2023 with 61 publications, this figure remains high, reflecting post-peak normalization dynamics or the influence of other factors, such as changes in research funding priorities. These data depict TELL as a dynamic and growing field, indicating continued interest in integrating technology into language learning, as well as the need for innovative learning methods in language teaching (Chang & Hung, 2019; Y. Chen, 2022; Shadiev & Yang, 2020; Webb & Doman, 2020).

The data revealed shows that research in the field of Technology-Enhanced Language Learning (TELL) has global contributions from various countries. The United States dominates the number of publications, strengthening its position as a leader in TELL research. Meanwhile, China and the Russian Federation made significant contributions, reflecting their important role in this research. The active contributions from Hong Kong, Spain, and Taiwan show that TELL research activities are not limited to large countries, and factors such as education policy and international collaboration play an important role. Global diversity can be seen from the active participation of Indonesia, the UK, India, and Japan. This shows that research in TELL is not only related to technological advances but is also closely related to local needs in language education. These data also indicate continued interest in TELL research globally, highlighting the potential for cross-national collaboration to advance knowledge and practice. Overall, this confirms that TELL is a dynamic and global research field that requires international cooperation to improve language education with technological support (Ghorbani & Golparvar, 2020; Seyyedrezaei et al., 2022; Zhang et al., 2023).

Keyword analysis of research in Technology-Enhanced Language Learning (TELL) provides in-depth insight into key focuses and trends in this field. The dominance of the keyword "Language Learning" (72 times) reflects the focus of TELL research on the language learning process itself, with research focused on how technology can enhance the language learning experience. The keyword "Engineering Education" (55 times) highlights the link between engineering education and TELL, reflecting technological or methodological innovations that develop in engineering applied to language learning. The high focus on the keyword "Students" (46 times) indicates that TELL research is attentive to learners, demonstrating an interest in understanding and enhancing students' learning experiences through technology in enriched learning. The importance of "E-learning" (44 times) emphasizes the transition of language learning to digital platforms, showing research related to online learning and how technology can be effective and efficient in facilitating language learning (Mahyoob, 2020; Rafiee & Abbasian-Naghneh, 2021; Sariyani et al., 2021).

The keywords "Technology" and "Learning Systems" (42 and 40 times) highlight the central role of technology in the development and evaluation of TELL learning systems. The high frequency of the keywords "Teaching" and "Education" (35 and 23 times)

reflects attention to aspects of teaching and education in TELL research, including teaching methods, curriculum strategies, and pedagogical approaches in technology-assisted learning contexts. The emergence of various keywords such as “Computer Aided Instruction,” “Foreign Language Learning,” “Mobile Learning,” “Foreign Language,” and “Natural Language Processing Systems” shows the diversity of topics in TELL research, covering various aspects of language learning enriched by technology, ranging from the use of mobile devices to the use of natural language processing systems. Overall, this keyword analysis illustrates that TELL is not only about the use of technology in language learning but also involves multidisciplinary aspects such as teaching, education, and student experience, emphasizing the effective integration of technology in the entire spectrum of language learning (Hakeem Barzani et al., 2021; Kessler, 2018; Revyakina & Sakharova, 2021).

WordCloud analysis highlights the dominance of “Engineering Education” with a high frequency (54), indicating the central role of engineering education in the context of learning technology, while the high frequency for “Students” confirms the primary focus on the student learning experience; the sustainability of “Learning Systems” indicates a great interest in the development and evaluation of learning systems, while the high frequency of “E-Learning” reflects a strong trend in technology-based education, especially in online and distance learning; key aspects such as “Language Learning” and “Teaching” indicate the importance of language learning, while keywords such as “Computer Aided Instruction”, “Natural Language Processing Systems”, “Machine Learning”, and “Deep Learning” highlight the role of advanced technology in the learning process; the existence of "Foreign Language Learning", "Sign Language", "English Languages", and "Natural Language Processing" reflects the diversity in language teaching and the use of technology for effective language learning; the integration of computing in education is reflected in "Education Computing", "Learning Technology", and "Digital Technologies"; the use of “Surveys” shows the importance of research and data collection in understanding educational trends; finally, the key role of "Human" shows that although technology is important, human factors remain central in the educational context.

