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ARTICLE

Enhancing Vocabulary Retention Through Personalized Learning: Evaluating the Impact of the "Baicizhan" App on students' Long-Term Memory

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ABSTRACT

In the digital era, personalized learning has gained significant attention in the realm of English vocabulary acquisition. While numerous mobile applications claim to enhance vocabulary memory, empirical evidence regarding their actual effectiveness and user experiences remains limited. This study aims to systematically evaluate the Baicizhan app in improving English vocabulary retention from a pedagogical viewpoint to meet the diverse needs of learners and support long-term memory storage. This study utilizes Cognitive Load Theory, Motivation Theory, and Constructivist Learning Theory to explore how the Baicizhan app enhances vocabulary acquisition and long-term memory by optimizing cognitive processing, fostering learner engagement, and promoting active knowledge construction through personalized learning pathways and multimodal resources. Data were collected through interviews with fifteen diverse users, revealing that Baicizhan significantly enhances learner engagement, motivation, and vocabulary retention through its personalized and interactive features. The results suggest that the app is effective in promoting long-term memory consolidation, aligning with cognitive and metacognitive learning principles. However, to further improve its effectiveness across varied learning

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environments, the app should be optimized based on user feedback and specific learning profiles. This study provides both theoretical and practical insights for enhancing mobile-assisted language learning tools to improve education quality.
Keywords: Vocabulary Building; Personalized Learning; Mobile Learning Application; Long-Term Memory

1. Introduction

In today's era of globalisation and information technology, the importance of English as a global lingua franca has become increasingly prominent. Acquiring a rich English vocabulary is the key to improving language proficiency and enhancing personal competitiveness[1]. However, many learners, especially non-native English speakers, face significant challenges in memorising and mastering English vocabulary[2,3]. Traditional methods of vocabulary memorisation are often boring and lack sufficient appeal, leading to a lack of interest and motivation on the part of learners, which in turn affects learning outcomes[4]. Therefore, it has become particularly important to explore and apply more effective English vocabulary memorisation tools and methods.

At present, there are many English vocabulary learning applications on the market, such as *Baicizhan, Memrise, Anki* and so on. These tools use multimedia, gamification and personalised learning strategies to help users memorise words. Although these apps have improved learners' interest and learning effectiveness to a certain extent, they still have some limitations[5]. For example, some applications lack sufficient interactivity and feedback mechanisms to adequately meet the needs of different learners[6]. In addition, systematic research on the effectiveness and user experience of these tools in practical applications is relatively limited.

In order to address the above issues, this paper focuses on analysing how the "Baicizhan" application, at a pedagogical can improve English vocabulary memorisation and how it can meet learners' individual needs and promote diversified learning styles[7]. "Baicizhan" is a mobile app that helps users memorize English words through fun visuals, games, and short daily lessons[8,9]. It adapts to individual progress, making learning efficient and engaging for diverse needs and styles. From a pedagogical perspective, this study not only seeks to increase students' vocabulary retention but also directly aligns with Goal 4 of the UN Sustainable Development Goals, which is to ensure that students from all backgrounds have equal access to technologically facilitated learning opportunities[1]. Additionally, by focusing on promoting individualized learning for students and closing learning resource gaps through intelligent recommender systems and personalized learning paths, the study aligns with Goal 10 and helps to improve educational equity and quality[10].

2. Literature Review

The application of personalized learning in mobile-assisted language learning has gained significant attention. Personalized learning strategies are increasingly recognized for their ability to meet the diverse needs of learners and enhance learning efficiency, with many reviews highlighting the development of these techniques and suggesting future research directions[11,12]. Recent research shows that the Baicizhan app effectively supports receptive English vocabulary learning among non-English major Chinese undergraduates, especially for less frequent words[13]. Its success is attributed to features like spaced repetition, gamification, and personalized learning, though individual factors like prior knowledge and motivation affect outcomes at higher vocabulary levels. These insights highlight how the "Baicizhan" app delivers a customized learning experience that adapts to individual learning progress and skill levels. The relationship between mobile learning applications and learner engagement has also been explored, revealing that personalization features and gamification elements play a critical role in increasing engagement and motivation as traditional vocabulary teaching lacks engagement[7,13]. This is consistent with the gamification and personalized learning plans found in apps like Baicizhan, proving their practical effectiveness. Challenges faced by users of language learning applications, such as Duolingo and Memrise, have been identified, including issues with incomplete functionality and poor user interface design, which may also affect the experience of using the "Baicizhan" app[14]. The influence of mobile learning applications on vocabulary memory is significant[15,16]. Mobile learning applications have been shown to significantly im-

