

Reinforcement Learning-Based Vocabulary Recommendation System for English Learners

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Abstract: Knowledge of vocabulary plays an important role in building English language proficiency since it helps learners develop skills in terms of reading, writing, speaking, and listening. Yet, conventional vocabulary learning techniques usually offer fixed word lists and uniform learning material to everyone; hence, making them less personalized and failing to cope with the needs of individuals and fill their vocabulary gaps. In this regard, this research work suggests a novel vocabulary recommendation system based on reinforcement learning technology, which enables the delivery of personalized vocabulary learning support via recommendations that change depending on learners' interactions and needs. The learner vocabulary profile is generated according to previous knowledge, difficult vocabulary items, retention skills, learning pace, and practice results of each learner. Further, on this basis, suitable vocabulary recommendations for learning and revision, along with relevant context examples and skill-based vocabulary practices, are offered to the learners. The efficacy of the system is estimated using an educational experiment lasting eight weeks in comparison to conventional vocabulary learning techniques. Results have shown that personalized vocabulary recommendations enhance the learning experience greatly. Personalized recommendations resulted in a 94.6% vocabulary improvement rate as opposed to an 82.4% vocabulary improvement rate of traditional learning. Personalized recommendations have been able to increase the vocabulary retention rate from 78.5% to 92.3% as well as the engagement level from 76.8% to 91.7%. It can be concluded from the above results that personalized vocabulary recommendations will enhance acquisition, retention, and application of vocabulary.

Key Words: reinforcement learning, vocabulary learning, english education, personalized learning, adaptive recommendation, learner engagement, language learning

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Introduction

Knowledge of vocabulary is an important factor in the study of the English language, as it affects learners' performance in the four skills of reading, writing, speaking, and listening. Good knowledge of vocabulary helps learners comprehend any meaningful conversation and communicate their thoughts. Nevertheless, it is one of the most difficult tasks in the process of learning English due to different factors, such as learners' capacity, vocabulary background, and exposure to language learning tools. Existing methods of vocabulary learning usually offer learners fixed lists of words and the same study materials, but do not solve their individual problems (Yin et al., 2025).

The recent development in the technology used for education purposes has led to the creation of digital learning environments, mobile-assisted vocabulary learning, and recommendation techniques in order to enhance vocabulary learning (Chen, 2025). These techniques allow for providing learners with better access to vocabulary resources; however, many current systems still operate on pre-defined learning paths without continuous adaptation of their recommendations depending on the progress of the learners

(Feng, 2025). There is a need for creating an adaptive approach to vocabulary learning, which would be able to determine the individual needs of the learners.

In this regard, this research proposes an RL-based vocabulary suggestion system for English learners. In this method, reinforcement learning techniques are utilized to comprehend the vocabulary needs of the learner and suggest appropriate vocabulary depending on their previous learning experiences and responses. This is different from the existing methods that suggest the same set of vocabulary for each learner irrespective of their performance and engagement. Various studies have shown that reinforcement learning techniques can be used to implement personalized learning systems that improve vocabulary learning and the English language learning experience (Meng, 2025; Pan, 2024).

The significant contributions of the research are:

1. It proposes a personalized vocabulary suggestion system to help English learners with their vocabulary development process by offering appropriate vocabulary suggestions based on their needs.
2. An adaptation technique is suggested to enhance the vocabulary recommendation process with regard to the interactions, responses, and performance of the learners.
3. An educationally based evaluation system is designed to evaluate the efficiency of personalized vocabulary assistance.

The rest of this paper is structured as follows: Section 2 reviews related work on vocabulary learning approaches, technology-enabled learning, and personalized recommendation techniques. Section 3 introduces the reinforcement learning-based vocabulary recommendation system. Section 4 provides details on the research methodology and performance metrics. Section 5 analyzes the findings and their educational significance. The final section (Section 6) concludes the paper.

