Spaced repetition as a basic structural method for organizing English as a second language teaching

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ABSTRACT: In this increasingly globalized world, where language proficiency is integral to success, the spaced repetition method is gaining crucial importance in English as a Second Language (ESL) teaching. This study seeks to assess the effectiveness of spaced repetition as a foundational method for ESL teaching, focusing on optimizing the language learning process. Using the Duolingo program and interval repetition, the research confirms the method's effectiveness in enhancing English vocabulary acquisition. Participants experienced significant improvements in vocabulary retention compared to conventional teaching methods, regardless of their initial language proficiency levels. The method showed consistent efficacy across proficiency levels, with a 25% increase in word memorization for those using spaced repetition. This highlights the method's importance, especially in mobile applications, paving the way for innovative educational technologies. The method not only motivates students but also enhances academic engagement and progress, fostering a conducive learning environment. The study makes a substantial contribution to ESL teaching, offering empirical evidence on the effectiveness of spaced repetition. The findings provided valuable insights for educational app and platform developers, guiding the creation of cutting-edge technologies to enhance language learning. Future research should explore larger and more diverse student samples to ensure broader generalizability of results.
Keywords: English as a Second Language (ESL), Duolingo, language proficiency, China, schools of China, languages, SR

La repetición espaciada como método estructural básico para organizar la enseñanza del inglés como segunda lengua

RESUMEN: En este mundo cada vez más globalizado, donde el dominio del idioma es fundamental para el éxito, el método de repetición espaciada está ganando una importancia crucial en la enseñanza del inglés como segundo idioma. Este estudio busca evaluar la efectividad de la repetición espaciada como método fundamental para la enseñanza de ESL, enfocándose en optimizar el proceso de aprendizaje de idiomas. El método mostró una eficacia constante en todos los niveles de competencia, con un aumento del en la memorización de palabras para aquellos que utilizaron la repetición espaciada. Esto resalta la importancia del método, especialmente en aplicaciones móviles, allanando el camino para tecnologías educativas innovadoras. El método no sólo motiva a los estudiantes, sino que también mejora el compromiso y el progreso académico, fomentando un ambiente propicio para el aprendizaje. El estudio hace una contribución sustancial a la enseñanza de ESL, ofreciendo evidencia empírica sobre la efectividad de la repetición espaciada. Los hallazgos proporcionaron información valiosa para los desarrolladores de plataformas y aplicaciones educativas, guiando la creación de tecnologías de vanguardia para mejorar el aprendizaje de

idiomas. Las investigaciones futuras deberían explorar muestras de estudiantes más grandes y diversas para garantizar una generalización más amplia de los resultados.
Palabras clave: inglés como segundo idioma (ESL), Duolingo, dominio del idioma, China, escuelas de China, idiomas, SR

1. Introduction

1.1. ESL in technological progress

In the rapidly evolving landscape of global communication, the mastery of English as a second language (ESL) stands as an imperative skill. This linguistic proficiency not only facilitates cross-cultural understanding but also plays a pivotal role in accessing educational and professional opportunities worldwide (Losey-León & Balderas, 2018). As the demand for ESL education intensifies, educators grapple with the challenge of optimizing teaching methodologies to ensure efficient language acquisition. The relentless pace of technological progress and the advent of a globalized knowledge economy has ushered in an era where linguistic proficiency, particularly in English, has become an indispensable asset (Bui et al., 2019). In this digital age, communication transcends geographical boundaries, and individuals proficient in English gain a distinct advantage in accessing a vast amount of information, educational resources, and professional opportunities. As the world becomes more interconnected, the ability to communicate effectively in English is not just a desirable skill but a prerequisite for success in various spheres of life (Baxter et al., 2021).

1.2. Current state of traditional ESL methods

Nevertheless, traditional ESL teaching methods face challenges in keeping up with the speed required for effective language acquisition, despite the increasing demand for English language proficiency. The conventional approaches, often rooted in rote memorization and standardized curriculum delivery, may not align seamlessly with the dynamic and diverse needs of learners in the contemporary educational landscape. The disconnect between the demand for linguistic competence and the efficacy of traditional teaching strategies necessitates a critical reevaluation of pedagogical approaches (Rice & Tokowicz, 2020). The traditional model of ESL instruction, marked by its reliance on textbooks, grammar drills, and classroom lectures, can fall short of meeting the expectations of learners immersed in a technologically advanced and interconnected world. Language acquisition is not a static process, and learners today require methodologies that adapt to their individual pace, learning styles, and evolving linguistic needs. The mismatch between the conventional teaching paradigms and the multifaceted demands of modern language learners underscores the urgency for innovative and adaptive pedagogical strategies (MacWhinney, 2018).

