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An approach to developing the scafwording application for vocabulary expansion in GRE preparation

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Abstract: This article examines the process of developing the Scafwording application aimed at enhancing vocabulary skills among users preparing for the GRE exam. The platform employs adaptive methods that integrate reinforcement learning algorithms to implement personalized approaches to the learning process.

The study's objective was to create a tool that facilitates the acquisition of vocabulary necessary for completing GRE tasks. The methodology is based on cognitive principles, including spaced repetition and simulation of conditions close to a natural language environment. The technological process of analyzing user interactions on the platform helps tailor educational programs to individual needs.

Interactive components and progress visualization, help maintain engagement in the learning process. The platform creates an environment for studying words in context, enhancing their practical application.

The results demonstrate that the Scafwording application is an effective tool for learning. The information presented in this study is valuable for students, educators, and professionals as it offers opportunities to learn language based on individually tailored strategies.

Keywords: Scafwording, GRE, vocabulary, reinforcement learning, spaced repetition, contextual learning.

Introduction: Modern educational technologies are driving the evolution of learning approaches, which are essential for exam preparation, which requires

mastering vocabulary and analyzing presented texts.

Traditional methods, such as paper flashcards or printed study materials, are gradually losing relevance. They are being replaced by mobile applications designed to optimize the learning process. However, most of these programs fail to account for individual learner characteristics, offering a standardized material acquisition path that is not adapted to varying knowledge levels, learning speeds, or preferred formats of content delivery. A lack of contextual tasks and limited interactivity further complicates the practical application of new words in real-life scenarios.

The relevance of developing educational tools that cater to individual user needs is supported by advancements in cognitive science. Technologies integrating adaptive algorithms enable the creation of solutions tailored to the unique characteristics of each learner. An example is an application employing algorithms that develop personalized learning trajectories.

This study aims to create a conceptual model of an application designed to enhance vocabulary acquisition during exam preparation. Emphasis is placed on personalized learning, leveraging data to adapt the educational process, and analyzing opportunities to extend the tool's application to other areas.

METHODS

Scientific studies dedicated to mobile applications for learning English and preparing for exams encompass a wide range of approaches. Researchers address aspects such as interface design, pedagogical methods, and evaluation systems for software.

Articles focusing on application development emphasize usability, adaptation to individual needs, and the creation of intuitive solutions. The work by Martell M. et al. [1] describes interfaces tailored for exam preparation, designed to meet the needs of users learning English as a foreign language. The study by Kazemainy F. et al. [2] examines the process of developing software that adapts to various educational tasks. Research by Martínez R. F. et al. [3] highlights the use of spaced repetition algorithms for memorizing terms.

The reviewed studies focus on methodologies leveraging modern technologies to achieve educational goals. Articles by Al-Jarf R. S. [4,5] analyze the practical value of mobile applications and flashcards for exam preparation. Aslan M. and Tütüniş B. [6] explore the personalization of learning processes through mobile devices. Research by Mao Y., Mofreh S. A. M., and Salem S. [7] investigates the impact of smartphones on educational processes. The work by Ene A., and Stirbu C. [8] describes tools designed to expand vocabulary.

Scientific studies in this field concentrate on developing methodologies for analyzing the functionality of educational software. The article by Lin C. H. et al. [9] proposes a framework for objectively evaluating mobile applications. In the study by Mirzaei S. et al. [10], the VLASTWA platform is analyzed, which integrates vocabulary learning with the development of strategic thinking skills.

In turn, the source [11] demonstrates a web application posted on the official website for expanding vocabulary in preparation for the GRE.

The work described in [12] examines the implementation of reinforcement learning methods in a system designed to personalize the educational process. It emphasizes that the use of a model based on AI algorithms allows for the adaptation of actions depending on a learner's achievements or errors, thereby facilitating modifications to teaching methods. Such a system adjusts the learning strategy based on results, ensuring the effective assimilation of material. It is argued that its implementation will improve outcome forecasting, enabling the system to adapt the process to each learner.

Thus, the scientific literature reflects the diversity of approaches. Some authors focus on creating user-friendly interfaces tailored to learners, while others emphasize the educational aspects of technology use. Limited attention has been given to tools analyzing the development of oral communication skills. Issues related to the universality of applications for different cultural and linguistic groups require further investigation. A promising direction involves developing methods that integrate interdisciplinary approaches to enhance the effectiveness of educational platforms.

