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A pedagogical classification framework for language learning and teaching tools based on Information and Communication Technologies

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Yanxia Bao

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ABSTRACT

Information and Communication Technologies (ICT) have been widely used in business, academic research, and especially in the field of education. Both general and specific research about how these technologies have been integrated into the teaching and learning process have been conducted over the last decades. However, there is a lack of solid research about how to classify existing ICT language learning resources and tools based on their functions and following pedagogical criteria. In this study, we review relevant research on language teaching and learning using ICT resources from 2014 to 2023, examined those ICT-based tools used both in face-to-face classrooms and online education environments, and then categorized these tools using a pre-established framework developed for this research aiming at the classification of ICT Resources for Language Learning. Based on our study, we identified existing ICT resources and established an analytical framework for future research. In the systematic review, we reviewed articles in 5 academic databases and then selected relevant papers to conduct our research. This study can serve as a guideline for educators to select the most appropriate ICT-based language learning tools for different aspects, functions and purposes of language learning, thus improving pedagogical effectiveness. It also provides a comprehensive overview of the types of resources available and how specific technologies are used in different teaching environments, promoting a more efficient and purposeful integration of technology and its diverse learning approaches within the language learning process.

Key words: Information and Communication Technologies (ICT); Language teaching.

Language learning; Classification; Pedagogical analysis.

RESUMEN

Las Tecnologías de la Información y las Comunicaciones (TIC) han sido ampliamente utilizadas en los negocios, la investigación académica y especialmente en el campo de la educación. Durante las últimas décadas, se han realizado investigaciones tanto generales como específicas sobre cómo se han integrado estas tecnologías en el proceso de enseñanza-aprendizaje. Sin embargo, faltan investigaciones sólidas sobre cómo clasificar los recursos y herramientas TIC existentes para el aprendizaje de idiomas en función de sus funciones y siguiendo criterios pedagógicos. En este estudio, revisamos investigaciones relevantes sobre la enseñanza y el aprendizaje de idiomas utilizando recursos TIC entre 2014 y 2023, examinamos las herramientas basadas en TIC utilizadas tanto en aulas presenciales como en entornos educativos en línea, y luego categorizamos estas herramientas utilizando un marco analítico previo desarrollado para esta investigación con el objetivo de clasificar los recursos TIC para el aprendizaje de idiomas. Con base en nuestro estudio, identificamos los recursos TIC existentes y establecemos un marco analítico para futuras investigaciones. En la revisión sistemática, revisamos artículos en 5 bases de datos académicas y luego seleccionamos investigaciones relevantes para realizar nuestra investigación. Este estudio puede servir como guía para que los educadores seleccionen las herramientas de aprendizaje de idiomas basadas en TIC más apropiadas para diferentes aspectos, funciones y propósitos del aprendizaje de idiomas, mejorando así la efectividad pedagógica. También proporciona una descripción general completa de los tipos de recursos disponibles y cómo se utilizan tecnologías específicas en diferentes entornos de enseñanza, promoviendo una integración más eficiente y decidida de la tecnología y sus diversos enfoques de aprendizaje dentro del proceso de aprendizaje de idiomas.

Palabras clave: Tecnologías de la Información y las Comunicaciones (TIC); Enseñanza de idiomas; Aprendizaje de idiomas; Clasificación; Análisis pedagógico.

RESUM:

Les Tecnologies de la Informació i les Comunicacions (TIC) han sigut àmpliament utilitzades en els negocis, la investigació acadèmica i especialment en el camp de l'educació. Durant les últimes dècades, s'han realitzat investigacions tant generals com específiques sobre com s'han integrat aquestes tecnologies en el procés d'ensenyament-aprenentatge. No obstant això, falten investigacions sòlides sobre com classificar els recursos i eines TIC existents per a l'aprenentatge d'idiomes segons les seues funcions i seguint criteris pedagògics. En aquest estudi, revisem investigacions rellevants sobre l'ensenyament i l'aprenentatge d'idiomes utilitzant recursos TIC entre 2014 i 2023, examinem les eines basades en TIC utilitzades tant en aules presencials com en entorns educatius en línia, i després categoritzem aquestes eines utilitzant un marc analític previ desenvolupat per a aquesta investigació amb l'objectiu de classificar els recursos TIC per a l'aprenentatge d'idiomes. A partir del nostre estudi, identifiquem els recursos TIC existents i establim un marc analític per a futures investigacions. En la revisió sistemàtica, revisem articles en 5 bases de dades acadèmiques i després seleccionem investigacions rellevants per a realitzar la nostra investigació. Aquest estudi pot servir com a guia perquè els educadors seleccionen les eines d'aprenentatge d'idiomes basades en TIC més apropiades per a diferents aspectes, funcions i propòsits de l'aprenentatge d'idiomes, millorant així l'efectivitat pedagògica. També proporciona una descripció general completa dels tipus de recursos disponibles i com s'utilitzen tecnologies específiques en diferents entorns d'ensenyament, promovent una integració més eficient i decidida de la tecnologia i els seus diversos enfocaments d'aprenentatge dins del procés d'aprenentatge d'idiomes.

Paraules clau: Tecnologies de la Informació i les Comunicacions (TIC); Ensenyament d'idiomes; Aprenentatge d'idiomes; Classificació; Anàlisi pedagògica.

Tables and figures

1. Introduction

Information and Communication Technologies (ICTs) is a broader term within the field of Information Technology (IT), and generally it refers to the infrastructure and components that support modern computing. Specifically, it encompasses any communication device or application, including mobile phones, computer and network hardware, software, the Internet, and satellite systems. It also covers various services and applications associated with these technologies, such as videoconferencing and distance learning (Schiliro & Choo, 2016).

According to UNESCO (2009), ICTs are defined as:

> "a diverse set of technological tools and resources used to transmit, store, create, share or exchange information. These technological tools and resources include computers, the Internet (websites, blogs and emails), live broadcasting technologies (radio, television and webcasting), recorded broadcasting technologies (podcasting, audio and video players, and storage devices) and telephony (fixed or mobile, satellite, visio/video-conferencing, etc.)."

Since the emergence of computers and the Internet, ICTs have had a monumental impact on the world, transcending cultural differences and geographical boundaries. It enables individuals, communities, and organizations to share and exchange information, as well as send and receive feedback. Today, with the continuous advancement of technology, ICTs not only provide easy access to global information but also offers platforms for studying and working.

ICTs are increasingly being applied across various sectors, including education, healthcare, entertainment, business, and the economy. They facilitate online learning, telemedicine, digital entertainment, e-commerce, and much more. Undoubtedly, ICTs will continue to shape our daily lives, presenting new opportunities and challenges. Their influence is expected to grow, driving innovation and connectivity across the globe.

Use of technology for education can be traced from early 20th century, marked by the introduction of educational films and Sidney Pressey's teaching machines (Das, 2019). Key developments include the integration of computer terminals in classrooms for

accessing course materials and remote lectures, pioneered by institutions like the University of Illinois. Stanford University's experiments with computer-based teaching for elementary school children marked a significant early application. Similarly, the introduction of computers in community colleges and the development of computer-based learning at institutions like the New Jersey Institute of Technology and the University of Guelph advanced educational technology in the 1970s and 1980s. The advent of the World Wide Web in the 1990s revolutionized education by enabling the creation of online course platforms and the delivery of digital learning materials. Initiatives like online lectures and tutorials became feasible, and the establishment of the first online high school underscored the expanding role of technology in learning. In recent years, videoconferencing has become a popular tool in education, enhancing interactive learning experiences and enabling virtual classrooms. Technologies such as webcams have further facilitated live lesson recordings and the dissemination of educational content online (Das, 2019).

Until today, ICTs have been widely used in classrooms and online teaching environments, with millions of studies conducted on teaching quality and learning outcomes. Scholars and educators have shown that ICTs facilitate the shift from content-centered curricula to competency-based curricula, and supports the transition from teacher-centered to student-centered teaching approaches (Adeoye et al. 2013), improves the quality of instruction by enabling collaborative leaning and providing fast, accurate feedback to learners (BECTA, 2004), promotes deep learning and enables educators to respond more effectively to the diverse needs of learners (Lau & Sim, 2008).

The rapid growth and evolution of ICTs have led to an abundance of diverse terminologies and a vast body of literature. Academic articles extensively cover various technologies used in teaching and learning, along with numerous papers focusing on integrating specific technologies into lessons or applying online tools for educational purposes. While these studies offer statistics and examples of ICT utilization in furthering research, there remains a lack of clear classification for these resources. This lack of clarity poses challenges for scholars and academics alike, as they endeavor to navigate the complexity of the environment and establish a unified understanding of ICT resources.

Therefore, in this research, we focus on the study of ICT resources for language learning and classify the existing ICT resources within a pre-established framework. We believe that this classification helps organize these resources, provides a clear guideline for users and greatly improves the efficiency of using these technologies. Furthermore, the framework will aid educators in preparing their classes, as the ICT resources are categorized by function, allowing users to select from corresponding categories for specific purposes, thereby enhancing teaching efficiency. Additionally, the classification provides an overview of the existing resources, such as which ICT tools are most commonly used, which ones are underutilized, and which areas are lacking. This insight paves the way for future research. Accordingly, our research can be used by educators, academic professionals, instructional designers and interested individuals, as the classification comprises technologies used in both formal and informal educational settings.

The classification of ICT resources for language teaching and learning used in this research has its origin in Romero-Forteza & Seiz-Ortiz (2006), who dedicated part of their research to researching various aspects of Computer-Assisted Language Learning (CALL), as well as the use and evaluation of ICT-based language learning resources and English for Specific Purposes. They believe that all ICT-based resources and tools can support language learning, but their effective use requires that teachers and learners understand the learning objectives, pedagogical functions, and related activities. Therefore, a classification system is necessary to identify the educational functions of these technologies and organize them into categories, helping users evaluate their potential. We will illustrate and elaborate on the framework in a later section.

The objectives of this research are specified as follows:

1) To review academic articles in language teaching and learning, identify the existing ICT resources and evaluate how they align with the pre-established framework of 14 classifications.

2) To analyze the identified resources within the theoretical framework of 14 established classes and assess the impact of the framework on the efficiency and accuracy of language teaching and learning research.

3) To classify these resources, justify the reasons of the classification and propose directions for future research and development in language learning and teaching based on the findings.

To achieve the objectives of this research, we first reviewed academic articles from seven sources using keywords such as ICT and language teaching (or learning). We then established a database of these articles. Subsequently, we analyzed the ICT resources mentioned in these articles, categorizing them according to the type of language, teaching or learning context, and their function or purpose. Finally, we classified these resources within our pre-established framework, summarised in Table 1.

No.	Tools	No.	Tools
1	For the development of didactic content	9	For translation management
2	For the acquisition of didactic content	10	For teaching development
3	For practice and use of the language	11	For natural language processing
4	For creation	12	For social and cultural projects
5	For communication and collaboration	13	For ICT-based exploration and research
6	For learning management	14	For immersive learning
7	For notetaking	15	For text review purposes[1]
8	For vocabulary management		

Table 1. Classification of ICT resources for language learning

[1] In his latest research, Seiz Ortiz completed the classification framework for ICT resources, adding a fifteenth category: Tools for Text Review. This new category includes subcategories such as Grammar Checkers and AI-based Textual Review Tools. In our research, we had previously classified Grammar Checkers under Category 3, Tools for Language Practice, and the latter under Category 4, Tools for Creation. In future research, we plan to review our database and recategorize them according to the updated classification framework.

2. Theoretical framework

Educational technology, also known as instructional technology, ICTs in education, Ed Tech, or learning technology, involves the study and ethical application of technological processes and resources to enhance learning and boost performance (Kaware & Sain, 2015). The rapid development of software and hardware, along with the increased acceptance of ICTs in education, brings about both unlimited possibilities and challenges regarding effective learning through the integrated use of ICTs for educators and learners.

Generally speaking, ICT tools refer to a wide range of technologies, applications, and devices that enable the processing, storage, retrieval, and transmission of data and information (Pandey & Kamlesh, 2023). These tools can be broadly categorized into hardware, software, and network-based tools, each designed to fulfill specific purposes and enhance productivity and efficiency. Hardware tools include physical devices such as computers, laptops, smartphones, servers, routers, and other peripheral devices. Software tools consist of applications, programs, and operating systems that enable users to perform tasks ranging from word processing and data analysis to graphic design and video editing. Network-based tools involve technologies that facilitate communication and collaboration over networks, including the Internet. Examples include email, video conferencing, social media, and cloud computing, interactive whiteboards, educational software, and online learning platforms, like virtual classrooms. For the purpose of our research, we discuss different classifications of ICT resources, mainly focused on education and language learning.

Regarding the classification of ICT resources in education, particularly in language learning, the increasing use of various tools has blurred the lines between categories, making it challenging to establish a standard classification system. Additionally, with the rise of multidisciplinary approaches and the widespread awareness of lifelong learning, many online tools now serve multiple purposes. For example, a particular online translation tool can be used both for language learning and as an interpreter to understand different cultures.

To address this complexity, we studied different theories to support our framework for classifying ICT resources by categorizing the existing ICT tools used in language learning.

For our research purposes, we only consider ICT tools that are used or can be integrated into the language teaching and learning process. That is to say, in this research we adopt the concept that “education using ICT” refers to the use of ICTs in teaching languages instead of ICTs themselves, where ICTs serve as a tool rather than being the primary focus of education (Ioannidis & Garyfallidou, 2001), and we mainly focus on web-based tools and applications applied in teaching and learning languages. Based on their respective functions, we categorize tools with similar functions into classification types and sub-classifications. Finally, we refer to all tools used for language learning collectively as ICT resources.

2.1 General classification of ICT resources from a non-academic perspective

An annual survey has been made since 2007 on the website *Top 100 Tools for Learning*, and the results can provide us with insights about what kind of ICT tools have been used in education. The latest results of ICT tools for learning, according to this classification, are shown in Figure 1.

According to “Top Tools for Learning”, ICT tools are categorized into five key areas: Content (& APPs), Content development, Learning platforms, Communication & Collaboration, and Web Tools.

Content (& Apps): This category encompasses a variety of tools designed to deliver and consume educational content in different formats, such as videos, podcasts, e-books, and online courses. Not surprisingly, leading this subcategory is *YouTube*, which serves as a vast repository of educational videos and tutorials across countless subjects. Other media like *Vimeo*, *Netflix*, and *TED Talks* are also popular in teaching and learning processes. Content and app tools in education make learning more accessible and engaging. They offer a wide range of content—from videos to courses—that suit different learning styles. Interactive features like quizzes and discussion forums keep learners involved, while regular updates ensure the information is up to date. These tools also allow for flexible learning, so you can study at your own pace. Additionally, they encourage collaboration through integration with other platforms and user-generated content. Overall, they enhance the learning experience by making education more interactive, flexible, and inclusive.

change since 2022	TOP 100	Tool	Description
same	1	YouTube	video hosting and sharing platform
up 1	2	Google Search	search engine
up 1	3	Microsoft Teams	enterprise collaboration platform
new	4	ChatGPT	AI chatbot that understands and generates natural language text
down 3	5	PowerPoint	Microsoft's presentation software
up 1	6	LinkedIn	professional social network
up 3	7	Wikipedia	online encyclopaedia
same	8	Word	Microsoft's documentation software
down 3	9	Google Docs & Drive	office suite/file sharing platform
down 5	10	Zoom	video meeting platform
down 2	11	Canva	graphics tool
up 14	12	Spotify	audio/podcast platform
up 5	13	Instagram	photo sharing social network
down 2	14	Excel	Microsoft's spreadsheet software
up 17	15	Google Classroom	educational learning platform
same	16	Kahoot	live engagement tool
up 4	17	WhatsApp	messaging app
up 1	18	Facebook	social network
up 1	19	Vimeo	video hosting and sharing platform
up 33	20	Netflix	documentaries/films

Figure 1. Top Tool for Learning 2023 (partial view, source: Top 100 Tools for Learning)

Content Development: this category includes a wide range of tools designed to help create and manage educational content, such as documents, presentations, spreadsheets, graphics, blogs and websites, quizzes and interactive educational materials. ICT tools for content development in education help educators create a wide range of learning materials like presentations, documents, and multimedia content. They make it easier to design engaging slideshows and websites using tools like *PowerPoint*, *Google Docs*, and *WordPress*, among many others. For professional-looking documents and graphics, there are tools such as *Adobe Acrobat Pro* and *Canva*. Interactive tools like *Quizizz* and *Nearpod* make learning more engaging with quizzes and interactive content, encouraging active participation of students. These

tools empower educators to create dynamic and personalized learning experiences that cater for different learning styles and needs.

