

RESEARCH ARTICLE

Technology-Assisted Language Learning Systems: A Systematic Literature Review

HAREESH BUDDHA¹, LIYANA SHUIB¹, NORISMA IDRIS², AND CHRISTOPHER IFEANYI EKE³

¹Department of Information Systems, Faculty of Computer Science and Information Technology, Universiti Malaya, Kuala Lumpur 50603, Malaysia

²Department of Artificial Intelligence, Faculty of Computer Science and Information Technology, Universiti Malaya, Kuala Lumpur 50603, Malaysia

³Department of Computer Science, Faculty of Computing, Federal University of Lafia, Lafia, Nasarawa 950101, Nigeria

Corresponding author: Liyana Shuib (liyanashuib@um.edu.my)

ABSTRACT This study provides a systematic review of technology-assisted language learning. This study provides a summary content of the reviewed articles in the aspects of technology usage, language, and learning skills, and the benefits offered by technology in language learning. The study focused on the published articles between 2012 and 2022. Out of 5719 articles initially retrieved from five academic databases and reviewed, twenty-seven (27) research articles were selected. Based on the review findings, the most used technology is the intelligent system (n=7). The study also revealed that the most common target language is English (n=22), whereas skills such as vocabulary, writing, and grammar gained the most attention in the selected studies. The review also identified and analyzed the empirical evidence on the benefits of technology in language learning, such as language performance development, motivation, metacognitive skills, positive attitudes towards learning, enhancement of students' learning retention, collaborative learning model, and extensive learning opportunity. Barriers to the implementation of the technology, such as learning anxiety, insufficient technology literacy, and technical limitations, were also recognized, and some suggestions were provided to overcome those barriers. Thus, this review can be used as a guide for educators and researchers who intend to design technology-assisted language learning and teaching in the future.

INDEX TERMS Language learning, learning skills, systematic literature review, technology-assisted language learning.

I. INTRODUCTION

The rapid growth in technology has brought a vast revolution in the domain of education, and it has remained that the absence of computer or internet access in the world will make it necessary for the recent growth [1]. Scholars and teachers are researching efficient methods to tutor students in various subjects by introducing new technology. This is because there is a notion that technology application has more impact on students learning attitude, behaviour, and interest in different subjects when compared to the traditional approaches to teaching [2]. The same thing applies to language learning systems. Thus, technology-enhanced education is gaining popularity. When conventional classroom instruction in person was not practicable, technological innovations in

education saved the day the year 2020 due to COVID-19 [1], [3]. Many studies, including those in [4], [5], and [6], maintained the fact that there are benefits to studying using technology, especially if it concerns foreign language acquisition. However, providing personalized feedback is still lacking in many language e-learning systems. To properly determine performance variance, it is essential to identify students' learning variations and how they impact the learning process [7]. Also, poor performance in second language acquisition has been primarily associated with learners' cognitive measures such as intelligence, reading disabilities, listening problems, etc. Nonetheless, a broader examination of individual learning variations is yet to be conducted. According to [8], "language learning styles and strategies" are the most essential variables among the learner's differences influencing performance in second language learning.

The associate editor coordinating the review of this manuscript and approving it for publication was Xueqin Jiang¹.

It is a common agreement among researchers in the second language teaching and learning domain that the level of success could influence individual learner differences and the eventual attainment of language learners. It is the key factor that, over the decades, the second language learning literature is flooded with discussion on learner styles, language strategies, and individual learner differences [9]. For optimal language progress, language instructors are expected to comprehend their students' learning styles and the cultural and cross-cultural roots that aid in shaping these styles. The inability to understand the learning styles and the corresponding partly cultural roots are actually not the teacher's problem. This is because various teachers' education training lacks the provision of the type of experience that would enable potential teachers to develop the competence in recognizing the learning styles of the students [10].

In relation to technology-assisted learning, it is asserted that the application of electronic learning tools, including notebooks personal computers (PC), tablets pc, desktop computers, and smartphones, has significantly improved, emerging the concept referred to as "Technology Assisted Language" (TALL) [11]. TALL is gaining ground as it is perceived that the approach of various technology-assisted language learning such as mobile devices or computers has opened the opportunity for efficient language learning [12]. The TALL concept in the scope of those studies leverages both computer-assisted language learning (CALL) and mobile-assisted language learning (MALL). CALL is a means of the learning process whereby the learner employs a computer to prepare and enhance their language learning abilities (such as writing, speaking, reading, and listening skills). Numerous merits of computer-assisted learning abound, such as the availability of authentic materials, experimental learning opportunities, high motivation, improved interaction opportunities, and global understanding [13]. On the other hand, MALL refers to any learning facilitated on a mobile device such as an mp3 player. Tablets, eBook readers, and podcasting [14]

Thus far, several reviews and surveys have been conducted in relation to the e-learning domain. For instance, Li et al. [15] conducted a review study on the learning styles. The study provided an overview of the current aspects of learning style classifications. The study also discussed the challenges and open research of learning styles in educational concepts. However, the study did not provide an in-depth review of the learning styles and strategies but only focused on their validity and usefulness. In another study, Lai et al. [16] carried out a systematic review of the evaluation of technology in education. The review covered the examination of themes or aspects involved in the use of technology in education. The results of the survey state that most of the papers evaluated learning in their studies. Some other papers evaluated affective behaviour, cognitive load, interpersonal skills, and learning styles. On the other

hand, Nabizadeh et al. [17] carried out a thorough analysis of the benefits, drawbacks, and assessment strategies of learning path personalization strategies. Path personalization parameters include the user's time limitation, the user's mastery of learning, the user's learning styles, and the user's knowledge background. However, the study centered more on the personalization method in the learning path. In relation to the adaptive learning system, Normadhi et al. [18] have performed a systematic literature review to identify different learner traits in adaptive learning systems. It reveals some learner characteristics such as learning styles and knowledge, cognitive styles, and personality types used to build student models. The study also identifies various methods (questionnaire or computer-based) applied in the context of adaptive learning environments to identify individual learner characteristics.

This review is different from the existing reviews because the existing studies concentrated on either the learning styles or the learning strategies, the learning paths, or the learning traits of the adaptive learning system. However, none of the existing studies provided a comprehensive review of the technology-assisted or language learning systems. Thus, this review provides in-depth details of studies focusing on the use of learning styles, specifically in language learning environments. It is the first of its kind in the field of learning styles used in technology-assisted language learning environments. The review then finds the problems and challenges faced by researchers in implementing such systems.

The major contributions of this study are as follows:

1. A comprehensive investigation of the technologies that have been used to assist in the language learning environment.
2. Outline and investigate the languages and the learning skills that previous scholars focused on.
3. A comprehensive review of the empirical evidence on the benefit of technology-assisted language learning.
4. A critical analysis of barriers posed to the learners and educators in implementing the technology in the language learning environment.

The remaining sections of the paper are organized thus; Section II of the paper provides a comprehensive background on technology-assisted language learning. Section III describes the review method. Review Results and Discussions are offered in section IV while section V wraps up the study.

II. TECHNOLOGY ASSISTED LANGUAGE LEARNING (TALL) SYSTEMS

In this section, a comprehensive background of TALL and the learning styles in TALL is provided. The section is divided into two subsections. Section A presents the technology-based learning and assisted language learning systems. In section B, the learning styles in TALL are provided. The details of the section are provided below.

A. TECHNOLOGY-BASED LEARNING AND ASSISTED LANGUAGE LEARNING SYSTEMS

Few language training professionals will oppose that the two major significant current revolutions in language learning are the beginning of technologies to teach-savvy learners, for whom these current technologies have been rooted in their daily lives [1]. The application of learning devices, including tablet PCs, desktop computers, smartphones, and notebook PCs, has progressively increased, combining both online and offline instructions. Various studies have maintained that smartphones and personal computers are the most employed among different learning devices in technology-assisted language learning [19], [20], [21]. In synchronization with the speedy development of technology and the revolutions in learners' understanding of that technology, several studies on technology-assisted language learning have been conducted [22], [23]. For instance, Uther and Banks [24] conducted a study on TALL content that compares the learning devices or learning platforms. In so doing, every participant tested their iPad and iPhone devices as language learning devices in correlation to sensory and cognitive affordance. In the study, forty-one people participated by completing the task with an iPad and iPhone and provided the rating observed in the quality of video and audio qualifying others to estimate the sending affordance in each device. Thereafter, the authors examined the mobile language learning (MLL) application as the device for cognitive affordance measurement in each device. However, the result of the study indicated that the iPad device performed better in both cognitive and sensory affordances. In another study, Cárdenas-Moncada et al. [25] carried out research on how students learning English were affected by digital game-based feedback mechanisms. (ELL) in higher institutions. The authors surveyed to examine students' perceptions and attitudes on the usage of Kahoot in English for foreign language (EFL) classes. In addition, the authors also conducted a questionnaire experiment study. The experimental results of the quasi-experiment indicated a statistically significant different score on a low-state test for students who use or disregard Kahoot. Also, the survey result indicated highly positive student attitudes and perceptions of the use of Kahoot. Thus, it contributes to the building of improved class roots and the fostering of enhanced academic preferences. However, one of the drawbacks of the Kahoot app is that it requires a strong Wi-Fi connection before it can function since multiple users connect to the platform. Similarly, Kew [26] conducted a study on the English language learning of a popular computer game known as Kahoot to enhance the performance of the students. In the study, the authors dug deeper by integrating the Kahoot application with the collaborative learning approach. The main aim of the study is to investigate the effect of Kahoot's application on the Japanese student's experience. Twenty (20) students in the population who enrolled in English class took part in the experiment. The findings from the research indicated that integrating Kahoot with collaborative learning had a positive effect on the students by adding

an improved engagement and learning experience on the students. However, the distraction from the background music in Kahoot, which could divert the attention of the student from learning to listening to music still remains one of the weaknesses of the study. However, up to the present time, none of the studies has comprehensively conducted systematic literature on TALL, which is the focus of this study.

B. LEARNING STYLE IN TECHNOLOGY-ASSISTED LANGUAGE LEARNING

Learning Styles is a way in which information is received, perceived, and stored. According to [27] "Learning style is a biologically imposed set of personal traits that make the same teaching and learning methods effective for some and ineffective for others". Learning styles affect the learning outcomes of the students [28]. Research conducted in educational settings has demonstrated the significance of learning style as a factor that determines academic success [29]. When teaching resources are customized to fit each student's unique learning style, students typically do better [30]. Research has also indicated a positive correlation between undergraduate students' learning styles and their academic achievement [31], [32], [33]. Choices for learning styles have been utilized in some research on school-age children's performance to forecast academic success [34], [35]. Learning styles and strategies are interrelated. Therefore, the discussion on the learning style cannot be completed without introducing the learning strategies. Learning strategies, on the other hand, are "methods for obtaining, establishing, or changing information" [36] that can be employed to thrive in an individual's study. For students, it is essential to recognize the study's method that can cause the acquired skills and knowledge to be sustained [36]. Knowing the learning strategies that are best beneficial for academic success is helpful to both the students and their instructors, who have the opportunity to execute the effective supportive methods in their syllabus [10]. Strategies are particularly crucial for language learning since they are devices for an effective and self-directed contribution that is helpful in the development of communication capability. Language learning strategies consists of dozens or hundreds of likely behaviors, including searching for conversation companions, organizing word for memorization purpose, or encouraging oneself to confront tough language task. Learning strategies are measures employed by learner for effective language learning, which may focus on the selected aspects of new information, monitoring and analyzing during procurement, expounding on new information during the encoding process, or having confident of the success in learning as a means of alleviating anxiety [37].

III. REVIEW METHOD

The systematic review, which initially originated in the field of medicine, is regarded as a reliable research method [38].

According to [39] “Systematic Literature Review (SLR) is a method to identify, evaluate and interpret available research literature relevant to a particular research topic or required to provide an answer to a given research question”. In this paper, the SLR is based on work proposed by [40]. Kitchenham and Charters [40] adapted the medical guidelines for SLRs to software engineering and sociology research. The purpose of conducting this SLR is to discover the research gaps in the existing studies, which contribute to further research. Thus, the research process objective is to recognize the research papers in the existing studies that investigate the technologies employed to assist in the language learning environment.

A. RESEARCH QUESTIONS

In order to review the latest research, the study targets previous works that have been published in the last decade between 2012 and 2022 based on research interest. For the identification of primary studies on which SLR will be based, the following research questions (RQs) have been formulated to achieve the objective of this research. To start with, the primary goal of this research is to find different technologies that are used to assist in the language learning environment by responding to the subsequent question in the study

RQ1: What are technologies that were utilized by the scholars in the previous studies in the language learning environment?

Various languages are being learned by language learners. In so doing, learners are expected to choose the language they want to learn. Moreover, irrespective of the choice of language that a learner has chosen, it is expected that the learners cover one of the skills of language learning, including reading skills, speaking skills, writing skills, listening skills, etc. Thus, this review’s second objective is to identify the various languages and learning skills that have been focused on by answering the following research question:

RQ2: What are languages and the learning skills that the previous researchers focused on?

The purpose of the application of technology in language teaching and learning is to see the effect on the learners. Thus, the effect of the technology on the learner can be positive or negative. This review intends to find the actual proof on the benefit of technology-assisted language learning by answering the following research question:

RQ3: What are the benefits of technology-assisted language learning?

The implementation of the technology in language learning poses a lot of barriers. Thus, this review aims to identify barriers to implementing the technology by answering the following research question:

RQ4: What are the barriers to the implementation of technology-assisted language learning?

B. REVIEW PROTOCOL

The review protocol defines the guiding method of the study by explaining the process employed to attain the objectives of this research. Thus, an efficient review protocol should

be predefined as it decreases the bias in the research [40]. Informal and formal searches have been done to identify the research objectives that were used to form the research questions (RQs), which helps in preparing a good protocol for the review. The process of review consists of various processes, including defining review research questions, setting the inclusion and exclusion criteria, the search strategy, studies selection, the quality assessment, data extraction, and data synthesis.

C. INCLUSION AND EXCLUSION CRITERIA

In the next step, selection criteria are created to select appropriate articles. This is done to improve the quality of the results and relies on “research questions, string search, and electronic databases” [39]. These criteria lay down a standard on which evaluation of extracted articles is done to decide whether to include or exclude such articles in the review. The inclusion criteria have been stated in the research protocol to clearly define the limits of review questions to reduce the article selection process. The criteria for the search process consist of the collection of suitable data from conferences and peer-reviewed journal articles that have been written in English and have been produced in six well-known academic databases, including IEEE Xplore, Science Direct, SpringerLink, ERIC, and Google Scholar, published in the last decade (2012 to 2022). The study should also surpass the minimum quality threshold criteria which are described in the next subsection. Exclusion criteria remove the studies from the review. Studies have been excluded if they are short papers, non-peer-reviewed papers, secondary or tertiary papers, duplicate studies, and non-English written or grey literature papers (e.g., books, thesis, dissertations, and so on). Duplicate papers of the same authors have also been excluded. The latest article is selected if many articles describe the same study.