An analysis of existing commercial and non-commercial applications for exam preparation reveals that many solutions while incorporating individual elements of theoretical frameworks, fail to fully realize the potential of modern adaptive approaches. Popular vocabulary memorization applications such as Quizlet and Memrise provide basic functionality, including user-generated flashcards, tests, and some gamification elements. More specialized platforms designed for GRE preparation (e.g., Magoosh, Kaplan, Barron’s) offer predefined vocabulary lists and practice exercises. However, in most cases, adaptation to individual learner characteristics is limited to adjusting difficulty levels or repeating incorrectly answered

questions, adhering to a static model. Features such as multiple iterations with varying levels of detailed hints and interactive feedback to strengthen semantic associations between a word and its meaning are often absent.

An evaluation of current solutions indicates that the methods employed often fail to adequately incorporate recent advancements in machine learning and behavioral data analysis. Notably, approaches based on reinforcement learning and intelligent decision-making models in educational environments remain underutilized. This situation appears paradoxical given the extensive empirical data on user experience and learning outcomes. Additionally, many applications offer only a limited range of contexts for vocabulary presentation. Research suggests that presenting vocabulary through multifaceted contexts, such as dialogues and stories, enhances retention. However, many platforms rely primarily on isolated definitions or sentence fragments.

When comparing existing solutions, some platforms implement basic adaptive mechanisms. For instance, Magoosh periodically revises the set of words presented based on test performance, and Quizlet allows users to create custom term sets. However, these adaptations are often simplistic and lack flexible adjustments to tailor the learning trajectory to individual cognitive models. Consequently, users encounter challenges such as inefficient repetition of words, suboptimal increases in complexity, and insufficient attention to previously overlooked terms. The absence of dynamic difficulty management, limited contextual cues, and ineffective integration of user behavioral patterns restrict the potential of current systems.

Thus, a review of the literature and existing applications demonstrates that despite the availability of theoretically grounded strategies (e.g., spaced repetition, contextualization, gamification), the market is dominated by tools that fail to fully leverage modern intelligent approaches to learning personalization and adaptation. This creates an opportunity for the development of a new solution capable of addressing the limitations of current systems. In the practical section of this study, a conceptual framework for an application will be presented. This application will integrate data analysis methods, reinforcement learning algorithms, and enhanced vocabulary contextualization to create an individualized trajectory for each user, taking into account their proficiency level, information processing style, and learning progress dynamics.

RESULTS AND DISCUSSION

The Scafwording application is based on findings from scientific studies examining memory and information retention processes. Its functionality adapts to individual user needs, beginning with assessing the user's proficiency level, customizing word repetition frequency, and generating personalized word lists. This includes a system of achievements and daily tasks.

The contextual learning feature facilitates comprehension of words through examples in sentences and exam-style tasks, including fill-in-the-blank exercises and analogy challenges.

The application's software component analyzes user learning activity to identify optimal approaches, adjusting the focus on words that present greater difficulty. This enables a tailored learning process aligned with the user's proficiency level and goals [1, 2]. The interface is designed for simplicity and convenience, allowing users to focus on studying. Progress is visualized through clear graphs displaying the number of words learned and retention percentage. Additionally, users can access consultations and recommendations to enhance learning efficiency.

The development of the application is guided by three principles: flexibility, interaction, and engagement. These principles ensure a personalized learning process, sustain user attention, and maintain interest in the learning activities [3, 6]. Table 1 below outlines the principles of application development.

Table 1. Principles of Application Development [4, 5, 7, 8]

Principle	Description
Flexibility	The application uses algorithms to process user data, accounting for individual challenges. Material that poses difficulties is repeated, while mastered content is excluded from further tasks.

User Interaction	Gamified elements such as quizzes make the learning process more engaging. Progress is demonstrated through visual graphs and tables.
Engagement	The application includes daily tasks, enabling the creation of communities focused on collaborative learning.

From a technological perspective, the Scafwording application utilizes cross-platform methods, ensuring accessibility for users of all devices. Data analysis is conducted using algorithms that generate predictions to optimize the sequence of material presentation. The simplicity of the interface is achieved through minimalism, an intuitive structure, and adaptive design elements [6, 9]. Figure 2 below illustrates the sequence of questions used in the daily quiz.