prove vocabulary retention by enhancing memory through repeated exposure and spaced reviews [15–17]. Their findings support the potential of the "Baicizhan" app to help users achieve long-term memory storage. Vocabulary is the very aspect of communicative competence and has a direct effect on the listeners, speaking, reading, and writing performance [3,4]. In English as a Foreign Language (EFL) teaching, there is a shortage of authentic input which limits the opportunity for new lexical items to be encountered by the learners more than once [16]. This weakness has decreased the chances of effective transfer of vocabulary to long-term memory, particularly where there is no reinforcement in the form of spaced repetition [16].

Adaptive learning technologies have been discussed to enhance vocabulary acquisition, as they adjust learning content based on individual differences, thereby improving learning outcomes [18]. The app's personalized learning plan is like these adaptive learning technologies, providing theoretical support for evaluating its impact on long-term memory storage [19]. The study also found that repeated exposure and spaced review of vocabulary are essential for memory consolidation, a strategy widely applied in mobile learning applications [20]. Zhang et al. [19] research explores how mobile learning apps can enhance long-term memory through spaced review and multiple presentation strategies, which can be applied to evaluate the effectiveness of the "Baicizhan" app in improving vocabulary memory retention. The learners' experience and challenges in utilizing language learning applications are critical areas of research, particularly in relation to vocabulary, memory and individual learner needs [21,22]. Li [9] elaborated on how innovations in language learning technologies, including personalized learning features, can enhance vocabulary acquisition and memory, focusing on the role of apps in this process [23]. Their research suggests that these technologies effectively support vocabulary learning and improve memory retention, providing a strong foundation for the "Baicizhan" app's potential to improve long-term English word memory. In addition, user experience design plays a crucial role in shaping learning outcomes. Research on user interface design reveals that the interface's simplicity and user-friendliness can significantly impact learner satisfaction and overall learning effectiveness [24]. This highlights the importance of optimizing the user interface of the "Baicizhan" app to cater to diverse learner needs and enhance vocabulary retention [14]. Furthermore, personalized learning features, which adapt to individual differences, can further address the varying needs of learners [16]. The learning of the vocabulary is diverse due to cognitive, social and cultural factors. Learners enter the learning environment with various prior experiences, linguistic exposure and education demands [10,18]. For example, learners with a Science and Technology (STEM) background can concentrate on terms linked to their field, and novices can be forced to concentrate on high-frequency vocabulary that is required for daily usage. Baicizhan app is uniquely capable of scaling the frequency and difficulty of the reviews which they based on performance to ensure that learners with diverse needs get what they need without overwhelming their minds. The other factor that determines retention of vocabulary is the home environment. Higher access to silent studying environment, family support, and reliable internet are likely to make learners undertake periodic spaced reviews [16]. On the other hand, learning routines may be disrupted by distractions, inconsistent schedules or technological constraints. The barriers are alleviated by Baicizhan, using offline mode, notification reminders and flexible scheduling, allowing the program to continue even under less favourable conditions [5].