Related Work

The conventional approaches to vocabulary learning include methods like using vocabulary lists, dictionary-based learning, flash cards, class-room based vocabulary games, and vocabulary applications on mobile phones. The recent studies on corpus-based evaluation of words for English teaching have emphasized the need for choosing appropriate vocabulary sources based on the learning goals and requirements of the learners (Yin et al., 2025). The technology-based vocabulary learning approaches have added new sources of vocabulary learning in the form of digital language platforms, mobile-assisted language learning platforms, and online vocabulary training sources. The intelligent learning platforms have tried to solve this problem by including recommendation procedures to choose appropriate vocabulary material for English teaching scenarios (Feng, 2025).

Personalized vocabulary learning techniques involve adaptive learning, learner-centric approach, and intelligent recommendations for providing vocabulary learning depending on the needs of the learner. Reinforcement learning-based vocabulary recommendation system personalizes itself through analyzing the interactions of the learner and making adjustments to vocabulary recommendations depending on learning. The adaptive reinforcement learning techniques have shown promising results towards improving vocabulary learning through making personalized word recommendations (Meng, 2025). Personalized learning path recommendation for vocabulary learning techniques have further demonstrated how reinforcement learning can help in making continual modifications to the vocabulary learning sequence depending on the progress of the learner (Pan, 2024). Cognitive behavior-based vocabulary learning systems have made an effort to find patterns in learners to personalize their vocabulary recommendations

(Sario et al., 2025). Techniques for deep reinforcement learning in education recommendation systems have also been studied for creating intelligent English learning systems (Wang, 2025). Reinforcement learning techniques for the growth of second-language vocabulary have shown promise towards improving vocabulary learning experiences (Khudhair et al., 2025).

The adaptive approach to curriculum personalization has brought another emphasis on changing the learning content depending on the learner's performance and engagement (Sridevi et al., 2025). Recommendation systems based on knowledge graph and reinforcement learning have been developed to propose suitable learning paths and overcome particular language difficulties (Zhou & Wang, 2025). The same recommendation approaches have been used to provide support for grammar learning based on adaptive difficulty recognition (Li & Li, 2025). Recommendations of reinforcement learning-based recommender systems have proven that continuous interaction-based recommendations can increase the efficiency of educational decisions (Afsar et al., 2022). Moreover, recommendation frameworks for education have shown the efficiency of reinforcement learning for personalized learning improvement (Tariq & Habib, 2024). Learner behavior analysis together with personalized recommendation approaches have brought extra insights into personalized adaptation of the learning experience for English Yang & Zhang, (2025). Recommendation techniques based on reinforcement learning in different areas have shown the potential of adaptive approaches in providing personalized educational content (Al-Hazaimeh, 2025).

Overall, these works show that reinforcement learning-based vocabulary recommendation can bring a learner-centered approach, which can adapt vocabulary recommendations continuously in terms of individual learning process, engagement, and educational needs.

Reinforcement Learning-Based Vocabulary Recommendation Framework

Overview of the Vocabulary Recommendation Process

Figure 1 describes the whole procedure of the vocabulary recommendation system based on reinforcement learning, in which the learners perform vocabulary tasks, and then their learning performance is assessed, and areas of strength and weakness are detected. Personalized vocabulary recommendation is offered according to the needs of the learners, followed by practicing and receiving feedback. The ongoing learning loop enhances future vocabulary recommendations.

