# AI-Driven Vocabulary Development in ESL Context: Advancing Autonomous Learning Through Technology

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## Abstract

*For ESL learners, the vocabulary learning process becomes a laboriously daunting one due to insufficient social and educational input. According to Schneider et al. (2002), the process of second language learning, specifically the vocabulary of the target language, requires the "ability to produce, differentiate, connect, and be bidirectional" (p. 419). In this situation, technology seems to be the ultimate savior. Technology is changing the pedagogical possibilities at a phenomenal rate, and the effects of this change have reached beyond the classrooms. With the advent of Artificial intelligence i.e. AI, technology has become more powerful, accessible, portable and adaptable providing learners with tools to make their learning personalized and accelerated. A shift has also occurred in the pedagogical perspectives and practices as well, bringing learners to the forefront instead of teachers. In such a scenario, TALL (Technology Assisted Language Learning) is expected to play a significant role in the teaching and learning of a second or a foreign language. Keeping in perspective, Beatty's (2010) assertion about finding ways to create "a better fit between good pedagogy and technology" (p. 206), this paper explores the potential of technology-assisted, autonomous, and self-regulated learning approaches and practices for lexical enrichment in ESL contexts. It investigates how AI-driven tools and applications can bridge the gap between theoretical, pedagogical frameworks and practical implementation, enhancing vocabulary acquisition and learner autonomy beyond the traditional classroom environment.*

**Keywords:** Artificial Intelligence, CAVL, MAVL, TALL, Vocabulary Development.

## 1. Introduction

This paper explores the most effective, innovative and impactful ways of the enhancement of second language learners' autonomous and self-regulated lexical enrichment through Technology-Assisted Language Learning (TALL). A part of the theoretical framework of the present study depends on the theory of Constructivism that claims that technology may support self-regulation because it promotes individuality, confidence and skills; provides a context for learning that supports both autonomy and relatedness and strengthens the learner's tendency to engage in intentional and autonomous learning processes.

Vocabulary enhancement is a tedious and time consuming process for ESL learners. Native English as a first language is acquired through incidentally encountered, natural inputs from birth. For Native speakers, vocabulary acquisition becomes naturally easy due to the formulaic

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sequences (Schmitt, 2010a) and the ongoing process of the incidental learning. According to the findings of Nation & Waring (1997b), "typical five-year old native English speakers are already familiar with 4000 to 5000 word families, and university graduates will possess about 20,000 word families by acquiring 1,000 word families every year, compared to ESL learners who tend to begin their English learning at almost point zero."

ESL learners are devoid of the incidental lexical input which is received by Native speakers in social, professional and academic settings. Furthermore, ESL learners generally begin learning their new English vocabulary after their first language (L1), which usually differs from L2 in terms of phonology, orthography, semantics, syntax, morphology, pragmatics, morpheme orders, etc. is already in a productive stage of fluency. Thus, according to Schmitt, (2010a) "learning English vocabulary is not an easy task especially for ESL learners who have to simultaneously deal with different cross-linguistic influences such as definitions, pronunciations, spellings, forms, and grammar associated with new words to build up formulaic sequences like natives."

This thematic review paper, based on secondary research, has been organized into three main sections i.e. CAVL (Computer Assisted Vocabulary Learning), MAVL (Mobile Assisted Vocabulary Learning) and AIVL (AI-Driven Vocabulary Learning). Under the umbrella term of Technology-Assisted Language Learning (TALL), these methodologies aim at using computer, mobile, and AI-driven technologies in learning or teaching foreign languages. "Such a technology, which has become a fixture in many homes nowadays, has significant impact on education and has been more and more integrated into classrooms" (Davis, 2006). Technologies that are fixed, e.g. desktop computers, remain available for limited usage restricted to a time and place. Technologies that are portable, such as mobile phones, and adaptable such as AI exert a far greater amount of freedom with regard to time and place.