3. Theoretical Underpinning

To better understand how the "Baicizhan" app supports English vocabulary acquisition and long-term memory retention, this study draws upon three core learning theories: Cognitive Load Theory, Motivation Theory, and Constructivist Learning Theory. These theories together provide a multi-dimensional framework to analyze how individual differences influence personalized learning outcomes in mobile-assisted language learning environments [19,23]. Cognitive Load Theory posits that learners' cognitive resources are limited, and their ability to process information depends on how cognitive load is distributed—whether intrinsic, extraneous, or germane [21,23]. The "Baicizhan" app applies this theory through features such as spaced repetition, word categorization, and progressive review tasks. These elements help users manage their cognitive load effectively by minimizing unnecessary distractions and reinforcing key vocabulary through structured repetition [23]. Such a design helps learners better encode and retrieve vocabulary items into long-term mem-

ory. As regards vocabulary building, intrinsic load depends on the complexity of words, pronunciation level, and the abstractness of meaning[6]. Extraneous load can be in the form of poorly assigned visuals or congested interfaces[21], whereas germane load is the cognitive effort to internalize new words within the pre-existing schemes. Baicizhan facilitates this process by ordering vocabulary on the scale of easy to difficult, making example sentences highly contextual and allowing a learner to choose how quickly the learner wants to review[19].

Constructivist Learning Theory emphasizes the active role of learners in constructing knowledge through personal experiences, interaction, and reflection. The "Baicizhan" app encourages self-directed learning by allowing users to choose learning content, set personalized goals, and monitor progress[17]. This autonomy supports active cognitive engagement and accommodates different learning styles and behaviors. Moreover, learners can internalize vocabulary more effectively when they are actively involved in the learning process[25]. Baicizhan embodies the concepts of constructivism in the form of interactive quizzes, topic word lists, and scenario-based activities that are close to real communication conditions[22]. These characteristics facilitate profound semantic coding and boost transfer of vocabulary to real life which is the most crucial fact in long-term memory.

According to Self-Determination Theory (SDT), sustained learner motivation depends on satisfaction of three basic psychological needs: autonomy, competence, and relatedness[26]. With regards to vocabulary acquisition via mobile applications like Baicizhan, autonomy is facilitated by giving the learner freedom in topics to learn, consisting of their own goals, and the ability to change the review schedules to their own pace[9,10]. The mastery indicators, adaptive review schedule, and customized feedback based on the performance of learners contribute to competence[7,19]. The elements, such as leaderboards, peer challenges, and community features are used to promote relatedness and give support and chances to engage in healthy social comparison[8,27].

In these theories, the intrinsic and the extrinsic motivation can be efficient in sustaining vocabulary learning over the long-term in a complementary manner. Achievement badges and the number of streaks stimulate extrinsic motivation in gamification as the reward of progress[5,8]. Conversely, personalised feedback and adaptive sequencing will help to develop intrinsic motivation as well by guaranteeing the necessity of the task in terms of alignment with personal interest and the level of proficiency[7,10]. This combination of the drivers of motivation not only keeps the learners engaged but lowers the chance that the learner will drop out and provides stable encounters with target vocabulary which is essential in long-term retention[5,16].

Research on personalized learning, gamification, and adaptive technologies in mobile-assisted language learning is limited. Current studies focus on short-term gains, leaving long-term vocabulary acquisition unclear. Social learning features' role in vocabulary retention is not explored. Interactions between personalized features and learner profiles and external factors like socioeconomic status are also understudied. Addressing these gaps will help optimize mobile learning tools for diverse user groups.

Hence, the research objectives of this study are

i) to explore the role of the "Baicizhan" APP in improving English word memory for different learners
ii) to explore how the "Baicizhan" APP meets the individual needs of learners and promotes diversified learning
iii) to investigate the underlying factors that contribute to student motivation when using the Baicizhan APP

4. Methodology

4.1. Research Design

This study uses qualitative research methods to explore the role of the "Baicizhan" application in improving English vocabulary memory and solving individual learning differences. Qualitative research can deeply capture the subtle experience of users and reveal their learning achievements and challenges. Data was collected through online interviews, which provided respondents with a space for free expression and focused on the core research issues. An online interview was selected as the main data collection method, because it can promote comfortable and open dialogue and help respondents share real experiences and opinions, thus enhancing the authenticity and richness of data[28].

