

Exploring Students' Use of AI-Assisted Tools for Autonomous Vocabulary Learning: A Case Study in Secondary Education

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Received: June 2026; Revised: July 2026; Accepted: August 2026; Published: September 2026

Abstract

Vocabulary learning is a gradual process that requires students' autonomy to support their vocabulary development. Metacognitive strategies encourage students to plan, monitor, and evaluate their learning progress. Furthermore, in the digital era, AI-assisted tools can support students to maintain self-regulated learning. Using a case study design, this inquiry uses interviews and questionnaires to collect data from a group of senior high school students. Twenty students participated in the investigation during a four-week implementation of a metacognitive strategy in a narrow reading program. The questionnaire was distributed before and after the program. To capture students' experiences during the program, students were instructed to write a reading journal. All data sources were analyzed descriptively. The results show that most senior high school students are familiar with using ChatGPT and Google Gemini. Indeed, in the context of vocabulary lookup, they have utilized the combination of Google Lens and Google Translate. The way students use AI-assisted tools has varied according to their level of proficiency. Students with limited vocabulary coverage used AI tools to improve their comprehension. Conversely, students with a sufficient vocabulary level used AI as a partner to enrich their knowledge and learn vocabulary productively. These findings yield two instructional implications: first, teachers need to guide students in using AI responsibly while integrating it into the learning process. Second, having access to AI tools is not enough; students must be prepared to become autonomous learners so they become lifelong learners.

Keywords: Autonomous vocabulary learning; Autonomous learners; Artificial intelligence; Vocabulary learning

How to Cite: Nada, L.S., Kweldju, S., & Laksmi, E.D. (2026). Exploring Students' Use of AI-Assisted Tools for Autonomous Vocabulary Learning: A Case Study in Secondary Education. *Journal of Language and Literature Studies*, 6(3), 1434-1447. doi: <https://doi.org/10.36312/jolls.v6i3.5885>



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INTRODUCTION

Vocabulary is a fundamental part to language acquisition but also has its own challenges in EFL contexts. It serves as the foundation for language proficiency, which enables students to understand and convey meaning in various contexts. A broader lexical repertoire helps students demonstrate better reading comprehension and fluency, and encourages effective communication abilities, vice versa. Therefore, vocabulary development is a main concern in language education and continues to attract considerable attention from researchers (Nation, 2013; Diantri et al., 2025; Yilmaz, 2025). Despite the importance of vocabulary, several challenges can be found in EFL learning practices. Many EFL learners faces difficulties in developing their vocabulary knowledge due to limited recurrent context, unsuitable learning strategies, and lack of students' motivation. Consequently, vocabulary acquisition cannot be presented optimally when it is needed to be implied in other language skills.

In this digital era, English exposure is become more accessible through online platforms, mobile applications, and AI-based tools. Therefore, these technologies are beneficial to support the gradual and cumulative process of vocabulary acquisition that requires repeated encounters with words in various contexts. To depend on classroom input for vocabulary acquisition is often insufficient. Consequently, students are expected to engage in vocabulary learning beyond the classroom through independent reading, social media exposure, and self-directed learning activities. The growing availability of digital resources has expanded students' opportunities to access learning materials autonomously. However, the skills and strategies for autonomous learning require students to manage their learning effectively. Obviously, fostering autonomous vocabulary learning in the EFL context is an important objective in current language education (Schmitt, 2010; Stepien, 2025; Sawaguchi, 2026).

Within the domain of vocabulary acquisition, autonomous learning allows students to take control over the material selection, organization, and application of vocabulary learning strategies. Students who engage in autonomous learning are likely to be exposed to authentic language input and develop personalized approaches to vocabulary retention. These students can adapt their learning practices to their individual goals and learning needs. Autonomous vocabulary learning is not only about memorizing a word list but also about learning through meaningful engagement with vocabulary through reading, communication, and other contextualized language use. However, autonomous learning does not imply that students study without a teacher or guidance; rather, students are required to manage their cognitive and behavioral processes. This point is reflected in self-regulated learning theory, which emphasizes learners' active involvement in planning, monitoring and evaluating their learning activities (Zimmerman, 2000). In vocabulary learning, this process may involve identifying target words, tracking vocabulary growth, and evaluating learning outcomes. Therefore, metacognitive regulation is an important mechanism that enables students to be active learners. Thus, understanding how students regulate their vocabulary learning activities is essential for promoting autonomous learning.