Learning platforms represent a crucial category of ICT tools designed to facilitate educational and corporate learning environments. Educational platforms like *Google Classroom*, *Moodle*, and *Canvas* simplify the management of online courses, assignments, and communication between teachers and students. *Google Classroom* integrates smoothly with other Google tools, making collaboration easier, while *Moodle* allows for personalized learning experiences. *Canvas* stands out for its user-friendly interface and comprehensive features. In corporate settings, platforms such as *aNewSpring* support professional training by offering tools for employee development, performance tracking, and certification management. These platforms enable organizations to deliver effective learning programs that enhance skills and drive team performance.

Communication and collaboration tools facilitate seamless interaction across various platforms. Email services like *Outlook* and *Gmail* ensure efficient correspondence; while messaging apps such as *WhatsApp*, *Telegram*, and *Discord* enable real-time communication and group chats. File sharing platforms like *Google Drive*, *OneDrive*, and *Dropbox* support collaborative work on documents and projects, enhancing teamwork regardless of location. Virtual whiteboard tools such as *Padlet*, *Miro*, and *Jamboard* allow for visual brainstorming and project collaboration. Video meeting platforms like *Microsoft Teams*, *Zoom*, and *Google Meet* facilitate face-to-face real time communication and presentations. Team collaboration tools such as *Slack*, *Trello*, and *Notion* streamline task management and project coordination, while social networks like *LinkedIn* and *Twitter(X)* support professional networking and community engagement. These tools collectively enhance productivity and connectivity in both professional and social contexts.

Web tools offer a wide array of applications that enhance productivity and simplify access to information across various online activities. *Google Chrome* and *Brave* are favored browsers known for their speed and security, providing reliable navigation experiences. *Google Search* and *Wikipedia* serve as go-to resources for quick information retrieval, while *Google Scholar* and *Zotero* cater specifically for academic research and references. Tools like *DeepL* and *Google Translate* facilitate seamless

language translation, promoting global communication. For content curation, *Wakelet*, *Pinterest*, and *Pocket* enable users to gather and organize online content effectively. *OneNote* serves as a versatile digital notebook for note-taking and collaborative project management. Enhancing productivity, *Grammarly* ensures writing accuracy, *Google Maps* aids in navigation and location services, and *Google Calendar* helps manage schedules efficiently. Together, these tools support a range of tasks from browsing and research to language translation, content organization, note-taking, and overall productivity enhancement in user-friendly and efficient ways.

We compared these five categories with our 14-type classification framework:

1. For the development of didactic content: This aligns closely with the "Content Development" category in the *Top 100* list. Tools like *PowerPoint*, *Word*, *Google Docs*, *Canva*, and various interactive content creation platforms fit here.
2. For the acquisition of didactic content: This corresponds well with the "Content (& Apps)" category, including platforms like *YouTube*, *Coursera*, *LinkedIn Learning*, and *TED Talks*.
3. For practice and use of the language: While not a specific category in the Top 100, this could include tools like *Duolingo* from the "Content (& Apps)" section, and potentially some interactive content tools from "Content Development."
4. For creation: This broadly overlaps with "Content Development," encompassing tools for creating various types of content.
5. For communication and collaboration: This directly matches the "Communication & Collaboration" category in the *Top 100* list.
6. For learning management: This aligns with the "Learning Platforms" category in the Top 100 list.
7. For notetaking: The *Top 100* list includes *OneNote* under "Web Tools," but doesn't have a specific category for note-taking tools.
8. For vocabulary management: This specific classification isn't represented in the *Top 100* categories, though some language learning apps might include this functionality.

9. For translation management: The *Top 100* list includes translation tools like *DeepL* and *Google Translate* under "Web Tools."
10. For teaching development: This isn't a specific category in the *Top 100* but could include elements from "Content Development" and "Learning Platforms."
11. For natural language processing: While not a specific category, *ChatGPT* is included under "Web Tools" in the *Top 100* list.
12. For social and cultural projects: This specific classification is not represented in the *Top 100* categories, though some social media tools under "Communication & Collaboration" might be relevant.
13. For ICT-based exploration and research: This could partially align with tools in the "Web Tools" category of the Top 100, such as *Google Search* and *Google Scholar*.
14. For immersive learning: This specific classification is not represented in the T*op 100* categories, suggesting a potential gap in the *Top 100* list for emerging technologies like Virtual or Augmented Reality (VR/AR) for learning.

In summary, the comparison reveals a notable overlap between the two classification systems, yet our 14 categories offer a more detailed and specialized breakdown of educational technology tools. The *Top 100* list provides a broader categorization based on tool functionality and popularity. Our classification system includes specific educational focuses such as language practice, teaching development, and immersive learning, which are not explicitly categorized in the *Top 100* list. This suggests that our classification may be better suited for addressing specific educational needs and emerging technologies in particular learning contexts such as language learning.

2.2 Classification of ICT resources from a perspective of integration

Rodríguez-Abitia & Kriscautzky-Laxague (2018) identified two crucial perspectives for successful integration of ICT in education: the technological axis and pedagogical axis. First, the former axis is technological, encompassing all the factors that contribute to an optimal ICT infrastructure, governance, management, and leverage. This perspective includes the technical and administrative aspects necessary for the effective deployment and utilization of ICT resources. It emphasizes the importance of

having robust technological frameworks and efficient management practices to ensure that ICT tools can be used to their full potential. In addition, it focuses on building a robust ICT infrastructure. It encompasses factors like optimal hardware, software, network connectivity, effective governance models, and strategies for managing and leveraging technology effectively.

Secondly, the pedagogical or educational axis is particularly concerned with three main factors: teachers, curriculum, and educational resources. It focuses on how ICT resources can be integrated into the educational process to enhance teaching and learning experiences. The role of teachers is crucial, as they need to be adept at incorporating technology into their teaching methods, and thus faculty development plays a crucial role in equipping educators with the required skills to integrate technology meaningfully into their teaching. The curriculum must also be designed to take advantage of technological advancements, ensuring that the content is relevant and engaging for students. Educational resources, such as digital textbooks and interactive learning platforms, play a significant role in supporting both teaching and learning activities. This dual approach highlights the need to address both technological and educational factors to achieve successful ICT integration in education.

Technological Axis

Rodríguez-Abitia & Kriscautzky-Laxague (2018) define infrastructure as the computing and networking services available for academic and administrative activities conducted by teachers, researchers, and students. This implies the essential technological backbone, including hardware, software, and network connectivity, supporting effective teaching, learning, and research. Within the technological axis, institutional commitment to ICTs is a fundamental dimension. This involves the management and governance of ICTs, reflected in the strategic planning and allocation of resources based on academic needs. A critical aspect of this commitment is the establishment of dedicated ICT units responsible for managing technological resources. These units ensure the institution remains responsive to technological trends and align ICT initiatives with educational models guiding technology integration (Organización de Estados Iberoamericanos para la Educación, la Ciencia y la Cultura, 2011). This holistic approach ensures that ICT resources are effectively integrated into

the institutional framework, enhancing academic and administrative functions and supporting the institution's mission. Below (Table 2) is the detail of components that form each one of the dimensions within the technological axis.

Dimension	Institutional Commitment with ICT	ICT Infrastructure
Components	• A plan exists for the integration of ICT in academic and administrative activities • The plan has evaluation mechanisms • A plan exists for integrating ICT in the teaching process • An organizational unit exists for undertaking the plan • If there is no plan: There are certain initiatives, and activities for integration ICT with educational models • There is an online educational offering, and inhibitors and promoters have been identified	• WiFi is available for students and professors • Wired connectivity is available for students and professors • Nature of classroom equipment available • Availability of spaces where students can work with computers • Loan system of computing devices • Online and other ICT services (LMS, administrative tasks, institutional personal pages, institutional e-mail)

Table 2 Technological Axis Components (source: Rodríguez-Abitia & Kriscautzky-Laxague, 2018)

The Institutional Commitment with the ICT dimension focuses on the strategic and organizational aspects of integrating technology into education. It includes components such as having a plan for incorporating ICTs in academic and administrative activities, evaluation mechanisms for this plan, a specific plan for integrating ICTs in teaching, and an organizational unit responsible for implementing these plans. Additionally, it considers alternative scenarios where formal plans might not exist but initiatives for ICT integration are still present. The dimension also addresses online educational offerings and the identification of factors that inhibit or promote ICT integration. On the other hand, the ICT Infrastructure dimension deals with the tangible technological resources available to students and faculty. This includes the provision of both Wi-Fi and wired connectivity, the nature of classroom equipment, availability of computer workspaces for students, a system for loaning computing devices, and various online ICT services. These services encompass learning management systems (LMS), tools for administrative tasks, institutional personal pages, and institutional email systems.

Pedagogical Axis

Rodríguez-Abitia & Kriscautzky-Laxague (2018) believed that integrating ICTs into education goes beyond just having technology available—it hinges on how people interact with and utilize it, that is to say, a critical factor in successful implementation is the human element, particularly the attitudes and skills of those involved in the educational process. According to Vázquez & Ramirez (2016), the effectiveness of information systems in daily operations and decision-making depends largely on people's comfort with technology. Similarly, Perera & Gardner (2017) stress that students' digital literacy directly impacts their ability to manage their learning independently. Key components for successful ICT integration include students, teachers, curriculum design, and digital resources. Of these, faculty development in creative technology use is crucial, as highlighted by Crompton H. (2017) and others. Without proper access to and training on relevant technologies, adoption among teachers remains low, as noted by Oye, Iahad & Rabin (2011), who advocate for mandatory training programs. In essence, while technology availability is essential, the attitudes, skills, and readiness of students and faculty play pivotal roles in successful ICT integration. Addressing these factors through targeted training and supportive resources is vital for enhancing educational outcomes in a digitally driven environment. As we move forward, balancing technological advancement with sound pedagogical practices will be key to realizing the full potential of ICTs in education. The details of the three dimensions within this axis are shown in Table 3.

Dimension	Faculty Formation	ICT Curricular Integration	Digital Educational Resources
Components	• Programs and projects are in place for developing ICT skills in faculty members • An organizational unit exists for that purpose • Diagnostic instruments exist for identifying the faculty profiles related to their use and domain of ICT • Challenges for ICT integration for teaching	• A virtual campus or platform for course delivery exists • ICT are explicitly integrated in the curriculum • ICT are used for teaching activities in blended or distance models • Diagnostic instruments are in place for identifying students' ICT skills	• Initiatives are in place for the development of Open Educational Resources (OER) • An organizational unit exists that is responsible for developing educational resources • Nature of the digital educational resources used • Existence of repositories

Table 3. Pedagogical Axis Components (source: Rodríguez-Abitia & Kriscautzky-Laxague, 2018)

Faculty development focuses on enhancing ICT skills among teachers through training programs. It includes dedicated units to manage these efforts, tools to assess faculty proficiency, and strategies to overcome teaching integration challenges.

ICT integration into the curriculum emphasizes embedding technology into academic programs. This involves using a virtual platform for course delivery, integrating ICTs directly into course content, utilizing technology in blended and online learning, and assessing students' ICT competencies.

Digital educational resources involve creating and managing digital learning materials. This includes developing Open Educational Resources (OER), establishing units to produce educational content, selecting appropriate digital resources, and creating repositories for these materials.

Each dimension - faculty development, ICT curriculum integration, and digital educational resources - plays a crucial role in ensuring technology is effectively integrated into education, enhancing learning outcomes and preparing learners for a digital future.

Based on the above theory, we categorized 14 types of tools which we collected into the above three dimensions:

1) Faculty Development

- For Teaching Development (Tool 10): Tools aimed at enhancing teaching methodologies and pedagogical skills among faculty members.

2) ICT Integration into the Curriculum

- For the Development of Didactic Content (Tool 1)
- For Practice and Use of the Language (Tool 3)
- For Creation (Tool 4)
- For Communication and Collaboration (Tool 5)
- For Learning Management (Tool 6)
- For Notetaking (Tool 7)

- For Vocabulary Management (Tool 8)
- For Translation Management (Tool 9)
- For Natural Language Processing (Tool 11)
- For ICT-Based Exploration and Research (Tool 13)
- For Immersive Learning (Tool 14)

3) Digital Educational Resources

- For the Acquisition of Didactic Content (Tool 2): Tools for accessing and integrating educational content into teaching materials.
- For Social and Cultural Projects (Tool 12): Tools used to support and enhance digital educational resources related to social and cultural contexts.

2.3 Classification of ICT resources from a pedagogical perspective

From the perspective of educators and scholars, ICT tools are often classified differently based on research purposes and educational contexts, and this is a natural phenomenon due to the versatile nature of ICT tools. A single tool can serve multiple users, including research scholars, teachers, self-taught learners, students, administrators, and curriculum designers, potentially falling into different categories solely because of these diverse users and their specific needs. For instance, a video conferencing platform might be classified as a research tool, a teaching aid, or a collaborative learning tool depending on its application. This flexibility in categorization reflects the adaptability of ICT tools and their potential to support various aspects of education and research, highlighting the importance of context when discussing and implementing these tools in educational settings.

2.3.1 Four types of ICT resources: (a) educational networking; (b) web-based learning; (c) mobile learning; and (d) classroom equipment.

Luo and Lei (2012) categorized ICT tools into four types based on delivery methods and technological contexts of ICT tools in education, and they aimed to provide a comprehensive yet distinct classification of ICT tools that educators and researchers

can easily understand and apply. It balances technological aspects with educational considerations, making it relevant for both technical and pedagogical discussions.

Educational Networking: This category emphasizes the social aspect of learning, where interaction and collaboration among learners are facilitated through social networking features.

Web-Based Learning: This category highlights tools that enhance the educational experience through the internet, enabling learners to access a wide range of resources and collaborate online.

Mobile Learning: This category focuses on the portability and convenience of mobile devices, which allow learning to occur anytime and anywhere, thus broadening the scope of educational activities.

Classroom Equipment: This category includes tools specifically designed to enhance the traditional classroom setting, making teaching and learning more interactive and efficient.

The categorization of ICT tools in this framework is primarily developed based on two key factors: application specificity and distinctive features. Application specificity refers to grouping tools according to their primary use case in educational settings, while distinctive features focus on the unique characteristics that define each tool's functionality, such as social networking capabilities, web-based interactivity, mobile usage, or classroom-specific applications. This categorization approach serves several important purposes. It provides clarity and organization, enabling educators and scholars to easily identify and select appropriate tools for their specific needs. The clear definitions enhance understanding of each tool's potential and limitations, facilitating more effective integration into educational practices. Additionally, this classification system is designed with adaptability in mind, recognizing the evolving and increasingly interconnected nature of ICT tools. This ensures that the categorization remains relevant and useful even as technology continues to advance and educational practices evolve. Definitions of these four categories are shown in Figure 2.

Type of ICT tools	Definition	Examples
Educational Networking	Online learning platforms that connect learners using social networking technologies, exhibiting similar functions to sites like Facebook or MySpace.	Ning, Classroom 2.0, Elgg
Web-Based Learning	A set of online applications or services that expand learners' abilities to interact and collaborate with each other in the process of searching, receiving, organizing, and generating educational content	Wiki, blog, podcasting, social bookmarking, virtual worlds
Mobile Learning	Mobile devices or technologies used for educational purposes that support different aspects of instruction or make new educational activities available.	Smartphone, PDA, GPS (for augmented reality games), interactive response pads
Classroom Equipment	Stand-alone devices that are used in traditional classrooms to facilitate the interaction between teachers and students in different class activities.	Interactive whiteboard, touchscreen computer, Kiosk

Figure 2. Types of ICT tools and examples (source: Luo and Lei, 2012)

The four-type classification by Luo and Lei combines technological and educational aspects, making it useful for both technical and pedagogical discussions. This approach helps educators understand how different tools can be integrated into their teaching practices. On the other hand, our fourteen-type classification is more focused on the specific functions of ICT tools in education, specifically in language learning, categorizing them based on their roles in various learning activities. This practical approach makes it easier for educators to choose tools for particular tasks.

Luo and Lei's classification is designed to be adaptable, acknowledging that technology and educational practices are constantly evolving. This flexibility allows the framework to remain relevant over time. Our fourteen-type classification provides a more detailed view of current ICT tools, which may need updating as new technologies emerge. To compare these typologies, we integrated the two. Below is an attempt to map each of the detailed classifications to the broader categories.

1. **For the development of didactic content**:
    - **Educational networking**: These tools often involve online platforms for creating and organizing educational materials, which provide materials to teachers.
2. **For the acquisition of didactic content**:

- **Educational networking**: Tools that help learners access educational content online align with web-based applications.

3. **For practice and use of the language**:
    - **Mobile Learning**: Mobile apps designed for language practice can make learning convenient and portable.
    - **Classroom Equipment**: Devices used in classrooms for language practice sessions.
4. **For creation**:
    - **Educational Networking**: Tools for collaborative creation can fall under educational networking when they involve social collaboration.
    - **Web-Based Learning**: Online platforms for creating content, such as wikis or multimedia projects.
5. **For communication and collaboration**:
    - **Educational Networking**: Tools that facilitate communication and collaboration among learners, similar to social networks.
6. **For learning management**:
    - **Web-Based Learning**: Learning Management Systems (LMS) that provide online course management and delivery.
    - **Classroom Equipment**: Devices used to manage classroom activities and student progress.
7. **For notetaking**:
    - **Mobile Learning**: Mobile apps designed for taking and organizing notes.
    - **Web-Based Learning**: Online tools that allow for note-taking and organizing information.
8. **For vocabulary management**:
    - **Mobile Learning**: Mobile apps specifically for managing and practicing vocabulary.