4.2. Interview Questions

The interview consisted of five primary questions, each with some sub-questions. These questions covered areas such as the reasons for using the "Baicizhan" app, how respondents learned about the app, the features they found most useful for vocabulary learning, and the specific impact of the app on their vocabulary retention. Further, the interview delved into how the app supports personalized learning and addresses the varying needs of learners. To align with the United Nations Sustainable Development Goals (SDGs), particularly **Goal 4** (Quality Education) and **Goal 10** (Reduced Inequality), the interview also included questions to assess the app's effectiveness in providing equitable learning opportunities and promoting inclusivity among diverse learners.

4.2.1. Research Objective 1

1. **How frequently do you use the Baicizhan app to learn English vocabulary?**
    - 1.1. At what time of day do you typically use the app?
    - 1.2. Approximately how long do you spend per session when using the app?
2. **What features of the Baicizhan app do you think are most helpful for your vocabulary?**
    - 2.1. How do these features meet your learning needs?
    - 2.2. Do you have any favorite features or areas that need improvement? Explain.

4.2.2. Research Objective 2

1. **Does the Baicizhan app provide personalized learning suggestions or content based on your learning situation?**
    - 1.1. How much do you think these personalized suggestions will help your study?
    - 1.2. Do these suggestions or contents help you improve your word memory effect in the short term? Why?
2. **In the process of using the app, what changes do you think have taken place in your knowledge of English words?**
    - 2.1. Can you give an example of how these changes have occurred?
    - 2.2. How will these changes affect your overall English learning?

4.2.3. Research Objective 3

1. **How does your family environment affect your use of the app to learn English words?**
    - 1.1. Do your family members support you to use the app? Explain.
    - 1.2. Does the learning atmosphere of your family have an impact on your use? Explain.
    - 1.3. How does your family environment affect your long-term use of the app?

4.3. Sampling Design

This study interviewed 15 users of the "Baicizhan" app, with different ages and genders. Specifically, there were 10 females and 5 males among the respondents, aged between 18 and 35. They were all active users of the "Baicizhan" app, and the time they had used the app ranged from 3 months to 2 years (**Table 1**).

This study followed a purposive sampling technique to select respondents who met specific criteria: they had to be vocational college students who had been using the "Baicizhan" app for at least six months. The sampling process involved contacting students through university channels, and student associations. Students were invited to participate after confirming that they met the selection criteria [29,30]. To ensure a diverse sample, respondents with varying program backgrounds, and usage experiences of the app were chosen. Invitations to participate were sent, including detailed information on the research purpose, methods, and time commitments, ensuring that participation was voluntary. When individuals declined, additional eligible candidates were recruited to achieve a representative sample aligned with the study's inclusion criteria [31].

4.4. Data Collection

Data collection occurred through video interviews and voice calls conducted via WeChat and the Tencent Meeting platform. These online communication platforms such as

WeChat and the Tencent Meeting allowed respondents to schedule interviews at their convenience, offering them a comfortable and familiar environment in which to share their experiences, thus improving the authenticity and completeness of their responses [32]. All interviews were recorded with respondents' consent, and the audio content was transcribed verbatim to ensure accuracy and preserve the details for later analysis [33,34].

Table 1. Respondent Details.

Respondent ID	Major	Gender	Education Level	Usage Frequency
1	Mechanical Engineering	Male	Undergraduate	Every day
2	Education	Female	Undergraduate	Every day
3	Economics	Male	Undergraduate	Every day
4	Chemistry	Female	Undergraduate	Every day
5	Information Technology	Male	Undergraduate	Every day
6	Accounting	Female	Undergraduate	5 times a week
7	Art Design	Male	Undergraduate	5 times a week
8	Psychology	Female	Undergraduate	5 times a week
9	Law	Male	Undergraduate	5 times a week
10	Medicine	Female	Undergraduate	5 times a week
11	Engliah	Male	Undergraduate	3 times a week
12	Medicine	Female	Undergraduate	3times a week
13	Engliah	Male	Undergraduate	2times a week
14	Engliah	Male	Undergraduate	2times a week
15	Education	Female	Undergraduate	2times a week

4.5. Ethical Considerations and Confidentiality

High integrity and ethical standards were upheld throughout the study procedure. A paragraph in the online questions explained the purpose of the study that assured respondents of the privacy and confidentiality of their data. This data was solely accessible and utilized by the members of this study group; no unauthorized individuals were granted access to it.