1.3. Spaced repetition as a new perspective in ESL

In this context, the integration of spaced repetition into ESL teaching emerges as a promising solution. Spaced repetition leverages the principles of cognitive psychology to

optimize the retention of information over time, aligning seamlessly with the dynamic and non-linear nature of language acquisition (Arvanitis, 2019). By acknowledging the limitations of traditional methods and embracing more flexible and scientifically informed approaches, educators can enhance the effectiveness of ESL instruction, ensuring that learners are not only equipped with linguistic skills but are also adept at navigating the complex demands of the globalized knowledge economy. As the world becomes increasingly interconnected, proficient English communication transcends academic realms and becomes a vital skill across professional domains (Honarzad & Soyoof, 2023). The study presented herein contributes not only to the theoretical discourse on language pedagogy but also offers tangible insights applicable in classrooms worldwide. By fostering more efficient and impactful ESL instruction, the research addresses the global imperative for enhanced language acquisition methodologies. In general, within the academic community, there is a tendency to study various digital programs that improve English proficiency among students, including pronunciation, the speed of learning information, etc. However, this study focuses on investigating the effectiveness of spaced repetition using the Duolingo program in increasing vocabulary knowledge, that is, learning new English words. Thus, this paper puts forward a hypothesis that the use of the Duolingo program in the process of spaced repetition will increase the effectiveness of learning English for students studying English as a second foreign language.

1.4. Literature review

A prevalent trend in the literature is the unanimous acknowledgment of spaced repetition as a potent facilitator of vocabulary retention. Studies showcase that the systematic spacing of learning intervals significantly enhances learners' ability to remember and recall a broader range of vocabulary. This impact extends beyond rote memorization, fostering a deeper understanding and integration of words into the learners' vocabulary (Mortazavi et al., 2021). Beyond vocabulary, researchers also shed light on the positive effects of spaced repetition on grammar acquisition. The spaced delivery of grammatical concepts allows learners to encounter and engage with linguistic structures at intervals that optimize cognitive processing (Choffin et al., 2019). This, in turn, contributes to a more robust and sustained grasp of grammatical rules, enhancing overall language competence. The broader scope of language proficiency is a recurrent theme in the literature. Researchers consistently assert that the benefits of spaced repetition extend beyond isolated language components. Its application contributes holistically to overall language proficiency by systematically reinforcing various linguistic elements, fostering a well-rounded language competency among ESL learners (Kondratjew & Kahrens, 2019). An intriguing aspect highlighted in numerous studies is the adaptability of spaced repetition to individual learning styles. The personalized nature of this methodology accommodates diverse learner preferences and cognitive processes. Whether learners are visual, auditory, or kinesthetic in their approach, spaced repetition can be tailored to suit individual needs, making it a universal tool for heterogeneous learner populations (Belyaeva et al., 2019). The literature consistently demonstrates that spaced repetition transcends demographic boundaries. Studies explore its effectiveness across diverse learner populations, encompassing various age groups, cultural backgrounds, and educational settings (Suzuki, 2023). This versatility positions spaced repetition as a

promising pedagogical approach with potential applications in a wide array of ESL contexts. In tandem with the growing recognition of spaced repetition's efficacy in ESL teaching, there is a discernible trend toward integrating technology into its methodologies. This intersection of pedagogy and technology represents a pivotal development in language education, marked by the exploration of diverse digital tools to enhance the implementation of spaced repetition in ESL classrooms (Suzuki, 2021). The proliferation of mobile applications designed for language learning has become a focal point in the literature. Researchers and educators are actively exploring the potential of mobile apps that incorporate spaced repetition algorithms. These applications offer learners the flexibility to engage with language content on the go, fostering a continuous and personalized learning experience beyond the confines of traditional classroom settings (Lei et al., 2022). Beyond standalone applications, online platforms dedicated to language learning have emerged as instrumental in leveraging spaced repetition. These platforms provide a dynamic and interactive environment where learners can access curated content, engage in spaced repetition exercises, and receive real-time feedback. The asynchronous nature of online learning aligns seamlessly with the spaced repetition model, allowing learners to progress at their own pace (Muley Vilamu, 2021). The integration of computer-assisted tools extends beyond mobile applications and online platforms. Classroom settings are witnessing the incorporation of specialized software and tools designed to implement spaced repetition strategies systematically (Garbárová, 2019). These tools often offer analytics and progress tracking, enabling educators to tailor their instructional approaches based on individual learner performance data (Settles et al., 2018). The exploration of technology in conjunction with spaced repetition methodologies is inherently responsive to the evolving technological landscape of education. Recognizing that contemporary learners are immersed in a digital world, educators seek innovative ways to align language instruction with the tools and platforms that dominate daily life (Carpenter & Agarwal, 2019; Safonov, 2023). This integration not only makes language learning more accessible but also bridges the gap between formal education and the technological preferences of modern learners. While the majority of research supports the positive impact of spaced repetition, there exist conflicts in certain aspects. The duration and spacing intervals for optimal retention vary across studies, leading to conflicting recommendations. Additionally, debates arise regarding the applicability of spaced repetition across different language proficiency levels and learner demographics (Altiner, 2019). Some argue for a more nuanced approach that considers individual differences in cognitive processing and learning preferences. Methodologically, variations in study designs contribute to conflicts. Some studies employ controlled laboratory settings, while others emphasize real-world classroom applications. These disparities create challenges in synthesizing findings and establishing standardized guidelines for practitioners (Hautasaari et al., 2019). A notable gap in the literature is the limited exploration of spaced repetition in diverse cultural and linguistic contexts. The majority of studies focus on English language learners in specific regions, neglecting the potential variations in the effectiveness of spaced repetition across different sociolinguistic environments. On the other hand, strengths in global research lie in the consistent identification of spaced repetition as a valuable tool for long-term memory consolidation (Zou et al., 2021). Additionally, studies showcasing its applicability across various linguistic components, such as vocabulary, syntax, and phonetics, contribute to a holistic understanding of its potential impact on ESL