Additionally, to support autonomous vocabulary learning, recent technological developments have introduced new possibilities such as artificial intelligence with significant implications for education. Particularly, the emergence of generative AI has enabled students to find explanations, answer questions, provide feedback, and facilitate personalized learning experiences. Research has shown that AI-based learning systems can contribute to sustained support for English learning by scaffolding students' understanding beyond classroom instruction (Purnama et al., 2024). Furthermore, discussions concerning the integration of AI in education have emphasized the importance of aligning technological innovation with ethical considerations such as transparency, responsibility, and learner agency (Irnawati et al., 2024). In vocabulary learning, AI support can help students access immediate assistance without requiring direct teacher intervention. Students use AI to obtain word definitions, explore words' meanings and context, generate example sentences, practice conversations, and receive corrective feedback. These accessibilities make AI potentially significant for students to engage in independent learning activities outside the classroom (Luckin et al., 2016).

Recent scholars suggest that generative AI tools such as ChatGPT can function as dynamic learning partners rather than passive information providers. Moreover, such tools can serve as interactive language-learning partners, providing students with opportunities to engage in meaningful communication and sustained language practice (Yang et al., 2022). Similarly, Stepien (2025) found that AI-generated vocabulary flashcards provide learners with flexible and personalized lexical support, while Sawaguchi (2026) demonstrated that ChatGPT can facilitate the use of vocabulary-

learning strategies when students encounter lexical bundles at various levels of difficulty. This previous research indicates that AI technologies may support not only vocabulary acquisition but also students' strategic engagement with language learning. Undoubtedly, generative AI systems can engage students in interactive and adaptive learning experiences, such as AI tools that generate contextualized examples, tailor explanations to learners' proficiency levels, and simulate interactions that promote vocabulary use. Those features align with the principles of learner autonomy, which allow students to control the pace, content, and direction of their learning.

Furthermore, AI can support metacognitive processes by helping students monitor their understanding, identify knowledge gaps, and evaluate their learning progress. These potential functions of AI are not only as a source of information but also as a strategic learning partner. Consequently, AI has become an increasingly important topic in technology-assisted language learning research (Kohnke et al., 2023).

Other research has reported positive findings on the use of AI in vocabulary learning. A systematic review by Yilmiz (2025) concluded that AI applications in the EFL context generally promote vocabulary development, students' engagement in learning, and personalized experiences. Specifically, Diantri et al. (2025) suggest that ChatGPT supports vocabulary mastery through features such as contextualized explanations, direct feedback, and interactive practice opportunities. Similarly, Mustafa and Dharmawan (2026) reported that AI-generated summaries served as effective digital scaffolds for senior high school students in comprehending complex English texts. Other research also explored the effectiveness of AI tools in improving vocabulary acquisition, writing performance, speaking skills, and overall language proficiency. Additionally, AI technologies have been found to offer immediate feedback and individualized support that may not always be available in traditional classroom settings (Zawacki-Richter et al., 2019).

The study investigates students' experiences in vocabulary learning that integrates AI tools during autonomous learning activities. While previous studies have explored AI-supported vocabulary learning (Diantri et al., 2025; Sawaguchi, 2026), AI-generated learning resources (Stepien, 2025), and AI-assisted language comprehension (Mustafa & Dharmawan, 2026), there has been limited attention to senior high school students on how they independently integrated AI tools as part of their autonomous vocabulary learning practices. Consequently, the present study seeks to address the gap by examining AI use through the complementary roles of students' autonomous vocabulary learning. Therefore, the following research questions guide this study: *What AI tools do students use to support their autonomous vocabulary learning through independent reading? And How do students integrate AI tools into their autonomous vocabulary learning practices?*

METHOD

Research Design

The study is a qualitative case study design aiming to explore Indonesian senior high school students' use of artificial intelligence (AI) assisted tools for autonomous vocabulary learning. This study is intended while the implementation of metacognitive strategy in a narrow reading program to promote students' autonomous ability in vocabulary learning. A case study design is considered appropriate because it is an in-depth investigation of an individual, group, or community conducted to gain a comprehensive understanding in a real-life context (Ary et al., 2010). The study's objective was to understand students' experiences and behaviors when using AI tools to autonomously learn vocabulary. Obviously, according to Adu (2024), a qualitative case study facilitates a comprehensive exploration through multiple sources of information. In line with that, Miles and Huberman (1994) assert that this approach is advantageous

when researchers seek to investigate individuals' experiences and interpretations of specific situations in a particular context. Therefore, the bounded case in the present study is a group of Indonesian senior high school students who use AI tools while learning vocabulary through independent reading. The design captured the phenomenon within multiple sources, such as questionnaires, students' reading journal and interviews.