Overall, this WordCloud shows that research in education and learning technology covers a broad range of topics, with a strong focus on technology integration, engineering education, student experiences, and language learning (Huang et al., 2019; Koretsky & Magana, 2019; Russell, 2020). This shows that the field is multidisciplinary and continues to adapt to changes in technology and educational needs.

Analysis of research topic trends in educational technology and language provides insight into the evolution of research interests and focus over recent years. Below is a breakdown of each of the topics listed:

1. Computational Linguistics (2014-2016): The rise of research in Computational Linguistics to its peak in 2016 indicates a growing interest in understanding and developing natural language processing applications, which is important in developing language learning technologies. The increase in research in this area is closely related to advances in natural language processing (NLP). This is reflected in research by

- Young et al. in "Recent Trends in Deep Learning Based Natural Language Processing", highlighting technological advances in NLP and its applications in Language learning (Young et al., 2018).
2. Education (2015-2020): Rising trends in education research reflect a continued focus on innovation and improvement in teaching and learning methods, particularly in technology. The emphasis on innovation and improvement in teaching and learning methods, especially with the use of technology, is emphasized by Bernacki et al. in "Mobile Technology, Learning, and Achievement: Advances in Understanding and Measuring the Role of Mobile Technology in Education" (Bernacki et al., 2020).
  3. Self-Directed Learning (2015-2020): The growth of research in this area indicates increasing interest in learning methods that empower students to take control of their learning process, an important aspect of online and hybrid education. Research such as by Doo & Zhu in "A Meta-Analysis of the Effect of Self-Directed Learning on Students' Academic Achievement in K-12 Online Learning" supports this trend, highlighting the effectiveness of self-directed learning methods (Doo & Zhu, 2023).
  4. Human-Computer Interaction (2016-2019): The 2019 peak of research in this area emphasized how humans interact with learning technologies, which is critical to effective user interface design. Work such as Li's in "A Review of Using Eye-Tracking Technology in Exploring Learning from 2000 to 2017" highlights the emphasis on human-computer interaction in educational contexts (Li, 2020).
  5. Human Engineering (2017-2020): Growth in this field highlights the integration of engineering principles in the design and implementation of educational systems, focusing on ergonomics and efficiency.
  6. Technology Adoption (2016-2020): This trend reflects research that focuses on how technology is adopted in educational contexts, which is important in understanding and improving the use of technology in learning.
  7. English Languages (2018-2022): Growth in research indicates continued interest in English language learning, given its role as a global language.
  8. Communication Skills (2017-2020): Increased research in this area reflects the importance of communication skills in technology-assisted education and learning.
  9. Mobile Technology (2017-2022): This trend highlights how mobile technology is increasingly important in education, especially with the increasing use of mobile devices for learning.
  10. Engineering Education (2016-2022): The significant growth in research in this area indicates an increased focus on integrating technology in engineering education and developing relevant curricula.
  11. E-Learning (2017-2022): Continued growth in e-learning sees increased use and development of online learning platforms, a trend accelerated by the COVID-19 pandemic.
  12. Language Learning (2017-2022): Continued interest in language learning research shows the importance of language as a key component in global education.

13. Students (2018-2022): The growth of research in this area indicates a continued focus on student learning experiences and outcomes in technology-enriched educational contexts.
14. Learning Systems (2019-2022): Increased research in learning systems indicates a focus on developing and evaluating effective learning platforms and tools.
15. Foreign Language Learning (2017-2021): The peak of research in 2021 in this area shows an increase in interest in foreign language learning, which is important in globalization and cross-cultural communication.
16. Deep Learning (2021-2023): The significant growth in deep learning research reflects the role of advanced technologies in changing how learning and information processing are carried out.
17. Foreign Language (2021-2022): As with foreign language learning, research in this area shows an increasing focus on learning various foreign languages.
18. Sign Language (2017-2022): Growth in sign language research reflects increasing recognition of the importance of inclusion and accessibility in education. Research on sign language and inclusion in education was analyzed by Bragg et al. in "Sign Language Recognition, Generation, and Translation: An Interdisciplinary Perspective" (Bragg et al., 2019).

Overall, these trends indicate that research in educational technology and language continues to grow, with an increasing focus on technology integration, the development of innovative learning methods, and attention to diverse educational needs. This reflects the dynamics in the education sector, which continues to adapt to technological advances and changing social conditions.