- **Web-Based Learning**: Online platforms that help in vocabulary building and practice.

9. **For translation management**:
    - **Web-Based Learning**: Online tools that facilitate translation and language learning.
    - **Mobile Learning**: Mobile apps that assist with translation tasks on-the-go.
10. **For teaching development**:
    - **Classroom Equipment**: Tools and devices used by teachers to develop and deliver instructional material in the classroom.
    - **Web-Based Learning**: Online resources and platforms for professional development of teachers.
11. **For natural language processing**:
    - **Web-Based Learning**: Online applications using NLP to enhance learning experiences, such as automated essay scoring.
    - **Mobile Learning**: Mobile tools employing NLP for language learning and processing tasks.
12. **For social and cultural projects**:
    - **Educational Networking**: Platforms that support collaborative social and cultural projects through networking features.
13. **For ICT-based exploration and research**:
    - **Web-Based Learning**: Online tools and platforms used for conducting research and exploring educational content.
    - **Mobile Learning**: Mobile applications facilitating research and exploration activities.
14. **For immersive learning**:

- **Classroom Equipment**: Virtual Reality (VR) and Augmented Reality (AR) devices used in classrooms for immersive learning experiences.
- **Mobile Learning**: Mobile VR/AR applications providing immersive educational experiences.

After the integration, we concluded that our classification provides more nuanced guidance for educators seeking tools tailored to specific educational tasks. It encompasses categories not explicitly addressed in Luo and Lei's framework, such as tools for natural language processing, immersive learning, and social and cultural projects. This reflects the evolving landscape of educational technology and the growing specialization of ICT tools. The fourteen-type classification emphasizes the specific functions of ICT tools in education, categorizing them based on their roles in various language learning activities. This practical approach simplifies the selection of tools for educators based on specific tasks.

2.3.2 Classification of ICT resources based on function

Lim and Tay (2003) adopted the typology of Chen, Hsu and Huang (2000) and grouped ICT tools in four categories: (1) informative tools, (2) situating tools, (3) constructive tools, and (4) communicative tools.

Informative tools are key resources that provide vast amounts of information in formats such as text, sound, graphics, or video. These tools, including multimedia encyclopedias and online resources, serve as extensive repositories of knowledge. While they passively present information, their true potential is realized when integrated with support structures that promote higher-order thinking. In educational settings, informative tools are frequently used to provide foundational content, forming the basis for critical analysis and synthesis. For instance, teachers might use the Internet, CD-ROMs, and *PowerPoint* presentations to deliver content and stimulate students' critical thinking. *PowerPoint*, in particular, is versatile, i.e. used for both presenting information and creating scenarios that encourage creative and critical thought. The adaptability of informative tools allows them to be employed differently according to lesson objectives. This versatility enhances their educational value, transforming passive learning into active engagement. When used effectively, informative tools support the development of higher order thinking skills, making them indispensable in modern education.

Situating tools are designed to immerse students in environments where they can experience contexts and events firsthand. These tools include simulations, games, and virtual reality systems, which provide interactive and engaging learning experiences. Hogle (1996) notes that computer games, as situating tools, increase interest, motivation, retention, and higher-order thinking skills. They improve cognitive learning strategies, such as organizational, memory, and compensatory strategies, and require critical thinking and problem-solving skills. The educational benefits of games depend on their intended purpose and context of use. In practice, situating tools have been integrated into classrooms effectively. For example, a virtual reality program in an English composition lesson created immersive scenarios that stimulated creative and imaginative writing. By experiencing virtual environments, students drew inspiration and context for their compositions, enhancing their engagement and creative output. Overall, situating tools provide experiential learning environments that enhance students' understanding, motivation, and cognitive skills, making them valuable in education.

Constructive tools in ICTs are versatile applications that help students manipulate information, build knowledge, and visualize their understanding. These tools, such as web authoring applications, enable students to create tangible products for educational purposes, like designing web pages to share ideas. Jonassen and Carr (2000) emphasized the role of technology as "mind tools" that facilitate higher-order thinking skills. These tools include databases, spreadsheets, semantic networking programs, expert systems, modeling tools, microworlds, and hypermedia authoring tools. They engage students in activities like evaluating, analyzing, synthesizing, and problem-solving, acting as cognitive extensions rather than teachers. In classrooms, common constructive tools are *PowerPoint* and *Word*, for instance, used for presentations and writing. Science lessons often incorporate data loggers and related software for experiments. Additionally, tools like *Publisher*, *Photoshop*, digital cameras, and web design applications are used for special projects and competitions, enabling students to produce creative work. In general, constructive tools are essential in education for fostering active learning and developing higher order thinking skills, allowing students to construct and represent their knowledge effectively (Lim & Tay, 2003).

We categorized our 14-type classification based on the four types of ICT tools (shown in Table 4, and we believe the results should help in understanding the different roles these tools play in educational contexts. Please note that the categorization of ICT tools is not absolute. Due to the versatile nature of these tools, they can often serve multiple purposes for different users. It is common for a single type of tool to fit into more than one category.

Category	ICT Tools
Informative Tools	For the acquisition of didactic content For note-taking For ICT-based exploration and research
Situating Tools	For immersive learning For social and cultural projects For practice and use of the language
Constructive Tools	For the development of didactic content For creation For vocabulary management For translation management For natural language processing
Communicative Tools	For communication and collaboration For learning management For teaching development

Table 4. Categorization of ICT Tools by Functional Categories

2.4 Classification of ICT resources for language learning

ICT tools have been used specifically for teaching and learning for a long time. Majumdar (2009) mentioned in his study that over 30 years ago, educators began using computers and related technologies for teaching and learning. Initially, this included Computer-Assisted Learning (CAL), Computer-Based Training (CBT), and Computer-Assisted Instruction (CAI). Later, these methods evolved into multimedia courseware, web-based instruction, and Computer-Mediated Communication (CMC) systems. Research indicates that using CAI to practice basic skills can be highly

effective. Students tend to learn more and at a faster pace in courses utilizing CAI, across various subjects and educational levels, including both general and special education.

According to Majumdar (2009), the types of CAL can be grouped as follows: (1) **Computer Assisted Learning**: CAL is interactive, flexible, and learner-centered. It includes drill and practice, tutorials, simulations, and instructional games. CAL is typically used for self-paced instruction, focusing on behavioral objectives to ensure skill mastery. (2) **Multimedia-Based Instructional Software**: Multimedia-Based Instructional Software combines interactivity with multimodal instruction. It features drill and practice, tutorials, and simulation and modeling. This software is used for self-paced learning, based on both behavioral objectives and constructivism, facilitating skill acquisition and knowledge construction. (3) **Web-Based Instruction**: Web-Based Instruction offers interactivity, just-in-time, and on-demand instruction. It supports computer-supported collaborative learning environments through asynchronous and synchronous virtual classrooms. This approach is primarily grounded in constructivism, emphasizing knowledge construction through interaction and collaboration.

When we narrowed down the typology of ICT resources to language learning, Davies et al. (2012) put forward two types of CALL (Computer Assisted Language Learning) applications: (1) Generic software application, and (2) CALL software applications.

Generic software applications, originally designed for general purposes, prove highly beneficial in language teaching when tailored to language learning activities. For instance, utilizing a word-processor for drafting, critical reflection, and editing effectively supports diverse language learning goals, aiding students in developing writing skills, refining their language proficiency, and fostering critical analysis of their work. The term Generic CALL refers to comprehensive authoring packages that cover all aspects of creating and interacting with CALL programs. These packages range from basic exercises such as gap-filling and multiple-choice questions to advanced activities integrating interactive multimedia elements. These tools offer versatile and engaging methods to enhance language learning, promoting greater interactivity and effectiveness in the learning process.

Generic software applications include:

- **Word-processors**: electronic worksheets, spellcheckers, grammar checker, and *Word* and *PowerPoint* documents, among others.
- **Presentation software**: for example, using *PowerPoint* as a presentation tool.
- **Computer Mediated Communication (CMC) applications**: Email, videoconferencing, Chat rooms, etc.
- **Web browsers and Web 2.0 applications**: including search engine, blogs, social networking, even applications of Mobile Assisted Language Learning (MALL)

CALL software applications, on the other hand, are designed to facilitate language learning objectives, whether explicitly stated or implied, based on the developers' theories of language acquisition. They offer interactive activities that help students acquire and apply language knowledge across various skills, such as vocabulary and grammar. These applications can be categorized as content-specific or content-free. Content-specific software comes with fixed linguistic content and activity formats, typical of commercial multimedia CDs. In contrast, content-free CALL software allows teachers to input custom content, enabling tailored language learning activities that cater for specific educational needs and student levels. Resources designed for language learning can be included in this category. Some examples include *German Grammar Visuals* CD-ROM, *Linguascope*, *Melvin*, etc.

Our classification of ICT resources can be neatly categorized into the above two groups with significant overlaps. We believed that this typology may not fully capture the complexity and diversity of modern educational technologies. In practice, many tools designed for general use (Generic Software Applications) can also be effectively applied to support language learning objectives. Similarly, CALL Software Applications often incorporate functionalities that extend beyond language-specific tasks, contributing to a richer educational experience. Therefore, while these categories provide a useful framework, they may need to be adapted or expanded to better reflect the evolving landscape of educational technology in research and practice.

It is important to note that another classification approach for language learning exists, focusing on specific skills. Scholars may categorize tools based on their functions, such as listening practice or reading comprehension, or they may combine skills, for

example reading-writing tools. This illustrates that there is no standardized method for classifying ICT resources, and existing classifications often overlap.

When applying the theoretical foundation for our classification, we based our research on previous theories. In general, the framework of our classification pertains to ICT-based applications, specifically covering the learning and teaching of a second language. The ICT resources in our classification include web tools, learning platforms, and tools for communication and collaboration (*Top Tools for Learning*). When the framework for our research was developed, the perspective was primarily pedagogical (Rodríguez-Abitia & Kriscautzky-Laxague, 2018). As discussed earlier, the 14 classes fall into the axis of pedagogical areas, including faculty formation, ICT curricular integration, and digital educational resources. Additionally, the framework of these 14 classes aligns well with the typology discussed by Luo and Lei (2012), which includes four types: educational networking, web-based learning, mobile learning, and classroom equipment. Furthermore, our 14-type classification match the functional classification developed by Lim and Tay (2003), who grouped ICT tools into four categories: informative tools, situating tools, constructive tools, and communicative tools.

In conclusion, as we continue to develop and perfect our typology, we make reference to existing theories, ensuring that our framework is well-grounded and non-contradictory. This research not only classifies existing ICT resources within our framework but also provides an opportunity to implement and refine the pre-established framework.

3. Methodology

In this research, we use the systematic review which is based on the methodology of Kitchenham (Kitchenham, 2007). A systematic literature review (SLR) is a comprehensive method to gather, evaluate, and interpret all relevant research on a specific research question or topic. In an SLR, individual studies serve as primary sources, while the review itself is a secondary study that synthesizes and analyzes these sources.

SLRs are conducted to consolidate existing evidence on treatments, technologies, or other subjects. By synthesizing empirical findings, they identify research gaps and suggest new areas for investigation. SLRs also provide a structured background for positioning new research within existing knowledge frameworks and can assess empirical support for theoretical hypotheses or generate new ones.

The significance of SLRs lies in their thorough and unbiased approach to literature reviews. Unlike traditional reviews, SLRs follow a predefined search strategy to capture all relevant literature, enhancing transparency and fairness. This systematic documentation of the search process and reporting of findings, both supportive and contradictory, minimizes bias and provides a reliable basis for evidence-based decision-making across various fields.

Advantages of SLRs include their ability to minimize bias through rigorous methodologies and provide insights across diverse settings. They also enable meta-analysis, integrating data across studies to detect meaningful effects that individual studies might miss. However, SLRs require substantial time and effort compared to traditional reviews. Additionally, the enhanced sensitivity of meta-analysis can detect both genuine effects and small biases, potentially affecting result interpretation.

Key features distinguishing SLRs from conventional expert reviews include:

- Development of a review protocol defining the research question and methodological approach
- Use of a predefined, comprehensive search strategy
- Meticulous documentation for transparency and reproducibility
- Explicit inclusion and exclusion criteria for evaluating primary studies
- Specific quality criteria for assessing each study's contribution

In summary, systematic literature reviews play a pivotal role in synthesizing and evaluating existing research, offering a robust foundation for advancing knowledge and informing evidence-based practices across various disciplines. Their systematic approach ensures comprehensive coverage and impartial assessment of research findings, contributing to the credibility and reliability of academic inquiry (Kitchenham, 2007).

According to Kitchenham, the methodology used includes the following stages: planning the review, developing the review and reporting the review.

3.1 Planning the review

Before undertaking a systematic review, it is crucial to verify its necessity. In some cases, these reviews are commissioned, requiring the development of a formal commissioning document. The pre-review phase is critical and involves two key steps: 1) Defining the research question(s), and 2) Creating a review protocol. The review protocol is a detailed plan that outlines the procedures to be followed during the review process. It is important that this protocol undergoes independent evaluation, particularly for commissioned reviews. These preliminary steps ensure that the review is well-structured, targeted, and methodologically sound from the outset. They also help to minimize bias and enhance the reliability of the review's findings. Systematic reviews summarize existing information thoroughly and without bias, helping to draw broader conclusions or prepare for further research. Key evaluation criteria include review objectives, sources searched, inclusion/exclusion criteria, quality assessment, data extraction and synthesis, and the feasibility of combining studies (Kitchenham, 2007). In conclusion, our research is necessary to conduct a systematic review to gather data from existing literature and analyze them based on our criteria.

According to these researchers, specifying research questions is crucial in any systematic review as they guide the entire review process. The search process must find primary studies that address these questions, data extraction must focus on relevant data, and data analysis must synthesize these data to answer the questions. The right question should be meaningful to both practitioners and researchers, potentially leading to changes in practice or increased confidence in current practices. For example, determining whether a specific analysis technique is more effective than expert opinion in predicting design document defects is useful to both groups. Additionally, questions should address discrepancies between commonly held beliefs and reality. In our case, before conducting the literature review, we need to address the following questions regarding the purposes of this research:

Objective 1: To review academic articles in language teaching and learning, identify the existing ICT resources and evaluate how they align with the pre-established framework of 14 classifications.

- What are the inclusion and exclusion criteria for selecting literature? How will these criteria be applied?
- Which sources will be searched to generate data for our research?
- Is the literature search likely to have covered all relevant ICT resources? Are there any limitations to the research?
- How will data be categorized within the pre-established framework?

Objective 2: To analyze the identified resources within the theoretical framework of 14 established classes and assess the impact of the framework on the efficiency and accuracy of language teaching and learning research.

- Is the sample size sufficient for conducting data analysis?
- How should the data be analysed, considering different aspects of language learning, such as writing, listening, reading, and speaking?
- How does these data fit into our framework of classification? How can we demonstrate that our framework provides advantages in practice use of ICT resources?
- How can we draw conclusions from our dataset to determine how our framework will benefit the typology of ICT classifications?

Objective 3: To classify these resources, justify the reasons of the classification and propose directions for future research and development in language learning and teaching based on the findings.

- How can we use the data to justify the conclusions generated from our research?
- How does our analysis provide evidence to support the validity of our framework?
- How will our conclusions guide future directions for the typology of ICT resources?

3.2 Conducting the review

A systematic review aims to identify all relevant studies using an unbiased search strategy, distinguishing it from traditional reviews. In this study, we use *Scopus*, in addition to five well-known journals specializing in language teaching and learning, as our primary sources of data. We will include literature published from 2014 to 2023.

Our search strategy involves identifying keywords relevant to our research. Initially, we assess titles and abstracts to determine relevance. If a study meets our criteria, we retrieve the full copy and document the file accordingly.

Regarding bibliography management and document retrieval, once identified, full articles must be obtained and tracked using a logging system. It is crucial to document all literature in detail so researchers and readers can assess the search's thoroughness. This documentation ensures transparency and replicability, with records and justifications for any changes made during the review process. Unfiltered search results are saved for potential reanalysis. Raw data collected from online databases are stored using *Excel* and *Google Forms* for organization.

Next step is data extraction. According to Kitchenham (2007), the design of data extraction forms in a systematic review is critical for gathering necessary information to address research questions and quality criteria effectively. If quality criteria are used to determine inclusion/exclusion, separate forms are required prior to the main data extraction. Alternatively, if quality criteria contribute to data analysis, they can be integrated into the same form. To ensure efficacy, data extraction forms should undergo piloting with a subset of primary studies. As we mentioned before, *Excel* and *Google Forms* are used by facilitating subsequent data analysis processes.