D. SEARCH STRATEGY

In the search strategy, Kitchenham and Charters [40] guideline was employed to develop the search string. Designing an effective search strategy is a critical requirement for subsequent steps. A search strategy is designed to initiate the SLR with a search through relevant electronic databases to collect appropriate literature. A thorough literature search process is the main factor that distinguishes SLR from the conventional review. An automatic search has been done in this study in two different phases. In the first phase, keywords, as well as the semantics of research, have been defined. In the second phase, digital libraries and journals which will be used for searching papers are determined. Based on this, search terms have been developed using the following steps [41], including the process of identifying keywords in suitable articles or books, identifying synonyms and alternate spellings for major terms, deriving major terms from research questions, joining the major terms together using the Boolean AND & OR operators, and finding keywords in appropriate articles or books. The developed searched string

TABLE 1. Inclusion and exclusion criteria.

Included studies	<ul style="list-style-type: none"> • Primary studies article • Articles that utilized technology tools in language learning • Full text available • Articles published between 2012 and 2022 • Articles that included the learning skill(s) in the language learning • Articles are written in the English language • Articles that satisfy the minimum threshold • Peer-reviewed journals and conference proceedings
Excluded studies	<ul style="list-style-type: none"> • Secondary or tertiary studies • Full text unavailable • Non-English written articles • Duplicate articles from different database • Articles that did not include any technology tool in the learning • Articles that did not include the learning skill(s) in the language learning • Articles that only presented theoretical concepts such as a lesson learned, discussion, and recommendations • Review papers, book chapters, magazines, and white papers.

and keywords for the search process are shown in TABLE 2. The search string is made up of three items; Q1, Q2, and Q3 (as seen in TABLE 2). The keyword was searched, focusing on the title and abstract to retrieve a good number of articles. In so doing, six well-known academic databases, including IEEE Xplore, Science Direct, SpringerLink, ERIC, and Google Scholar were chosen to recognize suitable articles. The comprehensive lists of the searched databases with their results are depicted in TABLE 3. Following Keywords (and their synonyms) obtained through research questions using the steps described above have been used in this review with slight alterations fitting in various libraries:

TABLE 2. Items and keywords.

Item	Keywords and phrases	Synonyms
Q1	Technology-assisted	Computer-assisted, mobile-assisted, intelligent system, game system, digital system, mobile system, mobile game, technology-enhanced, computer-enhanced, mobile-enhanced
Q2	Language	English language, foreign language second language, etc.
Q3	learning	Studying, practicing, reading

E. STUDY SELECTION

A systematic literature search was performed on the chosen database by utilizing suitable keywords, and a total of 5719 articles were obtained. To eliminate the irrelevant

TABLE 3. Study selection process results.

Online Databases	Initial results	Selected studies
IEEE Explorer	400	1
Springers	200	3
Science Direct	2500	11
ERIC	19	1
Google Scholar	2600	11
Total	5719	27

results, the selection criteria (inclusion and exclusion) were applied to the remaining articles, retaining peer-review journals and conference proceedings, and excluding review and non-academic papers (book chapters, magazines, white papers). This step left a total of 894 articles. Thereafter, the databases were scanned for redundancy and 19 articles were removed as duplicates of the remaining articles, returning a total of 875 articles. Next, the remaining 875 articles were searched by reading through the title and abstract to determine their relevance to the research questions. A total of 800 articles were obtained through this step. After that, the contents of 500 articles were scrutinized based on skimming and scanning reading techniques which yielded 80 relevant papers. In this step, those articles whose domain of teaching was not language were removed. Lately, references of 80 articles were checked again to avoid missing any relevant articles. In so doing, a snowballing method was employed. This was done by performing a manual search on Google Scholar. However, this search yielded an additional 20 articles, making a total of 100 articles. So, a total of 100 articles went through the study quality assessment criteria. Thus, the final results returned a total of 27 primary studies used for the SLR.

F. QUALITY ASSESSMENT (QA)

A set of criteria has been employed to check the quality of each chosen article and to determine its suitability for the systematic literature review [40]. The articles that have been included in the above step are checked for quality based on quality assessment criteria. A checklist for quality assessment has been adopted from [42]. TABLE 4 describes a checklist for the execution of quality assessment for every study selected for the review. Thus, the table provides a degree of the suitability of the study that can provide findings that will contribute to the investigation scope. Every question in the checklist is checked against a three-valued Likert scale containing different descriptions. Results obtained have been used to prepare a summary of the quality of the included studies. The results obtained after assessing studies based on QA1 to QA4 have been used to answer research questions RQ1 to RQ4 stated in this systematic review.

The method for awarding scores to the articles is outlined as Yes = 1, Partial = 0.5, and No = 0. In the first place, a rating of 1 is assigned if the article fulfills the criteria. Next, a rating of 0.5 is assigned if the article partially fulfills the

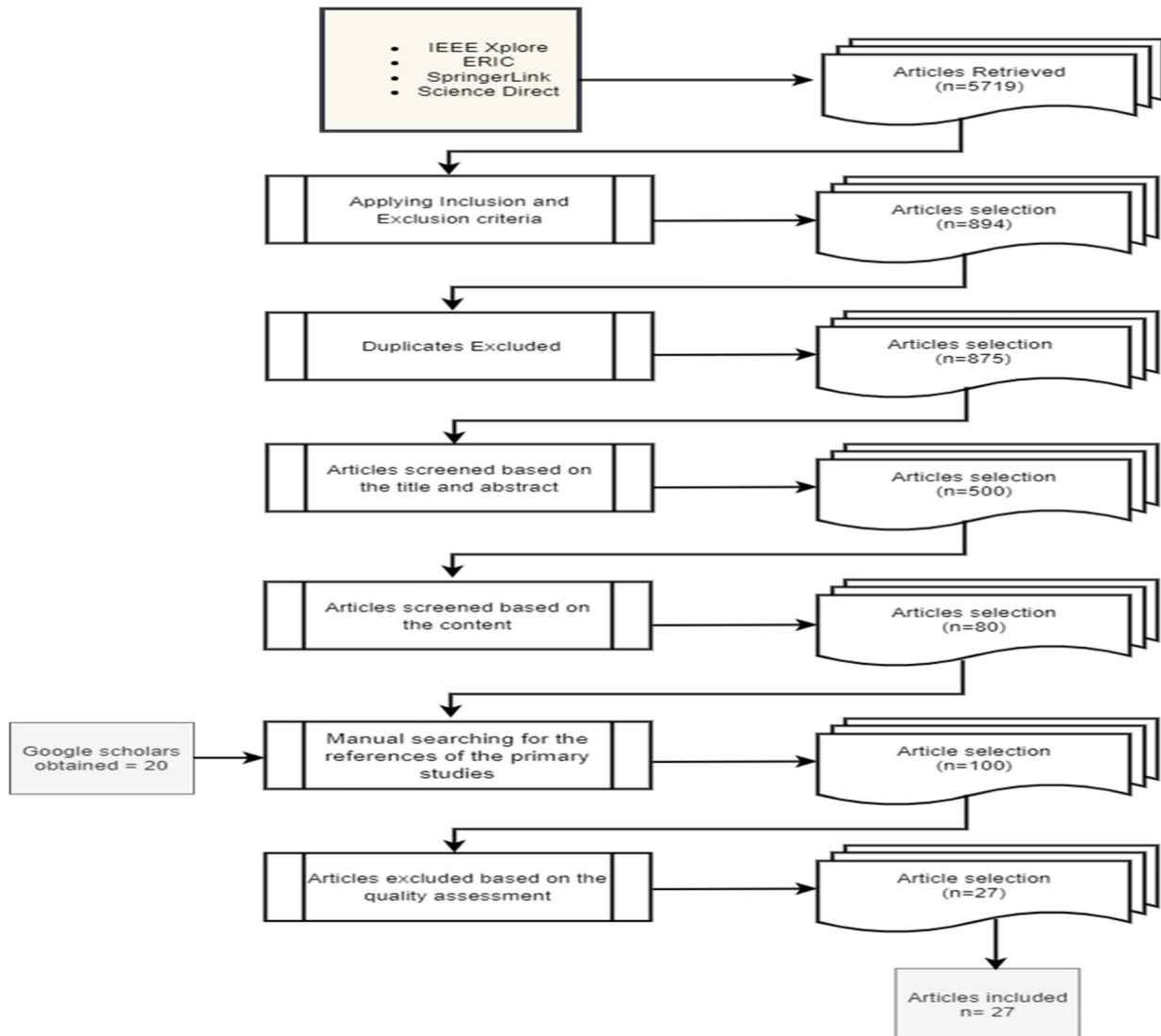


FIGURE 1. Article selection process.

quality criterion. Lastly, a rating of 0 is assigned if the article does not meet any quality criteria. Thus, the highest paper will be assigned a rating of 4 while the lowest a rating of 0.

The report on utilizing the quality assessment criteria using the TABLE 4 checklist is depicted in Figure 1. QA1 criterion examined if the aim/motive of the study was clearly described in the article. Based on QA1, 49 studies that clearly describe the aim of the study were selected. The Second criterion QA2 answers the question of the study and uses a technology-based platform to teach a language course. However, based on the assessment criteria, 36 studies have been selected. The third criterion (QA3) examined if studies included any language(s) in language learning, and the assessment found 23 studies that matched this requirement. The fourth (QA4) criterion checked if the studies describe the findings in detail, and 27 articles were found to describe the findings in detail for a systematic literature study. Therefore,

the 27 selected articles satisfy the defined objective of this systematic literature study, and it should be noted that no exclusion of articles ceased at this point of the selection phase.

G. DATA EXTRACTION AND SYNTHESIS

In this part of this research, all of the 27 chosen papers is carefully reviewed to develop a data extraction form that will hold the crucial information required to fulfill the review goal. A common information extraction form that was taken from [43] has been used to save data from a selection of papers. Digital object identifiers (DOIs), publication details, authors, dates of publication, and other fundamental information have all been organized using Endnote desktop software. Based on the first study categorization, particular data from each paper were then extracted using the primary study. Following two reviewers' assessment of the data

TABLE 4. Quality assessment checklist.

S/N	Criteria	Description checklist	Grading of response
QA1	Is the aim/motive of the study clearly described in the article?	No, the motive is not described Partial, the motive is not clearly described. Yes, the motive is well-described and clear	(Yes, Partial, No) {1, 0.5, 0}
QA2	Does the article present a study where technology-based platforms are used to teach a language course?	No, technology-based platforms are not used Partial, technology platforms are used but it is not used for teaching a language course. Yes, a technology-based platform is used	(Yes, Partial, No) {1, 0.5, 0}
QA3	Do the studies include any language(s) in language learning?	No, the study did not include any language in language learning. Partially, the study describes language learning but does not include any language. Yes, the studies included at least one language.	(Yes, Partial, No) {1, 0.5, 0}
QA4	Do the studies describe the findings in detail?	No, the findings are not described in detail. Partially, the details of the findings are unclear and can be derived from the references. Yes, the findings are described in detail.	(Yes, Partial, No) {1, 0.5, 0}

extraction, the Microsoft Excel spreadsheet was developed and completed as represented in TABLE 5. The data extraction is made up of 10 columns in the Microsoft Excel package, which includes the following: Article ID (A-ID), author name, country, underlying technology, the language taught, online database, learning skills, type of delivery, targeted learners, and article source. A detailed description of the categories of information provided in Table 9 is given in Appendix A. The selected articles were published in reputed journals and conference proceedings in the chosen domain. The article distributions consist of journals (n= 26) and conferences (n= 1). The chosen period for the review was specified in section III-C (2012 - 2022). However, 2019 recorded the highest publication year with seven published articles in the domain.

1) PUBLICATION SOURCE

This review study was carried out by selecting a sum of 27 primary studies, consisting of 26 journal articles and one conference proceedings within the research area as can be seen in Figure 2

TABLE 5. Description of categories of information in summary table 9.

S. No	Category	Description
1	Article ID (A-ID)	To allocate a unique number to a research article.
2.	Author Name (Year)	Author(s)' names and the year the paper was published
3.	Country	The country where the paper was released or the country where the author resides.
4.	Underlying technology	Type of technology used in the system (Augmented Reality, virtual reality, digital pen, etc.)
5.	Language taught	Part of the language taught by the system (English vocabulary, English grammar, Japanese functional expressions, etc.)
6	Databases	The online academic database that the study was sourced from.
7.	Learning skills	Types of learning skills that the study focused on.
8.	Types of article	The types of the articles (Journal or conference proceedings)
9.	Type of delivery	What is the type of delivery provided by the system (web-based or App-based, Computer-based, or mobile-based)?
10.	Targeted Learners	Who were the targeted learners who used the systems?

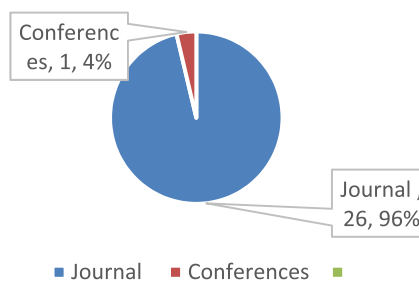


FIGURE 2. Article type.

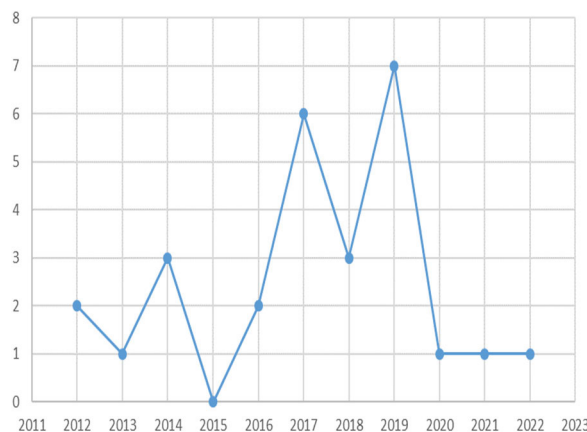


FIGURE 3. Distribution of studies.