Building connections between findings in research can provide deeper insight into how various aspects of educational technology and language learning are related and influence each other. The following is an analysis of the relationship between these findings:

1. The Influence of Computational Linguistics on Language Learning.

Advances in Computational Linguistics, especially in natural language processing, have contributed significantly to developing more effective language learning methods, including English and foreign language learning. This is closely related to trends in English Language Learning and Foreign Language Learning (Clark et al., 2010; Meurers & Dickinson, 2017; Moslemi Nezhad Arani, 2018; Pikhart, 2019).

2. Technology and Individualist Learning Approaches.

The increase in Self-Directed Learning and e-learning reflects how technology enables more personalized and independent learning methods, including mobile technology. The ease of access and flexibility mobile technology offers has helped facilitate this trend (Geng et al., 2019; Lalitha & Sreeja, 2020; Rashid & Asghar, 2016).

3. Human-Computer Interaction and Human Engineering in Education.

Increasing research in Human-Computer Interaction and Human Engineering shows how interface design and ergonomics are becoming important in developing educational tools and platforms. This is especially relevant in e-Learning and Learning

Systems, where user experience and convenience are key to learning effectiveness (Meng et al., 2023; Sang & Chen, 2022; Yang et al., 2018).

4. Technology Integration in the Education Curriculum.

Increasing research in Engineering Education and Technology Adoption shows how technology has become integral to the educational curriculum. This is not only limited to engineering education but also includes the use of technology in the context of language learning and communication skills development.

5. Communication Skills in the Digital Era.

Increased research in Communication Skills reflects the need for effective communication skills in the digital era, especially in the context of Human-Computer Interaction and e-learning, where interaction often occurs through technological intermediaries (Goulart et al., 2022; Tugtekin & Koc, 2020).

6. Use of Deep Learning in Learning System Development.

Advances in Deep Learning have significantly impacted the development of more sophisticated Learning Systems, enabling personalized learning and more efficient data analysis.

7. Inclusion and Accessibility in Education.

The increase in research in Sign Language shows a growing recognition of the importance of inclusion and accessibility in education, a theme that also emerges in individualized learning approaches and educational technologies that encourage a diversity of learning methods (De Meulder & Hualand, 2021; Lee et al., 2021; Liu et al., 2022).

Through these relationships, we can see how different fields in educational technology and language learning influence each other and develop together. Developments in one area often open up new possibilities or require changes in other areas, creating a dynamic and interconnected learning ecosystem.

## 6. CONCLUSION

From the research results, the Technology-Enhanced Language Learning (TELL) field shows a consistent growth trend, reaching a peak in 2022. This increase in interest is reflected in the distribution of publications involving global contributions from various countries, with the United States dominating, followed by China, the Russian Federation, and active contributions from multiple countries, demonstrating the diversity of TELL research globally. Keyword and WordCloud analysis highlighted the main research focus on "Language Learning", "Engineering Education", and "Students". This emphasizes the importance of technological development to enhance the language learning process and improve the student experience. The presence of keywords such as "E-Learning", "Learning Systems", "Teaching", and "Education" shows the role of technology in the development and evaluation of learning systems, as well as aspects of teaching and education in general in the TELL context.

Analysis of research topic trends over the past few years provides insight into the evolution of interest, such as the significant growth in "Deep Learning", showing the

impact of advanced technologies in changing the way learning and information are processed, especially the use of mobile technology. The relationship between the findings shows that advances in one research area often trigger changes in other areas, creating a dynamic and interconnected learning ecosystem. Overall, this research strengthens the understanding of the dynamics of TELL as a growing research field, emphasizing the importance of technology integration in language learning and supporting the need for innovative education. These conclusions can guide future research better to understand technology's role in language education contexts.