**Figure 1: Hierarchical description of Technology Assisted Vocabulary Learning**
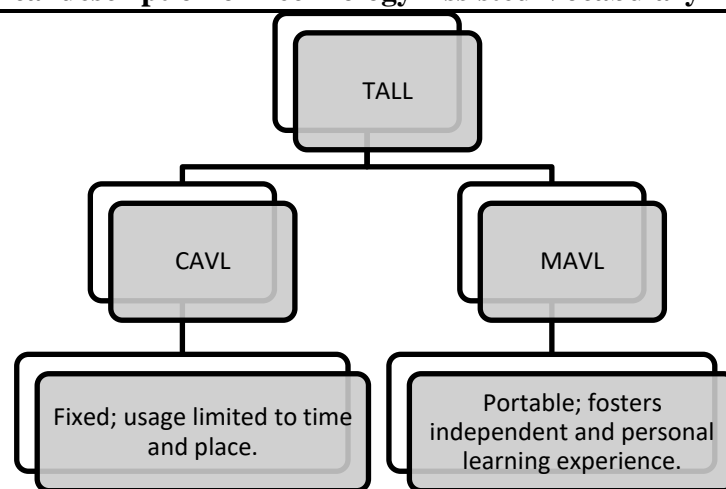


## SECTION ONE
## 2. CAVL (Computer Assisted Vocabulary Learning)

Ellis (1995) states, "Computers can structure training, practice, and testing to optimize the rate of vocabulary acquisition" (p. 123). A quick and easy access to an interestingly intricate range of vocabulary learning opportunities, such as vocabulary quizzes, digital flashcard websites, vocabulary lists and exercises, online dictionaries, and online games, is available for students

through CAVL. Nation (2013) asserts, "several advantageous features distinguish CAVL from other ways of learning." Wu (2015) states that "68% of the students declared that they spent double the amount of time on vocabulary learning outside the class in comparison to inside the class." It follows logically that students need to be autonomous and strategically empowered to gain most from the efforts and time they put into learning English vocabulary. CAVL aims to enhance autonomy; it monitors and controls users' learning conditions, providing immediate feedback on performance and progress, and maintaining the record of the learners' performance by storing it. Furthermore, it provides tailored material that's most suited to the current proficiency level of the learner. However, despite these potential benefits, research on CAVL has yet to produce convincing or noteworthy results yet. Nation (2013) asserts that "there is a need to develop programs that maximally exploit its exponential advantages."

Wu (2015) conducted a study to find the difference between the application of computer technology and the paper-based environment to enhance the use of vocabulary learning strategies and self-directed vocabulary learning. 61 freshman students used a "self-directed vocabulary learning system called Learning Vocabulary in Domain" and the system proved to be superior to the printed material. In addition, although no difference could be detected between the scores based on short term memory, students using the system surpassed the other group in the test conducted two and a half months later. The effect of CALL on vocabulary development of Iranian ESL Learners was investigated by Barani (2013). The research was designed to answer the following question: "Does Computer Assisted Language Learning (CALL) have any effect on vocabulary achievement of Iranian university students as ESL Learners?" 72 students, divided into experimental and control groups, participated in the study. The results demonstrated that CALL helps EFL learners learn language more efficiently. According to Barani (2013), "There was a significant difference between CALL users and nonusers in favor of the experimental group ($p < 0.05$)."

## 2.1 Defining CAVL (Computer Assisted Vocabulary Learning)

Within the scope of TALL (Technology Assisted Language Learning), computer and its software opened up many new horizons to language teaching/learning. CALL (Computer Assisted Language Learning) may be defined as "the search for and study of applications of the computer in language learning and teaching" (Levy, 1997, p. 1). The field of CALL has flourished for about more than five decades. Its growth as a field has been affected by both the gradual and consistent evolution of technology and the dominant pedagogical approaches in a specific period. Computer technology has gradually found inroads into language education and now it seems to be one of the major foci of researchers.

## 2.2 Multidimensionality of CAVL

Learners come across a multidimensional range of incidental and direct vocabulary learning activities in a computer assisted learning environment. Many studies explored the impact of diverse technology-integrated vocabulary systems (e.g. Ma & Kelly, 2006; Abraham, 2008; Basoglu & Akdemir, 2010; Oberg, 2011; Alnajjar & Brick, 2017). These studies focused on the importance of multimedia in texts (Kayaoglu et al., 2011), vocabulary enrichment through educational games (Ranalli, 2008; Cobb & Horst, 2011), and the advantages of multimedia glosses for L2 vocabulary development (Mohsen & Balakumar, 2011). Despite these contributions, the majority of these studies were conducted in experimental settings with limited sample sizes, which raises concerns about their generalizability. Notably, these studies don't account for the actual

number of learners who utilize these technological tools in real-world educational contexts, leaving a gap in understanding their widespread impact and usage among larger student populations. The following section will be devoted to discuss the myriad possibilities and options offered by the digital tools to facilitate the vocabulary learning process of ESL learners.