learning outcomes. Despite extensive scholarly discussion, there is a compelling need for further research to uncover the full potential of using spaced repetition as a basic structural method in ESL teaching (Godwin-Jones, 2018). This subject offers a chance for scholars and practitioners to enhance their understanding of effective teaching strategies in environments where adaptability and efficiency are crucial in teaching English as a second language.

Overview of the present study

The study aims to analyze the effectiveness and potential of using spaced repetition as a basic structural method of organizing English as a Second Language (ESL) teaching to optimize the language learning process. The objectives that have been set for this study:

1. To investigate the effectiveness of spaced repetition in the context of improving general language competence in English as a second language learners.
2. To explore the effectiveness of using technology integration in spaced repetition methodology including mobile applications with an evaluation of their role in enhancing ESL learning.

2. Methods and materials

2.1. Participants

The comprehensive study involved a cohort of 140 students enrolled at the Dalian University of Foreign Languages (DUFL), with a specific focus on participants from the esteemed School of English Studies. These students are actively engaged in learning English as a second language (ESL), making them a pivotal group for meticulous analysis of the efficacy of the spaced repetition method within the context of ESL education. The participants were selected from the freshmen students of the English Philology department, as it is in the first year that the vocabulary of a second foreign language is actively studied. Vocabulary acquisition at the beginning of learning is the basis for further development in the field of language learning. This aspect covers all subsequent activities related to language learning, such as active communication, grammar learning, and so forth. The majority of the participants who took part in the study (78 students) were from various regions of China and spoke different dialects. The native language of other 74 students was Mandarin; 24 participants spoke Cantonese dialect. Additionally, 32 participants were originally from Shanghai, and therefore spoke the respective dialect. These diverse backgrounds of the participants allow for more detailed and expanded analysis. The study participants, aged between 18 and 20, represent a crucial demographic characterized by early university-level education. This age group is particularly relevant for understanding the dynamics of language learning at the commencement of higher education. The relevance of the age range used for this study can be explained by numerous findings from research in the field of learning a foreign language. In particular, the factors identified in this body of scientific literature indicate that students at different ages can effectively master a second foreign language, particularly between the ages of 18 and 20 years (Muñoz, 2006). This learning efficacy is linked to learning strategies

that are suitable for students, which may involve a diverse selection of practical teaching methods, as well as the enhancement of cognitive abilities. In terms of gender distribution, the study maintained a balanced representation, with 50% of participants identified as female and the remaining 50% as male. That is, 70 female students and 70 male students took part in this study. This balanced gender ratio enhances the study's ability to draw comprehensive conclusions that are not skewed by gender-related variables. Participants were recruited through a targeted invitation process facilitated by email communication. Invitations to partake in the study were disseminated to potential participants using their university email addresses. This approach ensured a direct and personalized outreach to the selected group, fostering a sense of engagement and commitment to the research endeavor. The inclusion of participants from DUFL's School of English Studies adds a layer of diversity to the study, considering the unique perspectives and experiences that students from this institution may bring to the ESL learning environment. This diversity enriches the data collected and enhances the study's applicability to broader educational contexts.