The final step involves analyzing and classifying the data according to our framework. Our research incorporates both quantitative and qualitative studies. Quantitative studies provide data such as sample sizes, usage statistics of different ICT types, and other numerical measurements. Qualitative studies, on the other hand, include descriptions of the quantitative results and justifications for the classifications made based on our framework.

3.3 Reporting the review

Finally, we sum up the systematic review, and then communicate the results.

In this research, we use the adapted process of a systematic review (as shown in Figure 3) and develop the study in the following sections.

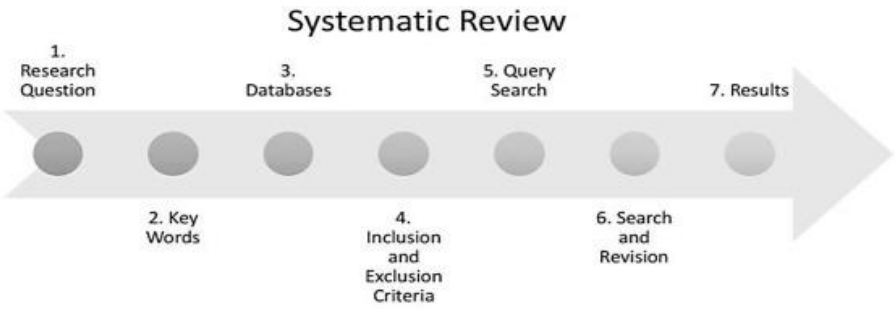

Figure 3. Systematic review process (source: Ramirez et al., 2018)

4. Research results and Discussion

With the rapidly evolving technological landscape, the field of ICT tools for language learning is constantly changing, and education has not hesitated to integrate the latest technology into teaching and learning. Although the application of ICT tools is widely utilized and studied, there is still no unified standard for the classification of ICT resources in the field of language learning, using functional and pedagogical criteria. As mentioned in the previous section, different scholars have defined and developed various typologies according to specific research purposes. Therefore, we conducted a systematic review of the literature from the past 10 years on subjects related to teaching or learning languages using ICTs. We believe that this research will provide a comprehensive overview of how these tools are being used. By categorizing and analyzing the existing tools, we aim to offer a resource that can guide educators in selecting appropriate technologies for their specific teaching contexts, thereby improving efficiency.

4.1 Research questions

The systematic review will analyze the designated studies to attain its objectives by addressing the following questions:

Q1: How do the identified ICT tools in language learning and teaching literature align with the pre-established framework of classification?

This research question serves multiple purposes. Firstly, it tests the robustness and comprehensiveness of our established framework against real-world data from the literature, thus validating it. By examining how existing tools fit into our classification framework, we can identify over- or under-represented categories, revealing potential gaps in tool development or research focus. It also helps us track the evolution of ICT tools over the past decade, highlighting shifts in focus or technological advancements. The findings contribute to the theoretical understanding of how ICT tools are conceptualized and categorized in language learning research. By systematically categorizing a wide range of tools into our 14-type classification, we aim to provide a comprehensive overview of the ICT landscape in language education, identifying trends, patterns, and shifts in their adoption and use. This knowledge is essential for educators, policymakers, and researchers to grasp the current state and future directions of ICTs in language learning and teaching.

Q2: What impact does the categorization of ICT tools into the 14 classes have on the efficiency and accuracy of research in language learning and teaching?

This question looks at how well our pre-established classification system holds up in practice and how useful it is. By testing the framework with real data, we would be able to see if it effectively organizes and interprets large amounts of information, making the research process smoother and more accurate. A solid classification system should simplify categorization, cut down on confusion, and group similar tools together for clearer comparisons. Evaluating this can also offer insights into improving research methods and suggest ways to standardize how ICT tools are categorized, which could enhance consistency in future studies and make meta-analyses easier. In addition, these findings could benefit not just language learning but the wider field of educational technology, contributing to more rigorous and replicable research practices.

Q3: How can the classification of ICT tools inform future research and development in the field of language learning and teaching?

This question explores how our classification system might influence future research and innovation. By systematically categorizing ICT tools, we could identify gaps and opportunities in the current landscape. For example, certain categories might highlight areas with few existing tools, signaling where further development is needed. This system could guide researchers and developers towards creating tools that address

specific educational needs. The insights from this classification could also influence curriculum design, teaching practices, and policy by showing which tools are effective and how they fit into language learning. Identifying trends and gaps might spark new ideas and improvements, and our system might even suggest ways to adapt tools creatively across different categories. Overall, the goal is to ensure our work has a meaningful impact on the future of language education.

4.2 Method

This study employs a systematic review methodology to examine the use of information and communication technology (ICT) tools in language learning and teaching over the past decade. Adopting the principles outlined by Kitchenham (2007), the research methodology is structured to ensure both rigor and transparency. The procedure is organized into six distinct phases: planning the review, developing a review questions, performing an extensive literature search, screening and selecting relevant articles, extracting and analyzing data, and reporting the findings.

The main objective of this research is to identify and categorize ICT tools referenced in literature published in the last ten years across five leading journals specializing in language study, teaching, and learning. The study will review these articles to extract information on ICT tools and categorize them according to a pre-established framework consisting of 14 types of ICT tools:

1. For the development of didactic content
    1.1- Preparation of didactic materials
    1.2- Preparation of game-based didactic materials
    1.3- Development of questionnaires
2. For the acquisition of didactic content
    2.1- Download of didactic materials and content
    2.2- Download of games and playful material for the class
3. For practice and use of the language

3.1- Online content-based practice

3.2- Practice (mobile application) based on content

3.3- Online linguistic practice

3.4- Linguistic practice (mobile application)

3.5- Online game-based practice

4. For creation

4.1- Creative tasks

5. For communication and collaboration

5.1- Communication tool

5.2- Collaborative platform

6. For learning management

6.1- Learning management systems (LMS)

7. For notetaking

7.1- Mobile application for note taking

8. For vocabulary management

8.1- Online dictionary

8.2- Dictionary mobile application

9. For translation management

9.1- Online translation resource

9.2- Mobile application for translation

10. For teaching development

10.1- Teaching information

10.2- Tool for teacher training

11. For natural language processing

11.1- Text-to-speech conversion tools

11.2- Speech recognition/synthesis tools

11.3- Textual analysis tools

12. For social and cultural projects

12.1- Social networks

12.2- Online practice communities

13. For ICT-based exploration and research

13.1- WebQuest

13.2- Online research resource

14. For immersive learning

14.1- Virtual worlds

14.2- Virtual reality

14.3- Augmented reality

To effectively address the research problem and objectives, we employed a qualitative methodology focused on a systematic literature review. The research questions are crafted to explore how ICT tools are categorized within our framework, evaluate the implications of this classification for understanding current trends and challenges, and provide insights for future research and development in language learning and teaching. Through this systematic review, we aim to develop a practical framework for classifying ICT resources and contribute to more effective integration strategies in language education.

4.2.1 Eligibility criteria

Keywords: ICT, language learning, language teaching, technology

The articles were considered eligible based on the following criteria:

a) in the English or Spanish language,

b) language learning is not limited to English, Spanish, China, or any other specific language.

C) published between January 1, 2014, and December 31, 2023

D) studies include research of languages or teaching languages using technologies.

4.2.2 Data sources and search strategy

We use the following scientific journals as our primary data sources, and if the size of the sample is not representative, we would enlarge our database by including websites.

I. **Language Learning & Technology**
II. **ReCALL Journal**
III. **CALL Journal**
IV. **JALT CALL**
V. **CALICO Journal**

For the search and selection of articles, since most sources in our database specialize in language research, we omitted the keyword when searching articles in the databases of the five journals. We used the following search terms and their combinations: "ICT," "tool(s)," "ICT tool," "ICT in learning," "teaching," "technology," etc. Nevertheless, when we conducted the search on the database, we found that the website is not user-friendly when using keyword searches. For example, in the journal "Language Learning & Technology," almost all the articles are related to technology, yet the search results were often incomplete. Therefore, we reviewed the journal volume by volume and browsed the abstracts for relevant research. Similarly, we collected data from the other journals by manually browsing through each volume. We selected qualified articles and established a comprehensive database using *Excel*.

4.3 Data analysis

In this research, we reviewed articles from the above-mentioned journals and selected a total of 299 articles. Of these, 197 articles are from *Language Learning & Technology*, published from 2014 to 2023; 54 are from *ReCALL*, published in 2023; 30 are from *CALL*, published in 2023; 10 are from *JALT CALL*, published in 2023; and 8 are from

CALICO Journal, published in 2023. Below is a brief overview of the distribution of our sample (Figure 4).

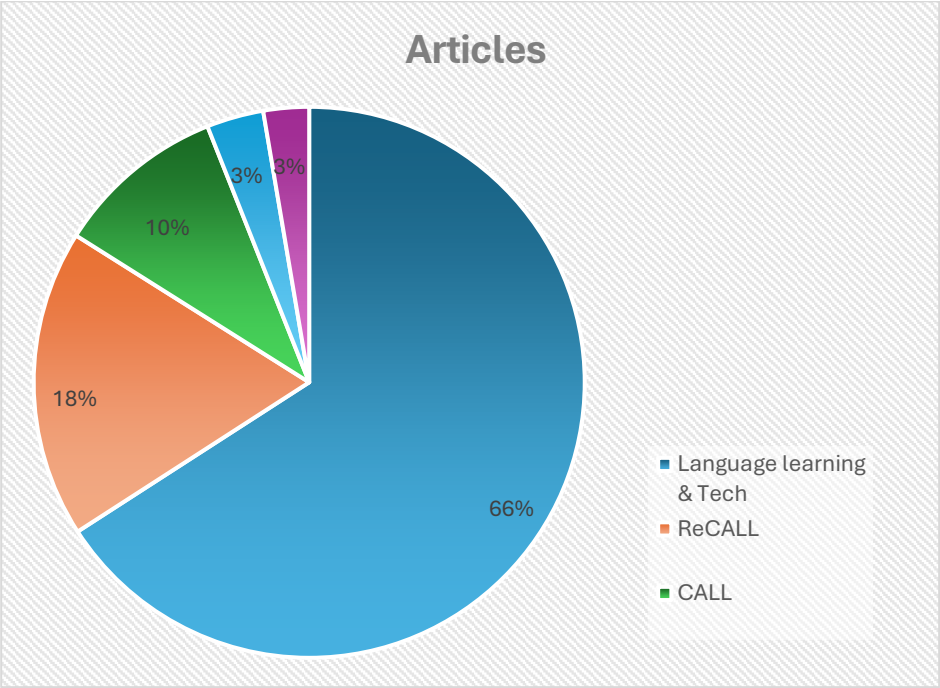

Figure 4. Distribution of sampled articles

The main purpose of this research is to identify and categorize the technologies used in these academic articles based on a specific classification framework. To achieve this goal, we employed a systematic approach for data extraction. First, we reviewed the abstracts of each article to determine if they met our selection criteria. Upon selection, we extracted the technologies mentioned and categorized them according to our predefined classification. To ensure a comprehensive analysis, we established a detailed database using an *Excel* spreadsheet. Each entry in the database includes not only the title and abstract of the article but also detailed information such as the targeted language, whether the objective is teaching or research, the specific technologies used, and other relevant details. This methodical process allows us to perform an in-depth analysis and provides a clear overview of the technological landscape in the reviewed academic literature.

In our research, we identified those technologies used in articles, either for language learning, teaching or research. Below is a comparison of technologies from our database between 2014 and 2023 (Table 5).

2014	2023
Inputlog 4.0, Camtasia 6.0, Microsoft Word 2010, EtherPad	GoogleDocs, Google DocuViz
Smartphones, pre-recorded VFPs, VoiceThread, Photovoice	Mobile-based writing tools (MBWTs)
Second life	AR, VR, eye track tools
Writing Pal (W-Pal), ICALL lessons, Lextutor, Voxopop	ICALL system (Feedbook), computer-assisted pronunciation training (CAPT), iCPRs
Corpus; Lextutor	Corpora, automatic assessment system
Video, audio	Video, film, TV serie
Web-based tools (online forums, weblogs, Skype, email)	Web-based tools, inlcuding Zoom, online chat machine translation (Google Translate). AI, ChatGPT
Video games	Digital games, online role-play games (WoW)

Table 5. Comparison of ICTs between 2014 and 2023 (Language Learning & Technology)

By 2023, there is a clear shift towards more advanced technologies in language learning. The advent of ChatGPT is a game changer, revolutionizing the field with its capabilities. The introduction of sophisticated AR and VR tools highlights a move towards integrating cutting-edge technologies that enhance interactivity and personalization. Software and applications have evolved significantly, tailored to meet specific needs more effectively. AI has made existing tools like *Google* platforms and *Facebook* more versatile, interactive, and responsive. As the diversity of technologies grows, the need to categorize and systematize the field becomes increasingly important. In the next section, we first describe the data from our database, followed by a quantitative analysis.

4.4 Results

From the articles we reviewed, we identified technologies used in language learning, teaching, and research, and then categorized them according to our framework of classification. Below is a discussion for each category.

1. **Tools for the development of didactic content**: including tools for preparation of didactic materials and preparation of game-based didactic materials. There are 6 records in our database for this category (see Table 6 below).

ICT used in articles	Targeted skill
Open-source project, anyone can visit the Web site (https://bitbucket.org/corsis/kmac)	Comprehensive
Delphi technique UNICollaboration (www.unicollaboration.eu)	Comprehensive
3D Virtual Worlds: VWs were created on a cloud-based platform AvayaLiveTM Engage	Comprehensive
ColloCaid project (www.collocaid.uk)	Writing
SMART Teacher	Comprehensive
A tailored collocation tool	Vocabulary

Table 6. Tools for the development of didactic content

Open-source projects like the one hosted on *Bitbucket*, the *Delphi technique*, and platforms like *UNICollaboration* provide collaborative and versatile environments for developing educational content. The use of 3D Virtual Worlds, such as those created on *AvayaLive Engage*, and projects like *ColloCaid* and *SMART Teacher*, demonstrate a focus on enhancing the teaching and learning experience through interactive and tailored tools. These tools support educators in creating engaging and effective instructional materials, including those for game-based learning, which can significantly enhance student engagement and learning outcomes.

Interestingly, one article (Shin & Lee, 2023) used ChatGPT to generate reading materials. From a research standpoint, ChatGPT could initially be placed in Category 1, as it functions as an open-source tool for teachers to create educational resources. Coincidentally, in his recent unpublished research, Seiz Ortiz (personal communication) introduced a fourth subcategory—AI-based learning materials tools—within this category, offering a new perspective on how to classify ChatGPT. However, given ChatGPT's primary function, we ultimately categorized it under Category 4: Tools for Creation.

2. Tools for the acquisition of didactic content: including download of didactic materials and content and download of games and playful material for the class. There are no technologies which are classified in this category from our database.

3. Tools for practice and use of the language: including tools for content-based online practice, content-based practice through mobile application, online linguistic practice, online linguistic practice through mobile application, and online game-based practice.