### 2.2.1 CAVL Programs

"Initial learning of words as well as further consolidation of words is provided by dedicated CAVL programs" (Ma, 2009). These programs are based on vocabulary that is both meaning and form focused. A distinction has been made between research-based CAVL programs and commercial programs by Ma (2009). According to Ma (2009), "The research based-programs included Lexica (described by Goodfellow, 1995), CAVOCA, an acronym for Computer Assisted VOCabulary Acquisition (Groot, 2000) and Wordchip (Decco et al., 1996), the software WUFUN (Ma, 2013)." Ma (2009), after making an empirical evaluation, asserts that "from a pedagogical perspective, they reflect both implicit, meaning focused learning as well as explicit, form-focused learning."

### 2.2.2 Online Dictionaries

Aural, pictorial and textual information about a word is provided by web-based dictionaries. These dictionaries present several advantages, such as "the response to learners' input intelligently (for example if the learner does not know the exact spelling of a word, the dictionary will generate several morphological possibilities based on the learner's input), secondly they display only the necessary information, leaving the learner to decide whether more information is needed or not" (Ma, 2009). These easily downloadable dictionary apps make the lives of the learners easy as they, being portable, rid them of the burden of the heavy traditional dictionaries and respond very well to learners' needs for vocabulary enhancement based on their daily requirements.

### 2.2.3 Game-Based Vocabulary Enhancement

Taylor (2009) states, "a combination of stimuli is desirable, with written consolidation for adults, in order to facilitate transfer from short-term to long-term memory" (p. 17). Online vocabulary games help the learners remember the vocabulary items for a longer time and retrieve words more easily and efficiently than the traditional classroom learners. Prensky (2001, p. 106) highlighted 12 reasons behind the efficacy of games. According to him some of these reasons include, "games motivate players (to achieve goals), gratify the ego (when winning), are fun (through enjoyment and pleasure) and spark the players' creativity (to solve the game)." The use of learning games as a learning tool was investigated by Wood (2001) who concluded that games could capture learners' attention more effectively than traditional media such as textbooks. Furthermore, Young et al. (2012), in a meta-analysis on games used for educational purposes, revealed that such games because of the inherent social nature of both language learning and of computer games positively affect the vocabulary learning process. The fun and relaxing elements attached with the games arouse the learners' interest and spur their motivation and confidence. Furthermore, the games that offer ongoing motivation ensure the learning process keeps going on.

### 2.2.4 Electronic Lexical Glosses

Electronic lexical glosses serve as incidental digital resources for vocabulary learning. Jones (2000) observed that the availability of computerized glosses has made the online texts much more easily comprehensible to learners. Several other studies (Yeh & Wang, 2003; Yoshii, 2006; Abraham, 2008; Yanguas, 2009) too indicated the effectiveness of multimedia glosses on

incidental vocabulary learning.  Although researchers and developers generally express a favorable view towards the use of digital tools in learning vocabulary, the attitude of the EFL learners towards the opportunities offered by these technologies has yet to be sufficiently explored. In this context, Stockwell (2013) discusses two kinds of motivation, an interest in a particular technology or a strong motivation for language learning, which explain why learners may choose to engage or not with a particular technology. Consequently, learners may exhibit varied approaches when it comes to the use of technology for language acquisition.

McLean et al. (2013) made some Japanese EFL learners use a digital flashcard website weekly over a period of one year. Using pre-tests and post-tests, they made a comparison amongst three groups and concluded that, in comparison to the control group, the use of Word Engine enhanced the receptive vocabulary knowledge of the treatment groups. Chien (2015) used three digital flashcard websites and compared Taiwanese college students' perceptions and attitudes toward their corresponding apps: Quizlet, StudyStack, and Flashcard Exchange. Findings revealed the positive attitudes of the participants towards the use of these websites to enhance their vocabulary, although the websites offered form and meaning activities mainly (Nation, 2013). In the study of Maftoon et al., (2012), 40 Iranian intermediate EFL learners were divided into two twenty-member groups to explore the effects of CALL on vocabulary development. The experimental group received VTS.S (a software program for vocabulary teaching), a digital dictionary, and teacher e-feedback. Meanwhile, the control group was taught vocabulary using conventional methods and a paper dictionary, with no access to specialized software. Their findings revealed that the treatment group outperformed the control group and thus proved the efficacy of CAVL.