## REFERENCES

- Bachore, M. M. (2015). Language Learning through Mobile Technologies: An Opportunity for Language Learners and Teachers. *Journal of Education and Practice*, 6(31), 50–53.  
<https://eric.ed.gov/?id=EJ1083417>
- Bernacki, M. L., Greene, J. A., & Crompton, H. (2020). Mobile technology, learning, and achievement: Advances in understanding and measuring the role of mobile technology in education. *Contemporary Educational Psychology*, 60, 101827.  
<https://doi.org/10.1016/j.cedpsych.2019.101827>
- Bragg, D., Koller, O., Bellard, M., Berke, L., Boudreault, P., Braffort, A., Caselli, N., Huenerfauth, M., Kacorri, H., Verhoef, T., Vogler, C., & Morris, M. R. (2019). Sign language recognition, generation, and translation: An interdisciplinary perspective. *ASSETS 2019 - 21st International ACM SIGACCESS Conference on Computers and Accessibility*, 16–31.  
<https://doi.org/10.1145/3308561.3353774>
- Chang, M. M., & Hung, H. T. (2019). Effects of technology-enhanced language learning on second language acquisition: A meta-analysis. *Educational Technology and Society*, 22(4), 1–17.  
[https://doi.org/10.30191/ETS.201910\\_22\(4\).0001](https://doi.org/10.30191/ETS.201910_22(4).0001)
- Chen, Y. Chen. (2022). Effects of technology-enhanced language learning on reducing EFL learners' public speaking anxiety. *Computer Assisted Language Learning*, 37(4), 789-813.  
<https://doi.org/10.1080/09588221.2022.2055083>
- Chen, Y. L., Hsu, C. C., Lin, C. Y., & Hsu, H. H. (2022). Robot-Assisted Language Learning: Integrating Artificial Intelligence and Virtual Reality into English Tour Guide Practice. *Education Sciences*, 12(7), 437.  
<https://doi.org/10.3390/educsci12070437>
- Clark, A., Fox, C., & Lappin, S. (2010). The Handbook of Computational Linguistics and Natural Language Processing. *Unsupervised Learning and Grammar Induction*, pp. 197-220.  
<https://doi.org/10.1002/9781444324044>
- Cohen, A. D., & Henry, A. (2018). Focus on the language learner: Styles, strategies, and motivation. In *An Introduction to Applied Linguistics* (pp. 165–189). London: Routledge.
- De Meulder, M., & Hualand, H. (2021). Sign language interpreting services: a quick fix for inclusion? *Translation and Interpreting Studies*, 16(1), 19–40.  
<https://doi.org/10.1075/tis.18008.dem>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct

- a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133(September), 285–296.  
<https://doi.org/10.1016/j.jbusres.2021.04.070>
- Doo, M. Y., & Zhu, M. (2023). A meta-analysis of effects of self-directed learning in online learning environments. *Journal of Computer Assisted Learning*, 40(1), 1-20.  
<https://doi.org/10.1111/jcal.12865>
- Dörnyei, Z. (2020). Innovations and Challenges in Language Learning Motivation. In *Innovations and Challenges in Language Learning Motivation*. London: Routledge.  
<https://doi.org/10.4324/9780429485893>
- Gacs, A., Goertler, S., & Spasova, S. (2020). Planned online language education versus crisis-prompted online language teaching: Lessons for the future. *Foreign Language Annals*, 53(2), 380–392.  
<https://doi.org/10.1111/flan.12460>
- Galynska, O. M., Shkoliar, N. V., Dziubata, Z. I., Kravets, S. V., & Levchyk, N. S. (2021). Innovative Teaching Technologies as a Way to Increase Students' Competitiveness. *International Journal of Education and Information Technologies*, 15(2021), 215–226.  
<https://doi.org/10.46300/9109.2021.15.22>
- Geng, S., Law, K. M. Y., & Niu, B. (2019). Investigating self-directed learning and technology readiness in blending learning environment. *International Journal of Educational Technology in Higher Education*, 16(1), 1–22.  
<https://doi.org/10.1186/s41239-019-0147-0>
- Ghavifekr, S., & Rosdy, W. A. W. (2015). Teaching and learning with technology: Effectiveness of ICT integration in schools. *International Journal of Research in Education and Science*, 1(2), 175–191.  
<https://doi.org/10.21890/ijres.23596>
- Ghorbani, M. R., & Golparvar, S. E. (2020). Modeling the relationship between socioeconomic status, self-initiated, technology-enhanced language learning, and language outcome. *Computer Assisted Language Learning*, 33(5–6), 607–627.  
<https://doi.org/10.1080/09588221.2019.1585374>
- Gilakjani, A. P. (2017). A Review of the Literature on the Integration of Technology into the Learning and Teaching of English Language Skills. *International Journal of English Linguistics*, 7(5), 95-106.  
<https://doi.org/10.5539/ijel.v7n5p95>
- Goulart, V. G., Liboni, L. B., & Cezarino, L. O. (2022). Balancing skills in the digital transformation era: The future of jobs and the role of higher education. *Industry and Higher Education*, 36(2), 118–127.  
<https://doi.org/10.1177/09504222211029796>
- Hakeem Barzani, S. H., Aslam, M. Z., & Aslam, T. (2021). The role of technology in ELL classes in the Turkish Republic of Northern Cyprus. *International Journal of Language Education*, 5(2), 30–39.  
<https://doi.org/10.26858/ijole.v5i2.14109>
- Huang, R., Spector, J. M., & Yang, J. (2019). Introduction to Educational Technology. *Lecture Notes in Educational Technology*, pp. 3–31. Singapore: Springer.  
[https://doi.org/10.1007/978-981-13-6643-7\\_1](https://doi.org/10.1007/978-981-13-6643-7_1)
- Kacetl, J., & Klímová, B. (2019). Use of smartphone applications in English language learning—A challenge for foreign language education. *Education Sciences*, 9(3), 179.