2) PUBLICATION YEAR OVERVIEW

This section provides the trend distributions of all selected studies between 2012 and 2022 as can be seen in Figure 3. Out

of the 27 articles selected, the first research was published in the year 2012. Between the years 2012 and 2018, there has been a little ascending and descending in the research trend. The review reports that there has been an increasing number of publications since 2017. Figure 3 indicated that most of the research was released in 2019. Thus, studies trend increased rapidly in 2019, which showed that 2019 had the highest publication year, followed by 2017. Additionally, the pattern indicates that 2014 and 2018 are the third-highest published years, with the same number of articles in each of them. Two articles each from the years 2012 and 2016 were published. The figure makes it clear that there was no study published in this area in 2015. There is only one study attributed to 2013, 2020, 2021, and 2022. It can be inferred that studies in the years preceding 2019 do not vary by a significant number, but there is a sharp increase in 2019, with the apparent increase in the number of studies on the use of technology-based platforms for language learning. The trend also showed that there was a decline in publications in 2020 that flattened the curve between the years 2020 and 2022. That highlights the decreasing interest in this research domain, due to covid-19 pandemic.

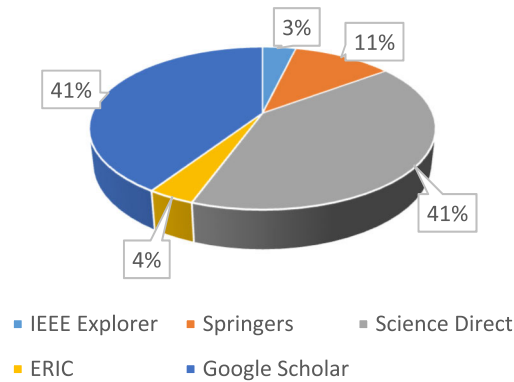


FIGURE 4. Article Database distribution.

3) ACADEMIC DATABASE DISTRIBUTIONS

Figure 4 depicts the academic database wise distributions for the 27 selected primary studies for the review. Out of the 27 selected articles, 1 of the articles was selected from IEEE Xplore, 3 from the Springers, 11 articles from Science Direct, 1 article from ERIC, and 11 articles were selected from Google scholars.

4) PUBLICATION COVERAGE OF RESEARCH

The country-wise publication distribution of the selected articles is reported. Publication country here means the country where the lead author resides. If this does not exist, the country of the paper where the paper was published is mentioned instead. Table depicts countries and their corresponding frequencies. According to Table 6, research in the field spans over wide geographical distribution. As can be seen from Table 6, Taiwan contributed the largest number

of the published articles selected, with a total number of 7 out of 27 articles. Next are China and Iran, with a total number of 3 articles each, followed by Japan, South Korea, Saudi Arabia, and the Netherlands with an equal number of 2 articles each. It can also be observed that the remaining countries such as Canada, Greece, Czech Republic, Egypt, Turkey, USA, and Spain are the least and they reported only one publication each. It shows that there is less research attention on the chosen domain in those countries. Overall, it can be inferred the topic in this study is more in trend in the Asia Pacific region. Figure 5 depicts the country-wise distributions of the study.

TABLE 6. Countries with the number of publications.

S/No	Country of publication	No of studies
1.	Taiwan	7
2.	China	3
3.	Japan	2
4.	Netherlands	2
5.	U.S. A	1
6.	Iran	3
7.	South Korea	2
8.	Saudi Arabia	2
9.	Czech Republic	1
10.	Greece	1
11.	Egypt	1
12.	Spain	1
13.	Canada	1

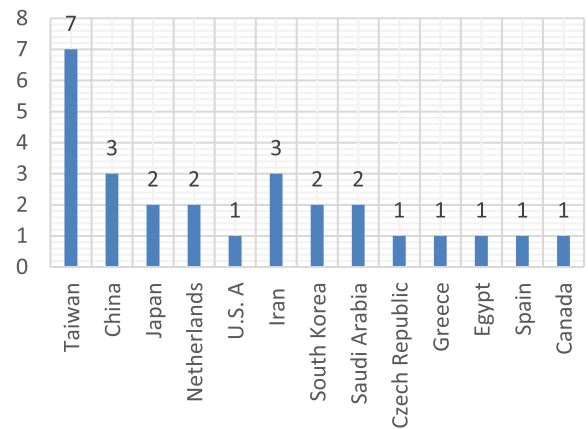


FIGURE 5. Country-wise distribution of the studies.

5) CONTEXT OF EDUCATIONAL LEVEL

It was also retrieved what level of education each study respondent had. The educational attainment of schoolchildren and university graduates differs. The number and percentage of studies with participants from various educational backgrounds are shown in Table 7 below. Several studies at different educational levels are shown in Table 4. It has been noted that language education approaches have been applied equally in university and school-based settings. Nonetheless, a greater number of school-based systems have been designed with primary school kids in mind.

Interestingly, vocabulary instruction is a component of every study done with elementary school pupils.

TABLE 7. Different educational level studies.

S. No	Educational level	No of studies
1.	Elementary School (Grade 3 4 5 6)	4
2.	Junior High School (Grades 7 8 9 10)	1
3.	Senior High School (Grade 11 and Grade 12)	2
4.	University students (Graduates and Undergraduates)	18
5.	Not clear	2

6) TYPE OF DELIVERY SYSTEMS

Technology-based systems can be delivered to the user end in four ways, which include Mobile-based applications, computer-based systems, paper-based systems, and web-based systems delivery using the internet. Table 8 describes the number of studies corresponding to each mode of delivery.

TABLE 8. Type of delivery systems.

Technology-based delivery systems	Number of studies
Computer-based system	17
Mobile-based application	9
Paper-based	1

IV. REVIEW RESULTS AND DISCUSSIONS

This section presents the review findings from the systematic literature and the discussions based on the findings. The section is divided into two subsections; the review findings presented in subsection A and the discussion presented in subsection B. The summary of the findings is presented in Table 9.

A. REVIEW RESULTS

The review results of our study are presented and discussed in the following section by answering the formulated research questions (RQ1 to RQ4). To make the findings very comprehensive and to enhance the reader's knowledge of the results, an example is provided for each research question.

1) WHAT TECHNOLOGIES WERE UTILIZED BY THE SCHOLARS IN THE PREVIOUS STUDIES IN THE LANGUAGE LEARNING ENVIRONMENT? (RQ1)?

The results for the kind of technologies employed in language learning that is associated with RQ1 show that there are significant technologies utilized to assist in language learning. The identified technologies from the selected studies have been grouped into ten (10) kinds of technologies: games, automated feedback, social networking,

virtual reality, speech recognition, collaborative writing tools, intelligent tutoring systems, digital pens, online video, and augmented reality.

a: GAME

Games are classified broadly into two categories namely, education-oriented games and leisure-oriented games. Other scholars describe these as significant games or teaching games [44]. These games which are termed significant have dependable features, with significant outlooks and some collections of visually appealing games [45]. Instructors are allowed to structure or restructure these games in a fashion that conveys the delivery of instructional content that impacts the learners. Learners however have the privilege of rehearsing language by enjoying the games outside formal teaching environments. Research has proven that educational games allow students to acquire significantly within a limited time with uncommon efficiency when compared with students who have no access to educational games [46]. Games are employed for the maturing of several phonological abilities, for instance, lexicon ability [47], enunciation ability [48], and audio and verbal abilities [49]. Engagement is perceived to be crucial with respect to 3-dimensional games. For instance, Berns et al. [50] implemented a game-like 3-dimensional virtual environment to demonstrate the impact on the student learning and motivation from foreign language perspectives. The platform was utilized to construct virtual space for the implementation of the various game levels. However, the experimental results of the study, according to the empirical research after testing various students, were remarkable, which showing the impact of the game on the student's language learning.

b: AUTOMATED FEEDBACK

This review denotes feedback as computer-supported counteractive feedback which is not the same as traditional head-on counteractive feedback [51]. The former replaces the feedback that is supplied by the instructor [52]. Instant response is supplied when students deposit linguistic resources into the programmed response structure. For instance, such responses can go a long way in tackling issues within the area of sentence construction. Feedback has the ability to ease instructors from some burdens, allowing them to pay attention to more important issues that might arise during delivery. Student on the other hand has the privilege of going through some of their assignment without seeing their instructors. Ranalli [53] explained that unambiguous is a key element if students must go through their inabilities. This means that a general response, when compared side by side with a definite response can save time but becomes unclear and helpless at some point. The shortcoming of the programmed response system is rooted in inefficiency. However, the fact that such programmed responses are not a determinant of personal dissimilarity allows the shortcoming not to be established by instructional factors rather technical

abilities [53]. Liaqat et al. [54], demonstrated how automatic feedback could meet English language learners' needs and practices. The study discovered a strong relationship between learning strategy and epistemic belief. Thus, the learners accurately assessed their writing skills through automatic feedback, which promotes meaningful discussion.

c: SOCIAL NETWORKING

A good fraction of learners from around the globe have developed an interest in learning languages via Social Networking Sites (SNS). SNS supplies facilities that aid students in language development summaries and share with their peers around the globe [55]. Students of linguistics sustain the ability to develop linguistic uniqueness, work on modelling a culture [56] or be part of a group that uses SNS in teaching and learning a language with the aim of building their verbal abilities and sharing insights with other students [55]. Currently, social media sites such as Facebook, Twitter, and Instagram are employed for this purpose. Chang [57], conducted a study at a national university in Taiwan to ascertain a solution to reducing the Taiwanese universities' low performance in English writing skills using social media. In their study, a blog was used as the writing platform. However, the experimental analysis of the results indicated that the utilization of blogs significantly enhanced the student's writing skills. In another study, Mompean and Fouz-González [58] researched the application of Twitter for linguistic coaching and tutoring instruments for increasing phonation ability. The findings proved that learners' phonation improved significantly and learners engaged more. In as much as social media sites have proven to be advantageous in mastering new dialects, there were a few challenges that were noted. For instance, Gao [59] drew attention to the fact that using digital devices for a long period has the potential to attack users' health, especially in the area of sight. Chen [60] went further to encourage students to have the right view of social sites else they lose focus. As such the need to build a sense of responsibility in the use of electronic devices becomes crucial. It is also important to understand how to structure electronic devices in such a way that students find them interesting in entertainment and education, however, monitoring has remained a challenge.

d: VIRTUAL REALITY (VR)

Professionally, VR is explained as a collaborative instrument that allows the management of graphical and acoustic demonstrative contents, which are facilitated by computer devices () [61]. VR is perceived to be an electronic atmosphere that allows students to experience the benevolence of togetherness [62]. Students utilize headdresses to enjoy the simulated world. Students are presented with an avatar, which allows them to navigate through the VR to associate with their co-learners in their preferred language [63]. From the research undertaken, it was revealed that there are several improvements associated with employing VR for learning

a dialect. Peng et al. [64] investigated the effect of 3-D virtual reality on non-native Mandarin speaker pronunciation learning by focusing on three language demonstration conditions, including audio, audio-visual animation, and human face video of a 3-dimensional (3-D) talking head. However, the subjective ratings demonstrated that the 3-D talking head attained outstanding user acceptance, and both 3-dimensional talking head and human face video were chosen compared to audio-visual animation. In another study, Yamazaki [65] showed that learners developed verbal proficiency and their collection of parenthetical terminologies was drastically advanced. Some researchers opined that the collaboration of improved Graphical User Interface and modelled assignments which are aided by VR allows students to rehearse the intended dialect often [66]. Students who desire to learn a dialect will have the advantage of enjoying theoretical factual models in an atmosphere that is not static but graphically resourceful [67]. Developing a VR that requires resources full can be very demanding both financially and technologically.

e: SPEECH RECOGNITION (SR)

Huang et al. [68] portrayed SR as an electronic-oriented course that allows for verbal messages to be translated and recorded. Auditory messages are sent into the system via a microphone, after which this message is studied in order to unravel patterns, the output is a text [69]. SR systems sustain the ability to supply prospects channelled towards the maturing of communication skills. SR consists of tremendous abilities that allow for supplying response, as such, the Automatic Correction and Feedback (ACF) system is incorporated, which allows learners mature their intonation skills [69]. Huang et al. [70] in their attempt to assist a lesson reviewer while reading English language paper-based, a digital pen and paper interaction platform combined with an attention recognition and review mechanism based on brainwave detection were utilized, which promotes learning performance of English language. In another research, Huang et al. [68] undertook a study and they verified how valuable it was to incorporate systems that convert spoken commands into their written equivalent in schooling. This system gives students of language the ability to improve the rate at which they understand assignments better than those who didn't have the privilege of accessing such systems. SR systems can also be harnessed with electronic-aided-conversion devices to help diverse ethnic interactions [71]. However, few among the challenges encountered using SR in mother-tongue interference, articulation, and pace among many.

f: COLLABORATIVE WRITING TOOLS

One of the necessary needs of the community today is the need for teamwork. Researchers have opined on some strategies that have the potential to improve teamwork in writing. Some of the strategies include wiki [72], Google Docs [73], blogs [74], and web-oriented word managing [75].