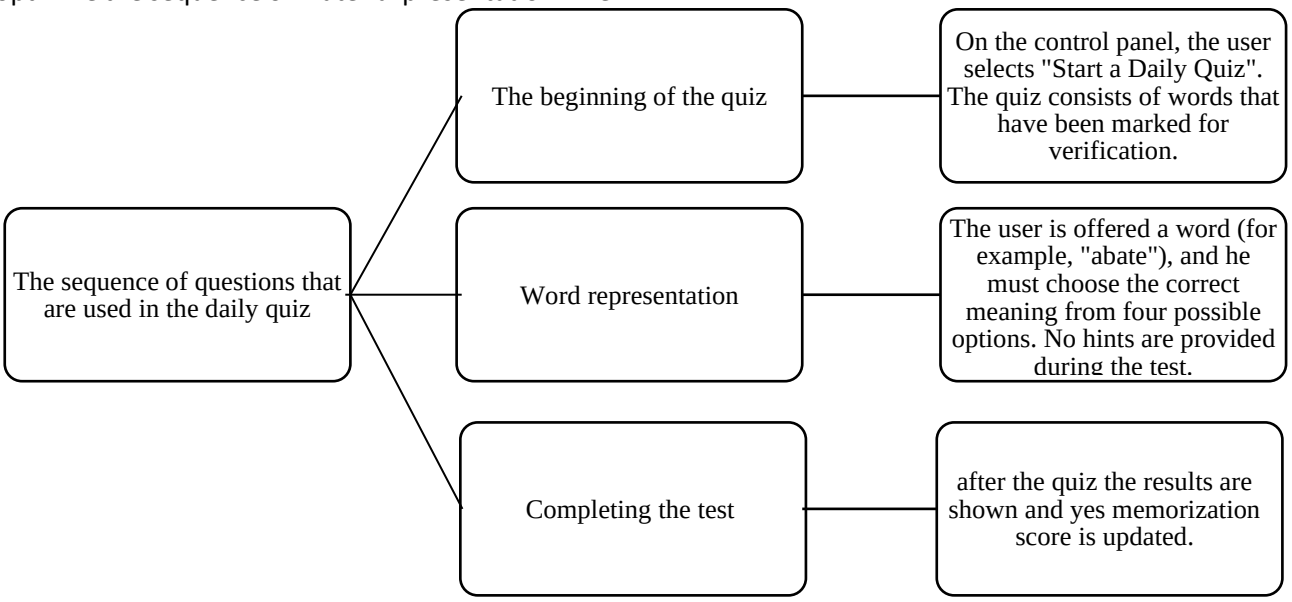

Fig.2. The sequence of questions used in the daily quiz

Vocabulary within the application is selected based on an analysis of frequency usage in exam-related texts. Thematic collections are created to cover various fields. Each word is accompanied by:

- a detailed description and usage examples,
- a list of synonymous and antonymous meanings,
- audio recordings by native speakers,
- visual elements that create associative imagery.

The vocabulary learning tools implemented in Scafwording include a spaced repetition system to reinforce the material, exercises incorporating words into texts, sentences, and paragraphs, and session results that provide knowledge assessments and recommendations for further study.

The application design focuses on developing mechanisms that adjust task complexity based on user capabilities. A flexible difficulty adjustment system is created, and materials are adapted to regional educational characteristics.

The application is versatile and can be used in various domains. Students gain a tool tailored to their learning style and proficiency level. Educators can track learner progress and refine their teaching methods. Researchers in the field of language acquisition use the platform to gather data on information retention mechanisms.

The functionality extends beyond exam preparation. The program is suitable for language learning, mastering specialized terminology, and applying gamified educational methods. Personalization

enables the platform to be tailored to specific objectives, providing materials aligned with user goals [4,5,10].

Example of a user interface for the learning flow:

1. Present one word at a time, offering the options "Know" and "Don't Know."

2. When the user selects "Don't Know," display hints (context, dialogue, or story) one at a time.

3. After showing a hint, present a question with multiple-choice options as easily clickable buttons with clear feedback.

4. For correct responses, highlight the option in green, proceed to the next word, and repeat from step 1.

5. For incorrect responses, highlight the option in red, display another hint, and disable it.

6. Once hints are exhausted, show a brief definition of the word and move to the next word, restarting from step 1 until the session words are completed.

7. At the end of the session, display a summary of learned words, marking incorrect words for further review.

The user interface for the daily quiz includes:

- Displaying each word with four answer choices below it.
- A summary of results at the end of the quiz. This summary should include an accuracy scale and personalized feedback based on accuracy.
- The word review section should display words, results, and an option to review each word. When the user selects "Review Word," a screen appears showing the correct and selected answers. After completing the individual review, the user returns to the word review screen [6, 7, 9].

The implementation of the hint mechanism was achieved using AI methods such as SARSA and Q-LEARNING. These algorithms are designed to operate under uncertainty and rely on previous experiences.