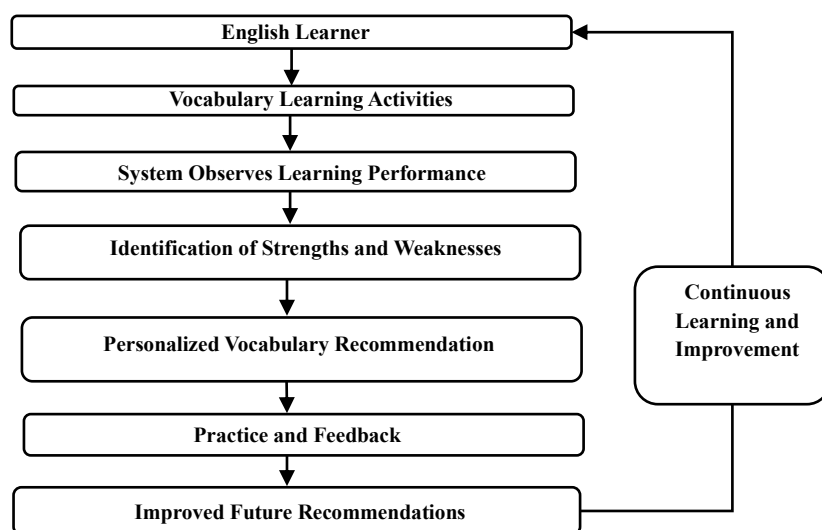


Figure 1: Vocabulary Recommendation Process for English Learners

Learner Vocabulary Profile Development

The vocabulary recommendation system based on reinforcement learning creates a personal vocabulary profile for each user taking into account learning progress of the learner, their vocabulary knowledge, and areas for improvement. The vocabulary profile is based on the previously learned words, vocabulary items that pose challenges for the learner, their vocabulary memorization capabilities, the pace of learning, the level of practice, and preferences for learning. This data helps the system determine the needs of each learner concerning their vocabulary learning. Thus, for learners who struggle with academic vocabulary, the system generates recommendations which include more academic vocabulary and its examples.

Vocabulary Recommendation Process

The word selection process aims at recommending words that will be appropriate in helping the learners develop language skills. The system recommends new vocabulary based on the level of competence of the learner, revision vocabulary to help reinforce the earlier learned vocabulary and context-based vocabulary through useful sentences and examples from life. Skill-based vocabulary which involves reading, writing, speaking, and listening activities is also recommended. For example, when a learner keeps struggling with words about emotions, the system recommends other related words together with contexts and activities.

Reinforcement Learning-Based Adaptation

With the use of the reinforcement learning method, the process of adaptation enhances the performance of recommendations on vocabulary since it takes into account learners' feedback and learning results at all times. In cases where learners comprehend the recommended words well, perform tasks, and have a high memory retention rate, the system is able to recognize the success of the recommendations and give more of the same vocabulary. In cases where there are problems such as mistakes, lack of participation, or poor memory retention of words, the system changes its recommendations by including more explanations and revision exercises.

Methodology

Research Design

In this research, an educational evaluation method has been employed to evaluate the effectiveness of the reinforcement learning-based vocabulary recommendation system for helping English learners. The study has been performed using English learners having different proficiency levels to understand the benefits of personalized vocabulary recommendation for English learners with different learning needs. The study has been performed in 8 weeks by using the learners to carry out vocabulary learning activities. In this study, there are two groups, one being the experimental group using a reinforcement learning-based vocabulary recommendation system and the other being the control group using conventional vocabulary learning approaches.

Vocabulary Learning Activities

The vocabulary learning activities were specifically aimed at enhancing learners' comprehension, utilization and retention of English words. The learning activities consisted of word introduction, whereby the learners were exposed to new vocabulary along with meanings and example sentences, followed by word meaning identification activities to help them understand the words better. Vocabulary use was further

reinforced by engaging learners in sentence formation activities. Contextual activities gave the learners a chance to understand the words from practical examples and sentences. Quizzes were used to assess their comprehension levels, and revision activities for continuous practice.

Evaluation Measures

The approach to recommending vocabulary was analyzed based on vocabulary improvement, retention, motivation, and satisfaction criteria. These criteria measured the level of knowledge enhancement, memory of words, involvement in activities, and acceptance of individualized vocabulary help for efficient English learning.

Vocabulary Improvement: Vocabulary improvement measures the increase in learners' vocabulary knowledge after completing the learning activities. It can be calculated as (Equation 1):

$$VI(\%) = \frac{\text{Post-Learning Score} - \text{Pre-Learning Score}}{\text{Pre-Learning Score}} \times 100 \quad (1)$$

Vocabulary Retention: Vocabulary retention evaluates the learner's ability to remember previously learned words after a specific period (Equation 2).

$$VR(\%) = \frac{\text{Number of Correctly Recalled Words}}{\text{Total Number of Learned Words}} \times 100 \quad (2)$$

Learning Motivation: Learning motivation measures learners' interest and participation in vocabulary learning activities based on questionnaire responses (Equation 3).

$$LM(\%) = \frac{\text{Obtained Motivation Score}}{\text{Maximum Possible Score}} \times 100 \quad (3)$$