### 2.3 Summary of Section One

The role of Computer-Assisted Vocabulary Learning (CAVL) in the realm of vocabulary acquisition for ESL and EFL students has become a new era in the field of language teaching. Many research papers confirm that computer-aided vocabulary learning (CAVL) tools including software program, online dictionary, games and electronic glosses offered learners an interactive and personalized experience for learning vocabulary. CAVL promotes autonomy, motivation, and strategic learning and provides immediate feedback, personalized content, and opportunities for incidental and explicit vocabulary learning. All of which were insights  or data points (Wu, 2015; Barani, 2013; McLean et al. 2013) highlight the superiority of CAVL over conventional methods in fostering vocabulary retention and long-term  recall. However, there is a scarcity of generalized studies of real-world usage and acceptance of CAVL tools among a  variety of learner populations. In addition to the new technologies discussed above, learner attitudes and motivations critically influence the adoption and effectiveness of these technologies as supported by the findings of the study of Stockwell (2013). While CAVL shows promise, more research  is required to resolve challenges, specifically those relating to its implementation in practice, scalability, and the impact of CAVL on learner engagement in larger educational settings.

## SECTION TWO
## 3. MAVL (Mobile Assisted Vocabulary Learning)

Mobile assisted vocabulary learning (MAVL) is considered to be the next generation of Computer Assisted Vocabulary learning (CAVL). It is a progression from a bulky desktop or laptop to a handy, portable device offering the same technological conveniences (Tai, 2012).  "The myriad range and versatility of smart phones and other handheld devices has further developed both the scope and range of learning activities as well as dimensions of learner autonomy" (Benson, 2007).

It has endowed the learners with greater flexibility and freedom over their learning directions. Mobile devices are believed to produce unique educational affordances in that they provide "portability, social interactivity, context sensitivity, connectivity, and individuality" (Churchill, Fox & King, 2012, p.252), helping the learner utilize the device in any way that suits them for a more meaningful and independent learning process. Likewise, Kukulska-Hulme (2009) acknowledged that "MALL helps to make a better distinction between formal learning in the classroom and informal learning outside the classroom."

Burston (2015) observes that due to several technological limitations, the early attempts to incorporate these devices in education were not very successful. However, with the arrival of Apple iPhone in 2007 and Android devices launched in 2008, technology caught up with the demands of users and these limitations have been gradually overcome. According to Godwin-Jones (2011), these devices are now associated with mini computers given their multiple functionalities. The direction of MAVL has taken on a more exciting turn. Omnipresence of Internet along with the availability vocabulary and language learning apps; learners have greater autonomy and abundant learning options than ever before.

Kukulska-Hulme and Shield (2008) point out that "MALL differs from computer-assisted language learning in its use of personal, portable devices that enable new ways of learning, emphasizing continuity or spontaneity of access and interaction across different contexts of use" (p. 273). MAVL is different from computer assisted vocabulary learning (CAVL) in that mobile learning helps learner-led rather than teacher-led L2 vocabulary acquisition. According to Thornton and Houser (2004; 2005), "Mobile phones can help extend learner opportunities in meaningful ways" (p. 1). Hung and Zhang (2012) also stated that "mobile technologies provide numerous chances and opportunities such as flexibility and ubiquity."

### 3.1 Defining MAVL (Mobile Assisted Vocabulary Learning)

Burston (2014) classifies the definitions of mobile learning into two categories, depending on the importance assigned to the mobility of the learner or to the use of the mobile device. In this context, Sharples, Taylor and Vavoula (2007) consider that "it is the learner that is mobile, rather than the technology…interactions between learning and technology are complex and varied, with learners opportunistically appropriating whatever technology is ready to hand as they move between settings, including mobile and fixed phones, their own and other people's computers, as well as books and notepads." This definition emphasizes the learner's mobility over the use of a mobile device, implying that any technology characterized by flexibility can be considered mobile learning. On the other hand, Kukulska-Hulme and Shield (2008, p.273) define mobile learning mobile learning as "learning mediated via handheld devices and potentially available anytime, anywhere." Palalas (2011, p. 76-77) attempts to incorporate both aspects of mobile learning by stating that "MALL can be defined as language learning enabled by the mobility of the learner and…portability of handheld devices…"

### 3.2 Multidimensionality of MAVL

Pegrum (2014, p. 131) states that vocabulary learning is the most common MALL activity reported in the literature. Likewise, Underwood (2014) asserts that mobile technology can assist several activities that contribute to vocabulary learning. According to him, "a lot of vocabulary apps have embedded vocabulary learning tools, such as flashcards, dictionary tools, notebook tool, game-like activities, derived from what research stated that works best for vocabulary learning."