These devices are well known and have been employed in mastering both scripting and communication abilities [76]. Students who are enthusiastic about learning a dialect can visit these scripting-aided systems to format written messages and the system has the ability to keep track of changes made to individual documents. This system allows students who write as a team to format their documents from any location, irrespective of time or geography. Collaborative writing-aided systems supply helpful structures that allow learners to document, format, or undo the formatting and keep a record of the changes made in the process [77]. Instructors can also utilize these systems to support learners in maturing their scripting and communication abilities [78]. These systems can provide different supports such as distribution of resources, interaction, and formatting of materials [79]. Zhang and Chen [80] investigated the effect of collaborative dynamics and assessment methods on learners' performance in online collaborative writing. In the study, a group of 82 tertiary institution students was employed to perform the collaborative writing tasks. However, the analysis of the results indicated that the students utilized provided the text of the improved fluency, phrasal complexity, and writing quality. In addition, more collaboration was observed during the task, which showed the effectiveness of the technology. In another study, Abrams [73] led learners of the German dialect on the rudiments of imaginative literature in the process the learners were given an assignment to propose dramatic play depicting the German culture using Google Docs. The outcome revealed that the set which worked as a team on writing the play provided a more interesting script compared to the set that didn't work as a team. In as much as the set that wrote as a team provided a more fascinating script, some of the team members complained that their opinion was not welcomed [81]. These set of learners didn't bring much to the table which in turn affects the rest of the team members.

g: INTELLIGENT SYSTEM (IS)

An IS can be viewed as a computerized machine with the ability to provide teaching services the same way as humans [82]. Students are expected to be real in providing their feedback as to how helpful such a system is, this is because the system keeps track of students' reactions. IS oftentimes makes the choice of the contents to be delivered to the students based on their feedback and reaction, which helps in upgrading students' rate of assimilation. Choi [83] fashioned an online IS with a feature that permits sending instant responses and it was discovered that this feature facilitated the learning of the students of Electronic Publishing for Learning (EPL). A good number of the students responded positively to this development. Mahmoud and El-Hamayed [84] simulated the educational process behavior using an intelligent tutoring system that consists of three models, namely, the tutor, the expert, and the question model. The IS supported the graphic user interface for easy interaction with the students and it was created for enhancing the student's skills in

Arabic grammar of fourth-grade students in Egypt. In another study, Allen et al. [85] proposed an improved form of IS that supplies participants with some form of assistance in lettering. The outcome of this development showed that relating with the system gave room for maturing the skill of lettering. This improvement stimulated a desire in the learners to use the system consistently. Moreover, the outcome revealed the link that exists between participants, the system, and the pleasure that comes along with engaging in a game [85].

h: DIGITAL PEN

Smartpen digital pen for second language learners initially came into existence in 2008 and until now, the documentation of its application is still lacking [86]. Despite the shortness of time in developing digital pen technology, its importance in enhancing learning performance cannot be over-emphasized [87]. For instance, Huang et al. [70] in their attempt to assist a lesson reviewer while reading an English language paper-based, a digital pen and paper interaction platform combined with an attention recognition and review mechanism based on brainwave detection, which promotes learning performance of English-language. In another study, Lai et al. [88] built a collaborative learning environment that merged digital pen technology and printed textbook to assist in English language learning. The interaction platform of the paper with digital pen grants the teachers an opportunity to produce paper-based activities together with the digital pen, enabling the students to utilize the hard copy reading tags to receive instant help such as recording oral reading, oral reading demonstration, and independent reading aloud.

i: ONLINE VIDEO

The art of filming pictorial objects over an electronic device is referred to as videography. Cyber-videography is a term used to capture resources that exist and are accessible over the cyber world. Electronic videotapes have significant importance in understanding and grasping foreign dialects. Lin and Wang [89] opined that open educational resources (OER) can nurture students in becoming fluent in a dialect that they are not familiar with and as a result, they presented a twin TED seminar in English for foreign language (EFL). Students first see a film and then go on to deliberate on the content of the film with other learners. The outcome proved that this method has a great effect on interacting with their peers, especially in a diverse ethnic language. Huang et al. [90] developed ubiquitous English vocabulary learning systems using a video clip as learning material. The system is capable of sensing the student's situation and offering them suitable learning materials in a real-world scenario [91]. The video clip is a form of visual information that is capable of offering students approximate real-world situations. The authors [92] investigated some of the benefits students derive from such a watch and discussed the approach. The procedures involved in covering such films

have significantly inspired learners to explore the vast riches of multi-cultural dialects and to understand the relationship that exists between these dialects. A good number of investigators are more concerned with the subtitles. The authors put forth a non-static subtitling method which has been confirmed to have great ability to help learners with their listening ability. This is due to the fact learners don't assimilate contents at the same rate as such the degree of information must be made available base on individual need. Hsu [93] discovered that the rate at which more difficult phrases appear in written resources is more than filmed resources. Speech and motion graphics are used hand in hand for this purpose. Nevertheless, several educational videos are accompanied with indigenous subtitles.

j: AUGMENTED REALITY (AR)

AR is an expertise that combines electronic material with the actual setting of the learner, which enables students to perceive the originality of the contents they are accessing. Three major features define an AR: synchronous collaboration, a combination of simulated and actual scenarios, and the ability to function in a three-dimensional environment [94]. Employing an electronic device like a handset or an earpiece in accessing AR describes the item being viewed. An instance of this is a learner who employs AR to examine an orange, not only will the textual description of the fruit appear, but the species and important facts about the fruit will also appear. Exploiting AR in an actual environment helps learners score their educational goals [95]. Ho et al. [96] utilized AR to develop a learning mechanism that aims to enrich students' experiences. Hsu [95] came up with a twin educational gaming strategy by taking advantage of AR, this strategy is employed in mastering the English language. The outcome gathered from the use of this method proved that AR permits universal and domestic education. It was noted that students enjoyed the intimacy that comes along with using this technology. Moreover, abilities such as logic reasoning, data processing, and meditation were improved and a sense of enthusiasm was awakened in the learners.

2) WHAT ARE LANGUAGES AND THE LEARNING SKILLS THAT THE PREVIOUS RESEARCHERS FOCUSED ON? (RQ2)

The study also identified seven various languages that the researcher has focused on, which include English, Japanese, French, Mandarin, Arabic, Korean, and German. Figure 6 depicts the target languages. As can be observed from the chart in Figure 6, the English language has been identified as the most used target language in the selected studies ($n = 22$). There are various reasons why English has been identified as the most target language in the selected studies. First of all, people of various native tongues frequently utilize English as a common language of communication since it functions as a worldwide lingua franca. Because of this, English is a widely desirable language for travel, academic pursuits, international business, and diplomacy.

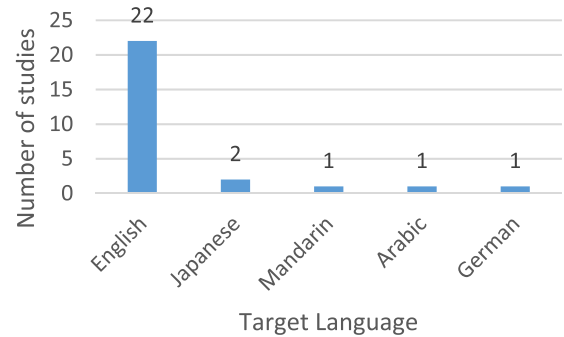


FIGURE 6. Target language with the number of studies.

In terms of economics and professional prospects, being able to speak and understand English is frequently required for a variety of jobs, particularly in multinational corporations and fields with a global emphasis. To improve their chances of acquiring a job, people try to improve their English language proficiency.

Regarding educational access, it has been noted that a large number of scholarly sources, research papers, and instructional materials are offered in English. For students and scholars to gain access to a broad range of information and take part in international educational discussions, they must be proficient in English.

In the field of technology and innovation, English is the most commonly used language. It is widely used in the tech business, which encourages people to learn the language because it is the language of choice for many programming languages, software record keeping, and advancements in technology.

In international travel and tourism, English is frequently used, and being able to speak it well can improve the quality of your trip. In this regard, many people learn English to successfully interact with individuals from different backgrounds and to communicate successfully when traveling. Moreover, the second most used target language is Japanese ($n = 2$). It can also be observed from the chart that the remaining three languages were used in one study each, which include Mandarin, Arabic, and German.

In addition to the target languages used in the selected studies, this study also identifies the language skills that the researcher focused on and it was observed that scholars concentrated more on enhancing nine different language skills, including vocabulary, writing, grammar, reading, tenses, listening, functional expression, auxiliary verb, speaking, and pronunciation, by employing the technology. While some researchers focused on one skill, some other researchers focused on more than one skill. For instance, a study in [97] focused on enhancing both tenses and auxiliary verbs. As can be seen from Figure 7, researchers focused more on enhancing the vocabulary and writing skills of language learners.

Vocabulary and writing skills are seen as the most used language learning skills for some reasons, First of all,

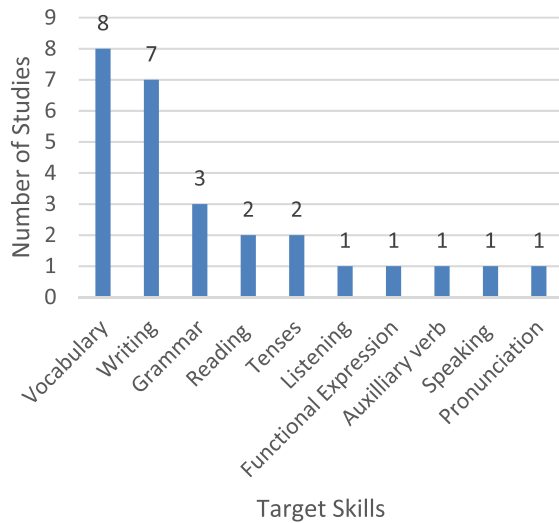


FIGURE 7. Target skills with the number of studies.

vocabulary serves as the foundation of language. Acquiring a broad vocabulary enables students to communicate more clearly and comprehend others more successfully. Fluency in the language is aided by having a large vocabulary. With a wider vocabulary at their disposal, learners can converse more fluently and effectively in a variety of linguistic situations. A strong vocabulary is necessary to interpret written works, including academic papers, articles, and literature. It improves general reading comprehension by helping students understand the meaning of words in context. For hearing to be effective, vocabulary is essential. Recognizing and interpreting a wide variety of words is necessary to comprehend spoken language, and having a large vocabulary helps with this. In academic and professional contexts, having a large vocabulary is tremendously advantageous. It helps with written expression, successful communication, and accomplishment of assignments like reports, essays, and presentation preparation.

On the other hand, writing enables students to express their opinions and ideas in a clear, organized way. It provides a platform for introspection and self-expression. Writing skills need knowledge of and use of sentence structures and grammatical rules by nature. Grammatical competency is developed by writing practice. Writing down ideas and points of contention helps to develop critical thinking abilities. Students need to assess data, organize their thoughts coherently, and make persuasive arguments. Spelling, punctuation, and other language mechanics are all part of writing skills. Communication that is clear and effective is facilitated by mastery of these components. In professional and academic contexts, writing is frequently the main form of communication. Writing emails, reports, research papers, and other materials requires strong writing abilities. Writing gives students a chance to hone and solidify their language skills. Writing exercises assist learners in retaining grammar, syntax, and vocabulary.

3) WHAT ARE THE BENEFITS OF TECHNOLOGY-ASSISTED LANGUAGE LEARNING? (RQ3)

The results for the empirical evidence on the benefits of utilizing technology-assisted language learning as associated with RQ3 show that there are numerous benefits in utilizing technology in language learning settings. Six (6) benefits were recognized. The identified benefits from the selected studies include language performance development, motivation, and metacognitive skills, positive attitudes towards learning, enhanced learning retention for students, a collaborative learning model, and a wealth of learning possibilities. A detailed description of the aforementioned benefits is provided below:

a: LANGUAGE PERFORMANCE DEVELOPMENT

EFL/ESL research on TALL majorly seeks to discover how the technology has helped in improving learners' overall understanding of the course when delivered. Several researchers stated that the educational advantages derived through TALL in increasing learners' mastery of spoken language skills are significant. To emphasize this, Hsieh et al. [98] carried out research on the mobile application, called LINE, with 42 learners. However, this learner was assigned to access the LINE's services in a reversed classroom location. The researchers' discovery opined that LINE was able to step up the efficiency of the reversed classroom settings, which is evidenced by the meaningfully increased results recorded in the oral examinations taken by students. Fang et al. [99] conducted similar research where they used transportable digital devices in a classroom which allows for communication and friendly responses to ascertain learners' oral accomplishment. The research engaged 40 EFL Taiwanese learners who were grouped into two, one for providing friendly response and other which receives no responses but governor the responses. The adoption of transportable devices allows learners the opportunity to oversee their performance and supply or obtain responses that aim at improving their performance. The learners also admitted that the progress they recorded was a result of the responses they received from their friends who use the same system Naderi and Akrami [100] nurtured their interest in learners' studying skills by searching the significance of Telegram and how it has impacted the studying ability of learners with respect to variations in the sex of the learners. The research engaged 147 unpaid workers and 103 learners were allowed to investigate 304 others. The investigation was delivered via Telegram, and the same was employed in explaining 12 reading chapters. The research noted a good impact as the researchers sighted the important role the Telegram application played in advancing learners' studying abilities. The research also exposed the fact that sex variation does not affect the outcome of the learners' studying ability. This is consistent with the findings of Nasr and Abbas [101], who summarized their research by noting that transportable digital gadgets provide the desired aids that learners need in order to improve their reading ability.

The research emphasized using chatting applications like WhatsApp or search engines like Google to retrieve and relate to educational resources. The researchers collected their data through interviews and learners' collections.

Another field of interest for researchers is the impact of the MALL application on learners' writing skills. Chang [57] carried out research intending to ascertain the contribution of MALL to learners' writing ability. They used blogs as a medium to tackle learners' writing challenges. Twenty-five learners from Taiwan were involved in the research. The study exposed that blogs helped assist learners with minimal writing expertise in stepping up their writing skills. Blogs can initiate and smoothen association among learners, giving them the privilege to assess their work with that of their counterparts, thereby sharing insight on how to improve their writing skills. Ngui et al. [102] studied the implementation of a novel tool that can be employed in grading learners' writing skills called e-Portfolio. To gain insight into this the researchers engaged 46 learners via dialogue and survey. The outcome of the study revealed that the e-Portfolio is a powerful instrument that will help in improving writing skills this instrument can be used in receiving feedbacks from teachers and learners as well, in addition it will support learners in contemplation their skills which is important in improving writing skills.

Listening ability is another area of kin interest. For instance, Vaezi et al. [103] carried out research in a learning atmosphere using transportable digital devices to ascertain learners' listening proficiency. The research engaged 119 Iranian learners the collection was made up of 36 males and 83 females, and the age bracket was 19 to 37. The learners were further classified into two, one of the classes which is the experimental class was exposed to a reversed learning atmosphere (an Original Acoustic Resource Class and an Educational Acoustic Resource Class) while the second class which is the control class was exposed to the standard learning atmosphere. The dual experimental classes were exposed to dissimilar acoustic resources: first and original acoustic resource, which were sourced from diverse online platforms such as the web for hearing and books for an educational acoustic resource. The outcome of the research revealed that the reversed learning environment which drew from transportable digital gadgets authenticates its efficiency to help learners improve their hearing capability. In addition, among the several resources presented the original acoustic resources were more helpful in achieving this.

To take it further, Chang et al. [104] studied the practice of a mobile instructional pervasive game (M-IPG) knowledge-absorbing technique to step up learners' linguistic success. They employed learners' previous success and skill level in reading, writing, sentence structure, and lexicon as data. The research engaged 137 learners who were split into two classes: the first was the experimental class was exposed to the M-IPG technique and the second class which was the control class was exposed to portable-centered coaching. The

M-IPG technique incorporated an investigative knowledge absorption method together with job request games which allowed for a healthy contest. The outcome showed that the M-IPG technique helped in improving the learner's overall accomplishment. In similar research, Albadry [105] supplied proof to support his claim that blogs together containing motion images help in improving sentence structure teaching. The study involved 60 volunteers who were classified into an experimental and control class with the class equal class weight of 30. The experiment showed that the motion images which were accompanied with audio had a greater impact on learning and teaching sentence structure. In addition, learners' involvement in the absorption activity was greatly improved, they noted that their involvement was a result of the captivating videos that were made available although connecting to the resource over the blog was a challenge.

b: POSITIVE ATTITUDES TOWARDS THE LEARNING PROCESS

Lots of research has been dedicated to unraveling the influence of MALL with respect to learners' experiences. Most of the research shows learners' confident conduct as regards the usage of this expertise. In one such research, Chang et al. [104] claimed that learners and instructors show interest in MALL notwithstanding the variation in the underlying principle. Learners claimed that a straightforward approach to MALL is key in stepping up their phonological ability. Instructors also motioned that the degree of engagement between learners and instructors within the system improved significantly.