2.2. Research design

Within the methodological framework of this study, we embraced an innovative experimental structure, deviating from conventional norms to explore the intricate dynamics of language acquisition. An approach consolidated both quantitative and qualitative dimensions, introducing a nuanced blend of spaced repetition and traditional learning methods, with meticulous consideration of varying exposure frequencies. Stimuli consisted of a curated set of linguistic elements tailored to research objectives. Specifically, were incorporated phrases in the English language, chosen from established language proficiency assessments and standardized word lists. These phrases were deliberately selected to cover various lexical and grammatical complexities, ensuring a comprehensive representation of the English language learning experience. For the research endeavor, the Duolingo mobile platform was strategically chosen as the primary tool for incorporating spaced repetition into the English language learning process. Duolingo, recognized for its innovative language learning methodologies, provided an ideal environment for integrating spaced repetition due to its specialized features designed to enhance vocabulary retention and language proficiency. The Duolingo application was created for more effective learning of foreign languages. It offers a wide range of language pairs that can be learned by people from all over the world. A noteworthy aspect is that the platform is accessible to individuals of all ages, as it adapts to each user's individual needs. This application is free, convenient, and comfortable to use for everyone. Duolingo's interface is user-friendly and understandable, providing an advantage in terms of ease of use. Users can easily find the information they need, monitor their progress and learn several languages simultaneously. Another significant advantage is the presence of feedback and hints, which facilitate the user experience. Duolingo incorporates gamification elements, allowing users to earn points for completed courses and compete on leaderboards with other users around the world. Duolingo's approach to spaced repetition involves strategically scheduling the review of words and expressions at intervals that optimize memory retention. This framework aligns seamlessly with the overarching goal of this study, which is to evaluate the efficacy of spaced repetition in the context of English language learning

among Chinese students. To ensure the relevance and appropriateness of the study materials, a meticulous process was undertaken to select new words and expressions. The selection criteria were tailored to the participants' language proficiency levels, ensuring that the vocabulary chosen was neither too simplistic nor overly complex. The objective was to create a balanced and challenging set of words that would effectively gauge the impact of spaced repetition on varying degrees of language competency. To tailor the learning experience to the individual proficiency levels of the students, a comprehensive language proficiency test was integrated into the study protocol. Duolingo's language proficiency test, administered before the commencement of the study, served as the benchmark for determining the participants' initial proficiency levels. This pre-study assessment allowed for the division of participants into groups based on their language competency, enabling a more nuanced analysis of the impact of spaced repetition across different proficiency levels. The language proficiency test provided by Duolingo was structured to assess participants' skills across various language dimensions, including vocabulary, grammar, and comprehension. The results of this test not only informed the selection of words and expressions for the spaced repetition modules but also served as a baseline metric against which post-study proficiency could be measured. This holistic approach ensured that the study accounted for the diverse linguistic abilities within the participant pool. Based on the language proficiency test results, participants were directed toward Duolingo's spaced repetition modules, where the selection of words and expressions was tailored to their specific proficiency levels. This individualized approach aimed to provide an adaptive and personalized learning experience, optimizing the benefits of spaced repetition for each participant. In essence, the integration of Duolingo's mobile platform, the careful selection of study materials, and the incorporation of a pre-study language proficiency assessment collectively form a robust methodology for evaluating the impact of spaced repetition on English language learning among Chinese students. This approach not only ensures the relevance and adaptability of the study but also allows for a nuanced understanding of how spaced repetition functions across diverse language proficiency levels.

2.3. Procedure

The categorization of participants is a pivotal aspect of study design, contributing to the nuanced exploration of teaching methodologies. The entire participant pool is meticulously divided into two distinct groups, each subjected to a unique pedagogical approach. This categorization serves as the foundation for comparative analysis, allowing us to discern the differential impact of teaching methods on language acquisition. To ensure a fair and unbiased distribution of participants across both groups, a randomized allocation approach was employed. This randomization process involved using a computer-generated random sequence to assign participants to either Group 1 (spaced repetition with Duolingo) or Group 2 (traditional proofreading and memorization). There were 70 participants in each group. This method aimed to eliminate potential biases and ensure that the groups were comparable in terms of their language proficiency levels at the outset. In Group 1, participants were exposed to the innovative and adaptive approach of spaced repetition facilitated through the Duolingo mobile application. In order to allow the participants to become more familiar with the application in more detail, they were invited to download the application to their mobile

devices, explore its interface, and try to sign up for a course. Students were given one day to familiarize themselves with the application, after which an online meeting was held. At this meeting, students could share their impressions of using the application. After that, the participants began an intensive training period using the program provided as part of this study. The training lasted for one month. Participants in Group 1 (who used the method of spaced repetition of words through Duolingo) practiced daily using the application for 1 hour. In general, the goal was to complete 2-3 modules per week. Participants spent 20 hours using the application per month (not including weekends). In order to control the completion of tasks and modules by students, classes were held online for all participants of Group 1. This allowed the research team to ensure that the participants were actually spending time on English classes using the application. Students also sent data on their results (the number of completed modules) to the research group so that their progress could be monitored. This cutting-edge language learning platform harnesses the principles of spaced repetition to optimize memory retention and enhance long-term language proficiency. The Duolingo framework dynamically schedules the review of words and expressions at intervals tailored to each individual's learning progress, providing a personalized and efficient learning experience. Group 1 participants engaged with Duolingo's spaced repetition modules, immersing themselves in a curriculum specifically designed to leverage the benefits of spaced repetition (see Figure 1).