Based on our observation, there are 125 records from the database, and we further categorized them into subcategories as follows (Table 7):

Subcategory	ICT tools	Total
3.1- Content-based online practice	Reading online (blog posting, news article, etc.), online chat, web-based tools (online forums, weblogs), Wiki, online courses, YouTube, Wikipedia,, Vlog, PowerPoint, iBook, online video or newspaper articles (NedBox), SPOC-based flipped classroom, blogs, online resources, TED Talks, BCTV shows (Sherlock and The Adventures of Merlin)	62
3.2- Content-based practice through mobile application	SMARTPHONES, MySpanishLab, Mobile app: PHONE Words, learning apps such as Duolingo, IdiomsTube, mobile-based writing tools (MBWTs), mobile application (app), mobile-supported TBLT, MALL: iPad2 and Penultimate, Mobile Learning: LiveCode based mobile application, Spaceteam ESL	16

	(a mobile game), Quizlet, Ed-Wonderland, Adventure German, WeChat, Phrasal Nerds: Phrasal Verbs, Telegram channel	
3.3- Online linguistic practice	Online Corpus, ICALL lessons for instruction, Writing Pal (W-Pal), Captioning on video, Voiceboard (Voxopop), Grammaticality Judgment Test (GJT), English Composition Test (ECT), English Writing Motivation Scale (EWMS), Grammar Checker, Video Podcast, Inspiration software, SMS, NaturalReader, Hylighter, online voice recording (VR) activities, peer-to-peer videoconferencing (VC) conversations, virtual language exchange (VE), eTandem, Improve Your Listening Skills (IYLS) platform, online synchronous classes, MyELT (web-based learning management system), Web-based lexicographic tools, online tests from AceReader and FReaderonline	20
3.4- Linguistic practice (mobile application)	MALL: iPad2 and Penultimate, Mobile Learning, Game-Based Practice, Spaceteam ESL, a mobile game, mobile-based writing tools (MBWTs), Duolingo, Mobile app: PHONE Words, MALL application Duolingo, mobile gaming application called Phrasal Nerds: Phrasal Verbs, social media: Telegram channel, mobile-mediated concept mapping, mobile application developed using finite-state transducer technology	14
3.5- Game-based online practice	Video games, Ragnarok Online, Game-based learning: World of Warcraft, web-based mini-games, target interactive technology (Kahoot!), Games (singleplayer and multiplayer), Her Story (vernacular murder mystery game), Digital game, Online role-play game (WoW), individual gameplay learning, Her Story (commercial murder mystery video game), Digital puzzle game Keep Talking and Nobody Explodes, self-designed digital game	13

Table 7. Tools for practice and use of the language

We directly used the terms from the articles to conduct a quantitative analysis and listed some of the items in the table above without omitting the repeated ones. The classification of ICT tools into different categories highlights their specific functions in language learning. **Online content-based practice** covers resources like blogs,

online courses, *YouTube*, and digital reading platforms, which help learners engage with language content and support various instructional methods. Tools such as *Microsoft Word*, grammar checkers, and online tests also fit here, as they aid in creating and refining educational materials and exercises. **Practice (mobile application) based on content** includes mobile apps like *Duolingo* and other writing tools that offer on-the-go practice tailored to language learning goals. **Online linguistic practice** features resources like ICALL systems and online dictionaries that provide focused practice and feedback on language skills. **Linguistic practice (mobile application)** encompasses mobile apps designed specifically for linguistic exercises. Last but not least, **online game-based practice** involves tools such as video games and interactive mini-games that make learning fun and engaging by incorporating educational elements into game formats. In our research, we found that some subcategories can be challenging to define. For instance, *Microsoft Word* is frequently used by teachers in various ways. Sometimes, it serves as a writing tool where features like spellcheck are emphasized, justifying its classification as a tool for online linguistic practice. At other times, it is used simply to complete class assignments, which could place it in the category of online content-based practice. However, given its versatile nature, we categorized it into the third category as a tool for online practice.

4. Tools for creation: including tools for creative tasks, like *Canva*, etc. Based on our analysis, there are 18 records which used tools for creation. Please see the table below for details (Table 8).

	Tools used in articles
Multimedia Creation	VoiceThread worshop; ASV (formerly Adobe Voice); tool for Video-dubbing, tool for creating digital stories in online course projects
Document Creation	Google Docs
Visual and Graphic Design	Animelliure.net; Canva; DeviantArt; Fandom
Robotics and Telepresence	Telepresence robot: Romo

	The robot Furhat
	Robot-Assisted Language Learning (RALL), Humanoid robot, computer-aided concept mapping (CACM)
	AI related: the system and image-to-text recognition process; Chat GPT

Table 8. Tools for creation

These ICT tools are classified as tools for creative tasks because they enable various forms of content creation and collaboration, essential for fostering creativity. Tools like *Google Docs* and other *Google* tools, support collaborative writing, allowing users to co-author and edit documents in real-time, encouraging a shared creative process. *VoiceThread*, *ASV* (formerly Adobe Voice), and video-dubbing tools help users create multimedia content by combining voice, text, and visuals to craft engaging stories and presentations.

Visual and graphic design tools like *Canva* and *Animelliure.net* (for subtitles), along with platforms like *DeviantArt* and *Fandom*, allow users to express their creativity through visual art and community-driven content. Robotics and telepresence tools, such as telepresence robot *Romo* and Robot-Assisted Language Learning (RALL), introduce innovative ways to interact and create in educational settings. Additionally, computer-aided concept mapping (CACM) and image-to-text recognition systems enhance the creative process by organizing ideas and integrating multimedia. These tools collectively support diverse creative activities, from writing and multimedia creation to visual design and interactive robotics, making them vital for an innovative learning environment. We need to pay attention to the classification of Google's tools, as they enable collaborative and cooperative work, both simultaneously and asynchronously. The *Google* suite is also a widely used platform for collaboration, fitting into the subcategory of the fifth type, tools for communication and collaboration. Additionally, with the advancement of technology, software like *Microsoft Word* and *PowerPoint* are acquiring similar functions to those of Google's tools. This creates a challenge in categorizing them correctly and ensuring broad acceptance.

In addition, to refine the classification framework, the following new subcategories have been added: 'Tools for Language-Based Creative Tasks' and 'AI-Based Creative

Tools.' These additions offer more granular detail, focusing on task-specific tool orientation. By incorporating these subcategories, the framework not only becomes more comprehensive but also provides clearer guidance for users navigating the classification system.

5. Tools for communication and collaboration: including communication tools and collaborative platforms. There are 54 articles incorporating this type of tools in our database. The details are listed in the table below (Table 9).

Communication tools	Email like Gmail
Virtual exchange	Skype, Zoom, Adobe Connect Pro, online video call, and other videoconferencing platform
Collaboration platform	Google Drive, Edmodo
Online chat	Campfire, exchange text messages using Google Takl, Google Hangouts, etc.

Table 9. Tools for communication and collaboration

These tools enable seamless interactions and information sharing, regardless of location. Video-conferencing platforms like *Skype* and *Zoom* allow for real-time face-to-face meetings, enhancing understanding and engagement among team members, educators, and students. *Adobe Connect Pro* supports web conferencing with features such as screen sharing and chat, making it ideal for interactive sessions. Email remains a versatile medium for asynchronous communication, facilitating the exchange of detailed information, documents and feedback. Online chat interfaces like *Gmail* chat and *Basecamp Campfire*, along with text messages, provide instant communication channels essential for quick updates and maintaining ongoing dialogue. Computer-mediated communication tools, including email and chat, streamline conversations by offering structured and searchable records. Additionally, computer-assisted language learning platforms that use written, audio, and screencast feedback in *Google Drive* improve the collaboration between educators and learners.

These ICT tools collectively support efficient communication and collaborative efforts, making them indispensable in educational, professional, and personal contexts.

6. Tools for learning management: A learning management system (LMS), like *BlackBoard* or *PoliformaT*, enables educational institutions to handle numerous online or blended courses through a unified interface and shared resources (Piña, 2010). According to Dabbagh & Bannan-Ritland (2005, as cited in Piña, 2010), the most common features of an LMS are categorized as pedagogical tools for content creation, communication, assessment, and administration. In our database, there are 19 articles discussing the learning management system, most of which are specially designed by the researchers or related institutions. Some tools are listed in the following table (Table 10).

Assessment	– Self-designed program developed by Educational Testing Service; – Grammaticality Judgment Test (GJT), English Composition Test (ECT). – The English writing motivation scale (EWMS); – Plickers (a free SRS); – Peer Review (Turnitin), Video Feedback; CyWrite System; – Automated writing evaluation (AWE) systems
Collaborative Learning Systems	– Computer-Supported Collaborative Learning (CSCL) System (Dialogue Box, Discussion Forum, Chat Room, Annotation Tool)

Table 10. Tools for learning management

The tools listed are categorized as learning management system (LMS) tools because they enhance teaching, learning, and assessment processes. Programs like self-designed CSCL systems support interactive learning with features like discussion forums and annotation tools. Assessment tools such as *GJT* and *ECT*, along with peer review systems like *Turnitin* and other CALL tools, provide valuable feedback and evaluation. Additionally, student response systems (SRSs) like *Plickers*, genre-based *AWE* systems, and dynamic assessment systems like *GPAM-WATA* integrate into

LMS for effective management of educational activities. These tools collectively contribute to a comprehensive and interactive learning environment.

Recently, we have enriched this category by adding new subcategories, such as Learning Experience Platform (LXP), Self-assessment tool, and Language proficiency assessment tool. These subcategories provide more detailed, functional, and user-oriented classifications, making it easier for users to select tools that align with their specific objectives. For educators, the systematic categorization enhances the efficiency of evaluating and choosing appropriate resources, allowing for a more targeted approach to teaching and assessment. In addition, we have been considering the introduction of a new category, Category 15: Tools for Text Review Purposes, which includes a subcategory for AI-Based Textual Review Tools. Many of the tools identified in our research that fall under this type were previously categorized as tools for learning management. In future research, we would refine our classifications and reallocate these tools into more specific subcategories to better reflect their functions.

7. **Tools for notetaking**: there is no specific tool for note taking in our database. However, with recent developments in the framework, a new subcategory, 'Mind Map Tools,' has been introduced. This addition means that tools like *Miro* could now be classified under this category. Due to time constraints in this research, we maintained the existing categorization, placing *Miro* in Category 4: Tools for Creative Tasks. In future research, we plan to revisit and potentially update the categorization to reflect these new developments more accurately.

8. **Tools for vocabulary management**: including online dictionary and dictionary applications for mobile devices. Our database includes six articles that focus on online dictionaries, such as the *Cambridge Advanced Learner's Dictionary*, *Collins COBUILD English Language Dictionary, Oxford Learner's Dictionary, Longman Dictionary of Contemporary English*, and *Merriam-Webster Online Dictionary*. These online dictionaries are considered essential tools for vocabulary management because they not only offer extensive support for understanding and expanding vocabulary but also provide detailed definitions, usage examples, pronunciation guides, and often thesaurus entries. Since they facilitate immediate access to accurate word meanings and correct usage, they are crucial for effective vocabulary acquisition and retention.

Additionally, their digital format allows for regular updates and easy integration with other educational resources, such as language learning apps and writing tools. Therefore, online dictionaries play a critical role in managing and enriching vocabulary development in the context of language learning.

9. **Tools for translation management**: including online translation resource and mobile application for translation. In our database, we identified 10 records that specifically use machine translation as a tool. Notably, *Google Translate* stands out in current research, reflecting its broad application across various aspects of translation, such as writing, reading comprehension, and multilingual translation.

Machine translation tools are classified as essential for translation management because they offer automated, instant translations across numerous languages, which is invaluable for both personal and professional use. These tools enable users to quickly convert text and speech from one language to another, thus supporting efficient communication and comprehension in diverse contexts. Moreover, they often incorporate advanced algorithms and neural networks, which enhance translation accuracy and contextual understanding over time. By streamlining the translation process and providing real-time support, machine translation tools play a crucial role in managing and optimizing translation tasks, making them indispensable in today's globalized world.

10. Tools for teaching development: including tools for teaching information and for teacher training. There are 11 articles discussing or studying this type of tools, and some examples are listed in the table below (Table 11).

Tools for teaching information	UNICollaboration (www.unicollaboration.eu)
Tools for teacher training	– SMART Teacher Lab; – Online CALL training courses, training workshop; – Self-designed corpora for training purpose;

	– A training system of 3D Virtual Worlds: created on a cloud-based platform AvayaLive Engage

Table 11. Tools for teaching development

Based on our observation, many tools in this classification are specifically designed for targeted training purposes and frequently operate as comprehensive systems. These systems often incorporate features such as virtual exchange, online interactivity, and progress tracking. They integrate various tools—including communication platforms and evaluation mechanisms—into a unified system. For instance, while systems designed for students might combine educational content with interactive elements, teacher training systems similarly use advanced technologies to engage educators and improve the quality of training. By leveraging these integrated tools, such systems aim to enhance the effectiveness of teacher development programs and support continuous professional growth.

11. **Tools for natural language processing**: including text-to-speech conversion tools, speech recognition/synthesis tools and textual analysis tools. There are 8 articles using this type of tools in their research. Please see the table below for details (Table 12).

Category	Tools
Text-to-Speech Conversion Tools	- Text-to-Speech (TTS) - Pre-recorded VFPs (Voice Feedback Programs) - Google's ASR dictation system
Speech Recognition/Synthesis Tools	- Accent Master Software - Automatic pronunciation assessment - Allophonic transcription tool

Textual Analysis Tools	– Spellchecking Software: Pedagogic Spellchecker (PSC) – Prototype computer-based pedagogic spellchecker (PSC)

Table 12. Tools for natural language processing

These tools facilitate interaction between computers and human language, enabling the processing and analysis of natural language data. Text-to-speech (TTS) conversion tools, like pre-recorded voice feedback programs and Google's ASR dictation system, convert written text into spoken words, enhancing accessibility for visually impaired users and language learners. They exemplify how NLP bridges the gap between textual data and human auditory perception. Additionally, speech recognition and synthesis tools such as *Accent Master Software*, automatic pronunciation assessment, and allophonic transcription tools interpret and generate human speech. They are essential for language learning, voice-controlled interfaces, and communication aids. Textual analysis tools, like *Pedagogic Spellchecker* (PSC), identify and correct errors in written text, thus improving communication accuracy. These tools showcase the core capabilities of NLP in understanding, processing, and generating human language, making them indispensable in modern educational and technological contexts.

12. **Tools for social and cultural projects**: including social networks, and online practice communities. We found 28 articles in our database that utilized tools like *Facebook*, *Twitter (X)*, *WhatsApp*, various blogs, and online weekly journals. These tools facilitate interactions that are crucial for language learning, teaching, and research. Social networks such as *QQ*, *Facebook*, *Twitter*, *WeChat*, *Telegram*, and *WhatsApp* enable real-time communication, cultural content sharing, and discussions. They help learners practice language skills in authentic contexts and foster a sense of community across diverse backgrounds. Their informal nature supplements formal instruction, enhancing language acquisition through social engagement. Additionally, online practice communities, including *Photovoice*, web forums, blogs, wikis, and

platforms like *Wikispaces*, support collaborative learning and cultural exchange. These tools enable activities such as collaborative writing, discussion posts, and virtual communities of practice, which are essential for developing language skills and cultural awareness. Telecollaboration tools like *Skype* and *Google Talk* allow real-time communication between learners and educators globally, enhancing learning with diverse perspectives and feedback. Thus, these tools integrate technology into language education, making learning more interactive and relevant to social and cultural contexts.

13. Tools for ICT-based exploration and research: including *WebQuest*, and online research resources. There are 36 articles which used this type of tools, most of which are online open-source platforms, web-based corpus. Also, we have included some software which are used for creating an operation system for an eye tracking tool used in research. For example, Choi (2023) conducted research to test whether enhanced captions can improve the efficiency of language learning. They used a desk-mounted binocular remote eye tracker (SMI RED-500 eye tracker) and analyzed the data with *BeGaze* software. We included the software in this category because of its research focus. Some examples for this type are listed in Table 13:

Tools for programming	Praat ColdFusion Keystroke Logging
Online corpus	Open American National Corpus British National Corpus Brown Corpus Corpus: MICASE, Oxford Bookworms Graded Readers, Corpus of Contemporary American English (COCA) Self-designed corpus
	AntConc concordance software Web-based lexicographic tools

Table 13. Tools for ICT-based exploration and research

The tools categorized under the ICT-based exploration and research category are essential for analyzing, managing, and enhancing language data, instructional activities, and research methodologies. *WebQuest* and online research resources like advanced *Google* search techniques and website builders such as *Weebly* support structured exploration and project-based research, providing crucial frameworks for gathering and analyzing information. Tools for corpora and corpus analysis, including *Inputlog 4.0*, *Camtasia 6.0*, and various linguistic corpora (e.g., *COCA*, *MICASE*), offer extensive data for examining language use patterns and trends, essential for linguistic learning and research. Instructional tools in ICALL lessons, such as SCORM-compliant software, and online courses facilitate interactive learning and professional development, making them integral to effective language teaching. Technologies for analysis, like *CyWrite*, keystroke logging, and eye-tracking tools, provide insights into user interactions and cognitive processes, enhancing both educational strategies and research. Specialized programs and software, including *ColdFusion* applications and AI motion sensing systems, offer tailored solutions for specific language processing tasks. Additionally, resources like academic vocabulary lists and diagnostic tests support specialized research and instructional activities. Collectively, these tools integrate technology into language education and research, making them indispensable for exploring and advancing linguistic knowledge.

14. **Tools for immersive learning**: including virtual worlds, virtual reality, and augmented reality. We found 21 articles that used these types of tools. Based on our observations, all three sub-categories are represented in our database. Table 14 lists the findings from our database.

Category	Tools
Virtual Worlds	Second Life English Village (virtual context) 3D Immersion

	a three-dimensional virtual environment (3DVE) EduVenture VR
Virtual Reality (VR)	VR (general) Mobile VR Oculus Go VR system PC game (VR) Role-play practice: “Poisoning the Pigeons in the Park”
Augmented Reality (AR)	AR (general) AR application Augmented reality (AR)

Table 14. Tools for immersive learning

The tools for immersive learning, such as virtual worlds, VR, and AR, can create interactive and engaging environments that significantly enhance the educational experience. Virtual worlds like *Second Life* and *3D Immersion* offer learners the opportunity to interact within simulated contexts, while VR tools like *Oculus Go* provide fully immersive experiences that simulate real-life scenarios. Additionally, AR and mixed reality technologies overlay digital elements onto the real world, blending virtual information with physical surroundings to enrich the language learning environment and offer dynamic, contextual learning opportunities. By integrating these technologies, educators can foster deeper engagement and practical application of knowledge, making learning more interactive and experiential. We have also introduced recently a third subcategory, 'Mixed Reality Tools,' which captures the rapid advancement of virtual tools in teaching and learning. This new subcategory effectively reflects the growing integration of mixed reality technologies in educational environments.