In a separate investigation, Chen and Chih-Cheng [106] exposed learners' opinions of transportable digital devices in EFL educational exercises. They employed assignment-based linguistic coaching as the educational background, the research aims to expose learners' view of transportable digital devices as a means of teaching. The outcome proved that learners see transportable digital devices with their applications as impactful as they relate to the system. However, instructors were advised to include entertaining content to strengthen engagement within the system thereby meeting learning objectives. Reynolds and Taylor [107] were not different in their opinion after researching how teachers recognized the transportable digital application Kahoot! and how it has impacted the delivery of resources in increasing learners' language prowess. Employing 78 learners from South Korean colleges the researchers were able to draw a conclusion on Kahoot! as it lacks the ability to provide a lasting impact on learners' language prowess. Nevertheless, the information generated from the data proved that the application can improve dynamic knowledge acquisition by motivating learners' kinesthetic, pictorial altitudinal, and melodious skills. Furthermore, learners placed great significance on the cooperative teaching methodology the application provided noting that the potency of Kahoot! is in its ability to house inspiring, attractive, and pleasurable educational resources [107], [108] Alharbi [109] supplied

proof to support his claim that employing motion pictures that are accompanied by sound in teaching language rules has a greater impact on learners. The study noted that learners find it more interesting being engaged through sighting and hearing, the learners were further advised to engage with mates in group discussions as they expound on the rules of language. Employing Spaceteam ESL, Grimshaw and Cardoso [110] revealed that an immersive knowledge-acquiring environment allows learners to initiate teamwork with other learners. Spaceteam ESL can engineer a pleasurable atmosphere for learners to work together in carrying out tasks on mobile devices. These learners were further encouraged to involve themselves in post-class discussions about the tasks completed during class hours as this will keep the learners motivated and involved even outside the class. Le [111] used a technology-driven application called Puppet Pals to ascertain the pleasure derived by learners who take transcontinental verbal communication classes. The system employed the fairytale-reporting strategy which was designed to fit the digital channels intended to reduce the complications associated with linguistic construction. The research employed 69 university intakes in Vietnamese, the exercise lasted for 51 days. The researchers carried out their evaluation using The Foreign Language Enjoyment Scale (FLES), audiovisual footage, and a mini-conference. The result revealed that learners confidently utilized the training methodology employed. The learners together with the instructors agreed that the technology can introduce a new dimension to the learning environment through novel approaches. Learners will have the freedom to imaginatively and constructively generate verbal communication by employing Puppet Pals. This innovative application helps reduce the stress learners struggle with in linguistic philosophy thereby encouraging learning enthusiasm.

c: MOTIVATION AND METACOGNITIVE SKILLS

Instructors can build a learning distinction that activates the motivation of students to the advanced stage, but the highest learning goal can be acquired provided that the motivation originated from the students [112]. Various studies show that the utilization of technology-assisted language learning not only improves students' learning progress but also influences the learning motivation of the students. For example, Kılıçkaya [113] examined students' capability in harnessing their computing devices as a learner's instrument support outdoors. The study's sample was made up of 50 English learners registered in a preparatory course for an advanced language exam survey in Turkey. The efficiency of the system is compared using the delayed post-test and the post-test results, which were performed five weeks apart. The students were taught using both conventional instruction and computer-based. However, the study shows that the teacher-driven grammar taught with computer-based materials outperformed those who were taught with conventional instruction.

The research shows that students using a computer for their learning usually use it as a device to assist in their learning styles. This trend often results in students' positive attitudes in the learning process. Further, the outcome of the study recommended that students' perception of learning a foreign language using a computer must be comprehensively strengthened to reinforce to boost their corresponding personalized learning models. Teachers are also required to develop outdoor instructional models according to the interaction design between students, students' computer usage attitude, students' perception of TALL, and the class homework organization.

The TALL application can represent a medium that inspires students' creativity for interaction and engagement in the learning process. Chang [57] stated that microblogging could lead to activity engagement for students. Students can be vigorously involved in writing tasks via this means with less devastating moods which are very common in traditional writing tasks. In other words, this approach could reduce the reasoning burden and as such enhance students' independence and motivation in EFL learning. In a related study, Chang et al. [104] who used M-IPG, or the mobile instructional pervasive game, found that in addition to being effective in supporting students' achievement, the combination of games and mobile technology helped improve students' confidence in their ability to use English. As a result, mobile technology is finally applied beyond basic interaction to create m-Learning, or meaningful learning environments [114].

d: ENHANCEMENT OF STUDENTS' LEARNING RETENTION

Numerous studies show that the intensity of mobile technology enhances students' learning retention. For example, Sandberg et al. [46] maintained in their study that the use of mobile applications teaches kids to successfully retain words utilizing long-term memory, which aids in the development of their vocabulary. Moreover, combining the viable and exciting components of mobile game software provides an opportunity for students to remember the learning resources [104]. In a similar study, Naderi and Akrami [100] asserted that the utilization of mobile technology in lecturing was demonstrated to be more efficient when compared with the traditional approach of teaching for enhancing students' vocabulary recollection. The discoveries of this study are in agreement with Chang's (2020) research on teaching writing skills using blogs. The author claims that blogs could support a communicative teaching paradigm by assisting students in editing each other's work, coming up with fresh ideas for their own writing, reacting to other people's work, and improving their writing through feedback from the teacher. These advantages assisted students deliberately in learning and retaining new vocabulary in their memory. In another study, Liu [115] conducted research on a "concept mapping strategy" by connecting mobile phones to enhance student's vocabulary. The author carried out a quasi-experimental study that consisted of 100 students equally distributed to

a control or experimental group. Instant message (IM) was used for teaching in both groups with diverse arrangements. Moreover, the experimental group arrangement utilized the embraced concept map of the students to arrange the vocabulary students learned during the teaching whereas no arrangement was adopted in the case of the control group. However, the results of the study indicated that the experimental group outperformed the control group in the retention of vocabulary. Thus, the concept mapping model can be seen as a valuable medium for improving students' vocabulary retention.

e: COLLABORATIVE LEARNING MODELS

Highlighting the importance of communication skills, the collaborative learning model has been strongly encouraged to enhance the students' interaction rate and language usage. Liaqat et al. [54] in their study on collaboration with proficient English language learners, in conjunction with the integration of both peer and automated feedback, revealed that engaging in collaborative learning led to a decrease in students' anxiety levels as opposed to individual learning. The utilization of technology-assisted language learning underscores its potential to advocate for a collaborative learning approach, presenting educational benefits in the realms of English as a foreign language and English as a second language instructional methodology. For instance, Albady [105] carried out empirical research that investigated the students' approaches to learning English by utilizing mobile devices such as tablets or iPads. The study utilized 21 students enrolled in a 21-week program at a Saudi public university. However, the study showed that the utilization of iPads improved the students' performance in collaborative settings, providing more chance to the students to communicate in the target language as the teacher provide them with the required assistance. Due to its portability and features that enhance the interaction of teachers and students in learning, the iPad is seen as a suitable learning aid.

Similarly, Chang [57] examined the usefulness of blog platforms in alleviating students' writing issues. The findings from the research recommended that blogs could offer assistance to low-proficient students in developing their writing skills. Thus, blogs can enhance reliability in communication among students, letting them evaluate their works and swap writing ideas, which consequently introduces a certain perception of their writing skills. Furthermore, research conducted by Grimshaw and Cardoso [110] demonstrated the effect of mobile devices in enhancing students' fluency. This research was carried out based on the assumption that English for second language learning exercise have a negligible emphasis on students' fluency as well as 308 language computerizations. Thus, the Spaceteam ESL mobile game apps offer pre-constructed learning skills to tackle this problem by motivating learners to create oral language as well as the practicing of their fluency. The research utilized 20 college students in Canada, equally allocated to a control group or experimental group. The

experimental group game arrangement is to engage students in a 15-minute open activity talk via Spaceteam ESL whereas no game arrangement was made for the control group. However, the findings from the research showed a better performance in the experimental group for oral fluency rating when compared with the control group by employing quantitative data. This shows the comfortability of students concerning the learning activities.

f: EXTENSIVE LEARNING OPPORTUNITIES

The major advantage of employing technology in the language learning concept is that it offers an extensive learning opportunity. Sandberg et al. [46] Eke looked at how well games and intelligent adaptations on a mobile app may improve pupils' vocabulary. Using a mixed-method methodology, the findings demonstrate that the game setting and clever adaption are beneficial in stimulating students' learning and enhancing their vocabulary. This study also suggested that mobile learning could facilitate collaborative teaching methods by providing ample opportunities for students to practice their language acquisition outside of the classroom. Similarly, Ngui et al. [102] emphasized the importance of more comprehensive classroom skills via the portability and accessibility of mobile technologies to help kids learn on their own. The adaptability of messaging apps and search engines can be used by educators. to enhance students' reading time, thereby developing their reading attention. The study also elaborated on another advantage for students who did not attend any classroom discussion to remain on track with the instruction [101]. In another study, Hsieh [98] provides proof for affording LINE to engage and encourage language learning platform that activate students' initiative in using English. This application permits students to collaborate with their colleagues or discuss with the teacher for the extra lesson outside the classroom hours.

4) WHAT ARE THE BARRIERS TO THE IMPLEMENTATION OF TECHNOLOGY-ASSISTED LANGUAGE LEARNING? (RQ4)

This subsection presents the findings regarding the barriers that hinder the implementation of technology-assisted language learning in relation to RQ4. The findings from the study identified three (3) major barriers that could hinder the implementation of TALL. These encompass anxiety related to learning, inadequate proficiency in technology, and constraints associated with technical drawbacks. A detailed description of the aforementioned barriers is provided below:

a: LEARNING ANXIETY

In contrast to the globally accepted instructional model, TALL implementation demands that students thoroughly use their mobile gadgets. As a result, students can access resources other than through handheld devices alone, the process that lands them into social media conversations, as well as the mandate to complete assignments or projects in any condition. As a result, when given assignments of this nature, pupils experience stress or overloaded. For instance,

Kurt and Bensen [116], in their study revealed that responses from students revealed that they experience frustration with completing tasks using the mobile application owing to the labor-intensive and complicated nature of the assignments. A different research by Bailey et al. [117] observed that engaging the Facebook social network platform for mutual tasks can cause problems for pupils. The authors interviewed students to ascertain their responses to posts emanating from their instructor. The study revealed that students with good rapport with their fellow mates complete their assignments more than others. This class affinity problem was also examined by Bailey [118], asserting that less intelligent students are likely to encounter learning nervousness (anxiety). A major drawback of using portable devices in a combined learning environment leads students into confusion due to poor understanding of the learning scope and a sense of mortification towards others in case of failure to complete the task.

b: INSUFFICIENT TECHNOLOGY LITERACY

Students' technical craftwork hinged on experience and background. The technological illiteracy could probably position a danger to the execution of TALL. For example, Chen and Chih-Cheng [106] uncovered that some learners need exceptional training in the MALL application, experiencing difficulties with the video editing they had to complete for their homework. Similarly, Reynolds and Taylor [107] also noted that several educators questioned Kahoot!'s effectiveness as a teaching tool and tended to favor the traditional format. The authors' views toward erudition (learning) in conjunction with poor technical skills Inadequate technical proficiency may prevent individuals from exploring the potential of handheld gadgets for language acquisition. The writers did acknowledge, nonetheless, that this application had the potential to provide rewarding learning experiences and function as a supplement to literature. Furthermore, low technology literacy could lead to unfavorable opinions about education in general. Cárdenas-Moncada et al. [25] intimated that unawareness of the adopted applications could lead to ineffective use of mobile language learning in class.

c: TECHNICAL LIMITATIONS

Studies have identified numerous technological impediments that presumably pose an insurmountable hindrance to TALL implementation. As mobile-based learning depended on network availability, poor internet bonds became irksome as they offered students challenges in finishing their online assignments [119]. Furthermore, it is necessary for portable devices to thoroughly considered for students to continue participating in remote contact. Teachers should also be aware of the message length limit, audio-visual restrictions, and the requirement for portable equipment with precise requirements, which some pupils cannot buy due to additional technological disadvantages [120]. Bailey et al. [117] noted that the present MALL technology challenges students

to possess high-level penmanship knowledge. From the student's responses to Facebook posts, the authors noted that students became inept at exhaustively expressing their views and beliefs via their documented rejoinders. Students find it difficult to complete online tasks including watching videos, reading educational materials, and finishing homework because of the limitations of mobile devices. A study by Yu [121] reported that students underwent mental or cognitive oversupply when they read their texts utilizing smaller screens on mobile gadgets. Relatedly, Le [111] observed numerous problems with Puppet Pals' execution due to its limited features in its free edition and its exclusive accessibility on Android devices. Teachers should also set aside time in class to familiarize students with the app because they were not acquainted with it before.

B. DISCUSSIONS

This SLR reviews 27 papers on technology-assisted language learning. To begin with, this study discussed the ten technologies that were utilized by the researchers in the previous studies that assisted in language learning, and examples were provided. Secondly, this study reported the languages and the learning skills that the previous studies focused on. The paper then went on to describe the empirical data supporting the advantages of utilizing such technologies in language learning settings. Finally, this study discussed the barriers in implementing TALL. The findings according to the RQs are reported in the subsections below.

1) FINDINGS ASSOCIATED WITH RQ1

By considering the use of technology, our findings showed that ten various technologies were utilized in this SLR. A detailed explanation was provided as well as examples of how they were utilized to assist in language learning. Our research indicates that a number of studies yielded positive results, indicating that learners' performance enhanced when technology was used to support their learning. Additionally, students view the usage of technology favorably. This shows that learners embraced and used technology, demonstrating its efficacy in supporting language acquisition.

When using technology for language instruction and learning support, we advise, stating that objectives should be prioritized over the technical means when using technology to foster language teaching and learning. For guidance in identifying the advantages of the technology, educators and learners may examine the technical recommendations and gain insight from the accounts of related study experiences. and prevent its drawbacks.

Furthermore, we can also observe from Table 9, which provides a summary of the technologies used in language learning. It is obvious that 6 studies on intelligent-based technology were utilized out of 27 total studies. Such information can guide teachers and researchers in designing learning and instruction to utilize and incorporate similar technology. On the other hand, the research domain lacks

some practical knowledge of the newly introduced technologies like the use of a digital pen as was reported in only one study. Thus, teachers and researchers may contribute to the domain by contributing new knowledge by investigating latest technology further.