4.6. Data Analysis

After the completion of data collection, the interview transcripts were systematically organized for analysis. First, the raw interview data were transcribed and organized into written drafts to ensure completeness [34]. The interview content was then coded using Excel, marking the main themes and key points from each interview [26]. This initial coding step helped identify recurring themes such as the app's impact on vocabulary retention, user engagement and its ability to meet diverse learning needs. A thematic analysis of respondent responses regarding the "Baicizhan" app's role in English vocabulary learning revealed three dominant themes [35]. First, individual differences in learning efficacy emerged, with adaptive algorithms tailoring content to proficiency levels [36] and multimodal inputs accommodating cognitive preferences [37]. Second, motivational dynamics were driven by gamified elements like progress streaks and badges, which reinforced intrinsic motivation through perceived autonomy and competence [38–40]. Third, long-term retention strategies were anchored in spaced repetition systems and dual coding techniques, which systematically reinforced memory encoding [41]. These findings underscore the app's capacity to harmonize personalized learning, motivational engagement, and evidence-based cognitive strategies, positioning it as a versatile tool for diverse learners in technology-enhanced language acquisition [41,42].

5. Results

5.1. Meeting the Individual Needs of Different Learners and Promoting Diverse Learning

The "Baicizhan" App effectively supports diverse learning styles and adapts to individual learner needs through its functional features, including image memory, review reminders, daily check-in, and challenge functions. Many respondents emphasized how these features cater to their unique learning preferences. One respondent shared, *"I remember words better when they are linked to pictures. The image memory function helps me create strong associations, making it easier to recall vocabulary."* Another user highlighted the importance of the review reminder: *"I used to struggle with forgetting words quickly, but now, with the app*

reminding me exactly when to review, I feel my vocabulary is more stable."

In addition to memory-enhancing tools, learners found motivation in the daily check-in feature. A respondent explained, *"I feel a sense of accomplishment when I see my learning streak continue. It pushes me to keep going even on days when I'm not in the mood."* For those who prefer a more interactive experience, the challenge function plays a crucial role. Additionally, a user expressed, *"Competing with other learners makes vocabulary learning fun and exciting. It doesn't feel like studying, but rather like playing a game where I'm improving at the same time."* These responses illustrate that "Baicizhan" provides personalized and engaging learning strategies, ensuring that learners with varying preferences can effectively build their vocabulary.

An interesting finding is that users were encouraged to keep up regular study habits by the app's progress-tracking dashboard. "*I feel proud and want to keep improving when I see my progress chart going up*," one respondent expressed while another commented, *"I can set my own study time according to my routine, which makes it less stressful and more manageable for me to stick with it every day*." To the majority of the respondents, the adaptable learning schedule was cited as a major advantage that motivated and spurred them in their learning.

5.2. Facilitating Long-Term Memory and Vocabulary Storage

Most respondents agreed that *"Baicizhan"* significantly enhances long-term vocabulary retention, particularly through spaced repetition, multiple exposure strategies, and memory reinforcement techniques. One respondent stated, *"Since using the app regularly, I've noticed that words I used to forget quickly now stay in my memory for much longer."* The review reminder function was widely praised, as one respondent explained, *"It reminds me to review at the perfect time, just before I forget, which really helps in making the words stick."* Another respondent mentioned, *"Before using the app, I had trouble retaining new words, but now, with repeated testing and reviews, I feel much more confident."*

The image memory function also played a key role in improving long-term retention. A respondent shared, *"When I associate a word with a picture, it creates a lasting impression. Even after weeks, I can recall the word just by remembering the image."* Additionally, some learners found audio-based reinforcement helpful. One respondent stated, *"Hearing the pronunciation repeatedly and matching it with the word helps me remember it better, especially when I encounter it later in real conversations."* These findings confirm that *"Baicizhan"* effectively strengthens vocabulary retention by incorporating multi-sensory learning strategies and scientifically backed repetition techniques.