Instruments and Data Collection

The questionnaire was distributed to 20 eleventh graders to examine the AI tools that they used during an independent reading activity. Additionally, the interview was conducted to seek relevant and rich insight into how they use AI tools to help their vocabulary development. As the study aimed to explore students' actual practices rather than statistical findings, open-ended questionnaires and interview transcripts were reviewed and categorized to come up with the final interpretation. The data was collected through a pre-questionnaire, a post-questionnaire, and a semi-structured interview. The pre-questionnaire was administered before the independent reading activity to obtain the primary information regarding students' use of AI and their autonomous vocabulary learning practices. At the same time, the interview enabled participants to provide real practices of using AI as a strategy to solve the challenges while doing an independent reading activity. Moreover, the post-questionnaire was administered to capture additional information regarding students' perception and reflection on utilizing AI tools to scaffold their vocabulary learning through independent reading.

Data Analysis

The data analysis was done qualitatively. The interview transcripts and students' reading journal were analyzed using thematic analysis based on the proposed framework by Braun and Clarke (2013), following data familiarization, initial coding, theme searching, and interpretation. Additionally, the pre- and post-questionnaire were analyzed descriptively from open-ended responses. The results from the questionnaire did not provide statistical significance but rather provided contextual information and supported data triangulation. Finally, data from all instruments are integrated during the interpretation to enhance the credibility and comprehensiveness of the findings. Through this process, the researcher was able to obtain a holistic understanding of how Indonesian senior high school students used AI tools for assistance during autonomous vocabulary learning through independent reading.

RESULTS AND DISCUSSION

Results

Research Question 1: What AI tools do students use to support their autonomous vocabulary learning through independent reading?

Students' Awareness and Adoption of AI Tools in Autonomous Vocabulary Learning

The findings indicate that AI tools have become an integrated component of students' autonomous vocabulary learning practices during independent reading activities. The questionnaire results demonstrate a high level of students' awareness of AI as a learning support tool. Specifically, responses to Item 18, *"I use digital tools like AI to help my understanding and give corrective feedback,"* revealed that 50% of students strongly agreed and 45.5% agreed with the statement, while only one participant expressed disagreement. This finding indicates that 95.5% of students recognized AI as a valuable resource for overcoming vocabulary-related difficulties. Rather than representing a newly introduced technology, AI had already become embedded in students' strategies for managing comprehension barriers during autonomous learning.

Similarly, Item 16, *"I find additional materials from the internet to boost my vocabulary growth,"* received positive responses from 90.9% of participants, suggesting that students were accustomed to utilizing digital resources beyond traditional learning materials. These findings demonstrate that students' autonomous vocabulary learning was supported by a broader digital learning ecosystem, where AI tools functioned as complementary resources alongside dictionaries, online materials, and other learning supports.

Types of AI Tools Used by Students

The analysis of interview data and questionnaire responses revealed that students utilized three major categories of AI-supported tools during their autonomous vocabulary learning activities: (1) generative AI chatbots, (2) AI conversational partners, and (3) AI-based translation tools. Each category represented a different level of engagement with technology and reflected students' diverse learning needs when encountering vocabulary difficulties during independent reading. Generative AI chatbots, particularly ChatGPT and Google Gemini, emerged as the most frequently used tools. Students employed these platforms primarily to verify unfamiliar word meanings, compare interpretations obtained from other sources, and obtain additional explanations when the meaning of a word could not be determined solely from the reading context. Unlike conventional translation tools that generally provide direct equivalents, generative AI enabled students to explore contextual meanings, cultural references, and broader explanations related to vocabulary use.

The second category involved AI conversational partners, such as Character.AI, which represented a more interactive application of artificial intelligence in language learning. Rather than using AI only as an information provider, some students utilized conversational AI as a virtual speaking partner to practice English communication, apply newly acquired vocabulary, and develop confidence in producing language. This demonstrates a transition from receptive vocabulary learning, where students mainly recognize and understand words, toward productive vocabulary learning, where students actively use vocabulary in meaningful interactions.

The third category consisted of AI-based translation tools, including Google Translate and Google Lens, which were primarily used for immediate comprehension support. Students relied on these tools to obtain word-level translations, understand sentence meanings, and overcome difficulties caused by multiple unfamiliar words within reading passages. Overall, these findings indicate that students integrated AI tools flexibly according to specific learning purposes, positioning AI not as a replacement for independent learning but as a supportive scaffold that enhanced vocabulary comprehension, contextual understanding, and opportunities for language practice.