SARSA is a method in which learning is built within the framework of its policy. The algorithm uses past actions and their consequences to adjust future steps. Q-LEARNING, on the other hand, employs off-policy learning. This method allows the algorithm to explore various strategies, taking into account long-term rewards, and enabling it to act independently of prior decisions. For example, consider an employee who has just joined a team. If their training is based on experience gained through their strategy, this illustrates policy-based learning. Conversely, if training occurs through observing colleagues' actions and applying that knowledge to their work, it represents off-policy learning.

The anatomical simulator model presented demonstrates the operation of an intelligent tutoring system (ITS) developed according to general ITS principles. In this system, the student interacts with a web interface connected to a tutor model that substitutes for a human instructor. The tutor generates questions based on various scenarios stored in the content database. These questions are then sent to the student, who responds.

The tutor evaluates the accuracy of the responses and saves the progress information in the system supporting the student model. The results are accumulated in a centralized database. Depending on the responses received, the tutor may offer additional hints, ask new questions, or modify the scenario, allowing the learning process to be tailored to the current needs of the student.

The development process of the simulator for the Interactive Training System involves the use of scenario and student classes, which facilitate data extraction and display during the training process. Artificial intelligence interacts with students according to predefined schemes. Responses are analyzed based on a conceptual map: correct answers lead the system to proceed to the next question, while incorrect ones prompt the provision of a hint. At the initial stage, the probability of receiving a hint is 33%.

The simulator's structure is organized into three cycles: the student cycle, the scenario cycle, and the question cycle. The question cycle ends when all questions for a given scenario are completed. The scenario cycle concludes when the student has answered all questions across all scenarios. The training cycle ends once all students have completed all assignments.

During interactions between students and the artificial tutor system, each student's data is saved for analysis. The functions that process this data are described in Table 2.

Table 2. Description of data processing functions [12]

Feature name	Description
Time stamp	Timestamp is stored when the student has entered his/her answer

Student	Name of the student
Scenario description	The description of a scenario where the student is answering a question
Question	The question which the student is solving
Student question thinking time	End of the tutor's question to the beginning of the student's answer or the End of the tutor's hint to the beginning of the student's answer
Student answer	The answer that the student has given for a question under a scenario.
Correct?	This feature indicates whether an answer is right or wrong
Hint	The hint number
Hint type	The type of hint; whether a hint given is in video, text, or diagrammatic format
Hint time	The time needed by an average student to read/view a hint

The reinforcement learning method enables the modeling of scenarios where both the sequence of actions and the choice itself are critical. The application of these algorithms contributes to the optimization of the entire process. For instance, after several video hints, a brief textual or schematic hint summarizing the material can prove effective, despite video hints generally demonstrating better results. To determine the optimal strategy for selecting hints, the type of hint was randomly chosen whenever a student was unable to provide the correct answer. Each type of hint was selected with an equal probability of 131/3%. After 1000 iterations, an analysis of the data revealed the distribution of hint types.

A similar approach with epsilon reduction was used to develop personalized recommendations tailored to each student. The objective was to compare the effectiveness of Q-learning and SARSA in optimizing hints adapted to individual learner needs. Q-learning demonstrated the highest average reward. This method updates Q (S, A) values more frequently, which is particularly evident when observations are limited [12].

Based on the above, Scafwording can be characterized as a learning application designed for exam preparation, aimed at developing skills in text analysis, context comprehension, and terminology acquisition. Its functionality is powered by data processing algorithms that adapt the learning process to the user's characteristics.

The program records mistakes, collects data on time spent completing tasks, and analyzes learner behavior. Based on the gathered information, it builds a model to create optimal repetition strategies. Tasks are distributed according to the user's mastery level, with studied topics appearing less frequently. Gamification elements make the learning process more engaging.

Scafwording integrates modern technologies and educational methodologies, effectively organizing the learning process to address linguistic and professional challenges.

CONCLUSION

The Scafwording application is designed to expand vocabulary in preparation for the GRE exam. Its development is based on reinforcement learning algorithms that utilize user data analysis to create individualized educational trajectories. This approach addresses learner-specific characteristics, enabling the creation of personalized programs.

The application's functionality encompasses foreign language learning, professional terminology acquisition, and integration into corporate training. This versatility positions the platform as a universal solution for students, educators, and cognitive activity professionals.

The concept combines data analysis algorithms with cognitive psychology methods. Implementing this

model provides opportunities for the development of educational programs that meet modern demands, accommodating the needs of various user categories.

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