Learning Satisfaction: Learning satisfaction evaluates learners' acceptance and experience with the personalized vocabulary recommendation approach (Equation 4).

$$LS(\%) = \frac{\text{Obtained Satisfaction Score}}{\text{Maximum Satisfaction Score}} \times 100 \quad (4)$$

Results and Discussion

The efficiency of the reinforcement learning-based vocabulary recommendation system was analyzed based on the effect that the system had on vocabulary improvement of learners, their vocabulary retention capacity, and engagement with vocabulary learning activities. In other words, the efficiency analysis was devoted to identifying whether personal recommendations of vocabulary can be beneficial for English learners compared to regular vocabulary learning methods.

Vocabulary Improvement

The improvement of learners' vocabulary was assessed through the comparison of their performance in vocabulary learning activities before and after such activities. The comparison was done between learners using traditional vocabulary learning techniques and those using reinforcement learning-based recommendations.

Table 1 shows that the use of personalized vocabulary suggestions enhances vocabulary acquisition in learners through the provision of appropriate vocabulary based on their needs and advancement. This

ensures that learners are able to concentrate on important vocabulary and overcome any challenges in learning vocabulary.

Table 1: Comparison of Vocabulary Improvement Between Traditional and Reinforcement Learning-Based Vocabulary Learning Approaches

Learning Approach	Vocabulary Improvement (%)
Traditional Vocabulary Learning	82.4
Reinforcement Learning-Based Vocabulary Recommendation System	94.6

Vocabulary Retention Ability

The ability to retain vocabulary was investigated in order to see how well the learners can remember and use the new vocabulary that has been learned. Retention capability is an important aspect of English language learning since successful vocabulary learning entails the application of vocabulary beyond the learning process.

Table 2: Comparison of Vocabulary Retention Ability Between Traditional and Reinforcement Learning-Based Vocabulary Learning Approaches

Learning Approach	Vocabulary Retention (%)
Traditional Vocabulary Learning	78.5
Reinforcement Learning-Based Vocabulary Recommendation System	92.3

Table 2 reveals that students who have been subjected to personalized vocabulary recommendations were able to retain vocabulary better than those using conventional methods. The high rate of retention implies that regular engagement with the right vocabulary words, along with context-based samples and revision exercises, is key to vocabulary memory. The personalized recommendation tool helps learners revisit difficult vocabulary and offers extra practice opportunities when needed. The consistent learning approach prevents forgetting of learned vocabulary and enables learners to use the vocabulary confidently in various contexts. Hence, personalized vocabulary recommendation facilitates vocabulary learning as well as its retention.

Learner Engagement and Learning Motivation

Evaluation of learner engagement involved examining the involvement of learners in vocabulary activities, accomplishment of learning tasks, and their interest in pursuing further vocabulary exercises. This is because learner engagement in the language learning process is very significant since learners require constant exposure to new vocabulary for success.