Generative AI Chatbots: ChatGPT and Google Gemini as Vocabulary Support Tools

Generative AI chatbots, particularly ChatGPT and Google Gemini, were among the most frequently mentioned tools used by participants. Students primarily used these platforms to verify vocabulary meanings, compare interpretations, and obtain additional explanations when encountering unfamiliar words.

For example, FU explained: *"I usually use Google Translate, sometimes I use AI. I use GPT or Gemini."* This statement indicates that students combined conventional digital translation tools with generative AI applications when attempting to understand unfamiliar vocabulary. Similarly, BN stated: *"I use Google or AI."*

These responses suggest that students viewed AI not as a replacement for existing resources but as an additional layer of assistance when conventional strategies were insufficient. Furthermore, FM reported using Gemini AI to confirm vocabulary meanings: *"I match the meaning with Google Translate or Gemini AI."* This practice

demonstrates that students used AI as a verification mechanism to increase confidence in their vocabulary interpretation. Instead of accepting the first meaning obtained from translation tools, students compared information from different digital sources before constructing understanding. Another participant, CI, explained that she used AI applications when she encountered difficulty understanding vocabulary and no longer relied solely on a physical dictionary. This suggests that AI functioned as a problem-solving resource used after students had attempted other strategies.

AI as a Conversational Partner for Productive Vocabulary Development

Beyond the conventional use of AI for vocabulary lookup and meaning verification, one participant demonstrated a more advanced integration of AI through conversational interaction. AN reported using Character.AI as an English-speaking partner to practice communication skills during autonomous learning activities. She explained, “*If not [practicing with myself], I chat using the c.ai application—yes, in English.*” Furthermore, she described the interactive nature of this practice by stating, “*I’m not gonna lie, I use AI. So, we can call with AI to talk about random stories.*” These statements indicate that AI was perceived not only as a source of linguistic information but also as an accessible communication partner that could facilitate continuous language practice beyond classroom contexts.

This finding reveals that students’ engagement with AI extended beyond receptive vocabulary learning, where learners primarily focus on recognizing and understanding word meanings, toward productive vocabulary development, where they actively retrieve, construct, and apply vocabulary in communicative situations. Through AI-mediated conversations, AN had opportunities to practice newly encountered words, experiment with sentence construction, and develop greater confidence in expressing ideas in English. Unlike traditional vocabulary learning activities that may separate vocabulary knowledge from actual language use, conversational AI created an environment where vocabulary could be immediately activated within meaningful interactions.

Furthermore, the availability and flexibility of AI-based conversational platforms appeared to reduce psychological barriers commonly experienced during language practice. Because AI does not create the same social pressure as human interaction, students may feel more comfortable experimenting with unfamiliar vocabulary, making errors, and repeating expressions until they gain confidence. Therefore, this finding demonstrates that AI can function as an interactive learning scaffold that supports the transition from vocabulary recognition to vocabulary production. In this context, AI contributes not only to lexical knowledge development but also to students’ communicative competence and autonomy in managing their own language learning processes.

Google Translate and Google Lens as Immediate Comprehension Support

Google Translate and Google Lens were also widely utilized, particularly when students encountered multiple unfamiliar words within reading passages. Students reported using these tools to obtain word-level translations, sentence-level meanings, and overall story comprehension.

FM explained that she initially searched for possible meanings using Google Translate, whereas AW described using Google to identify the meaning of individual unfamiliar words before rereading the entire passage. However, FM also highlighted the limitation of translation tools when dealing with culturally specific meanings. She explained that when she could not determine the appropriate interpretation from translation alone, she consulted Gemini AI to obtain contextual explanations.

This finding suggests that students differentiated between simple translation needs and deeper meaning interpretation. Translation tools were used for immediate lexical

access, while generative AI was employed when students required contextual, cultural, or conceptual explanations.