The rapid growth of social networking applications has helped Mobile-assisted language learning (MALL) reach new heights (George, 2014; Bensalem, 2018). Smart phones as effective tools for language learning have replaced personal computers since they are more personal, "more user-friendly, portable, flexible" (Sharples, Taylor, & Vavoula, 2007) and easy to access. Students tend to enjoy using their smart phones because they can easily access the learning materials and can practice the language anytime and anywhere (Kukulska-Hulme, 2012; Hayati et al., 2013).

The following section will be devoted to discuss the myriad possibilities and options offered by some of the mobile apps to help facilitate the vocabulary learning process of EFL learners.

### 3.2.1 WhatsApp

Smart phones seem to exert a dramatic influence on the ways in which learning takes shape. Underwood (2014) summarizes that "mobile apps can significantly provide opportunities for encountering language in context, for noticing new words, for sharing new vocabulary and offering access to just in time communication help with the facilitation of spatially and temporally distributed words study."

Bensalem (2018) conducted a study to investigate the development of academic vocabulary knowledge among forty Arab EFL (English as a Foreign Language) students, comparing the effectiveness of WhatsApp as a learning tool with the traditional method of vocabulary instruction. Results from this study showed that the WhatsApp group significantly excelled on the posttest vocabulary test than the control group. Usefulness of WhatsApp in educational context was also examined in the Turkish context. Basal, Yilmaz, Tanriverdi and Sari (2016) how effective WhatsApp was for learning idioms from the Michigan Corpus of Academic Spoken English in comparison to traditional classroom activities. Fifty first-year students from a university in Turkey participated in the study. The findings revealed that the experimental group outperformed the control group in the posttest. The researchers concluded that WhatsApp positively influenced the learning of idioms.

Numerous teachers have begun using WhatsApp as a platform for students to access and submit vocabulary-related tasks. WhatsApp gives learners a sense of belonging to a learning community (Sweeny, 2010). Active learning is encouraged through WhatsApp (Rambe & Bere, 2013). Communication with peers is another significant function of WhatsApp (Bouhnik & Deshen, 2014). It fosters interaction between students and teachers and helps them save time (Lauricella & Kay, 2013) and improve class management, keeping students up-to-date with teaching-learning activities (Awada, 2016). According to Sweeny (2010), "students may take assignments more seriously as their contributions in a WhatsApp group are public."

### 3.2.2 Dictionary Apps

Mohd Asraf & Supian (2017) looked into the extent the mobile assisted activities enhanced the learners' metacognition. The researchers collected data from video reports, interviews and an activity log of 21 Malaysian students, and analyzed according Kukulska-Hulme, Norris, & Donohue's (2015) pedagogical framework for mobile assisted language teaching. They reported that the most frequent activities utilized outside the classroom were the use of online dictionaries; video features on the phones for speaking and pronunciation practice and posting on social media as a means of practicing the newly acquired vocabulary in writing. The autonomous nature of these activities resulted in effective vocabulary learning and increased learner autonomy through the enhancement of the metacognitive skills. Aural, pictorial and textual nature of the online

dictionary/dictionary apps has already been highlighted in section 1.3.2. This appeal to senses helps the learners in retaining and retrieving the words.

### 3.2.3 Online Games

Vocabulary building is an uphill task that requires a lot of grit on the part of the learners. If the vocabulary building games are fun, relaxing and motivating, the learners' interest is more likely to sustain. Foreman et al., (2004) assert, "The use of interactive games has impacted on the mode of learning." It is generally agreed by the research community that the visual appeal and attraction of the games help learners remember, retain and retrieve the words they encounter. "Appropriate use of sensual stimuli is believed to be beneficial to learning, not only for ordinary learners but also for learners with learning difficulties" (Schmidt, 2005). That's why it is important to make sure the vocabulary based games offer constant motivation through an increased appeal to the senses, enhanced interactivity and an increasingly engaging sense of challenge. Students, who learn vocabulary through online games, prefer a higher degree of self-regulated learning and like to be in full control of their own learning with regard to time, place and pace.

Smart phones ensure learning that is fun based and motivating. Students nowadays are lucky to experience their own personalized modes and modalities of learning and may choose from a myriad range of apps and games to learn and practice new words. Installing the right apps and downloading the right games (No, I am not talking about Candy Crush, Angry Birds or Blue Whale!) that encourage mental activity can ensure a smooth and effective vocabulary learning process.