- <https://doi.org/10.3390/educsci9030179>
- Kessler, G. (2018). Technology and the future of language teaching. *Foreign Language Annals*, 51(1), 205–218.  
<https://doi.org/10.1111/flan.12318>
- Kim, D. E., Hong, C., & Kim, W. H. (2023). Efficient Transformer-based Knowledge Tracing for a Personalized Language Education Application. *L@S 2023 - Proceedings of the 10th ACM Conference on Learning @ Scale*, 336–340.  
<https://doi.org/10.1145/3573051.3596183>
- Koretsky, M. D., & Magana, A. J. (2019). Using technology to enhance learning and engagement in engineering. *Advances in Engineering Education*, 7(2), 1-59.  
<https://api.semanticscholar.org/CorpusID:203997537>
- Lalitha, T. B., & Sreeja, P. S. (2020). Personalized Self-Directed Learning Recommendation System. *Procedia Computer Science*, 171(2020), 583–592.  
<https://doi.org/10.1016/j.procs.2020.04.063>
- Lee, C. K. M., Ng, K. K. H., Chen, C. H., Lau, H. C. W., Chung, S. Y., & Tsoi, T. (2021). American sign language recognition and training method with a recurrent neural network. *Expert Systems with Applications*, 167(2021), 114403.  
<https://doi.org/10.1016/j.eswa.2020.114403>
- Li, Y. (2020). Visual education of music courses for college students based on human-computer interaction. *International Journal of Emerging Technologies in Learning*, 15(2), 175–186.  
<https://doi.org/10.3991/ijet.v15i02.12535>
- Liu, Z., Pang, L., & Qi, X. (2022). MEN: Mutual Enhancement Networks for Sign Language Recognition and Education. *IEEE Transactions on Neural Networks and Learning Systems*. <https://doi.org/10.1109/TNNLS.2022.3174031>
- Loewen, S., Crowther, D., Isbell, D. R., Kim, K. M., Maloney, J., Miller, Z. F., & Rawal, H. (2019). Mobile-assisted language learning: A Duolingo case study. *ReCALL*, 31(3), 293–311.  
<https://doi.org/10.1017/S0958344019000065>
- Mahmood, S. (2021). Instructional Strategies for Online Teaching in COVID-19 Pandemic. *Human Behavior and Emerging Technologies*, 3(1), 199–203.  
<https://doi.org/10.1002/hbe2.218>
- Mahyoob, M. (2020). Challenges of e-Learning during the COVID-19 Pandemic Experienced by EFL Learners. *Arab World English Journal*, 11(4), 351–362.  
<https://doi.org/10.24093/awej/vol11no4.23>
- Meng, Q., Yan, Z., Abbas, J., Shankar, A., & Subramanian, M. (2023). Human-Computer Interaction and Digital Literacy Promote Educational Learning in Pre-school Children: Mediating Role of Psychological Resilience for Kids' Mental Well-Being and School Readiness. *International Journal of Human-Computer Interaction*, 1–15.  
<https://doi.org/10.1080/10447318.2023.2248432>
- Meurers, D., & Dickinson, M. (2017). Evidence and Interpretation in Language Learning Research: Opportunities for Collaboration With Computational Linguistics. *Language Learning*, 67(S1), 66–95.  
<https://doi.org/10.1111/lang.12233>
- Meyran-Martínez, C., Bacca-Acosta, J., & Buchner, J. (2022). Technology-Enhanced Education of English in Ubiquitous Context: An Overview of the Past 60 Years. *Intercultural Communication and Ubiquitous Learning in Multimodal English Language Education*, pp. 244–274. Pennsylvania: IGI Global.  
<http://dx.doi.org/10.4018/978-1-7998-8852-9.ch012>