In sum, from our database, we identified 342 tools used in those articles, and we classified them accordingly. The details are shown in Table 15.

Category	Number of tools

1. For the development of didactic content	7
2. For the acquisition of didactic content	0
3. For practice and use of the language	126
4. For creation	15
5. For communication and collaboration	54
6. For learning management	20
7. For note-taking	0
8. for vocabulary management	6
9. for translation management	10
10. for teaching development	11
11. for natural language processing	8
12. for social and cultural projects	28
13. for ICT-based exploration and research	36
14. for immersive learning	21

Table 15. Overview of the results

4.5 Discussion

For this research, we collected a total of 299 articles in our database from five journals, published between 2014 and 2023 (Table 16).

Journal	Total articles	Published date
Language Learning & Technology	197	From 2014 to 2023
ReCALL	54	2023
CALL	30	2023
JALT CALL	10	2023

CALICO	8	2023

Table 16. Sources of the database

We identified 342 technologies from the above articles which are used for language learning, teaching, and research. We categorized these ICT technologies into our ICT classification framework, and the distribution of each category is shown in Figure 5.

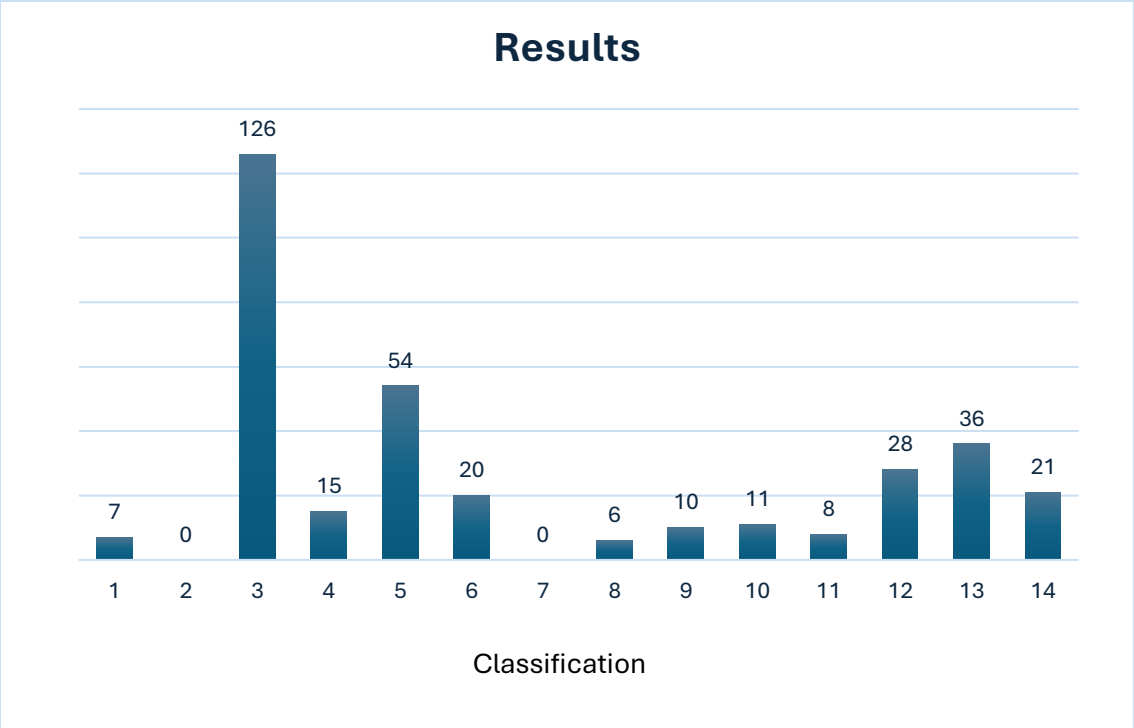

Figure 5. Distribution of classes

The analysis of ICT resources used in language learning, teaching, and research across five journals reveals significant trends in how these technologies are integrated into practice and how they facilitate research and language acquisition. Notably, it is uncommon for practitioners to rely on a single type of ICT. Instead, they typically combine multiple technologies to enhance their effectiveness. For instance, in a study focused on improving students' pronunciation, the authors employed an online classroom supported by videoconferencing, augmented reality (AR) filters, and annotation technologies (Wen et al., 2023).

With globalization and the rapid development of technologies, cultural exchanges have become increasingly complex, influencing language learning and use. ICTs are extensively utilized to meet learners' needs, as highlighted by Wilkinson (2016). He pointed out that certain aspects of Computer-Assisted Language Learning (CALL) are particularly pertinent to foreign language acquisition from the perspective of interactionist theory. These aspects include novel input formats like hyperlinked text with multimedia integration and visual features of CALL applications that enhance input properties such as typographic or phonological characteristics. These features appear to increase awareness of language elements and common errors (Wilkinson, 2016).

Our data analysis revealed a significant trend: the extensive use of ICT tools in language practice, with 126 tools identified. This dominance underscores a strong emphasis on practical language application, highlighting the importance of immersive, interactive, and repetitive practice in language acquisition. It illustrates the shift from traditional, teacher-centered classrooms to student-centered online learning environments. These tools encompass a range of applications and platforms that facilitate speaking, listening, reading, and writing exercises, allowing users to interact simultaneously. This trend reflects a pedagogical shift towards more dynamic and engaging methods of language learning.

The category of tools for communication and collaboration ranks second with 54 identified tools, while tools for ICT-based exploration and research rank third, with 36 tools identified. The prominence of communication and collaboration tools aligns with the widespread use of social networks globally, especially during the COVID-19 pandemic. This category includes tools such as *Zoom*, *Skype*, and platforms for virtual exchange. On the other hand, the strong showing in ICT-based exploration and research tools indicates a robust integration of these tools into research-based pedagogies. This category includes various online corpora, like *Coh-Metrix*, and other integrated development environments that allow users to design their own systems or projects.

To validate our analysis, we conducted a bibliometric study (with *Biblioshiny* [2]) using data from *Scopus*, focusing on the keywords **"ICT in language learning"** and examining research from 1997 to 2024 (Figure 6). This study generated a frequency map (Figure 7) that provided key insights into our research. Firstly, the high frequency of terms such as **"students"** and **"e-learning"** emphasizes a learner-centered approach and highlights the prominence of online education platforms. This finding is consistent with our largest category, **"Tools for Practice and Use of Language"**.

Furthermore, the frequent mention of **"students"** and **"teaching"** underscores the crucial role of ICT tools in facilitating student interaction and engagement. Categories like **"practice and use of the language"** and **"communication and collaboration"** are central to the educational experience of students, reflecting their importance within our framework. The substantial frequency of **"students"** supports the relevance of tools designed for these purposes and reinforces their role in creating effective learning environments which are learner centred. This also demonstrates the comprehensive integration of ICT in education, indicating that educators and teachers are increasingly utilizing online resources to expand their research and enhance their teaching, particularly in the context of language practice and application.

Similarly, the frequent appearance of the term **"e-learning"** highlights the growing importance of digital learning tools in modern education. This term's prominence supports the relevance of categories such as **"practice and use of the language"**, **"communication and collaboration"**, and **"immersive learning"**, all of which are closely related to various aspects of e-learning. Thus, our framework effectively captures the key areas where e-learning tools are applied.

In summary, the high frequency of terms like **"students"**, **"e-learning"**, and **"teaching"** aligns well with the categories in our classification framework. This correlation validates the relevance of our classification by demonstrating that it

[2] *Biblioshiny* is a web-based tool integrated with the *Bibliometrix R* package, designed for bibliometric analysis. It allows users to analyze and visualize academic data without the need for coding. In our research, we used *Biblioshiny* to extract data from *Scopus* and perform bibliometric analyses, such as citation trends and keyword analysis, to support our data analysis.

accurately reflects the focal points of current research and literature in the field of ICT tools for language education.

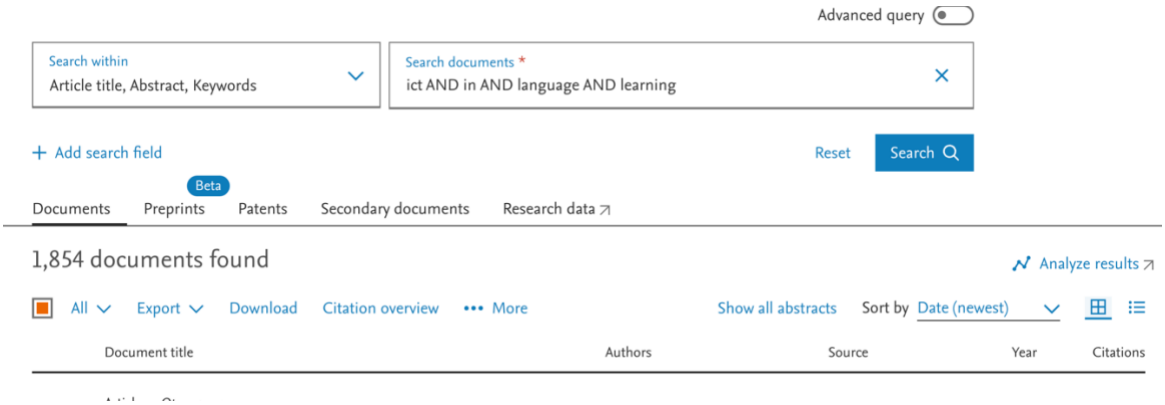

Figure 6. Database of *Scopus*

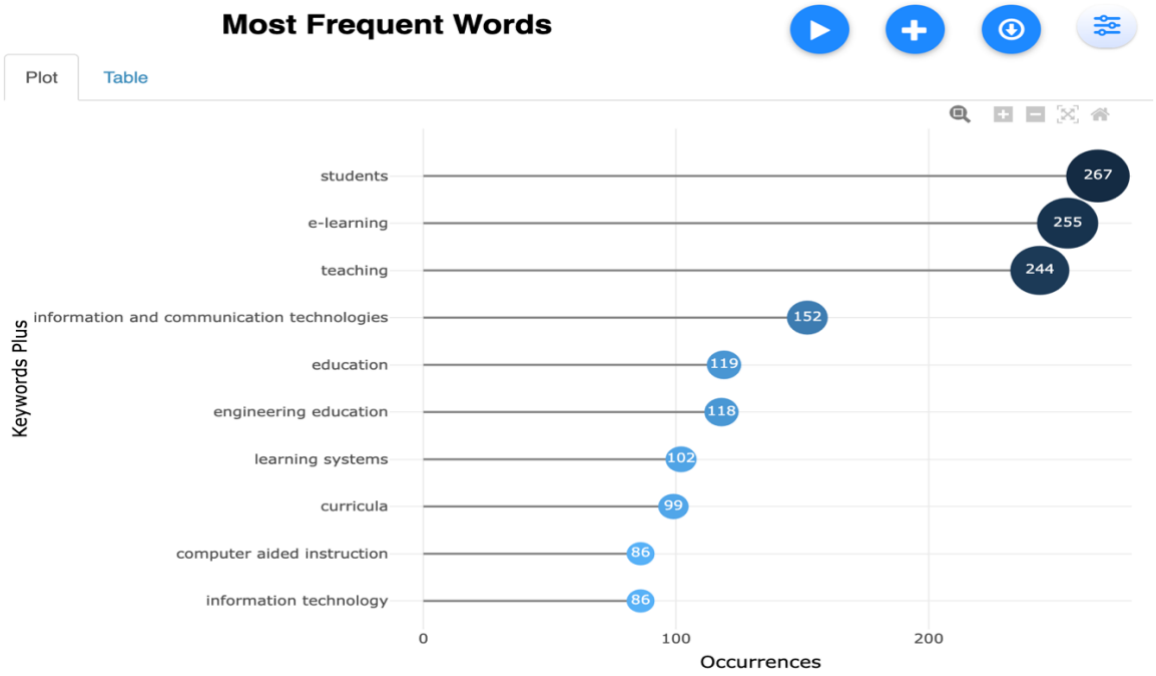

Figure 7. Map of words frequency (data extracted from *Scopus*)

Nevertheless, certain categories reveal a notable absence of tools, particularly those for notetaking and the acquisition of didactic content, both of them reporting zero tools. This absence could point to potential gaps or underexplored areas within the current

ICT landscape for language education. The lack of tools specifically for notetaking is particularly surprising, given that effective note-taking is a fundamental skill for language learners, aiding in comprehension and retention. On the one hand, note-taking tools such as *Microsoft OneNote* and *Apple Notes* are often integrated within broader systems. This integration might lead researchers to overlook these tools in their analyses, as their functionality might be considered basic or inherently embedded in more comprehensive platforms. On the other hand, traditional document applications like *Microsoft Word* and *Google Docs* also support note-taking functions, offering features such as text formatting, multimedia insertion, and organizational tools. These multifunctional applications could serve the note-taking needs but are not explicitly categorized as such in the current data. The absence of dedicated note-taking tools in the records highlights a potential area for further exploration and development. Researchers and developers might need to address this gap by exploring and innovating within this domain to provide more specialized solutions for language learners. Additionally, a more comprehensive review of resources, including those that may not have been initially categorized, could offer insights into addressing this shortage and enhancing the overall toolkit available for effective language learning.

In addition, the categories of creation (15 tools) and immersive learning (21 tools) reflect a moderate but clearly growing interest. Tools for creation likely involve student-generated content, which enhances creativity and personal expression in language learning. These tools enable learners to engage in activities such as producing multimedia projects and shaping their educational experiences. Immersive learning tools, including virtual reality (VR) and augmented reality (AR) applications, represent an emerging trend toward more experiential and situational learning contexts. These tools simulate real-world environments or scenarios, allowing learners to interact with and immerse themselves in dynamic learning experiences. As education becomes increasingly multidisciplinary, language learning is also embracing creativity and innovation. Tools like *Canva* and *Miro*, which facilitate telecollaboration and collaborative creation, are becoming more and more popular. Similarly, platforms for video dubbing and creation are gaining traction, providing learners with new ways to practice and apply their language skills. VR and AR tools, which offer interactive and engaging experiences, are also on the rise.

We extracted data from *Scopus* with the keywords **"virtual language learning"** and generated a chart (Figure 8) that clearly shows the growing popularity of virtual tools. This map suggests that the categories of creation and immersive learning are likely to expand significantly soon. Furthermore, we categorized human droids and robots under creation tools. While these technologies provide immersive learning experiences, they offer more than just conversation practice. Human droids and robots have the potential to integrate various resources and deliver comprehensive teaching and learning services, especially with advancements in artificial intelligence (AI). These tools could transform language education by offering interactive and adaptive learning experiences tailored to individual needs, further enhancing their potential in language education settings.