### 3.2.4 More Apps, More Learning

Today's generation spends a lot of their time using social media. This time can be used effectively and constructively. Some of the coolest personalities of the world including the renowned writers, poets, and athletes use Twitter and Facebook on daily basis. Getting connected and inspired by them can add a lot of value to the time spent. Forming vocabulary learning groups on Facebook and sharing relevant posts can also help boost the advantages of collaborative learning and offer emotional and intellectual support. YouTube also abounds with many educational videos. Students can not only learn a new language easily through videos but also watch movies, travel guides or historical stuff or anything constructive of their interest to help boost their vocabulary. The smart phone also works as a great reading device by offering smart apps like Kindle; helping the learners read and expand their vocabulary anywhere and at any time.

Many studies have been conducted to explore the educational benefits of mobile phones. Underwood (2014) enumerates in his article different ways in which mobile technology supports vocabulary learning: language capture and sharing which involves capturing observations about new words along with associated media (Pemberton & Winter, 2011); just in time communication help through apps such as Google translate (Demmans Epp, 2013); study reminders (e.g. SMS, Whatsapp). Dearman and Truong (2012) explained how vocabulary wallpapers detecting location and showing target language on the phone's wallpaper could enable situated incidental learning. Inserting target language translations in the L1 texts helps facilitate micro-learning (Trusty & Troung, 2011). Micro-learning also happens through subtitles of videos or through auto correction of messaging systems (Cai et al., 2014).

**3.3 Summary of Section Two**
In conclusion, Mobile-Assisted Vocabulary Learning (MAVL) represents a transformative approach to language acquisition, leveraging the portability, interactivity, and versatility of mobile devices to enhance learner autonomy and engagement. By providing tools such as WhatsApp, dictionary apps, online games, and other interactive platforms, MAVL offers learners unique opportunities to encounter, practice, and retain new vocabulary in dynamic and context-sensitive ways. The studies discussed highlight the significant benefits of mobile technology in fostering collaborative learning, metacognitive development, and personalized learning experiences. However, some of these studies, while promising, reveal limitations, such as small sample sizes, reliance on self-reported data, and the challenge of isolating variables that influence learning outcomes. Additionally, many focus on short-term effects without addressing long-term vocabulary retention or potential distractions caused by mobile devices. Despite these weaknesses, the collective findings emphasize the immense potential of MAVL to bridge formal and informal learning contexts seamlessly. As technology continues to evolve, the possibilities for MAVL in enriching vocabulary learning for diverse learners remain vast and promising, provided future research addresses these limitations for more robust and generalizable results.

# SECTION THREE
## 4. AI-Driven Vocabulary Learning
Artificial Intelligence (AI) has emerged as a transformative force in education, offering innovative solutions to enhance vocabulary learning (McLaughlin, & Osborne, 2020). By leveraging tools like adaptive learning platforms, chatbots, and natural language processing (NLP), AI creates personalized, engaging, and efficient learning experiences tailored to individual needs (Miller, 2023). Its ability to provide real-time feedback, track progress, and adapt content ensures learners can acquire and retain vocabulary more effectively. Moreover, AI bridges the gap between theoretical learning and practical application, empowering learners to use new words confidently in diverse contexts (Kucuk, Zeynep, & Solmaz 2021).

### 4.1 Individualized Learning Paths
AI systems are great at generating individualized learning paths. These systems adjust the content that students receive based on analysis of their performance so that it fits their level and goals, creating a stimulating and effective approach to vocabulary acquisition (Chen, & Choi, 2021). Adaptive tools like Duolingo and Memrise represent that model well, actively adjusting lessons based on progress. Such personalization ensures that learners focus on vocabulary that is both relevant and challenging, optimizing their study time (McLaughlin, & Osborne, 2020). Additionally, AI tools can identify common errors or gaps in understanding, offering targeted exercises to reinforce retention and comprehension.

### 4.2 Natural Language Processing (NLP)
Tools like Grammarly and Google Translate, powered by natural language processing (NLP), offer real-time, context-sensitive suggestions for vocabulary usage, grammar, and sentence structure (Mishra, & Kumar, 2020). Such real-time assistance helps learners practice their language skills and use new words correctly and in context. The immediate feedback allows learners to understand nuances in word usage, such as idiomatic expressions or collocations, which are often difficult to grasp through traditional learning methods (Su, & Yang, 2023). Moreover, NLP-

powered tools expose learners to authentic language patterns, making their vocabulary more versatile and applicable in real-world scenarios.