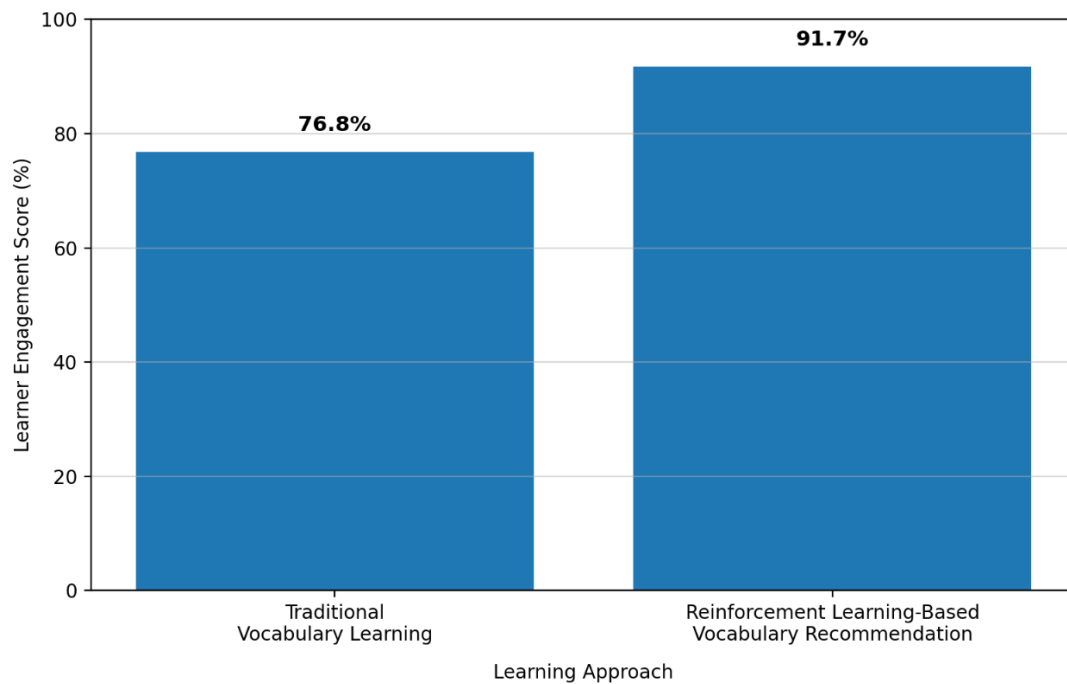


Figure 2: Comparison of Learner Engagement Scores Between Vocabulary Learning Approaches

Figure 2 illustrates the comparison between learner engagement levels from vocabulary learning using the traditional method and the vocabulary recommendation using reinforcement learning. From the results, it is evident that personalization of vocabulary learning through reinforcement learning leads to increased learner engagement (91.7%) compared to traditional vocabulary learning (76.8%).

Discussion

From the analysis of the findings, it is clear that reinforcement learning-based vocabulary recommendation helps to learn English vocabulary effectively. In particular, it increases the ability to know the words, retain them, and engage more in vocabulary learning. Personalized vocabulary learning thus helps to overcome several limitations of conventional ways of vocabulary teaching. It is evident from the findings that learning vocabulary becomes easier if the learners get the words as per their personal learning circumstances rather than as per a pre-defined vocabulary list. The approach thus helps the learners to learn those vocabularies that would help them improve and revise too. From the educational viewpoint, it becomes clear that the reinforcement learning-based vocabulary recommendation could help the English teachers and students in several ways. It does not replace classroom teaching at all; however, it helps to provide a personalized learning experience to the learners. It is very helpful in larger classes where teachers may face difficulty in helping all learners individually in the area of vocabulary.

Educational Implications

The results obtained from the present research indicate that there is significant educational benefit to using the suggested reinforcement learning algorithm-based recommendation system to help students learn English vocabulary individually. Individual characteristics such as knowledge level, learning speed, and personal requirements are taken into account in the process of suggesting proper vocabulary terms. The use of this method helps the teacher find out about the problems of the students and create corresponding activities. The use of the system allows for learning vocabulary not only in classroom settings but also in individual conditions. The system provides appropriate recommendations depending on the learner's skill level.

Conclusion

In this research work, the researchers attempted to explore the efficiency of the reinforcement learning-based vocabulary recommendation system for personalized English vocabulary learning. The main problem with conventional approaches of vocabulary learning was overcome in this model, where the recommendation of vocabulary was made considering the learner's knowledge status, progress in learning, difficulties, and patterns of interaction.

Evaluation results have shown the positive influence of personalized vocabulary recommendations on education. The learners who used proposed recommendations have reached a vocabulary improvement of 94.6%, while the vocabulary improvement of 82.4% has been achieved by learners who used conventional vocabulary learning. In addition, vocabulary retention has been enhanced from 78.5% to 92.3%, proving that contextual examples, vocabulary practice, and personalized vocabulary recommendations improve retention and application of newly acquired vocabulary. Moreover, personalization of learning activities has resulted in an increase in engagement of English learners from 76.8% to 91.7%. All these results confirm the usefulness of reinforcement learning-based vocabulary recommendations.

Despite the positive outcome obtained in the course of the research, future research may include studies conducted with the help of a larger number of participants with different educational backgrounds and English proficiency levels. In addition, it is possible to consider the use of speaking, writing, and listening exercises along with personalized vocabulary recommendations. Long-term implementation in the classroom can be studied further.

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