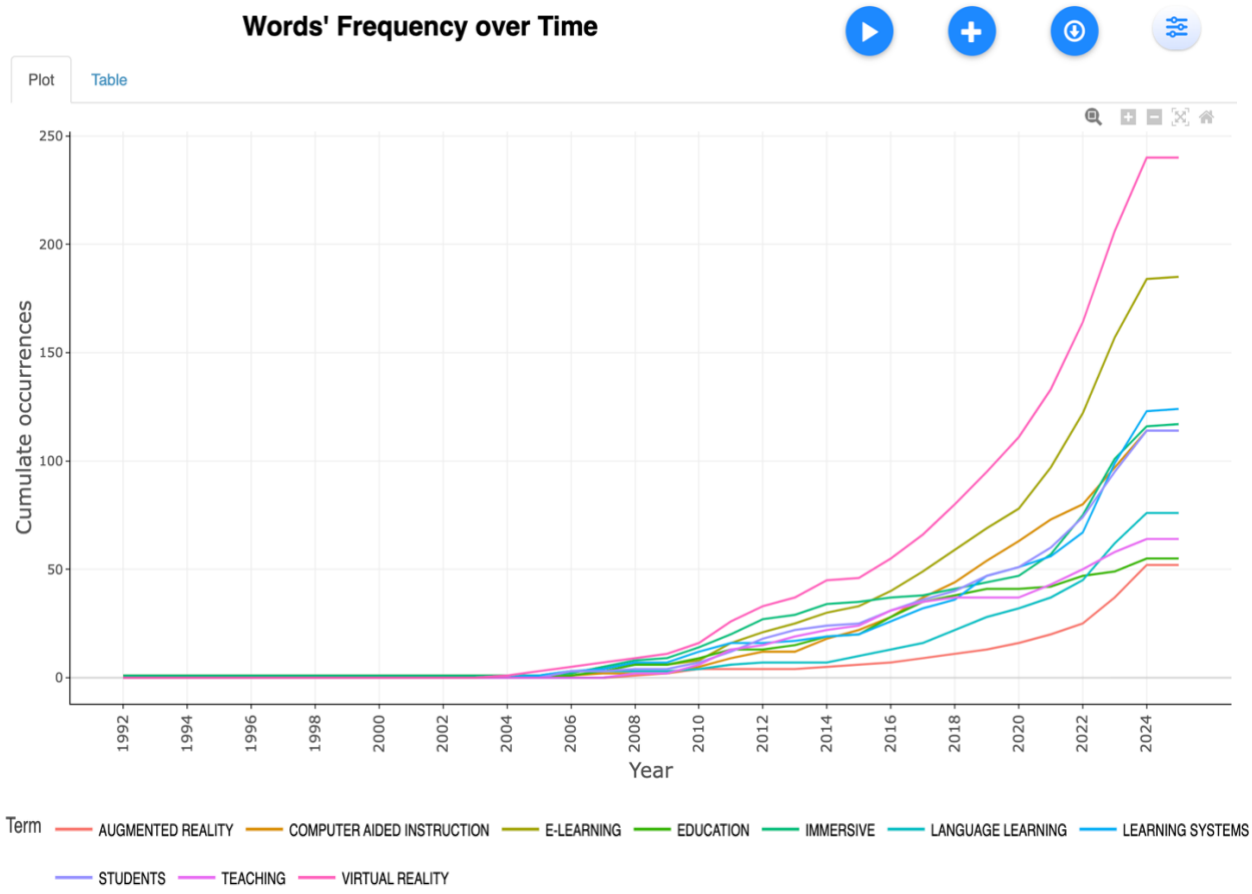

Figure 8. Words´ Frequency over time (data extracted from *Scopus*)

Tools for teaching development (11 tools) and natural language processing (8 tools) also appear, albeit to a lesser extent. Teaching development tools may encompass

platforms for teacher training and professional development, which are crucial for maintaining high teaching standards. Natural language processing tools, which facilitate automated language analysis and feedback, remain in their nascent stages but hold significant potential for the future. We believe that with more technologies, researchers are keen to develop new ICT tools to train educators in order to improve teaching methods and enhance the education environment. In addition to focusing on training teachers, researchers are also showing great interest in uncovering the undiscovered aspects of language using new technology, as illustrated in Figure 9 (a chart generated using data from *Scopus* and *Bibliometrix*). There is a strong emphasis on developing advanced natural language processing (NLP) systems, integrating artificial intelligence (AI) and machine learning to handle complex language tasks. The data indicates a multidisciplinary approach, combining computational linguistics and AI to enhance language processing capabilities. Overall, the trends point to a dynamic field that seeks to create intelligent, efficient, and versatile language processing tools.

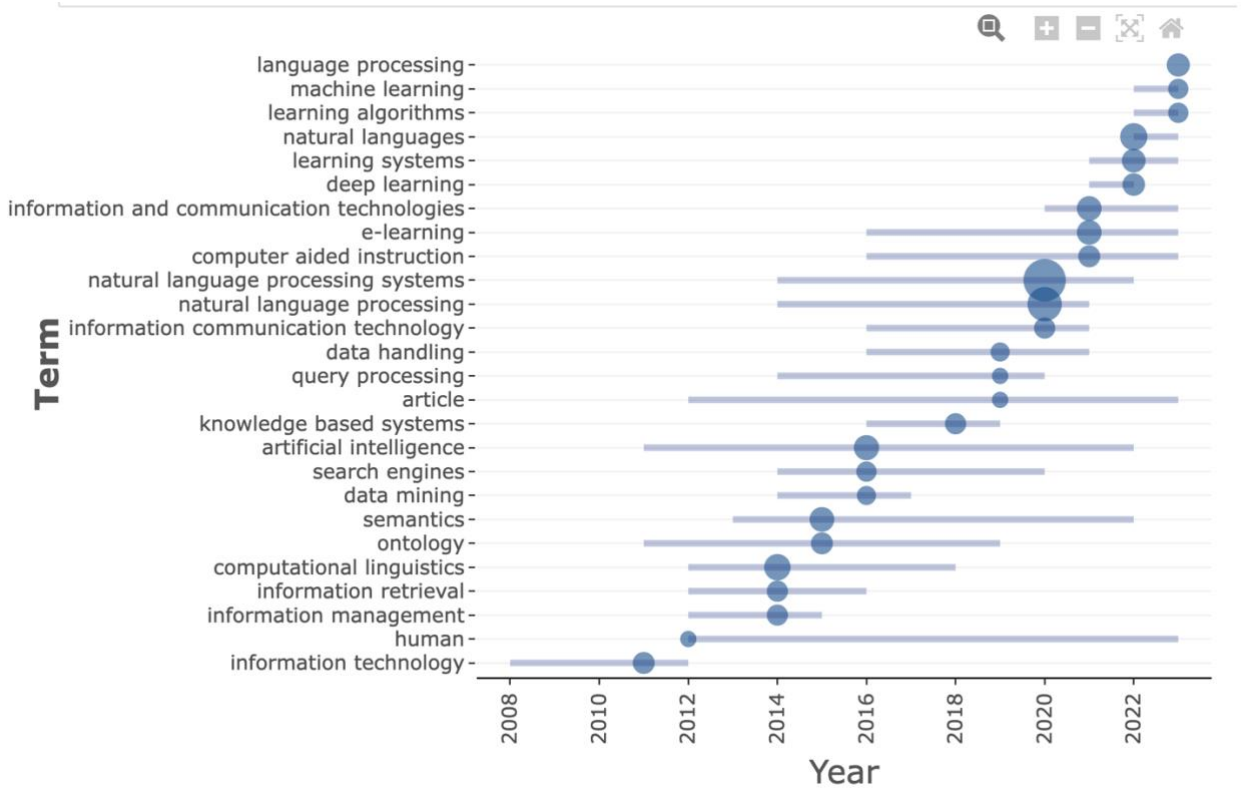

Figure 9. Trend Topics in natural language processing (data extracted from *Scopus*)

In summary, our research indicates trends that suggest a strong emphasis on practical language use, communication, and research, with notable strengths in interactive and collaborative tools. Nevertheless, there are clear opportunities for growth in areas like note-taking and didactic content acquisition. The overall landscape indicates an ongoing evolution toward more interactive, creative, and immersive learning experiences in language education, with room for further innovation and expansion in underrepresented categories (Figure 10).

Figure 10. Key words from our database

Next, our research questions will be reviewed.

Q1: How do the identified ICT tools in language learning and teaching literature align with our established framework of classifications?

The identified ICT tools in language learning and teaching literature generally align well with our established classification framework, demonstrating both strengths and areas for potential growth. The alignment is particularly evident in categories such as "practice and use of the language," which includes 126 tools, and "communication and collaboration," with 54 tools. These categories are prominently represented, indicating a clear priority in the literature for tools that facilitate active engagement and collaborative learning environments. This focus aligns with the evolving concept of literacy in the twenty-first century, which extends beyond traditional reading and writing

to encompass digital, art, oral, and written literacies. As Wilkinson (2016) notes, L2 activities now incorporate tasks like digital storytelling, blog interaction, email writing, source evaluation, plagiarism avoidance, and electronic portfolio development. These tasks not only enhance language skills but also foster broader digital literacy competencies.

Additionally, the categories for "learning management" (20 tools) and "immersive learning" (21 tools) show substantial alignment with the framework. They reflect the importance of managing educational processes effectively and incorporating immersive technologies to create engaging and realistic learning experiences. The presence of 36 tools for ICT-based exploration and research further supports the emphasis on advancing research methodologies and exploring new educational frontiers.

The category for "ICT-based exploration and research" with 36 tools underscores the significant role of technology in advancing research methodologies and exploring new educational scenarios. For example, a teacher might compile a collection of web resources on verb tenses or pronunciation features, and then design activities for students to practice with the material. This approach not only supports research but also enhances teaching by providing practical, interactive resources for learners. This strong alignment suggests that the integration of ICT in research is a critical area of focus, promoting the development of innovative tools and methods in language education.

However, the framework also reveals areas where the alignment is weaker, such as "acquisition of didactic content" and "note-taking," both of which have zero identified tools. This discrepancy suggests that either existing technologies are not being adequately utilized or that there is a lack of development in these specific areas. These gaps present opportunities for further research and innovation to address these needs.

There is moderate alignment in categories like "creation" (15 tools), "social and cultural projects" (28 tools), and "natural language processing" (8 tools). Although these areas show clear interest and development, the number of tools indicates that there is still room for growth. Tools that support creativity, social-cultural integration, and automated language analysis are essential for a well-rounded language education, and their current representation suggests that their potential is not yet fully realized.

Overall, the identified ICT tools fit well with our established framework, revealing strong trends in interactive and collaborative learning. However, they also highlight areas that need more focus. This alignment offers a clear snapshot of the current state of language education and helps guide future efforts to develop and integrate ICT tools more effectively.

Q2: What impact does the categorization of ICT tools into the 14 classifications have on the efficiency and accuracy of research in language learning and teaching?

We believed that categorizing ICT tools into 14 distinct classes would significantly boost the efficiency and accuracy of research in language learning and teaching. By organizing these tools systematically, researchers and educators could gain several advantages.

Firstly, this classification helps researchers narrow down their focus from the vast and growing pool of ICT resources. Instead of sifting through a vast array of tools, they can focus on categories that align with their goals, making their investigations more targeted and efficient. In addition, the framework enables educators to tailor their teaching strategies more effectively. Each category highlights different aspects of language learning, such as communication or vocabulary management, allowing educators to design practices that best fit their needs. The framework also aids in smart resource allocation. Institutions can invest in tools that directly support their educational objectives. For example, if a school aims to improve students' writing skills in a second language, we recommend focusing on tools in Category 3. After analyzing data from our database, we concluded that most users have employed this type of tool for language practice, specifically for writing (Figure 11). Additionally, if the school is interested in developing a system related to this goal, we would suggest considering tools from Category 13, which are designed for ICT-based exploration and research.

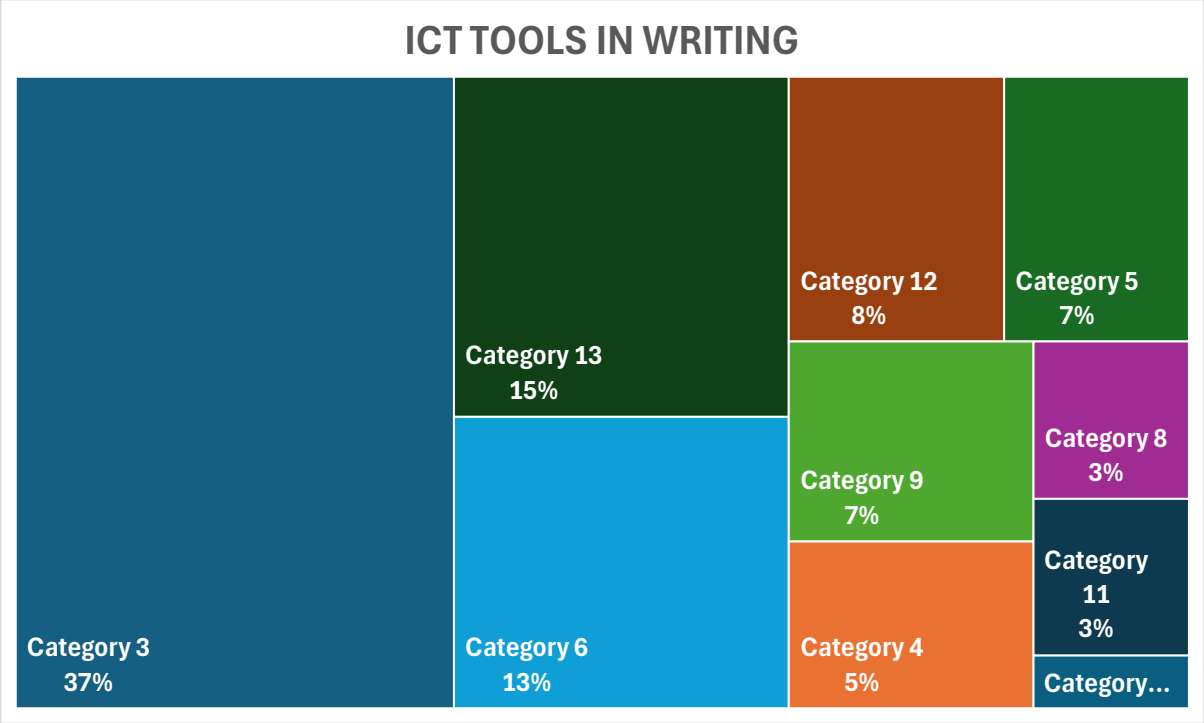

Figure 11. ICT tools used in writing

Moreover, this approach encourages a holistic view of technology use. Instead of concentrating on individual tools, educators can consider how different categories work together. For example, combining creation tools with communication tools can enhance student interactions and learning experiences. The framework also supports broader research efforts by making it easier to compare and synthesize findings across categories. Researchers can analyze trends and assess which tools are most effective for different aspects of language learning.

For example, we analyzed data based on the language skills (Figure 12). The breakdown by language skills (speaking, listening, reading, and writing) allows for a more nuanced analysis of how different ICT tools impact specific areas of language learning. This can lead to more targeted research and interventions. For example, Category 3 (practice and use of language) has high numbers across most skills, highlighting its broad applicability. Additionally, the data reveals trends such as high numbers in the "Comprehensive" column for several categories, suggesting a focus on integrated language learning approaches using ICTs. This common framework helps standardize research approaches and terminology, making it easier to compare studies and aggregate findings across different contexts.

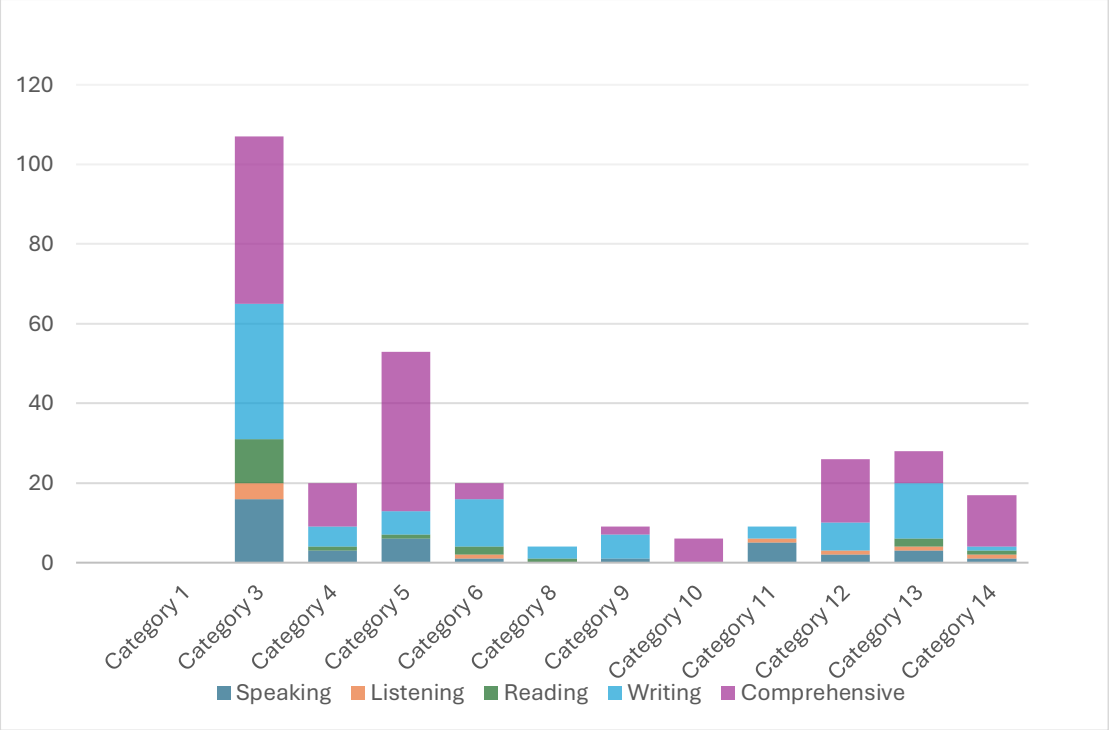

Figure 12. ICTs used for language learning (by skills)

Moreover, the detailed categorization allows for more precise evaluation of specific ICT tools and their impacts on language learning, rather than treating all technology use as a single category. The inclusion of categories like immersive learning (Category 14) reflects the evolving nature of technology in language education, keeping research relevant to current practices. Overall, this categorization system provides a structured framework for researching ICTs in language learning, which can increase efficiency and accuracy by allowing for more targeted, comparable, and comprehensive studies. However, researchers should remain open to emerging technologies or applications that may not fit perfectly within these categories to ensure the continued relevance and comprehensiveness of their work.

Finally, the categorization brings much-needed consistency and clarity. It provides a common language for discussing ICT tools, reducing confusion and making it easier to develop specific criteria for evaluating their impact.