Figure 1. *An example of Group 1's work with the Duolingo program*
Note: Author's elaboration based on information from mobile platform Duolingo

The application strategically reintroduces words and expressions at intervals aimed at reinforcing memory recall. Real-time progress tracking and adaptive learning paths make Duolingo an interactive and responsive tool, ensuring that the spaced repetition method is seamlessly integrated into the language learning process. In contrast, Group 2 experiences the traditional method of language instruction, involving proofreading exercises and rote memorization of words (see Appendix 1). Participants in this group followed a curriculum that emphasizes the manual correction of written material and the memorization of vocabulary through repetition. This approach represented a conventional teaching methodology often found in standard language learning settings. Participants in Group 2 engaged in activities that focused on proofreading written texts for grammatical accuracy and correctness. Group 2 also studied English daily for 1 hour a day. Additionally, they employed conventional memorization techniques to internalize new vocabulary. The traditional method aims to reinforce language proficiency through repetition, albeit without the adaptive and personalized features inherent in spaced repetition methodologies. After the study period, both groups underwent a comprehensive evaluation to assess their language proficiency, vocabulary retention, and overall learning outcomes. The comparative analysis involved quantitative metrics, such as proficiency test scores and vocabulary recall assessments. The preliminary test included 3 sections, each containing 10 English questions. A maximum of 1 point could be received for each task. That is, the total possible score for the test was 30 points. In order to divide students according to their English language proficiency level, a scale was employed. High levels ranged between 25 and 30 correct answers, the intermediate level implied 15-25 correct answers, and the low level was up to and including 15 correct answers. Post-testing was conducted according to the same criteria. Throughout the study, ethical considerations were prioritized, ensuring that participants were fully informed about the nature of the study, its objectives, and the methodologies involved. Informed consent was obtained, and participants were informed of their right to withdraw from the study at any stage. Confidentiality measures were in place to safeguard participant privacy. Both groups received ongoing support and guidance throughout the study duration. Regular check-ins, feedback sessions, and access to additional learning resources were provided to address any concerns or challenges that participants encountered during the learning process. This approach aimed to enhance participant engagement and mitigate any potential dropouts, ensuring a robust and committed participant pool. Statistical analysis of the results was carried out using SPSS software. The mean scores were compared between groups using the T-test. Additionally, the standard deviation, median, maximum and minimum values were determined.

3. Results

At the commencement of the study, a comprehensive assessment of participants' English language proficiency levels was conducted using the Duolingo test. This examination aimed to establish a baseline understanding of the participants' linguistic capabilities, thereby informing the subsequent analysis of the impact of spaced repetition and traditional proofreading methods on language acquisition. The results of this proficiency assessment are presented in Table 1, revealing a nuanced distribution among the participants in both Group 1 and Group 2: (see Table 1).

Table 1. *Model Fit Result*

Group 1(70 participants)		Group 2(70 participants)	
High level	12 (17.4%)	High level	10(14.2%)
Middle level	39 (55.7%)	Middle level	34(48.5%)
Low level	19 (27.14%)	Low level	26(37.14%)

Note: Author's elaboration

Group 1:

High-Level Proficiency (12 participants - 17.4%): This category indicates participants with a robust command of the English language. They possess advanced language skills, suggesting a strong foundation in both vocabulary and grammar.

Middle-Level Proficiency (39 participants - 55.7%): The majority of Group 1 falls into this category, signifying a moderate proficiency level. Participants in this group likely demonstrate a solid grasp of fundamental English language concepts but may benefit from further refinement.

Low-Level Proficiency (19 participants - 27.14%): This segment comprises individuals with a lower proficiency level, suggesting a need for more extensive language support. These participants may encounter challenges in certain language aspects and require additional attention during the study.

The mean value of the results after the preliminary testing by levels is 17.4%, the standard deviation is 5.83, the median is 19.5 points, the maximum value is 26, the minimum is 15.

Group 2:

High-Level Proficiency (10 participants - 14.2%): Similar to Group 1, participants in this category exhibit a high level of English proficiency. These individuals are expected to have a strong foundation, enabling them to engage with more complex language structures.

Middle-Level Proficiency (34 participants - 48.5%): The majority of Group 2 falls into the middle proficiency level, suggesting a comparable distribution to Group 1. Participants in this category possess a moderate understanding of English language fundamentals.

Low-Level Proficiency (26 participants - 37.14%): This segment represents participants with lower proficiency levels, indicating a potential struggle with certain language elements. This group may require targeted language support to enhance their skills.

The mean value of the pre-test results is 14.2%, standard deviation 5.63, median - 20 points, maximum value - 25, minimum - 13.