Some respondents also emphasized the value of contextual learning, pointing out that it made it easier for them to remember the meaning and usage of new terminology when they saw it in short stories or sample sentences. *"I don't just remember the word when I learn it within a story, I remember the entire scene, and that's what makes it stick,"* one respondent explained. *"Being able to see my improvement over time motivates me to keep reviewing, and it reinforces what I've learned by showing me how far I've come,"* said another respondent, who like many of the respondents, expressed gratitude for the progress tracking function.

5.3. Differences in Learners' Knowledge Construction Using the "Baicizhan" App

The study revealed that different learners construct knowledge differently when using *"Baicizhan"*, depending on their preferred cognitive strategies. Some respondents relied heavily on the image memory function to enhance their recall ability. One respondent noted, *"I'm a visual learner, so when I see an image linked to a word, it helps me process and store the information faster."* Others, however, preferred the review reminder and repeated testing to reinforce their memory through consistent repetition. A respondent explained, *"For me, reviewing words multiple times is the key. If I don't see a word often, I will forget it quickly, so I like that the app brings it back at the right time"*.

Another group of learners found the challenge mode particularly beneficial, as it introduced competition into the learning process. A respondent shared, *"I love the ranking system and competing with others—it makes me feel more driven to improve my vocabulary."* Additionally, some learners combined different strategies to maximize their retention. One respondent mentioned, *"I use image memory for new words, review reminders for reinforcement, and challenges to keep things exciting. This combination works best for me."* These differences reflect how *"Baicizhan"* offers a flexible

learning environment that accommodates varied cognitive styles and learning preferences.

5.4. Influence of Family Environment on Application Usage and Learning Outcomes

The family environment significantly influences learners' engagement with *"Baicizhan"* and their overall success in vocabulary acquisition. Respondents from supportive households reported higher app engagement and stronger learning outcomes. One respondent shared, *"My parents always ask me about the new words I've learned and encourage me to use them in sentences, which helps reinforce my learning."* Another respondent stated, *"In my family, education is highly valued, so they support me in using apps like this and even discuss English words with me."*

Conversely, learners from families with weaker educational support found it challenging to maintain consistent learning habits. One respondent explained, *"No one in my family is particularly interested in English learning, so I don't always feel motivated to study."* Additionally, financial conditions influenced access to *"Baicizhan"* premium features. A respondent mentioned, *"I really wanted to try the advanced lessons, but since they require a paid subscription, I can't access them."*

Moreover, family expectations also affected the way learners used the app. Some respondents reported that their families encouraged a structured study routine, while others had a more relaxed approach. A learner explained, *"My parents expect me to study English in a formal way, like reading textbooks, so they don't fully understand why I use an app instead."* These insights highlight that family support, financial resources, and cultural attitudes toward education shape learners' engagement with mobile-assisted language learning tools like "Baicizhan".

5.5. Learners' Perception of "Baicizhan's Role in Language Application and Communication Skills

Beyond vocabulary memorization, some learners emphasized *"Baicizhan"* role in practical language application and communication skills. One respondent noted, *"The app helps me recognize more words when reading articles or watching movies in English. I can now understand more content without using a dictionary."* Another respondent shared, *"Since using the app, I feel more confident using new words in conversations, even though it doesn't directly teach speaking skills." "Even though the app doesn't directly teach speaking skills, I feel more confident using new words in conversations since using it,"* said another respondent. *"I can recall the words I learned in the app when I write emails or short essays, which makes my writing more varied and precise," remarked another respondent.* Many respondents commented that they could *"apply words"* in real-life contexts because according to them they *"understand how to use them naturally"* thanks to the sample sentences provided in the Baicizhan application.

However, some learners felt that while the app was useful for building vocabulary, it lacked interactive speaking and listening practice. One respondent expressed, *"I wish there were more pronunciation exercises or speaking tasks to help me apply these words in real conversations."* These findings suggest that while *"Baicizhan"* excels in vocabulary retention, its impact on broader language skills could be enhanced by integrating more speaking and listening activities.