Overall, this structured approach to categorizing ICT tools helps streamline research, optimize resource use, and improve our understanding of how technology can enhance language education. Within our ICT tools classification framework (Table 17),

educators and teachers can gain a clear understanding of which technologies are best suited for specific aspects of language learning. This empowers educators to make informed choices, ensuring a more effective and targeted integration of technology into the language learning process. By categorizing tools into distinct areas, such as practice and use of the language, communication and collaboration, and immersive learning, educators can select the most appropriate technologies that align with their instructional goals and the needs of their students. This strategic approach not only enhances the learning experience but also optimizes resource allocation, promotes innovative teaching methods, and supports the development of comprehensive language skills.

	Speaking	Listening	Reading	Writing	Comprehensive
Articles	34	7	16	76	127
Category 1	0	0	0	0	0
Category 3	16	4	11	34	42
Category 4	3	0	1	5	11
Category 5	6	0	1	6	40
Category 6	1	1	2	12	4
Category 8	0	0	1	3	0
Category 9	1	0	0	6	2
Category 10	0	0	0	0	6
Category 11	5	1	0	3	0
Category 12	2	1	0	7	16
Category 13	3	1	2	14	8
Category 14	1	1	1	1	13
Note: Category 2 and 7 are omitted because no result falls into these two.					

Table 17. Classification details of ICTs used in language skills

Q3: How can the classification of ICT tools inform future research and development in the field of language learning and teaching?

The classifications of ICT tools can significantly inform future research and development in the field of language learning and teaching by highlighting current strengths, identifying gaps, and suggesting areas for innovation. Analyzing the data from the chart provides insights into where efforts are most concentrated and where there are opportunities for further development.

We used *Scopus* to generate a database containing 643 articles from 1982 to 2024 and conducted a bibliometric study (Figure 13), confirming that our classification framework could assist researchers and educators in future teaching and research. The classifications of ICT tools could significantly inform future research and development in the field of language learning and teaching by highlighting current strengths, identifying gaps, and suggesting areas for innovation. The frequency data in the image underscores the prominence of deep learning, learning systems, and natural language processing, which suggests that future research could focus on integrating these technologies into language learning tools, particularly in categories such as practice and use of language (Category 3), natural language processing (Category 11), and immersive learning (Category 14). By mapping current research trends to these 14 categories, researchers could pinpoint underexplored areas, especially where few studies address notetaking (Category 7) or vocabulary management (Category 8), indicating opportunities for innovation.

Term	Frequency
deep learning	76
learning systems	62
human	61
natural language processing systems	58
machine learning	55
teaching	49
natural language processing	45
article	44
students	42
learning algorithms	41

Figure 13. Trend topic (data from *Scopus*)

Furthermore, the presence of terms like "machine learning" and "learning algorithms" indicates potential for interdisciplinary approaches, combining insights from computer science and language pedagogy, which could lead to more sophisticated tools for developing didactic content (Category 1) and acquiring didactic content (Category 2). The high frequency of "human" in the data emphasizes the importance of user-centric approaches, suggesting that future research could focus on designing ICT tools across all categories to better support human learning processes. In addition, the prominence of "learning systems" suggests a trend toward adaptive learning, which could guide developments in learning management (Category 6) and ICT-based exploration and research (Category 13), leading to more personalized language learning experiences.

Moreover, since natural language processing (NLP) appears frequently, researchers might explore its application across multiple categories, particularly in translation management (Category 9) and communication and collaboration (Category 5). The term "students" in the frequency list highlights the importance of learner perspectives, which suggests that future research should involve more student feedback and user studies across all ICT tool categories. The classification framework could also provide a structure for long-term studies on the effectiveness of different ICT tools, thereby informing best practices in categories like teaching development (Category 10) and social and cultural projects (Category 12).

To sum up, the data from our study reveals a strong focus on tools for "practice and use of the language" (126 tools) and "communication and collaboration" (54 tools) (Figure 14). This suggests that current research and development prioritize interactive and practical language use, which are essential for developing core language skills such as listening, reading, writing, speaking, and conversation. These areas of emphasis are critical for creating engaging and effective language learning experiences. Future research could further enhance these tools by integrating more advanced features like adaptive learning technologies and AI-driven personalized feedback to improve learner outcomes.

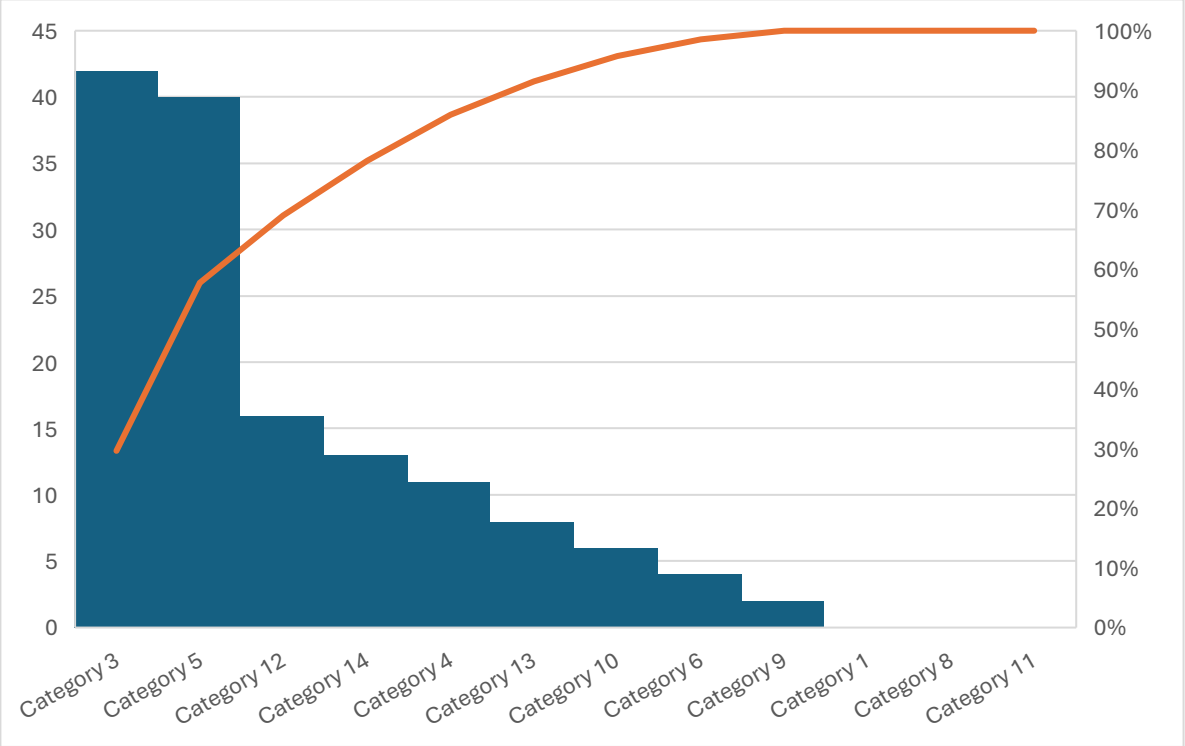

Figure 14. ICT tools in language learning (comprehensive skills)

In Figure 14, the X-axis of the graph represents the types of ICT tools, arranged from left to right in descending order of proportion, with the proportions decreasing as you move to the right. The Y-axis on the left represents the number of articles for each type, while the Y-axis on the right shows the cumulative percentage.

On the other hand, the absence of tools in categories like "note-taking" and "acquisition of didactic content" highlights significant gaps in the current landscape of ICT tools for language learning. Addressing these gaps could involve developing innovative note-taking applications that cater specifically to language learners, incorporating functionalities that support vocabulary building and content retention. Additionally, creating tools for the acquisition of didactic content could provide learners with diverse and tailored educational materials, thereby enriching their learning experiences.

Moreover, the moderate number of tools in categories such as "immersive learning" (21 tools) and "ICT-based exploration and research" (36 tools) indicates an emerging interest in integrating cutting-edge technologies like virtual reality (VR) and augmented reality (AR) into language education. These tools have the potential to create

immersive and situational learning experiences that can significantly enhance language acquisition. Future research could focus on evaluating the effectiveness of these immersive tools and expanding their use in various educational contexts.

In conclusion, the classification of ICT tools into these 14 categories not only provides a clear picture of current research focuses but also highlights areas ripe for innovation and further investigation. By addressing the identified gaps and building on the strengths of existing tools, future research and development can create more comprehensive, effective, and engaging language learning solutions.

4.6 Implications, limitations, and future research

Based on our observations, ICT resources have been fully integrated and are widely used across the globe. In our study, we noticed that the use of ICT resources spans teaching, learning, and pure research, covering languages from English, Spanish, and Chinese to Swedish, Irish, and Latvian (see Figure 15). Some studies in our database conduct research on language learning in general, indicating that the models they studied could be applied to other languages. For example, Fryer et al. (2020) investigated how chatbots affect foreign language learning, showing that chatbots can handle various languages and that their study results could be applied to many language learning contexts. Additionally, we observed that scholars are increasingly leveraging ICT resources to conduct research across multiple languages, making multilingual research more prevalent and accessible.

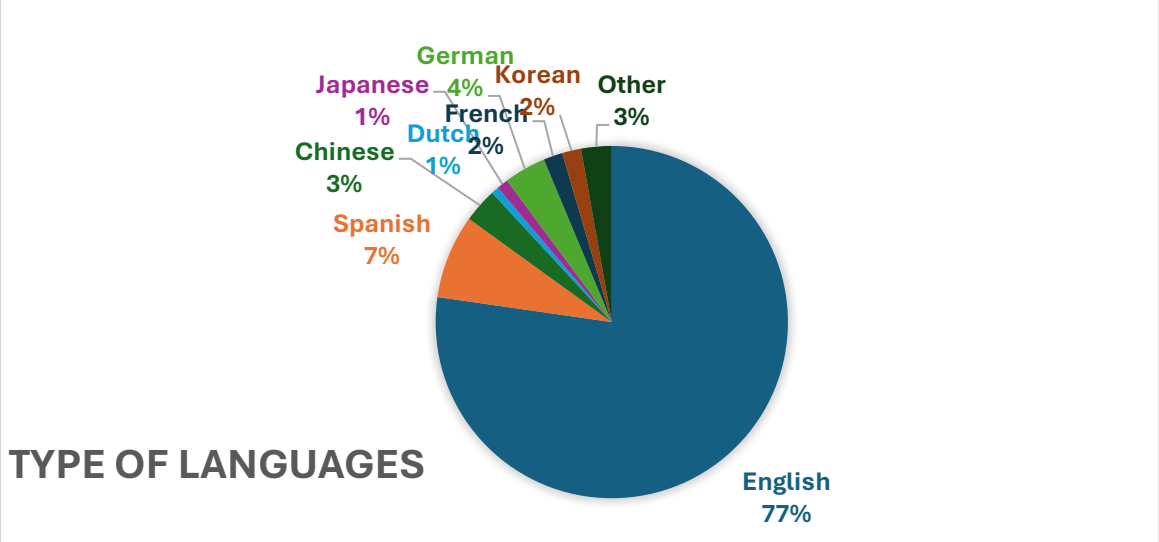

Figure 15. Type of targeted languages

Our categorization of ICT tools into 14 distinct categories has several significant implications for language learning and teaching. Firstly, it highlights the comprehensive integration of ICT tools across different aspects of language education, from didactic content development to immersive learning experiences. This categorization underscores the versatility of ICT applications, encouraging educators and researchers to explore a wider range of tools tailored to specific educational needs.

Secondly, the framework allows for the identification of gaps and opportunities within the current use of ICT resources. The notable absence of tools for note-taking and didactic content acquisition suggests areas where future innovation and research might be particularly impactful. By pointing out these underexplored categories, our framework directs attention to potential avenues for development that could enhance language learning and teaching.

Moreover, the trend of using ICT resources for multilingual research indicates a shift towards more inclusive and globally relevant educational practices. This trend facilitates the sharing of knowledge and methodologies across different linguistic contexts, promoting a more collaborative approach to language education research. The ability of ICT tools to support multilingual studies underscores their role in bridging linguistic barriers and fostering a more interconnected global educational landscape.

In conclusion, our research and the resulting 14-category framework provide a valuable roadmap for the future of ICTs in language learning and teaching. By highlighting current strengths, identifying gaps, and suggesting areas for innovation, this framework could guide researchers, educators, and policymakers in making strategic decisions that enhance the integration and effectiveness of ICT resources in language education. The ongoing evolution and increasing sophistication of these tools promise to continue transforming the landscape of language learning, making it more dynamic, inclusive, and effective.

However, this research does have limitations. The categorization process may oversimplify the complex and multifaceted nature of ICT tools. By grouping diverse tools into broad categories, we run the risk of overlooking the nuances and unique features of individual tools. For instance, one ICT tool can serve multiple functions, making it challenging to fit neatly into a single category. *Google Docs*, for example, is

used by researchers for notetaking and by teachers for collaborative writing in the classroom. Thus, classifying it under Category 4 may not fully capture its varied uses.

Additionally, our data is limited to articles from specific journals, which may not comprehensively represent the global landscape of ICTs in language learning. These journals specialize in language learning, and the ICT resources they discuss may be limited to certain types. For example, we did not identify any resources in our Category 7, Tools for notetaking. The rapid development of ICT resources further complicates the typology. Many tools are cross-platform and versatile. *ChatGPT*, for instance, is available online and on mobile devices. It has been used to generate teaching materials (as noted by Shin & Lee, 2023), can serve as a translation tool, and may soon be integrated with VR goggles. Thus, classifying it solely under Category 4, Tools for Creation, may limit its perceived functionality. This suggests a need for more subcategories to better segment these tools. Lastly, while we aimed for a comprehensive review, the swift pace of technological advancement means our study is constrained by the publication dates of the articles reviewed. We also need to clarify the definitions of each category to ensure they are self-explanatory, making our typology more intuitive and easier to accept and use.

In future research on our ICT resource classification, we could focus on several key areas to improve its effectiveness. On the one hand, we might consider the ten characteristics proposed by Towndrow and Vallance (2004, p. 105) to complete and furnish our theoretical framework on this typology:

- Facilitate activities that are difficult or impossible in a print-based realm
- Enable the integration of digital media
- Provide flexibility regarding time and place of learning
- Offer access to a wide range of information
- Support a focus on both the products and processes of learning
- Allow instructional material to be stored and reused
- Encourage discussion and consultation
- Provide channels for feedback and assessment

- Minimize or eliminate the need to duplicate existing materials
- Save time for learners and instructors

In addition, we would consider whether the use of ICTs provides L2 learners with enriching and diverse language learning experiences in the classroom (Wilkinson, 2016).

On the other hand, we might first refine the categories and add new subcategories to better capture the diverse functionalities of ICT tools. We could expand our data sources to include a broader range of journals and publications, which might offer a more comprehensive view of global ICT practices. We might collect feedback from educators and researchers which could help us identify practical limitations and areas for improvement. Also, staying updated with technological advancements is essential to ensure our classification remains relevant and up to date. We could analyze how cross-platform and multifunctional tools are used in various educational contexts, which might assist in refining our classifications. Finally, evaluating the real-world impact of our classification system could provide insights into its effectiveness and guide further adjustments.

5. Conclusion

While the integration of ICT in education has been extensively studied, research specifically focused on classifying ICT tools for language learning based on their functions is relatively scarce. Existing studies often approach ICT integration primarily from a technological perspective, which might overlook the broader educational context. Teachers today face a wide range of ICT resources, from free web tools to advanced commercial programs, all of which could significantly enhance L2 learning.

Given the variety of digital tools available, teachers might explore new possibilities that were not feasible even a decade ago. As educators Stommel and Morris (2024) believe, effective digital teaching involves working with familiar tools, incorporating them incrementally, adapting and improvising, and allowing space for creative exploration. Teachers need to be clear about their educational goals and understand how specific ICT tools could enhance learning. Designing meaningful activities that

engage learners and contribute to their motivation is essential for achieving greater learning effectiveness.

We reviewed 299 articles from five journals, covering the period from 2014 to 2023. Through this analysis, we identified and categorized the technologies discussed into our framework. Our classification framework effectively reflects current trends in ICT resources and systematically organizes the available tools. This structured approach not only highlights existing ICT tools but also establishes a foundation for future research. We hope that our research will open new avenues for studying ICT resources and inspire further exploration in this evolving field.

Our research, focused on classifying 14 types of ICT language learning tools, aims to bridge the gap in understanding and utilizing these resources. By linking L2 theories with ICT tools and considering practical implications of tool selection, we seek to provide a framework that could help teachers make informed decisions. This system could guide educators in implementing ICTs in ways that align with their educational goals, offer significant pedagogical value and foster more effective, innovative language learning experiences. Additionally, learners could use the framework to manage their learning and personalize resources, promoting autonomy, while educational researchers could study the impact of technology-based tools on enhancing learning outcomes.

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