2) FINDINGS ASSOCIATED WITH RQ2

In relation to the language taught, the results of our findings indicated that English is the most common target language, followed by Japanese. In addition, the study also discovered that the English language was studied 20 times more than the Japanese language. One of the major reasons for such findings is that the English language is currently the most commonly and globally spoken language today. Other previous researchers also affirmed that fact even though some studies opposed that notion [122], [123]. Based on the findings, the researchers and educators could be advised to source more resources in relation to the English language in top journals. Other languages such as French, Mandarin, Korean, German, and Arabic had a very negligible consideration in the research domain despite their uniqueness and specialty in their tradition. Therefore, teachers and researchers should pay more attention to those underexplored languages for further study.

With respect to the learning skills, the results from our findings showed that researchers focused more on vocabulary, grammar, and writing skills. One of the likely rationales behind the findings is that the conventional classroom places more emphasis on the language input compared to the language output. As a result, conventional classroom teaching focuses on reading and listening skills with the help of textbooks, notebooks, and pens. Therefore, the goal of researchers in the utilization of technology to facilitate language output is because, it could assist the learner in producing language output through vocabulary, grammar, and writing skills. Another rationale one can identify could be that the grammar, vocabulary, and writing skills are quite simple to implement with technological assistance. Other learning skills such as tenses, pronunciation, auxiliary verbs, and reading skills received very little attention. Thus, researchers and educators can consider exploring such skills in their further research.

3) FINDINGS ASSOCIATED WITH RQ3

As indicated in the review results, the empirical evidence on the benefits of technology-assisted language learning has been classified into six main benefits: language performance development, motivation, and metacognitive skills, positive attitudes towards learning, enhancement of students' learning retention, collaborative learning model, and extensive learning opportunity. In relation to language performance development, technology has helped learners in their overall understanding of the course when taught and also increases language mastering skills. Also, there is a positive attitude towards learning by learners since learners have confidence

and are motivated concerning the usage of technology, which also serves as a key to stepping up their phonological ability. Technology usage can enhance learners' motivation and interest in learning. Technology offers language learners input, output, and feedback on the target language.

Furthermore, the study also reveals that the students learning retention can be enhanced by the intensity of technology in language learning. It also shows that collaborative learning reduces the anxiety level when compared with individual learning. Extensive learning opportunities are another benefit that technology-assisted learning offers because students can utilize more than one technology for extensive language learning [46]. It also gives a teacher an efficient approach to the course outline preparation and interaction with many students. These findings generally concluded that some researchers have merely identified these benefits as applicable to technology-assisted language learning but provided inadequate attention. In any situation, the utilization of technology is promoted and teachers can shift their teaching activities, together with their teaching styles and strategies to effectively utilize the current materials

4) FINDINGS ASSOCIATED WITH RQ4

We provide various barriers related to the implementation of technology in language learning. One major barrier that we observed from the review is that some researchers did not report any issues that they encountered with the implementation of technology during their investigation. This knowledge is essential because knowing the issues experienced by the learners, researchers, and educators in an exact study could assist them in learning how to avoid or address them in their studies. Thus, we suggest that researchers report such information in their subsequent research.

Some barriers were narrated in the reviewed articles that resulted in unsuitable inputs, shallow interaction, and incorrect feedback. Some other issues are due to students' obstructions with software or hardware implementation or interruption from the learning tasks. This study attempts to give an associated idea of how to solve such issues. Another issue based on our review is insufficient technology literacy. In this case, learners do not know how to make use of technology effectively for their language learning. Ziegler [124] discovered that during their study on computer-based communication, aiming to enhance writing skills, students often employ symbols and abbreviations such as emoticons to express their emotions instead of utilizing suitable language forms that contain models. As a result of that, learners are often discouraged by information overload especially when they surf the internet for suitable vocabulary while working on vocabulary-building tasks. In a related study, Tono [125] maintained that learners utilizing vocabulary of small size may choose incorrectly translated words that are suitable to the context when they make use of electronic dictionaries. Thus, this barrier advises that learners

TABLE 9. Summary of research findings.

S/N	Authors (Year)	Country	Article Id	Language taught	Database	Learning skills	Underlying technology	Type of delivery	Targeted Learners
1	[80]	China	Assessing collaborative writing in the digital age: An exploratory study	English	Science Direct	Writing	Collaborative learning	Computer – based	Undergraduate University students
2	[54]	Canada	Collaborating with Mature English Language Learners to Combine Peer and Automated Feedback: a User-Centered Approach to Designing Writing Support	English	Springer	Writing	Automated feedback	Computer based	Language Instruction for Newcomers to Canada (LINC) program
3	[57]	Taiwan	Exploring Solutions to Decrease Taiwanese University Lower Achievers' English Writing Difficulties via Blogging	English	Google scholars	Writing	Social network	Computer based	University students
4	[128]	Taiwan	Effects of gender and different augmented reality learning systems on English vocabulary learning of elementary school students	English	Springer	Vocabulary	Game, Augmented reality	Mobile-based	Third- grade school students
5	[129]	Japan	Development of a computer-assisted Japanese functional expression learning system for Chinese-speaking learners	Japanese	Springer	Functional expression	Intelligent tutoring system	Computer-based	Chinese-speaking learners studying Japanese
6	[97]	Greece	An intelligent adaptive fuzzy-based inference system for computer-assisted language learning	English	Science Direct	Tenses and auxiliary verb	Intelligent tutoring system	Computer-based	40 students from a private school of foreign languages
7	[118]	South Korea	Social Networking for Language Learning Participation in Relation to Task Value and L2 Writing Anxiety	English	Google scholars	Writing	Social network	Computer based	University students
8	[119]	Iran	Iranian female students' perceptions of the impact of mobile-assisted instruction on their English-speaking skill	English	Google scholars	Speaking	Voice thread/ social network	Mobile-based	Female students of higher institution
9	[103]	Iran	Investigating Listening Comprehension through Flipped Classroom Approach: Does Authenticity Matter?	English	Google scholars	Listening	Voice recording /audio	Computer based	University students
10	[109]	Saudi Arabia	Integration of Video in Teaching Grammar to EFL Arab Learners	English	Google scholars	Grammar	Video	Computer based	Second year undergraduate students.
11	[100]	Iran	EFL Learners' Reading Comprehension Development through MALL: Telegram Groups in Focus	English	ERIC	Reading	Intelligent system	Mobile based	University students
12	[64]	China	Evaluating a 3-D virtual talking head on pronunciation learning	Mandarin	Science Direct	Pronunciation	Virtual reality, voice recording, video	Computer-based	Foreign Ph.D. students from the University of Chinese Academy of Sciences, who had attended the same Chinese language learning class for only two weeks.
13	[121]	Taiwan	Incorporating Facebook into an EFL Writing Course: Student Perception and Participation in Online Discussion	English	Google scholar	Writing	Social network	Computer based	University students
14	[70]	Taiwan	An English Diagnosis and Review System Based on Brainwave Attention Recognition Technology for the Paper-Based Learning Context with Digital-Pen Support	English	IEEE	Reading	Digital Pen	Paper-based	108 students at a commercial and industrial vocational high school in New Taipei City, Taiwan
15	[95]	Taiwan	Learning English with augmented reality: Do learning styles matter?	English	Science Direct	Vocabulary	Augmented reality	Mobile-based	Third grade elementary school students
16	[104]	Taiwan	A mobile instructional pervasive game method for language learning	English	Springers	Vocabulary, grammar, reading, and writing.	Game	Mobile based	University students

TABLE 9. (Continued.) Summary of research findings.

17	[105]	Saudi Arabia	An Investigation into the Role of Tablet Devices in Facilitating Collaborative Learning in EFL Language Course	English	Google scholars	grammar, listening, speaking, reading, and writing	Collaborative writing	Mobile-based	University students
18	[116]	Cyprus	Six seconds to visualize the word: improving EFL learners' vocabulary through VVVs	English	Google scholars	Vocabulary	Video	Mobile based	University students
19	[117]	South Korea	An Investigation of Facebook for Language Learning: Better Understanding Perceptions and Participation	English	Google scholars	Writing	Facebook (Social network)	Computer-based	University students
20	[130]	Netherland	The effects of animated pedagogical agents in an English-as-a-foreign-language learning environment	English	Science Direct	Tenses	Robotic	Computer-based	Undergraduate Students
21	[84]	Egypt	An intelligent tutoring system for teaching the grammar of the Arabic language.	Arabic	Science Direct	Grammar	Intelligent tutoring system	Computer based	Fourth- grade school students
22	[131]	USA	Heritage language literacy maintenance: A study of Korean-American heritage learners	English	Google scholars	Writing	Intelligent tutoring system	Computer based	56 Korean-English bilingual students in grades 4–12 and university undergraduates.
23	[46]	Netherland	The added value of a gaming context and intelligent adaptation for a mobile learning application for vocabulary learning	English	Science Direct	Vocabulary	Virtual reality	Mobile based	School students (8-9 years of age)
24	[132]	Japan	A language learning support system using course-centered ontology and its evaluation	Japanese	Science Direct	Grammar	Intelligent system	Computer based	First- year University students
25	[50]	Spain	Game-like language learning in 3-D virtual environments	German	Science Direct	Vocabulary	Game	Computer based	University students
26	[90]	Taiwan	A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use	English	Science Direct	Vocabulary	Online video	Mobile based	University students 40
27	[133]	China	Effects of a vocabulary acquisition and assessment system on students' performance in a blended learning class for English subject	English	Science Direct	Vocabulary	Intelligent tutoring system	Computer based	Students of Grade three in a junior middle school

are required to be provided with proper training and efficient learning strategies.

Some studies narrated a barrier that has an undesirable effect on learners' well-being on technology usage, including anxiety, physical discomfort, negative emotions, etc. Zhonggen [126] cautioned that learners may feel worried when they spend a long time playing language games, which can pose a threat to effective learning. Gao [59] was worried about learners spending too much time on social networking sites as it could damage their eyes. In addition, they will likely get addicted after using games or networking sites for a long time. Thus, it is important to teach learners about the carefulness of getting addicted to technology and how to handle technology usage. A learner may also encounter technical limitations such as technological issues when applying technology due to a lack of skills. If regular assistance is regularly provided, then learners will nurture a negative attitude towards technology and ravage their time. Thus, an immediate response is to be provided when a technical issue is being experienced by the learners. Moreover, adequate time is required to be given to the

learners to get trained on the use of technology, as well as its importance and drawbacks, in order to effectively utilize it for learning [127].

V. CONCLUSION

This study presented a comprehensive review of technology-assisted language learning systems. This study is based on the guidelines proposed by [40]. The comprehensive review covered published articles on the technology employed in language learning between 2012 and 2022. A total of 5719 articles were initially selected from five academic databases. However, twenty-seven (27) primary studies were selected after the screening process using the defined selection criteria and quality assessment. The review was critically based on the underlying technology, learners' language and learning skills, the empirical evidence on the benefits of technologies, and the barriers to implementing those technologies. The SLR was performed by answering four research questions. The findings from the SLR revealed that an intelligent system and social network are the most used technology to assist in language learning. On the other

hand, augmented reality is the least employed technology by researchers in the language learning domain, indicating that researchers who want to conduct further studies can consider it. Moreover, the study also shows that English is the most used language by researchers and educators in the research domain. They utilized it as English for a foreign language or English for a second language. Also, the study showed that researchers paid more attention to improving the vocabulary and writing skills of language learners. In some studies, researchers paid attention to one single skill, and in others to more than one. Furthermore, this study identified some benefits of applying technology in the language learning environment and some barriers that can be faced in the implementation of the technology in language learning, as well as some suggestions for overcoming those barriers. Thus, application of technology in language learning is very important as the benefits outweigh the drawbacks. Therefore, this review can be used as a guide for educators and researchers who intend to design technology-assisted language learning and teaching in the future. One of the limitations of this study is related to the timeframe of the literature search. The possibility of temporal bias is one important drawback. Because the search is limited in duration, pertinent studies published after that time may not be found by the SLR. The absence of emerging trends, recent advancements, or crucial insights could result in a knowledge gap in the state of the field.

For future trends and potential research directions, the authors will consider data analytics and learning analytics. To shape the future of technology-assisted language learning (TALL) systems, data analytics, and learning analytics are essential components. The goal of researchers and developers using data mining is to build systems that can forecast the behavior, performance, and problem areas of learners. With the use of advanced analytics, content distribution can be adjusted in real-time to provide individualized learning paths that cater to each student's needs. Furthermore, a potential direction is the investigation of sentiment analysis in educational settings. It might be insightful to examine learners' emotional and cognitive states as they interact with TALL systems. As a result, platforms with emotional intelligence that adapt to the emotional state of the student and provide a more interesting and encouraging learning environment may be created.

APPENDIX A

See Table 9.