6. Discussion

RO1: To explore the role of the "Baicizhan" APP in improving English word memory for different learners

This study demonstrates that the Baicizhan app drives dramatic improvements in English vocabulary learning due to the application's general adaptive alignment with Cognitive Load Theory. Specifically, the wide variety of features utilized in the application contributes to the long-term retention by decreasing the extraneous load and cultivating the indispensable germane processing[6]. It is notable that all respondents have identified the critical role of Baicizhan in their individual progress.

The findings are consistent with the dual coding principle, which suggests that a pairing of verbal with visual information results in more robust than either verbal or visual memory traces. The design of the application reflects this principle since it offers vocabulary items in audio format, in image form, and in their contextual use, which enables more profound encoding. All of these stimuli serve to convert passive vocabulary understanding into active recall, a critical component of long-term learning. Prior research corrobo-

rates that mobile learning applications improve vocabulary recall through repeated and multimodal exposure [15,17,21]. Moreover, the app's personalized algorithm, which matches content with user proficiency, closely imitates the profile-based learning systems examined in the literature on personalized education [15]. While testing algorithms via the app's personalized matching, all learners had gains in vocabulary memory, no matter what their matching levels were prior to Baicizhan and regardless of educational level or cultural background.

Furthermore, spaced repetition, which promotes language consolidation into long-term memory and aligns with dispersed practice notions in cognitive psychology, is incorporated into Baicizhan's learning cycle. By carefully reintroducing words at predetermined intervals, the application ensures that forgetting is minimized and retrieval strength is enhanced. This enhances memory retention and fosters learner autonomy by enabling users to monitor their progress and adjust their learning rate [14,16,17,21]. By bridging the gap between theoretical models of cognition and their practical application, these design features are excellent illustrations of how technology-enhanced language learning can boost productivity and student engagement in the vocabulary acquisition process [5,16,24].

As such, besides the fact that adaptive technology can mitigate the lack of language proficiency, it can assist in attaining Sustainable Development Goal 4 and promote quality equality.

RO2: To explore how the "Baicizhan" APP meets the individual needs of learners and promotes diversified learning

Respondents mentioned that features such as the challenge mode, the daily check-in function, and the possibility to construct a personal word bank allowed them to learn using the skills and reinforce that most appeal to them and match their higher cognitive functions, which is yet another similarity to some principles embedded in Constructivist Learning Theory [17,22,25]. The challenge mode encourages social interaction and competition, which triggers reflective learning and strategic adaptation through peer performance in a manner, which is similar to Vygotsky's idea of the zone of proximal development. The individual word choice in line with personal preferences creates additional constructs granting proficient knowledge acquisition. The discovery of the association between prior knowledge and novelty is a fundamental principle of constructivist teaching and further indicates the application's efficiency in promoting contextualized learning [22,25].

Gamification appeared to be another integral part of Baicizhan's success. The ranking system and various arachnids, as well as the streak-dependent rewards, were found in-game-based vocabulary programs that amplified commitment and engagement [4,9]. Thus, the gamified displacement and reiteration of words increase the number of daily interactions with the application and enhance the emotional component, the foundation of internal and external motivation. Based on Self-Determination Theory, the app enhances motivation through dual pathways. It nurtures autonomy by enabling learners to set their own goals, and it builds competence through scaffolded challenges that incrementally raise task difficulty [26]. Additionally, the use of a learning calendar to control personal learning pace can also be tied to motivation theories that stress the necessity of learner control for the sake of keeping the user engaged [1].

The study's findings also show how well Baicizhan's adaptive structure serves a variety of learners, from novices with little exposure to more experienced users looking to expand their vocabulary [14,18]. Users with different linguistic backgrounds, cognitive styles, and prior knowledge can benefit from meaningful vocabulary gains because of the app's dynamic difficulty level adjustments, diverse content presentation, and algorithmic incorporation of learner feedback [14,16,18,24]. This flexibility confirms the app's potential to improve word memory across diverse learner groups by leveling the playing field for less skilled students and maintaining motivation and challenge for more experienced users [5,8,19].