Table 1. AI tools Applied to Support Autonomous Vocabulary Learning

AI Tool Category	Specific Tools Identified	Primary Functions in Vocabulary Learning	Interpretation of Findings
Generative AI Chatbots	ChatGPT, Google Gemini	- Checking word meanings - Verifying vocabulary interpretation - Providing contextual explanations - Supporting text comprehension	Students used generative AI as an additional source to confirm understanding rather than as the first solution. AI functioned as a higher-level support system when conventional strategies were insufficient.
AI Conversational Agents	Character.AI (c.ai)	- Practicing English conversation - Applying newly learned vocabulary - Developing productive vocabulary use	AI was transformed from a passive information source into an interactive communication partner. This indicates a shift from receptive vocabulary learning toward productive language practice.
AI-Based Translation Tools	Google Translate	- Word-level translation - Sentence-level meaning clarification - Immediate comprehension support	Translation tools provided quick lexical access and reduced comprehension barriers during reading. However, students recognized limitations when meanings depended on cultural or contextual interpretation.
Visual AI/Digital Recognition Tools	Google Lens	- Identifying unknown words from text images - Supporting reading comprehension	Google Lens helped students overcome practical difficulties when processing large amounts of unfamiliar vocabulary in authentic texts.
General AI Applications	Unspecified AI applications	- Vocabulary lookup - Dictionary replacement/support	These applications served as backup resources when students experienced difficulties with traditional vocabulary-learning methods.

The findings demonstrate that students utilized multiple AI-supported tools during autonomous vocabulary learning, with each tool serving a distinct function based on their specific learning needs. Generative AI chatbots, particularly ChatGPT and Google Gemini, were primarily employed for vocabulary meaning verification, contextual interpretation, and obtaining more detailed explanations of unfamiliar words or expressions. Students did not merely rely on AI-generated translations but used these platforms to confirm their initial understanding and explore meanings that were dependent on textual or cultural contexts.

Meanwhile, conversational AI tools such as Character.AI represented a more interactive form of AI integration by providing opportunities for students to practice productive vocabulary use through simulated communication. Through AI-mediated conversations, students were able to retrieve previously learned vocabulary, construct sentences, and apply new expressions in meaningful contexts. This indicates that AI supported not only vocabulary comprehension but also the transition toward active language production.

In contrast, translation-based tools, including Google Translate and Google Lens, were mainly used as immediate comprehension aids when students encountered

unfamiliar words or complex sentences during independent reading. These tools helped students overcome initial comprehension barriers and continue engaging with reading materials. However, the findings indicate that students generally positioned AI as a complementary learning resource rather than a substitute for their own cognitive efforts. Students still attempted to infer meanings from context, consult dictionaries, or discuss difficulties with peers before seeking AI assistance. Therefore, AI functioned as a learning scaffold that enhanced students' autonomy, vocabulary development, and strategic management of learning difficulties.

Research Question 2: How do students integrate AI tools into their autonomous vocabulary learning practices?

AI as a Sequential Learning Strategy Rather Than a First-Choice Solution

The findings indicate that students did not immediately depend on AI whenever they encountered unfamiliar vocabulary. Instead, AI was integrated into a sequential problem-solving strategy: Contextual guessing → Dictionary/Google Translate → AI assistance

ND described this process: *"First, I try to guess the meaning from the context. Then I check the dictionary or Google and write down important new words."* This strategy indicates that students maintained an active role in vocabulary discovery before seeking technological assistance. Similarly, AN explained that she attempted to infer meanings from surrounding words before consulting digital resources. CI also reported using AI only after she could not resolve difficulties through a physical dictionary. The placement of AI at the final stage demonstrates students' metacognitive awareness. Students did not perceive AI as a substitute for thinking but rather as a scaffold that supported difficult learning situations.

AI for Meaning Verification and Contextual Understanding

Students also integrated AI as a tool for deeper comprehension rather than only obtaining direct translations. FM explained: *"I guessed the meaning through connecting words, then searched for the explanation using Gemini AI."* BN similarly stated: *"I use AI when I want to understand the story as a whole because it provides explanations."* These responses indicate that AI supported both lexical and textual comprehension. Students with stronger vocabulary knowledge used AI to explore cultural meanings and contextual interpretations, whereas students with weaker vocabulary knowledge sometimes used AI primarily for immediate understanding of texts.

AI as a Tool for Productive Vocabulary Practice

The use of Character.AI represented the most advanced form of AI integration. AN used AI-generated conversations to practice speaking and apply newly learned vocabulary. She explained: *"I use AI, so we can call with AI to talk about random stories."* She also reported increased confidence when using new vocabulary in daily communication: *"When I feel kind of nervous, I'm anxious, I'm anxious like that."* This practice reflects movement from vocabulary recognition toward productive vocabulary use. Through repeated interaction with AI, students gained opportunities to retrieve vocabulary in authentic communicative situations.

AI Within a Broader Resource Management System

The findings further show that AI was integrated alongside other learning resources rather than replacing human interaction. Questionnaire data indicated that 86.4% of students sought assistance from friends or teachers, while 95.5% used AI to overcome comprehension barriers. RM explained: *"I ask my friends first; if there is no solution, then I check my phone."* This demonstrates that students employed multiple resources, including peers, teachers, dictionaries, and AI, as part of autonomous learning management.