REFERENCES

- [1] M. Prensky, "Digital natives, digital immigrants part 2: Do they really think differently?" *Horizon*, vol. 9, no. 6, pp. 1–6, Nov. 2001.
- [2] P. J. Miller, Amy, Wendy, and Beth: *Learning Language in South Baltimore*. Austin: University of Texas Press, 2011.
- [3] G. Theophilus and C. I. Eke, "Machine learning-based e-learners' engagement level prediction using benchmark datasets," *Int. J. Appl. Inf. Syst.*, vol. 12, no. 41, pp. 23–32, Sep. 2023.
- [4] E. Bos and J. Plassche, "A knowledge-based, English verb-form tutor," *J. Interact. Learn. Res.*, vol. 5, no. 1, p. 107, 1994.
- [5] G. Madhavaiah, C. Nagaraju, and S. Peter, "Importance of technology in teaching and learning English language," *Int. J. Sci. Res. Rev.*, vol. 2, no. 3, pp. 146–154, 2013.
- [6] L. Rudak, "Susceptibility to e-teaching," in *Proc. Conf., ICT Competitiveness*, 2012, pp. 10–16.
- [7] N. Sadeghi, Z. M. Kasim, B. H. Tan, and F. S. Abdullah, "Learning styles, personality types and reading comprehension performance," *English Lang. Teach.*, vol. 5, no. 4, pp. 116–123, Mar. 2012.
- [8] R. L. Oxford, "Use of language learning strategies: A synthesis of studies with implications for strategy training," *System*, vol. 17, no. 2, pp. 235–247, Jan. 1989.
- [9] A. A. Ahmadishokouh and F. Samadi, "The possible differences between learning styles used by Russian, English, French, and Arabic language learners," *Int. J. Multicultural Multireligious Understand.*, vol. 8, no. 9, p. 471, Oct. 2021.
- [10] T. Türkbek, "The effects of interactive teaching strategies on speaking skills of students learning Turkish as a second language," *J. Lang. Linguistic Stud.*, vol. 15, no. 3, pp. 1011–1031, Oct. 2019.
- [11] M.-H. Ko, "Learner perspectives regarding device type in technology-assisted language learning," *Comput. Assist. Lang. Learn.*, vol. 30, no. 8, pp. 844–863, Nov. 2017.
- [12] A. Coşkun and Z. Marlowe, "The place of technology-assisted language learning in EFL listening: A review of literature and useful applications," in *Enriching Teaching and Learning Environments With Contemporary Technologies*. IGI Global, 2020, pp. 102–116.
- [13] M. A. Ghufiron and F. Nurdianingsih, "Flipped classroom method with computer-assisted language learning (CALL) in EFL writing class," *Int. J. Learn., Teaching Educ. Res.*, vol. 20, no. 1, pp. 120–141, Jan. 2021.
- [14] D. S. M. Zain and F. A. Bowles, "Mobile-assisted language learning (MALL) for higher education instructional practices in EFL/ESL contexts: A recent review of literature," *Comput. Assist. Lang. Learn. Electron. J.*, vol. 22, no. 1, pp. 282–307, 2021.
- [15] Y. Li, J. Medwell, D. Wray, L. Wang, and L. Xiaojing, "Learning styles: A review of validity and usefulness," *J. Educ. Training Stud.*, vol. 4, no. 10, pp. 90–94, Aug. 2016.
- [16] A. Lai, C. Chen, and G. Lee, "An augmented reality-based learning approach to enhancing students' science reading performances from the perspective of the cognitive load theory," *Brit. J. Educ. Technol.*, vol. 50, no. 1, pp. 232–247, Jan. 2019.
- [17] A. H. Nabizadeh, J. P. Leal, H. N. Rafsanjani, and R. R. Shah, "Learning path personalization and recommendation methods: A survey of the state-of-the-art," *Expert Syst. Appl.*, vol. 159, Nov. 2020, Art. no. 113596.
- [18] N. B. A. Normadhi, L. Shuib, H. N. M. Nasir, A. Bimba, N. Idris, and V. Balakrishnan, "Identification of personal traits in adaptive learning environment: Systematic literature review," *Comput. Educ.*, vol. 130, pp. 168–190, Mar. 2019.
- [19] D. Kim, D. Rueckert, D.-J. Kim, and D. Seo, "Students' perceptions and experiences of mobile learning," *Lang. Learn. Technol.*, vol. 17, no. 3, pp. 52–73, 2013.
- [20] J. Goranson, "Learner perceptions and preferences of device type in vocabulary learning," *Multimedia-Assisted Lang. Learn.*, vol. 17, no. 3, pp. 37–67, Sep. 2014.
- [21] S. Smith and S. Wang, "Reading and grammar learning through mobile phones," *Lang. Learn. Technol.*, vol. 17, no. 3, pp. 117–134, 2013.
- [22] N. Cavus and D. Ibrahim, "Learning English using children's stories in mobile devices," *Brit. J. Educ. Technol.*, vol. 48, no. 2, pp. 625–641, Mar. 2017.
- [23] R. Dashtestani, "Moving bravely towards mobile learning: Iranian students' use of mobile devices for learning English as a foreign language," *Comput. Assist. Lang. Learn.*, vol. 29, no. 4, pp. 815–832, May 2016.
- [24] M. Uther and A. P. Banks, "The influence of affordances on user preferences for multimedia language learning applications," *Behav. Inf. Technol.*, vol. 35, no. 4, pp. 277–289, Apr. 2016.
- [25] C. Cárdenas-Moncada, M. Veliz-Campos, and L. Veliz, "Game-based student response systems: The impact of Kahoot in a Chilean vocational higher education EFL classroom," *Comput.-Assisted Lang. Learn. Electron. J.*, vol. 21, no. 1, pp. 64–78, 2020.
- [26] K. S. N. Et. al, "Japanese students' English language learning experience through computer game-based student response systems," *Turkish J. Comput. Math. Educ.*, vol. 12, no. 3, pp. 1993–1998, Apr. 2021.

- [27] T. Larkin and D. Budny, "Learning styles in the classroom: Approaches to enhance student motivation and learning," in *Proc. 6th Int. Conf. Inf. Technol. Based Higher Educ. Training*, 2005, pp. 1–8.
- [28] S. Cassidy, "Learning styles: An overview of theories, models, and measures," *Educ. Psychol.*, vol. 24, no. 4, pp. 419–444, Aug. 2004.
- [29] M. J. Gohar and N. Sadeghi, "The impact of learning style preferences on foreign language achievement: A case study of Iranian EFL students," *Proc.-Social Behav. Sci.*, vol. 171, pp. 754–764, Jan. 2015.
- [30] J. Stevenson and R. Dunn, "Knowledge management and learning styles: Prescriptions for future teachers," *College Student J.*, vol. 35, no. 4, pp. 483–491, 2001.
- [31] M. Moenikia and E. Zahed-Babelan, "The role of learning styles in second language learning among distance education students," *Proc.-Social Behav. Sci.*, vol. 2, no. 2, pp. 1169–1173, 2010.
- [32] F. Shirazi and S. Heidari, "The relationship between critical thinking skills and learning styles and academic achievement of nursing students," *J. Nursing Res.*, vol. 27, no. 4, p. e38, Aug. 2019.
- [33] B. Williams, T. Brown, and J. Etherington, "Learning style preferences of undergraduate pharmacy students," *Currents Pharmacy Teach. Learn.*, vol. 5, no. 2, pp. 110–119, Apr. 2013.
- [34] J. Rahmani and M. Azali, "The relationship between learning styles and academic achievement in female high school students of Esfahan," *J. Res. Curriculum Planning*, vol. 9, no. 33, pp. 140–131, 2012.
- [35] M. A. Ramaniya, "EFL junior high school students' learning style," *Art Teach. English Foreign Lang.*, vol. 2, no. 1, pp. 50–55, 2021.
- [36] J. Neroni, C. Meijs, H. J. M. Gijsselaers, P. A. Kirschner, and R. H. M. de Groot, "Learning strategies and academic performance in distance education," *Learn. Individual Differences*, vol. 73, pp. 1–7, Jul. 2019.
- [37] R. Mitchell, F. Myles, and E. Marsden, *Second Language Learning Theories*. Evanston, IL, USA: Routledge, 2019.
- [38] R. Mallett, J. Hagen-Zanker, R. Slater, and M. Duvendack, "The benefits and challenges of using systematic reviews in international development research," *J. Develop. Effectiveness*, vol. 4, no. 3, pp. 445–455, Sep. 2012.
- [39] S. Keele, "Guidelines for performing systematic literature reviews in software engineering," EBSE, Tech. Rep. EBSE-2007-01, pp. 1–57, 2007.
- [40] B. Kitchenham, R. Pretorius, D. Budgen, O. P. Brereton, M. Turner, M. Niazi, and S. Linkman, "Systematic literature reviews in software engineering—a tertiary study," *Inf. Softw. Technol.*, vol. 52, no. 8, pp. 792–805, 2010.
- [41] A. Grewal, H. Kataria, and I. Dhawan, "Literature search for research planning and identification of research problem," *Indian J. Anaesthesia*, vol. 60, no. 9, p. 635, 2016.
- [42] Z. Papamitsiou and A. A. Economides, "Learning analytics and educational data mining in practice: A systematic literature review of empirical evidence," *J. Educ. Technol. Soc.*, vol. 17, no. 4, pp. 49–64, 2014.
- [43] B. Kitchenham and P. Brereton, "A systematic review of systematic review process research in software engineering," *Inf. Softw. Technol.*, vol. 55, no. 12, pp. 2049–2075, Dec. 2013.
- [44] Y. G. Butler, "The use of computer games as foreign language learning tasks for digital natives," *System*, vol. 54, pp. 91–102, Nov. 2015, doi: 10.1016/j.system.2014.10.010.
- [45] J. Alvarez and D. Djaouti, "An introduction to serious game definitions and concepts," *Serious Games Simul. Risks Manage.*, vol. 11, no. 1, pp. 11–15, 2011.
- [46] J. Sandberg, M. Maris, and P. Hoogendoorn, "The added value of a gaming context and intelligent adaptation for a mobile learning application for vocabulary learning," *Comput. Educ.*, vol. 76, pp. 119–130, Jul. 2014.
- [47] C.-M. Chen, H. Liu, and H.-B. Huang, "Effects of a mobile game-based English vocabulary learning app on learners' perceptions and learning performance: A case study of Taiwanese EFL learners," *ReCALL*, vol. 31, no. 2, pp. 170–188, May 2019.
- [48] A. Schremm, A. Hed, M. Horne, and M. Roll, "Training predictive L2 processing with a digital game: Prototype promotes acquisition of anticipatory use of tone-suffix associations," *Comput. Educ.*, vol. 114, pp. 206–221, Nov. 2017.
- [49] W.-Y. Hwang, T. K. Shih, Z.-H. Ma, R. Shadieff, and S.-Y. Chen, "Evaluating listening and speaking skills in a mobile game-based learning environment with situational contexts," *Comput. Assist. Lang. Learn.*, vol. 29, no. 4, pp. 639–657, May 2016.
- [50] A. Berns, A. Gonzalez-Pardo, and D. Camacho, "Game-like language learning in 3-D virtual environments," *Comput. Educ.*, vol. 60, no. 1, pp. 210–220, Jan. 2013.
- [51] E. Rassaei, "Computer-mediated text-based and audio-based corrective feedback, perceptual style and L2 development," *System*, vol. 82, pp. 97–110, Jun. 2019.
- [52] J. Li, S. Link, and V. Hegelheimer, "Rethinking the role of automated writing evaluation (AWE) feedback in ESL writing instruction," *J. Second Lang. Writing*, vol. 27, pp. 1–18, Mar. 2015.
- [53] J. Ranalli, "Automated written corrective feedback: How well can students make use of it?" *Comput. Assist. Lang. Learn.*, vol. 31, no. 7, pp. 653–674, Sep. 2018.
- [54] A. Liaqat, C. Munteanu, and C. Demmans Epp, "Collaborating with mature English language learners to combine peer and automated feedback: A user-centered approach to designing writing support," *Int. J. Artif. Intell. Educ.*, vol. 31, no. 4, pp. 638–679, Dec. 2021.
- [55] C. Maier, S. Laumer, A. Eckhardt, and T. Weitzel, "Giving too much social support: Social overload on social networking sites," *Eur. J. Inf. Syst.*, vol. 24, no. 5, pp. 447–464, Sep. 2015.
- [56] G. Blattner and M. Fiori, "Virtual social network communities: An investigation of language learners' development of sociopragmatic awareness and multiliteracy skills," *CALICO J.*, vol. 29, no. 1, pp. 24–43, Sep. 2011.
- [57] W. Y. Chang, "Exploring solutions to decrease Taiwanese University lower achievers' English writing difficulties via blogging," *Comput.-Assist. Lang. Learn. Electron. J.*, vol. 21, no. 2, p. 116, 2020.
- [58] J. A. Mompean and J. Fouz-González, "Twitter-based EFL pronunciation instruction," *Lang. Learn. Technol.*, vol. 20, no. 1, pp. 166–190, 2016.
- [59] Y. Gao, "An analysis of social media use within and outside of college English classes in China," M.S. thesis, Faculty Educ., Univ. Western Ontario, Canada, 2019.
- [60] H.-I. Chen, "Identity practices of multilingual writers in social networking spaces," *Lang. Learn. Technol.*, vol. 17, no. 2, pp. 143–170, 2013.
- [61] V. P. Dennen and R. C. Branch, "Considerations for designing instructional virtual environments," in *Proc. Annu. Conf. Int. Vis. Literacy Assoc.*, Chicago, Oct. 1995.
- [62] F. Biocca, "Communication within virtual reality: Creating a space for research," *J. Commun.*, vol. 42, no. 4, pp. 5–22, Dec. 1992.
- [63] Y.-C. Shih, "A virtual walk through london: Culture learning through a cultural immersion experience," *Comput. Assist. Lang. Learn.*, vol. 28, no. 5, pp. 407–428, Sep. 2015.
- [64] X. Peng, H. Chen, L. Wang, and H. Wang, "Evaluating a 3-D virtual talking head on pronunciation learning," *Int. J. Hum.-Comput. Stud.*, vol. 109, pp. 26–40, Jan. 2018.
- [65] K. Yamazaki, "Computer-assisted learning of communication (CALC): A case study of Japanese learning in a 3D virtual world," *ReCALL*, vol. 30, no. 2, pp. 214–231, May 2018.
- [66] M. Park, "Innovative assessment of aviation English in a virtual world: Windows into cognitive and metacognitive strategies," *ReCALL*, vol. 30, no. 2, pp. 196–213, May 2018.
- [67] B. Dalgarno and M. J. Lee, "What are the learning affordances of 3-D virtual environments?" *Brit. J. Educ. Technol.*, vol. 41, no. 1, pp. 10–32, 2010.
- [68] Y.-M. Huang, R. Shadieff, and W.-Y. Hwang, "Investigating the effectiveness of speech-to-text recognition applications on learning performance and cognitive load," *Comput. Educ.*, vol. 101, pp. 15–28, Oct. 2016.
- [69] S. M. McCrocklin, "Pronunciation learner autonomy: The potential of automatic speech recognition," *System*, vol. 57, pp. 25–42, Apr. 2016.
- [70] Y.-L. Huang, C.-M. Chen, and M. Lin, "An English diagnosis and review system based on brainwave attention recognition technology for the paper-based learning context with digital-pen support," in *Proc. 6th IIAI Int. Congr. Adv. Appl. Informat.*, Mar. 2017, pp. 643–648.
- [71] R. Shadieff, A. Sun, and Y. Huang, "A study of the facilitation of cross-cultural understanding and intercultural sensitivity using speech-enabled language translation technology," *Brit. J. Educ. Technol.*, vol. 50, no. 3, pp. 1415–1433, May 2019.
- [72] H.-C. Hsu and Y.-F. Lo, "Using Wiki-mediated collaboration to foster L2 writing performance," *Lang. Learn. Technol.*, vol. 22, no. 3, pp. 103–123, 2018.
- [73] Z. I. Abrams, "Collaborative writing and text quality in Google Docs," *Lang. Learn. Technol.*, vol. 23, no. 2, pp. 22–42, 2019, doi: 10.125/44681.
- [74] S. Sauro and B. Sundmark, "Critically examining the use of blog-based fanfiction in the advanced language classroom," *ReCALL*, vol. 31, no. 1, pp. 40–55, Jan. 2019.