RO3: To investigate the underlying factors that contribute to student motivation when using the Baicizhan APP

The Baicizhan app's link to long-term vocabulary retention aligns with the spaced repetition theory and dual-coding theory. The high reliance on memory encoding and recall makes such techniques more appropriate for mobile learning [19,21]. Respondents reported improved word retention, attributing their success to timely review notifications and multimodal stimuli that reinforced memory through repeated exposure. Effort, efficiency, and reward are closely tied to

motivated behavior that Baicizhan stimulates with its pattern of repeated learning effort. Teaching theories often explain why students improve their learning practices in incremental ways. The circle of effort, reward, and acknowledgment is how Baicizhan's networking influence works. Therefore, the operationalization of long-term learning goals is suggested by the minimum acknowledged data and the present perspective on the objectives of sustained motivated behavior and long-term learning progress [39].

The findings explain Baicizhan's capacity to maintain student motivation. The app fosters intrinsic motivation by satisfying learners' requirements for autonomy, competence, and relatedness, according to the Self-Determination Theory [26]. According to Cognitive Load Theory, its architecture reduces needless mental strain, focusing attention on learning that is relevant and sustaining interest [19,23]. Contextualized and multimodal information, in line with constructivist principles, empowers students to actively construct and customize their knowledge, increasing relevance and enjoyment [22]. When taken as a whole, these components encourage the motivational factors necessary for long-term learning in addition to aiding vocabulary retention.

This study is unique in both style and content as it offers a rich, theory-driven analysis of the Baicizhan vocabulary app by integrating multiple learning frameworks namely Cognitive Load Theory, Constructivist Learning Theory, and Self-Determination Theory [6,22,26] to explain its effectiveness emphasizing user-centered insights, highlighting how specific app features support long-term retention, motivation, and personalized learning. Moreover, it contextualizes mobile learning within global education equity goals (SDGs 4 and 10), presenting Baicizhan not just as a learning tool, but as a means of promoting inclusive, high-quality education regardless of socio-economic background [43].

7. Conclusion

The study highlights the effectiveness of the "Baicizhan" app in enhancing English vocabulary retention through personalized learning features, spaced repetition, and gamification. The app caters to various learning styles, supporting long-term memory retention and improving learner motivation. It also demonstrates its potential in promoting educational equity by offering accessible resources, regardless of financial background. A study by Kowang et al. [43] found that students' employability is more influenced by the quality of their learning environment and material than by the quality of their learners, suggesting higher education institutions should focus on creating better learning environment. Harnessing the use of Baicizhan app could be in the right direction.

8. Limitations and Future Research

The study on the "Baicizhan" app's effect on English vocabulary memory has limitations due to its qualitative research method, lack of quantitative data support, short study time, and insufficient analysis of individual differences, suggesting future research should expand the sample range and use quantitative methods.

Future research should explore personalized learning technology implementation in diverse learning environments, address user feedback and functionality challenges in the "Baicizhan" app, study factors like family support and economic conditions, integrate AI or VR for enhanced learning, and compare different learning applications for informed educational technology development.

Author Contributions

Conceptualization, M.H., P.V., N.H., S.S. and H.B.; methodology, M.H., P.V., N.H., S.S. and H.B.; analysis, M.H., P.V., N.H., S.S. and H.B.; validation, M.H., P.V., N.H., S.S. and H.B.; formal analysis, investigation, M.H., P.V., N.H., S.S. and H.B.; resources, M.H., P.V., N.H.; data curation, M.H., P.V., N.H.; writing—original draft preparation, M.H., P.V., N.H.; writing—review and editing, M.H., P.V., N.H., S.S. and H.B.; visualization and project administration, M.H., P.V., N.H., S.S. and H.B.; funding acquisition, P.V. All authors have read and agreed to the published version of the manuscript.

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A written informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data is unavailable due to privacy concerns.

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Conflicts of Interest

The authors declare no conflict of interest.

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