AI Use and Students' Metacognitive Awareness

Students demonstrated awareness regarding when and why AI should be used. LI stated: *"I learn using the help of AI, and so far, I have experienced few difficulties."* However, she also acknowledged: *"I never study for too long because I get bored easily."* This indicates that students were conscious of their learning habits and attempted to regulate their engagement. Nevertheless, questionnaire findings revealed that students were less consistent in monitoring whether AI-assisted vocabulary learning resulted in long-term retention. Item 9 showed an equal proportion of agreement and disagreement (45.5%), suggesting that AI was often used to solve immediate comprehension problems rather than systematically support vocabulary memory development.

AI as a Confidence-Enhancing Learning Scaffold

Finally, students perceived AI as a source of emotional and cognitive support. Several participants reported that AI reduced frustration when encountering difficult vocabulary and increased confidence during independent reading. CI explained that AI helped clarify difficult parts of texts, while LI stated that AI reduced difficulties caused by encountering many unfamiliar lexical items simultaneously. The findings demonstrate that students integrated AI as a flexible learning scaffold within autonomous vocabulary development. AI supported comprehension, vocabulary verification, contextual interpretation, productive language practice, and confidence building, while students continued to maintain control over learning decisions.

Table 2. The Integration of AI tools into Autonomous Vocabulary Learning Practices

Integration Pattern	Evidence from Data	Learning Function	Interpretation
1. AI as a Sequential Learning Strategy	Students generally followed the sequence: Contextual guessing → Dictionary/Google Translate → AI assistance	Encouraging independent meaning construction before using AI	Students demonstrated metacognitive control by using AI as a support mechanism rather than immediately depending on it.
2. AI for Meaning Verification and Context Checking	Students used AI after making initial interpretations of unfamiliar words.	- Confirming vocabulary accuracy - Understanding cultural meanings - Supporting whole-text comprehension	AI supported deeper comprehension beyond direct translation by providing contextual explanations.
3. AI as a Speaking and Vocabulary Production Partner	AN used Character.AI for interactive English communication.	- Practicing vocabulary in communication - Increasing confidence in language production	AI enabled students to transform vocabulary knowledge from recognition into active use through conversational practice.
4. AI as Part of Multi-Resource Learning Management	Questionnaire results showed 86.4% sought help from friends/teachers, while 95.5% used AI for comprehension support.	Combining AI with human and traditional resources	Students positioned AI within a broader learning ecosystem involving peers, teachers, dictionaries, and online resources.
5. AI Supporting Metacognitive Awareness	Students consciously decided when and why AI should be used.	- Monitoring learning difficulties - Selecting appropriate support strategies	Students showed awareness of AI's role as assistance, although they were not always consistent in monitoring

Integration Pattern	Evidence from Data	Learning Function	Interpretation
			long-term vocabulary retention.
6. AI as a Confidence-Enhancing Scaffold	Students reported reduced frustration and increased confidence when using AI during independent reading.	- Reducing anxiety - Increasing learning confidence - Supporting independent reading persistence	AI functioned as an emotional and cognitive scaffold that helped students continue autonomous learning activities.

Table 2 illustrates that students integrated AI tools into their autonomous vocabulary learning practices through several interconnected strategies, demonstrating that AI was not used as a single-purpose application but as a flexible learning scaffold. The first pattern shows that students applied AI through a sequential learning strategy, in which they attempted to construct meaning independently before seeking technological assistance. The process of *contextual guessing* → *dictionary/Google Translate* → *AI assistance* indicates that students maintained an active cognitive role during vocabulary learning. Rather than immediately depending on AI-generated answers, students first utilized their own linguistic knowledge and contextual reasoning to infer meanings. AI was subsequently used to confirm interpretations, resolve uncertainty, and provide additional explanations when conventional strategies were insufficient. This pattern suggests the presence of metacognitive awareness, where students consciously regulated when and why external assistance was needed.