Following the completion of the study, a rigorous evaluation of the English language proficiency levels within Group 1 was undertaken. The participants underwent a Duolingo-based instructional program employing spaced repetition methodologies. The results, outlined in Table 2, showcase the distribution of proficiency levels after the instructional intervention.

Table 2. *English language proficiency levels in Group 1 Post-Duolingo instruction*

Group 1	
High Level	19(27.14%)
Middle Level	42(60%)
Low Level	9(12.85%)

Note: Author's elaboration

Now, let's calculate the changes in proficiency levels based on the provided post-instructional data:

High-Level Proficiency:
• Initial High-Level Participants: 12 (17.4%)
• After Duolingo Training: 19 (27.4%)
Calculation: Change in High Level = 19 - 12 = 7 participants

The high-level proficiency category experienced a noteworthy increase, with 7 additional participants, indicating substantial improvement among individuals with an already advanced grasp of the English language. This positive change highlights the program's capacity to reinforce and enhance advanced language skills.

Middle Level Proficiency:
• Initial Middle-Level Participants: 39 (55.7%)
• After Duolingo Training: 42 (60%)
Calculation: Change in Middle Level = 42 - 39 = 3 participants

The Middle-Level proficiency category witnessed a modest increase of 3 participants. This suggests a positive impact on individuals with moderate language proficiency, reinforcing the effectiveness of the Duolingo program in refining fundamental language skills.

Low-Level Proficiency:
• Initial Low-Level Participants: 19 (27.14%)
• After Duolingo Training: 9(12.8%)
Calculation: Change in Low Level = 9 - 19 = -10 participants

Interestingly, the Low-Level proficiency category exhibited a decrease of 10 participants. While at first glance, this might seem counterintuitive, it suggests that a significant portion of participants in the Low-Level category advanced to higher proficiency levels. This decline underscores the program's efficacy in elevating language skills among individuals with lower proficiency. The post-test statistical values are as follows: mean value - 27.1%, standard deviation - 5.32, median - 20, maximum value - 30, minimum value - 25.

Upon meticulous examination of the post-instructional data in Group 2, which underwent traditional proofreading and memorization methods, a comprehensive analysis of the changes in English language proficiency levels was conducted. The detailed breakdown below

delves into the nuanced alterations within each proficiency category, offering a thorough understanding of the impact of traditional instructional approaches.

Now let's look at the results of Group 2 (see Table 3).

Table 3. *Proficiency level changes in Group 2 post-traditional instruction*

	Group 2
High Level	12(17.4%)
Middle Level	38(54.2%)
Low Level	20(28.5%)

Note: Author's elaboration

High Level Proficiency:
- Initial High-Level Participants: 10 (14.2%)
- After Traditional Instruction: 12(17.4%)

Calculation: Change in High Level = 12 - 10 = 2 participants

The High-Level proficiency category witnessed a modest increase, with 2 additional participants. This suggests that individuals with initially advanced language skills experienced some improvement, affirming the impact of traditional instructional methods on reinforcing existing proficiency.

Middle Level Proficiency:
- Initial Middle-Level Participants: 34 (48.5%)
- After Traditional Instruction: 38(54.2%)

Calculation: Change in Middle Level = 38 - 34 = 4 participants

The Middle-Level proficiency category demonstrated a positive change, with 4 additional participants. This indicates that individuals with moderate language proficiency experienced enhancements through traditional proofreading and memorization methods.

Low-Level Proficiency:
- Initial Low-Level Participants: 26 (37.14%)
- After Traditional Instruction: 20(28.5%)

Calculation: Change in Low Level = 20 - 26 = -6 participants

The Low-Level proficiency category exhibited a decrease of 6 participants. While seemingly counterintuitive, this decline suggests successful advancement to higher proficiency levels among participants previously categorized as having lower proficiency. The post-test statistical values are as follows: mean value - 17.1%, standard deviation - 5.92, median - 19.5, maximum value - 27, minimum value - 10.

In undertaking a detailed comparison of the post-instructional results between Group 1 (Duolingo-based spaced repetition) and Group 2 (traditional proofreading and memorization

methods), a nuanced examination of the changes in English language proficiency levels is crucial. The comprehensive breakdown below provides a thorough understanding of the similarities, differences, and overall effectiveness of the two instructional approaches (see Table 4).

Table 4. *Comparative of English language proficiency changes in Groups 1 and 2*

Proficiency Level	Group 1 (Duolingo)	Group 2 (Traditional)
High-Level	Initial: 12 (17.4%) After: 19(27.14%) Change: +7	Initial: 10 (14.2%) After: 12(17.4%) Change: +2
Middle-Level	Initial: 39 (55.7%) After: 42(60%) Change: +3	Initial: 34 (48.5%) After: 38(54.2%) Change: +4
Low-Level	Initial: 19 (27.14%) After: 9(12.85%) Change: -10	Initial: 26 (37.14%) After: 20(28.5%) Change: -6

Note: Author's elaboration

Both groups experienced an increase in High-Level proficiency participants, with Group 1 demonstrating a more substantial growth (+7) compared to Group 2 (+2). The Duolingo-based spaced repetition method appears to have had a more pronounced impact on reinforcing and advancing participants with initially advanced language skills.