- [75] G. Kessler, D. Bikowski, and J. Boggs, "Collaborative writing among second language learners in academic web-based projects," *Lang. Learn. Technol.*, vol. 16, no. 1, pp. 91–109, 2012.
- [76] S.-T.-A. Hung and H.-T.-D. Huang, "Blogs as a learning and assessment instrument for English-speaking performance," *Interact. Learn. Environ.*, vol. 24, no. 8, pp. 1881–1894, Nov. 2016.
- [77] I. Elola and A. Oskoz, "Collaborative writing: Fostering foreign language and writing conventions development," *Lang. Learn. Technol.*, vol. 14, no. 3, pp. 51–71, 2010.
- [78] G. Kessler and D. Bikowski, "Developing collaborative autonomous learning abilities in computer mediated language learning: Attention to meaning among students in WiKi space," *Comput. Assist. Lang. Learn.*, vol. 23, no. 1, pp. 41–58, Feb. 2010.
- [79] K. R. Parker and J. T. Chao, "WiKi as a teaching tool," *Interdiscipl. J. E-Skills Lifelong Learn.*, vol. 3, pp. 57–72, Jan. 2007.
- [80] M. Zhang and W. Chen, "Assessing collaborative writing in the digital age: An exploratory study," *J. Second Lang. Writing*, vol. 57, Sep. 2022, Art. no. 100868.
- [81] H. S. Alyousef and M. Y. Picard, "Cooperative or collaborative literacy practices: Mapping metadiscourse in a business students' Wiki group project," *Australas. J. Educ. Technol.*, vol. 27, no. 3, pp. 463–480, 2011.
- [82] M. Malekzadeh, M. B. Mustafa, and A. Lahsasna, "A review of emotion regulation in intelligent tutoring systems," *J. Educ. Technol. Soc.*, vol. 18, no. 4, pp. 435–445, 2015.
- [83] I.-C. Choi, "Efficacy of an ICALL tutoring system and process-oriented corrective feedback," *Comput. Assist. Lang. Learn.*, vol. 29, no. 2, pp. 334–364, Feb. 2016.
- [84] M. H. Mahmoud and S. H. A. El-Hamayed, "An intelligent tutoring system for teaching the grammar of the Arabic language," *J. Electr. Syst. Inf. Technol.*, vol. 3, no. 2, pp. 282–294, Sep. 2016.
- [85] L. K. Allen, S. A. Crossley, E. L. Snow, and D. S. McNamara, "L2 writing practice: Game enjoyment as a key to engagement," *Lang. Learn. Technol.*, vol. 18, no. 2, pp. 124–150, 2014.
- [86] K. Schreiner, "Uniting the paper and digital worlds," *IEEE Comput. Graph. Appl.*, vol. 28, no. 6, pp. 6–10, Nov. 2008.
- [87] C.-M. Chen, C.-C. Tan, and B.-J. Lo, "Facilitating English-language learners' oral reading fluency with digital pen technology," *Interact. Learn. Environ.*, vol. 24, no. 1, pp. 96–118, Jan. 2016.
- [88] W.-C. Lai, P.-Y. Chao, and G.-D. Chen, "The interactive multimedia textbook: Using a digital pen to support learning for computer programming," in *Proc. 7th IEEE Int. Conf. Adv. Learn. Technol. (ICALT)*, Jul. 2007, pp. 742–746.
- [89] Y.-J. Lin and H.-C. Wang, "Using enhanced OER videos to facilitate English L2 learners' multicultural competence," *Comput. Educ.*, vol. 125, pp. 74–85, Oct. 2018.
- [90] Y.-M. Huang, Y.-M. Huang, S.-H. Huang, and Y.-T. Lin, "A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use," *Comput. Educ.*, vol. 58, no. 1, pp. 273–282, Jan. 2012.
- [91] G.-J. Hwang, C.-C. Tsai, and S. J. Yang, "Criteria, strategies and research issues of context-aware ubiquitous learning," *J. Educ. Technol. Soc.*, vol. 11, no. 2, pp. 81–91, 2008.
- [92] H.-C. Yeh, "Exploring the perceived benefits of the process of multimodal video making in developing multiliteracies," *Lang. Learn.*, vol. 22, no. 2, pp. 28–37, 2018.
- [93] W. Hsu, "The effects of audiovisual support on EFL learners' productive vocabulary," *ReCALL*, vol. 26, no. 1, pp. 62–79, Jan. 2014.
- [94] R. T. Azuma, "A survey of augmented reality," *Presence, Teleoperators Virtual Environ.*, vol. 6, no. 4, pp. 355–385, 1997.
- [95] T.-C. Hsu, "Learning English with augmented reality: Do learning styles matter?" *Comput. Educ.*, vol. 106, pp. 137–149, Mar. 2017.
- [96] S.-C. Ho, S.-W. Hsieh, P.-C. Sun, and C.-M. Chen, "To activate English learning: Listen and speak in real life context with an AR featured U-learning system," *J. Educ. Technol. Soc.*, vol. 20, no. 2, pp. 176–187, 2017.
- [97] C. Troussas, K. Chrysiadi, and M. Virvou, "An intelligent adaptive fuzzy-based inference system for computer-assisted language learning," *Expert Syst. Appl.*, vol. 127, pp. 85–96, Aug. 2019.
- [98] J. S. Chen Hsieh, Y.-M. Huang, and W.-C.-V. Wu, "Technological acceptance of LINE in flipped EFL oral training," *Comput. Hum. Behav.*, vol. 70, pp. 178–190, May 2017.
- [99] W.-C. Fang, F. A. K. Cassim, C.-N. Hsu, and N.-S. Chen, "Effects of reciprocal peer feedback on EFL learners' communication strategy use and oral communication performance," *Smart Learn. Environ.*, vol. 5, no. 1, pp. 1–16, Dec. 2018.
- [100] S. Naderi and A. Akrami, "EFL learners' reading comprehension development through MALL: Telegram groups in focus," *Int. J. Instruct.*, vol. 11, no. 2, pp. 339–350, Apr. 2018.
- [101] A. N. Hazaea and A. A. Alzubi, "Impact of mobile assisted language learning on learner autonomy in EFL reading context," *J. Lang. Educ.*, vol. 4, no. 2, pp. 48–58, Jun. 2018.
- [102] W. Ngui, V. Pang, W. Hiew, and L. Wah, "Exploring the impact of e-portfolio on ESL students' writing skills through the lenses of Malaysian undergraduates," *Comput.-Assist. Lang. Learn. Electron. J.*, vol. 21, no. 3, pp. 105–121, 2020.
- [103] R. Vaezi, A. Afghari, and A. Lotfi, "Investigating listening comprehension through flipped classroom approach: Does authenticity matter," *CALL-EJ*, vol. 20, no. 1, pp. 178–208, 2019.
- [104] C. Chang, J.-L. Shih, and C.-K. Chang, "A mobile instructional pervasive game method for language learning," *Universal Access Inf. Soc.*, vol. 16, no. 3, pp. 653–665, Aug. 2017.
- [105] H. Albady, "An investigation into the role of tablet devices in facilitating collaborative learning in EFL language course," *Int. J. Emerg. Technol. Learn.*, vol. 12, no. 4, p. 39, Apr. 2017.
- [106] T.-H. Chen and C.-C. Lin, "Enhancing L2 English learning through mobile-assisted TBLT: EFL learners' perspectives," *J. AsiaTEFL*, vol. 15, no. 2, pp. 453–461, Jun. 2018.
- [107] E. D. Reynolds and B. Taylor, "Kahoot!: EFL instructors' implementation experiences and impacts on students' vocabulary knowledge," *Comput.-Assist. Lang. Learn. Electron. J.*, vol. 21, no. 2, pp. 70–92, 2020.
- [108] S. Wichadee and F. Pattanapichet, "Enhancement of performance and motivation through application of digital games in an English language class," *Teach. English Technol.*, vol. 18, no. 1, pp. 77–92, 2018.
- [109] M. A. Alharbi, "Integration of video in teaching grammar to EFL Arab learners," *CALL-EJ*, vol. 20, pp. 135–153, Jan. 2019.
- [110] J. Grimshaw and W. Cardoso, "Activate space rats! Fluency development in a mobile game-assisted environment," *Lang. Learn. Technol.*, vol. 22, no. 3, pp. 159–175, 2018.
- [111] V. Le, "Digital storytelling with Puppet Pals to generate freshmen's enjoyment in English speaking," *Comput.-Assist. Lang. Learn. Electron. J.*, vol. 21, no. 3, pp. 175–197, 2020.
- [112] E. L. Deci, R. Koestner, and R. M. Ryan, "A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation," *Psychol. Bull.*, vol. 125, no. 6, pp. 627–668, 1999.
- [113] F. Kılıçkaya, "Computer-based grammar instruction in an EFL context: Improving the effectiveness of teaching adverbial clauses," *Comput. Assist. Lang. Learn.*, vol. 28, no. 4, pp. 325–340, Jul. 2015.
- [114] S. Sabri, A. Gani, E. Yadegaridehkordi, C. I. Eke, and L. Shuib, "A survey on mobile learning for adult learners: State-of-the-art, taxonomy, and challenges," *IEEE Access*, vol. 10, pp. 83884–83897, 2022.
- [115] P.-L. Liu, "Mobile English vocabulary learning based on concept-mapping strategy," *Lang. Learn. Technol.*, vol. 20, no. 3, pp. 128–141, 2016.
- [116] M. Kurt and H. Bensen, "Six seconds to visualize the word: Improving EFL learners' vocabulary through VVVs," *J. Comput. Assist. Learn.*, vol. 33, no. 4, pp. 334–346, Aug. 2017.
- [117] D. Bailey, I. Park, and S. A. Haji, "An investigation of Facebook for language learning: Better understanding perceptions and participation," *CALL-EJ*, vol. 18, no. 2, pp. 14–30, 2017.
- [118] D. Bailey, "Social networking for language learning participation in relation to task value and L2 writing anxiety," *CALL-EJ*, vol. 20, no. 1, pp. 1–18, 2019.
- [119] F. Ataeifar, F. Sadighi, M. S. Bagheri, and F. Behjat, "Iranian female students' perceptions of the impact of mobile-assisted instruction on their English speaking skill," *Cogent Educ.*, vol. 6, no. 1, Jan. 2019, Art. no. 1662594.
- [120] D. Tafazoli, M. E. G. Parra, and C. A. Huertas-Abril, *Cross-Cultural Perspectives on Technology-Enhanced Language Learning*. Hershey, PA, USA: IGI Global, 2018.
- [121] L.-T. Yu, "Incorporating Facebook into an EFL writing course: Student perception and participation in online discussion," *CALL-EJ*, vol. 19, pp. 1–22, Jul. 2018.

- [122] A. Ghanizadeh, A. Razavi, and S. Jahedizadeh, "Technology-enhanced language learning (TELL): A review of resources and upshots," *Int. Lett. Chem., Phys. Astron.*, vol. 54, pp. 73–87, Jul. 2015.
- [123] R. Shadiev, W.-Y. Hwang, and Y.-M. Huang, "Review of research on mobile language learning in authentic environments," *Comput. Assist. Lang. Learn.*, vol. 30, nos. 3–4, pp. 284–303, May 2017.
- [124] N. Ziegler, "Synchronous computer-mediated communication and interaction: A meta-analysis," *Stud. Second Lang. Acquisition*, vol. 38, no. 3, pp. 553–586, Sep. 2016.
- [125] Y. Tono, "Application of eye-tracking in EFL learners' dictionary look-up process research," *Int. J. Lexicography*, vol. 24, no. 1, pp. 124–153, Mar. 2011.
- [126] Y. Zhonggen, "Differences in serious game-aided and traditional English vocabulary acquisition," *Comput. Educ.*, vol. 127, pp. 214–232, Dec. 2018.
- [127] R. J. Pearson, "Tailoring clicker technology to problem-based learning: What's the best approach?" *J. Chem. Educ.*, vol. 94, no. 12, pp. 1866–1872, Dec. 2017.
- [128] T.-C. Hsu, "Effects of gender and different augmented reality learning systems on English vocabulary learning of elementary school students," *Universal Access Inf. Soc.*, vol. 18, no. 2, pp. 315–325, Jun. 2019.
- [129] J. Liu, H. Shindo, and Y. Matsumoto, "Development of a computer-assisted Japanese functional expression learning system for Chinese-speaking learners," *Educ. Technol. Res. Develop.*, vol. 67, no. 5, pp. 1307–1331, Oct. 2019.
- [130] T. Carlotto and P. A. Jaques, "The effects of animated pedagogical agents in an English-as-a-foreign-language learning environment," *Int. J. Hum.-Comput. Stud.*, vol. 95, pp. 15–26, Nov. 2016.
- [131] C. E. Kim and D. O. Pyun, "Heritage language literacy maintenance: A study of Korean–American heritage learners," *Lang., Culture Curriculum*, vol. 27, no. 3, pp. 294–315, Sep. 2014.
- [132] J. Wang, T. Mendori, and J. Xiong, "A language learning support system using course-centered ontology and its evaluation," *Comput. Educ.*, vol. 78, pp. 278–293, Sep. 2014.
- [133] J. Jia, Y. Chen, Z. Ding, and M. Ruan, "Effects of a vocabulary acquisition and assessment system on students' performance in a blended learning class for English subject," *Comput. Educ.*, vol. 58, no. 1, pp. 63–76, Jan. 2012.



LIYANA SHUIB received the B.Comp.Sc. degree (Hons.) from Universiti Teknologi Malaysia, Skudai, Malaysia, the Master of Information Technology degree from Universiti Kebangsaan Malaysia, and the Ph.D. degree from the University of Malaya, Kuala Lumpur. She is currently a Senior Lecturer with the Department of Information Systems, Faculty of Computer Science and Information Technology, University of Malaya. She is presently supervising several postgraduate students.



NORISMA IDRIS received the B.Comp.Sc. degree (Hons.) from Universiti Teknologi Malaysia, Skudai, Malaysia, the Master of Information Technology degree from Universiti Kebangsaan Malaysia, and the Ph.D. degree from the University of Malaya, Kuala Lumpur. She is currently a Senior Lecturer with the Department of Artificial Intelligence, Faculty of Computer Science and Information Technology, University of Malaya. She is presently supervising several postgraduate students. She has more than 20 articles relevant to her research interest.



CHRISTOPHER IFEANYI EKE received the Master of Science degree in mobile computing from the University of Bedfordshire, Luton, U.K., in 2011, and the Ph.D. degree from the Department of Information Systems, Faculty of Computer Science and Information Technology, University of Malaya, Kuala Lumpur, Malaysia, in 2021. He is currently a Lecturer with the Department of Information Systems, Faculty of Computing, Federal University of Lafia, Nigeria. He has published a number of journal articles and conference proceedings related to his research interests, such as data science, NLP, information systems and security, cloud computing, machine learning, big data, and social media analytics.

...



HAREESH BUDDHA received the M.Sc. degree in computer science from Staffordshire University, in 2007. He is currently pursuing the Ph.D. degree with the Department of Information Systems, University of Malaya. He is a Software Engineer in Sydney, Australia.