Furthermore, Table 2 reveals that AI integration extended beyond vocabulary comprehension toward broader aspects of language development and learner autonomy. Students used AI for meaning verification, contextual understanding, productive vocabulary practice, and confidence enhancement. The use of conversational AI, particularly Character.AI, demonstrates a transition from passive vocabulary recognition toward active vocabulary use through communication practice. In addition, students positioned AI within a wider learning ecosystem involving teachers, peers, dictionaries, and online resources, indicating that AI complemented rather than replaced existing learning strategies. However, the findings also reveal that students primarily used AI to overcome immediate comprehension difficulties and were not always consistent in evaluating whether AI-supported learning contributed to long-term vocabulary retention. Overall, Table 2 indicates that AI functioned as a personalized learning scaffold that supported students' autonomy, strategic decision-making, and engagement in vocabulary learning activities while maintaining students' active involvement in the learning process.

Discussion

AI-Assisted Tools as a Scaffold for Autonomous Vocabulary Learning

The present study demonstrates that AI-assisted tools have become an integrated component of students' autonomous vocabulary learning practices, particularly during independent reading activities. The high level of students' awareness of AI as a learning support resource indicates that digital technologies have moved beyond being supplementary materials and have become part of students' personal learning ecosystems. The questionnaire findings showed that 95.5% of students recognized AI as useful for improving comprehension and providing corrective feedback, while 90.9% reported using digital resources to support vocabulary growth. These findings support previous research emphasizing that autonomous vocabulary learning requires learners to access multiple sources of input beyond classroom instruction (Schmitt, 2010; Benson, 2011).

The findings are consistent with self-regulated learning theory, which conceptualizes autonomous learning as learners' ability to plan, monitor, and evaluate their learning processes (Zimmerman, 2000). In this study, students did not demonstrate passive dependence on AI-generated responses. Instead, they actively negotiated when and how AI should be used. For example, students generally followed a sequence of contextual guessing, dictionary or translation consultation, and finally AI assistance. This pattern suggests that AI functioned as a metacognitive support mechanism rather than replacing students' cognitive engagement.

This finding extends previous discussions on AI in language education. Earlier studies have often emphasized AI's capacity to provide immediate feedback, personalized explanations, and adaptive learning experiences (Luckin et al., 2016; Zawacki-Richter et al., 2019). However, the present study contributes a more nuanced perspective by showing that the effectiveness of AI depends on how learners integrate it into their existing strategies. Access to AI alone does not automatically create autonomous learners; rather, learners need strategic awareness to evaluate when AI assistance is beneficial and when independent reasoning should be prioritized.

Diverse Functions of AI Tools in Vocabulary Development

The findings reveal that students used different AI applications according to their specific vocabulary learning needs. Generative AI chatbots, particularly ChatGPT and Google Gemini, were mainly used for meaning verification, contextual interpretation, and obtaining deeper explanations of unfamiliar vocabulary. This finding confirms previous studies suggesting that generative AI can support vocabulary acquisition by providing contextualized explanations and personalized feedback (Kohnke et al., 2023; Diantri et al., 2025).

Unlike traditional translation tools that generally provide direct lexical equivalents, generative AI allows learners to explore semantic relationships, cultural meanings, and contextual variations. In this study, students used AI after attempting their own interpretation, suggesting that AI supported deeper vocabulary processing rather than simple word substitution. This finding aligns with Nation's (2013) view that vocabulary learning requires repeated encounters with words across meaningful contexts. AI-generated explanations can therefore provide additional contextual exposure that strengthens learners' understanding of lexical items.

However, the findings also reveal differences based on students' vocabulary proficiency levels. Students with limited vocabulary knowledge tended to use AI primarily to overcome immediate comprehension difficulties, whereas students with stronger vocabulary foundations used AI to expand their knowledge and explore productive vocabulary use. This extends previous research by demonstrating that AI does not function uniformly for all learners; rather, its educational value depends on learners' existing linguistic resources and strategic competence.

From Receptive Vocabulary Learning toward Productive Language Use

One important contribution of this study is the identification of AI as a conversational partner that facilitates productive vocabulary development. While many previous studies have focused on AI as a tool for information retrieval or vocabulary support, this study demonstrates that conversational AI can create opportunities for active language production. One participant used Character.AI as an English-speaking partner to practice communication and apply newly learned vocabulary in simulated conversations.

This finding supports Yang et al. (2022), who found that AI chatbots could function as English conversation partners by providing learners with opportunities for interaction and sustained practice. The current study extends this argument by

demonstrating that conversational AI can support vocabulary development specifically by enabling learners to retrieve and apply lexical knowledge in meaningful exchanges. The transition from receptive to productive vocabulary learning is pedagogically significant. According to Nation (2001), vocabulary mastery involves not only recognizing word meanings but also being able to retrieve and use words appropriately in communication. In this study, AI-mediated conversations provided students with opportunities to experiment with vocabulary, construct sentences, and develop confidence. Therefore, AI-supported interaction may represent a pathway for transforming vocabulary knowledge from passive recognition into active communicative competence. Furthermore, conversational AI may reduce psychological barriers associated with language production. Students often experience anxiety when speaking a foreign language because of fear of making mistakes or being judged. The availability of AI as a non-threatening communication partner allows learners to practice repeatedly without social pressure.