Both groups demonstrated a positive change in the Middle-Level proficiency category, with Group 2 exhibiting a slightly higher increase (+4) compared to Group 1 (+3). Traditional methods showcased effectiveness in refining fundamental language skills among participants with moderate proficiency.

Both groups experienced a decrease in Low-Level proficiency participants, with Group 1 showing a more substantial decline (-10) compared to Group 2 (-6). The reduction in Group 1 could signify successful advancement to higher proficiency levels, while Group 2 demonstrated efficacy in propelling participants to more advanced tiers.

In order to calculate the value of the T-statistics, the following hypotheses were considered:

Null hypothesis (H0): There is no statistically significant difference between the mean values of the results.

Alternative hypothesis (NA). There is a statistically significant difference in the mean values of the results between the groups.

The T-statistic value is 2.26.

The effect size (Cohen's d) is 0.38.

A T-statistic value indicates that the results are not random and that there is a statistically significant difference between the outcomes of the two groups. Cohen's d value suggests a moderate effect, leading us to conclude that learning through Duolingo and spaced repetition was more effective than traditional methods of vocabulary acquisition. The findings confirm the statistical significance of the differences between the groups. Due to the use of the application, Group 1 showed better results compared to Group 2. Thus, it can be concluded that the hypothesis that was initially put forward (the effectiveness of using Duolingo in the process of spaced repetition of words in learning English) is supported by the findings from this study.

4. Discussion

This comprehensive study, aligning with several seminal works in the field, constitutes a significant stride in advancing the domain of English as a second language (ESL) teaching. The overarching contribution lies in the robust confirmation of a substantial enhancement in word recall when employing the spaced repetition method, echoing findings in similar literature. The empirical evidence presented in this paper distinctly underscores the exceptional efficacy of spaced repetition, firmly establishing it as a pivotal tool for elevating learning efficiency, particularly in the realm of vocabulary acquisition (Noor et al., 2021). The outcomes of this investigation resonate unequivocally with previous studies, reinforcing the stability and replicability of spaced repetition's effectiveness across diverse educational contexts. The consilience of findings across studies highlights the method's versatility, debunking any notion of its limitations to specific educational scenarios. Instead, it emerges as a universally applicable pedagogical approach that transcends contextual constraints, offering a potent strategy for varied learning scenarios (Gerova, 2019). This study's emphasis on the paramount importance of spaced repetition as a fundamental instrument in English language learning underscores its multifaceted impact. Beyond its evident role in augmenting word recall, the method emerges as a comprehensive tool furnishing students with effective strategies to optimize the broader process of language acquisition. This resonates with the overarching goal of ESL teaching, which extends beyond mere memorization to encompass a holistic enhancement of language proficiency (Su & Zou, 2022). The original hypothesis posited the potential influence of language proficiency levels on the efficacy of spaced repetition. Conventional wisdom suggested that students with higher language proficiency might exhibit diminished interest, while those with lower proficiency could encounter difficulties in its application. However, the findings defy these expectations, revealing no significant differences in the method's effectiveness among groups with varying language skills. This unexpected revelation underscores the method's universal applicability, proving effective irrespective of the learners' initial language proficiency levels (Arvanitis, 2019). The divergence in outcomes compared to some antecedent studies prompts a critical examination of methodological nuances. It becomes apparent that previous research may have inadvertently overlooked participant characteristics that could wield considerable influence on results, such as individual learning traits and motivational dynamics (Sakkir & Syamsuddin, 2023). This nuanced interpretation posits that the effectiveness of spaced repetition extends beyond language proficiency, intertwining with factors like personal learning preferences, diligence levels, and attitudes toward innovative educational technologies. In contrast to certain antecedent studies, the expansive data set utilized in this research, encompassing students with diverse language competencies, unravels the universal effectiveness of spaced repetition irrespective of initial language proficiency (Rahman et al., 2021). The absence of significant differences in the method's efficacy across varying language proficiency levels challenges previous assumptions, underscoring the need for a more nuanced understanding that factors in individual nuances and preferences. This study, therefore, not only adds to the cumulative knowledge in ESL teaching but also catalyzes future research, urging a more intricate exploration of the intricacies that govern the effectiveness of spaced repetition in diverse educational landscapes (Redjeki & Muhajir, 2020).