### 4.3 Gamification and Motivation
In fact, gamified components, like badges, leaderboards, and progress trackers, are embedded in the AI applications to keep learners engaged and motivated (Miller, 2023). Tools like Lingvist and Quizlet utilize gamification which turns vocabulary learning into an exciting and rewarding adventure, which guarantees interest over a long period. These features create a sense of accomplishment and competition, encouraging learners to consistently interact with new vocabulary (Thenmozhi, Mahato, & MU, 2023). Additionally, gamification helps in reinforcing memory through repetitive exposure in engaging formats, making the retention of words more effective and enjoyable.

### 4.4 Speech Recognition and Pronunciation Practice
Speech recognition technology has revolutionized pronunciation practice. Tools like ELSA Speak and Google Assistant help learners achieve phonetic accuracy by offering instant feedback on their speech (Thenmozhi, Mahato, & MU, 2023). This encourages repeated practice and enhances learners' confidence in oral communication. By practicing vocabulary aloud, learners not only improve their pronunciation but also internalize the meaning and proper usage of words, aiding long-term retention. Moreover, these tools help learners identify and correct pronunciation errors, making them more adept at using vocabulary in real-world conversations (Kucuk, Zeynep, & Solmaz 2021).

### 4.5 Conversational Practice
AI chatbots, such as ChatGPT and Replika, simulate real-life conversations, providing learners with opportunities to use newly acquired vocabulary in meaningful contexts (Su, & Yang, 2023). These tools foster fluency by engaging learners in interactive dialogues tailored to their interests and skill levels. Through conversational practice, learners gain confidence in applying vocabulary naturally, improving both their expressive and receptive language skills. Furthermore, chatbots expose learners to diverse contexts and sentence structures, helping them understand how to adapt vocabulary usage based on the situation.

### 4.6 Data-Driven Insights
AI platforms generate detailed analytics on learners' strengths, weaknesses, and progress (Kucuk, Zeynep, & Solmaz 2021). These insights empower educators to design targeted interventions and support learners effectively. Tools like Kahoot! and Microsoft Insights integrate data analytics to provide actionable feedback for both learners and instructors. By identifying vocabulary gaps and highlighting areas of improvement, these platforms allow learners to focus on specific words or patterns they struggle with (Thenmozhi, Mahato, & MU, 2023). Additionally, the data-driven approach ensures that learners receive personalized vocabulary exercises, maximizing their progress and retention over time.

### 4.7 Bridging Theory and Practice
Learning with CAVL and MAVL methods narrows the space between pedagogical theories and pragmatic approaches, one of the most recent additions to the discourse being the integration of AI for these systems. The power of AI to handle massive amounts of data and provide on-

demand, tailored response helps speed things up for learning vocabulary. Learners can choose greater autonomy and ownership of their own learning journey. This integration allows students to actively apply theoretical concepts of language learning to practical, real-life scenarios, ensuring deeper engagement with new vocabulary. Furthermore, AI systems offer immediate, context-specific feedback, making theoretical knowledge more relevant and actionable in day-to-day communication.

### 4.8 Integration of Artificial Intelligence into CAVL and MAVL

That is how AI Vocabulary Learning (AIVL) will improve Computer-Assisted Vocabulary Learning (CAVL) and Mobile-Assisted Vocabulary Learning (MAVL) substantially. AI can combine visual, auditory, and conversational elements to create immersive and interactive learning environments. Chatbots and virtual assistants, for example, can have learners engage in natural language conversations, prompting them to practice vocabulary in context. AI-driven second language vocabulary learning can also employ game-based learning techniques like leaderboards, rewards and challenges to enhance motivation and participation. Studies (Thenmozhi, Mahato, & MU, 2023) proved that gamification is very effective in reinforcing vocabulary memory retention as well as creating a positive attitude towards learning the target language. Models of advanced AI, such as BERT and GPT, expose learners to examples of vocabulary usage in context, illustrating how words come together in a practical setting. By providing a context and knowledge of the applied theory, this method encourages the use of vocabulary in practice, which enables the student to actually use their new words in conversation.