AI Integration as a Multi-Resource Learning Strategy

The study also challenges the assumption that AI replaces human interaction in autonomous learning. Instead, students positioned AI within a broader resource management system involving teachers, peers, dictionaries, and online resources. The findings showed that 86.4% of students still sought assistance from friends or teachers, while 95.5% used AI for comprehension support. This indicates that AI complemented existing learning resources rather than replacing them.

This finding corresponds with current discussions emphasizing responsible AI integration in education. Irnawati et al. (2024) argue that AI adoption should maintain learner agency, ethical awareness, and responsible usage. The present study supports this perspective by showing that students maintained ownership of learning decisions while using AI strategically. Nevertheless, the findings also identify an important limitation: students primarily used AI to solve immediate comprehension problems rather than systematically support long-term vocabulary retention. The questionnaire findings indicated that students were not always consistent in monitoring whether AI-assisted learning contributed to lasting vocabulary development. This suggests the need for instructional guidance to help students move from using AI as a problem-solving tool toward using it as part of deliberate vocabulary learning strategies.

CONCLUSION

This study concludes that AI-assisted tools play a significant role in supporting senior high school students' autonomous vocabulary learning through independent reading activities. The findings demonstrate that students used multiple AI applications, including generative AI chatbots, conversational AI agents, and translation-based tools, each serving different learning purposes. Generative AI platforms such as ChatGPT and Google Gemini supported vocabulary verification, contextual understanding, and deeper interpretation of unfamiliar expressions, while conversational AI such as Character.AI created opportunities for students to practice productive vocabulary use through interactive communication. Translation tools, including Google Translate and Google Lens, primarily assisted immediate comprehension by reducing lexical barriers during reading. These findings indicate that AI has expanded the possibilities of autonomous vocabulary learning by providing flexible, personalized, and accessible support beyond classroom boundaries.

Furthermore, this study highlights that successful AI integration depends not merely on technological availability but on students' strategic and metacognitive awareness. Students generally used AI as a complementary resource after attempting independent reasoning, contextual guessing, or conventional learning strategies. AI

therefore functioned as a scaffold that supported comprehension, confidence, and vocabulary development while allowing students to maintain control over their learning processes. However, students still require guidance to maximize AI's potential for long-term vocabulary retention and self-regulated learning. Future research should investigate AI-assisted vocabulary learning through longitudinal designs and explore factors such as teacher readiness, institutional support, digital infrastructure, and learners' AI literacy to develop more sustainable models of AI-integrated language education.

RECOMMENDATION

This study is limited to the context of senior high school in rural areas and was conducted over a short period. For the future research, it is encouraged to examine the AI-assisted autonomous vocabulary learning in other educational settings or a longitudinal study to deeply understand the long-term impacts on students' productive vocabulary learning. Furthermore, in facilitating AI integrated tools to students' autonomous vocabulary learning, researchers should extend the focus that influence the successful implementation of AI-integrated vocabulary learning such as teacher readiness, institutional supports, technological infrastructure, and learning resources. Exploring these dimensions may provide a comprehensive understanding of how AI can foster students' autonomous vocabulary learning.

ACKNOWLEDGMENT

The authors would like to express their sincere appreciation to all students who participated in this study and generously shared their experiences regarding AI-assisted vocabulary learning. Gratitude is also extended to the teachers and school administrators who provided valuable support during the implementation of the independent reading program. Their cooperation and commitment contributed significantly to the successful completion of this research. The authors also acknowledge the academic guidance and institutional support provided throughout the research process. This study represents a collaborative effort to better understand how emerging artificial intelligence technologies can support autonomous language learning in secondary education contexts.

Declaration of Using AI Tools

The authors acknowledge the use of artificial intelligence (AI)-assisted tools during the preparation of this manuscript. AI tools were utilized to support language refinement, improve writing clarity, organize ideas, and assist in reviewing the structure of the manuscript. The use of AI was limited to editorial and linguistic support and did not replace the authors' intellectual contributions, data analysis, interpretation of findings, or academic judgment. All research procedures, theoretical arguments, interpretations, and conclusions presented in this article remain the sole responsibility of the authors.

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