- Moslemi Nezhad Arani, S. (2018). Teaching and Researching Computer-Assisted Language Learning. *GiST Education and Learning Research Journal*, 17(2018), 260–267. <https://doi.org/10.26817/16925777.421>
- Pikhart, M. (2019). Computational Linguistics and Its Implementation in e-Learning Platforms. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 11701 LNCS, 634–640. [https://doi.org/10.1007/978-3-030-29374-1\\_51](https://doi.org/10.1007/978-3-030-29374-1_51)
- Pokrovskaya, I. L., Kolodko, T. M., Aliyeva, Z. K., Tymoshchuk, I. V., & Vakariuk, R. V. (2020). Integration of cloud technologies in teaching foreign languages in higher education institutions. *International Journal of Learning, Teaching and Educational Research*, 19(2), 46–59. <https://doi.org/10.26803/ijlter.19.2.4>
- Rafiee, M., & Abbasian-Naghneh, S. (2021). E-learning: development of a model to assess the acceptance and readiness of technology among language learners. *Computer Assisted Language Learning*, 34(5–6), 730–750. <https://doi.org/10.1080/09588221.2019.1640255>
- Rashid, T., & Asghar, H. M. (2016). Technology use, self-directed learning, student engagement, and academic performance: Examining the interrelations. *Computers in Human Behavior*, 63(2016), 604–612. <https://doi.org/10.1016/j.chb.2016.05.084>
- Revyakina, N., & Sakharova, E. (2021). Psychological and pedagogical support of the educational process: Synergetic approach. *E3S Web of Conferences*, 273(2021), 12124. <https://doi.org/10.1051/e3sconf/202127312124>
- Richards, J. C. (2015). The changing face of language learning: Learning beyond the classroom. *RELC Journal*, 46(1), 5–22. <https://doi.org/10.1177/0033688214561621>
- Russell, V. (2020). Language anxiety and the online learner. *Foreign Language Annals*, 53(2), 338–352. <https://doi.org/10.1111/flan.12461>
- Sang, Y., & Chen, X. (2022). Human-computer interactive physical education teaching method based on speech recognition engine technology. *Frontiers in Public Health*, 10(2022), 941083. <https://doi.org/10.3389/fpubh.2022.941083>
- Sariani, Khairat, M. El, & Yaningsih. (2021). An optimization of language learning in writing through e-learning: Encountering COVID-19 pandemic. *International Journal of Language Education*, 5(1), 528–541. <https://doi.org/10.26858/IJOLE.V5I1.15375>
- Seyyedrezaei, M. S., Amiryousefi, M., Gimeno-Sanz, A., & Tavakoli, M. (2022). A meta-analysis of the relative effectiveness of technology-enhanced language learning on ESL/EFL writing performance: retrospect and prospect. *Computer Assisted Language Learning*, 1–34. <https://doi.org/10.1080/09588221.2022.2118782>
- Shadiev, R., & Yang, M. (2020). Review of studies on technology-enhanced language learning and teaching. *Sustainability (Switzerland)*, 12(2), 524. <https://doi.org/10.3390/su12020524>
- Shen, C., & Ho, J. (2020). Technology-enhanced learning in higher education: A bibliometric analysis with latent semantic approach. *Computers in Human Behavior*,