### 4.9 Summary of Section Three

However recent technological advancements in AI-driven vocabulary learning (AIVL) have transformed the dynamics of language learning. With that being said, the promising technologies of AI will continue to reshape the field of language learning into a more inclusive, accessible, and learner-oriented approach. But considering the evolving and increasingly advanced nature of AI chatbots, we need to ponder on some of the negative consequences that might come from these technological advancements. The convenience and ability of AI based language models are indeed many but it is equally important that they are developed and used in an ethical domain, where due diligence is exercised and the integrity of information remains intact.

## 5. Implications

Unending possibilities are offered by technology to learn or consolidate English vocabulary in a computer and mobile assisted language learning context. According to Underwood (2014), "technology eases several activities that have a contribution to vocabulary learning e.g. rich associations could be promoted through reception and production of multimedia; games and social media offer various opportunities for practice; learners could look up vocabulary, capture, share anytime, anywhere; noticing and processing are stimulated through glossing, automated highlighting and embedding questions about target vocabulary in texts; exposure could also be increased as target language can be inserted in learners' daily interactions; technology can also make vocabulary and tasks more meaningful and adapted to learners' interests and social settings; also spaced review, retrieval, testing, use of vocabulary, look up, can all be prompted through system notifications, messaging and flashcards."

This study has significant implications for lexical enrichment of ESL learners shedding light on the modern teaching/learning bends and trends. CAVL and MAVL because of their trendiness,

versatility, portability, adaptability and the ability to help foster independent and personal learning experiences, are in conjunction with the autonomous learner-centered approach to learning resulting in a growing support among researchers for the use of mobile devices in the teaching-learning environment (Moreira et al., 2016). These devices are expected to enhance self-regulated productive learning "where learners show responsibility for and initiate their own learning, share learning with experts and peers" (Vavoula & Sharples, 2008, p. 297). Through CAVL and MAVL, ESL learners can easily explore the plethora of activities that are readily available through their favorite mobile apps and computer software. According to Thenmozhi, Mahato, & MU (2023), these technologies can help teachers avoid the time consuming, boring and less effective vocabulary learning techniques e.g. list learning and move on to incorporating more stimulating, motivating and engaging technology assisted vocabulary learning techniques into their daily vocabulary lessons. The ESL materials developers should also be aware of the myriad possibilities which have been created by CAVL and MAVL and utilize their potential to exponentially enhance the linguistic competencies of ESL learners and create an autonomous learning environment that is not only encouraged but also supported by these devices.

Additionally, AI has a lot of interesting prospects in terms of combining with vocabulary learning. By leveraging machine learning and natural language processing, AI-based solutions help generate customized learning paths that deliver content tailored to an individual's unique needs, abilities, and preferred style of learning (Thenmozhi et al., 2023). Natural Language Processing (NLP) technologies (Mishra, & Kumar, 2020), provide learners with immediate feedback in terms of word usage, grammar and sentence structure, thereby converting vocabulary learning into an experience that is interactive and timely. Gamified AI applications maintain the users' season through interactive features such as rewards and challenges, whereas speech recognition tools encourage accurate pronunciation and phonemes (Kucuk et al., 2021). Additionally, AI-based chatbots and virtual assistants create actual conversational scenarios that allow students to practice using new lexicon in context. AI platforms provide useful data-driven insights for educators about the progress of learners, what they have understood, and where the gaps are, allowing educators to target the areas where intervention and support are needed. Not only do these functionalities support the core tenets of learner autonomy and self-regulated learning, this also seeks to address the variety in the needs of ESL learners.

## 6. Conclusion

To conclude, the integration of computer-assisted, mobile-assisted, and AI-driven vocabulary learning (CAVL, MAVL, and AIVL) offers transformative advantages for ESL learners. These technologies provide a dynamic, flexible, and adaptive environment that enhances vocabulary acquisition through engaging, interactive, and personalized experiences. The versatility of CAVL, MAVL, and AIVL—ranging from multimedia-rich contexts and social interaction opportunities to AI-powered personalization and real-time feedback—aligns well with the principles of autonomous learning. By enabling learners to take control of their learning processes and offering tailored support, these tools foster a self-regulated approach that not only enhances vocabulary retention but also cultivates lifelong language learning habits. Furthermore, educators can now leverage AI to provide personalized learning pathways, data-driven insights, and interactive experiences that keep students motivated and engaged. Therefore, as ESL education continues to evolve, embracing these cutting-edge technologies will be crucial to supporting linguistic competence and creating modern, learner-centered environments that cater to diverse learner needs.

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