- 104, 106177.  
<https://doi.org/10.1016/j.chb.2019.106177>
- Shortt, M., Tilak, S., Kuznetcova, I., Martens, B., & Akinkuolie, B. (2023). Gamification in mobile-assisted language learning: a systematic review of Duolingo literature from a public release of 2012 to early 2020. *Computer Assisted Language Learning*, 36(3), 517–554.  
<https://doi.org/10.1080/09588221.2021.1933540>
- Sultanova, D., Muratova, M., & Jalolova, I. (2020). Computer Technology is the Best Means of Formation Learning Environment for Studying and Teaching English Language. *Bulletin of Science and Practice*, 6(4), 411–415.  
<https://doi.org/10.33619/2414-2948/53/46>
- Symonenko, S. V., Zaitseva, N. V., Osadchyi, V. V., Osadcha, K. P., & Shmeltser, E. O. (2020). Virtual reality in foreign language training at higher educational institutions. *CEUR Workshop Proceedings*, 2547, 37–49.  
<https://doi.org/10.31812/123456789%2F3759>
- Taghizadeh, M., & Ejtehad, A. (2021). Investigating pre-service EFL teachers' and teacher educators' experience and attitudes towards online interaction tools. *Computer Assisted Language Learning*, 36(8), 1633–1667.  
<https://doi.org/10.1080/09588221.2021.2011322>
- Tugtekin, E. B., & Koc, M. (2020). Understanding the relationship between new media literacy, communication skills, and democratic tendency: Model development and testing. *New Media and Society*, 22(10), 1922–1941.  
<https://doi.org/10.1177/1461444819887705>
- Webb, M., & Doman, E. (2020). Impacts of flipped classrooms on learner attitudes towards technology-enhanced language learning. *Computer Assisted Language Learning*, 33(3), 240–274.  
<https://doi.org/10.1080/09588221.2018.1557692>
- Yang, S., Mei, B., & Yue, X. (2018). Mobile Augmented Reality Assisted Chemical Education: Insights from Elements 4D. *Journal of Chemical Education*, 95(6), 1060–1062.  
<https://doi.org/10.1021/acs.jchemed.8b00017>
- Young, T., Hazarika, D., Poria, S., & Cambria, E. (2018). Recent trends in deep learning-based natural language processing [Review Article]. *IEEE Computational Intelligence Magazine*, 13(3), 55–75.  
<https://doi.org/10.1109/MCI.2018.2840738>
- Zafrullah, Z., Bakti, A. A., Riantoro, E. S., Kastara, R., Prasetyo, Y. B. A., Rosidah, R., Fitriani, A., Fitria, R. L., Ramadhani, A. M., & Ulwiyah, S. (2023). Item Response Theory in Education: a Biblioshiny Analysis (1987-2023). *Journal of Education Global*, 1(1), 101–114.  
<https://penaeducentre.com/index.php/JEdG/article/view/30>
- Zhang, R., & Zou, D. (2022). Types, purposes, and effectiveness of state-of-the-art technologies for second and foreign language learning. *Computer Assisted Language Learning*, 35(4), 696–742.  
<https://doi.org/10.1080/09588221.2020.1744666>
- Zhang, R., Zou, D., & Cheng, G. (2023). Technology-enhanced language learning with null and negative results since 2000: A systematic review based on the activity theory. *Education and Information Technologies*, 29(2022), 1–61.  
<https://doi.org/10.1007/s10639-023-11993-1>
- Zhao, Y. (2013). Recent Developments in Technology and Language Learning. *CALICO*

*Journal*, 21(1), 7–27.

<https://doi.org/10.1558/cj.v21i1.7-27>

Zhao, Y., & Lai, C. (2023). Technology and Second Language Learning: Promises and Problems. In *Technology-Mediated Learning Environments for Young English Learners: Connections In and Out of School* (pp. 167–205). London: Routledge.  
<https://doi.org/10.4324/9781003418009-8>

Zou, B., & Thomas, M. (2019). Recent Developments in Technology-Enhanced and Computer-Assisted Language Learning. *Recent Developments in Technology-Enhanced and Computer-Assisted Language Learning*, 1–478.  
<https://doi.org/10.4018/978-1-7998-1282-1>

Zou, D., Xie, H., & Wang, F. L. (2018). Future trends and research issues of technology-enhanced language learning: A technological perspective. *Knowledge Management and E-Learning*, 10(4), 426–440.  
<https://doi.org/10.34105/j.kmel.2018.10.026>

Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, 18(3), 429–472.  
<https://doi.org/10.1177/1094428114562629>