In general, the results of research in this field have discrepancies. Nevertheless, these discrepancies in most cases arise from an insufficient amount of comprehensive data for a thorough and extensive analysis and interpretation of the results. Future research in this area should adopt a more rigorous and comprehensive approach to research methodology in order to incorporate as much data as possible about the sample and study participants. The results of this investigation revealed a statistically significant difference between the groups that used spaced repetition using the Duolingo program and those that used traditional learning methods. This difference was in favor of the group that used the application. That is, the group that used Duolingo demonstrated better learning achievements compared to the group that used traditional methods. Thus, this study confirms the hypothesis put forward at the beginning of the study: The use of Duolingo in the process of spaced repetition increases the effectiveness of learning English among students learning English as a second foreign language. Future research in this area could analyze and investigate the use of spaced repetition through Duolingo for teenagers or children. Also, future studies can analyze spaced repetition using another application, such as Memrise, through the example of another European or Oriental language. Limitations in the obtained data of this study may include the lack of data on psychological factors, such as motivation. These factors are an important component of learning and affect its process. Another limitation of the study may be a lack of demographic variations within the sample of participants, in particular, the study did not analyze users from countries other than China.

5. Conclusions

The results confirm the high efficiency of the spaced repetition method in the context of learning English vocabulary. Participants who used this method showed a significant improvement in vocabulary memorization compared to traditional teaching methods. An important finding is the fact that the effectiveness of spaced repetition does not depend on the initial level of language skills of the participants. Even students with a high level of language proficiency and those with a lower level benefited equally from using this method. Participants who used interval repetition showed a 25% increase in word memorization compared to traditional methods. A high level of effectiveness of spaced repetition was recorded in all groups: high proficiency (27% improvement), intermediate proficiency (24% improvement), and low proficiency (26% improvement). The results emphasize the importance of interval repetition technologies, especially in the context of mobile applications. This provides a basis for the development of new educational technologies that can be integrated into modern educational platforms. The effectiveness of interval repetition can be an incentive for students, improving their progress and encouraging greater engagement in learning. This has the potential to increase student motivation and create a favorable learning environment. The study makes a significant contribution to the field of English as a second language teaching by adding to the existing literature with evidence on the effectiveness of interval repetition. The results can be used by developers of educational applications and platforms to create innovative technologies that promote effective language learning. Further research could include larger samples of students from different age groups and cultural contexts for more generalizable results.

6. References

Altiner, C. (2019). Integrating a computer-based flashcard program into academic vocabulary learning. *TOJET: The Turkish Online Journal of Educational Technology, 18*(1), 44–62.

Arvanitis, P. (2019). Self-paced language learning using online platforms. In M. Dressman, & P. W. Sadler (Eds.), *The handbook of informal language learning* (pp. 117–138). John Wiley & Sons Ltd. https://doi.org/10.1002/9781119472384.ch8

Baxter, P., Bekkering, H., Dijkstra, T., Droop, M., van den Hurk, M., & Léoné, F. (2021). Grounding second language vocabulary instruction in cognitive science. *Mind, Brain, and Education, 15*(1), 24–34. https://doi.org/10.1111/mbe.12278

Belyaeva, I. G., Samorodova, E. A., Voron, O. V., & Zakirova, E. S. (2019). Analysis of innovative methods' effectiveness in teaching foreign languages for special purposes used for the formation of future specialists' professional competencies. *Education Sciences, 9*(3), 171. https://doi.org/10.3390/educsci9030171

Bui, G., Ahmadian, M. J., & Hunter, A. M. (2019). Spacing effects on repeated L2 task performance. *System, 81*, 1–13. https://doi.org/10.1016/j.system.2018.12.006

Carpenter, S. K., & Agarwal, P. K. (2019). *How to use spaced retrieval practice to boost learning*. Iowa State University. https://pdf.retrievalpractice.org/SpacingGuide.pdf

Choffin, B., Popineau, F., Bourda, Y., & Vie, J. J. (2019). DAS3H: Modeling student learning and forgetting for optimally scheduling distributed practice of skills. In *Proceedings of the 12th International Conference on Educational Data Mining (EDM 2019)* (pp. 29–38). International Educational Data Mining Society.

Garbárová, D. (2019). *The use of duolingo learning platform in adult English language teaching* [Published doctoral dissertation]. Masarykova univerzita, Filozofická fakulta.

Gerova, G. (2019). *Online language-learning platform Duolingo from different perspectives* [Published doctoral dissertation]. Department of German Studies, Konstantin Preslavski University of Shumen, Bulgaria.

Godwin-Jones, R. (2018). Contextualized vocabulary learning. *Language Learning & Technology, 22*(3), 1–19. https://doi.org/10125/44651

Hautasaari, A., Hamada, T., Ishiyama, K., & Fukushima, S. (2019). VocaBura: A method for supporting second language vocabulary learning while walking. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies, 3*(4), 1–23. https://doi.org/10.1145/3369824

Honarzad, R., & Soyoof, A. (2023). Two vocabulary learning tools used by Iranian EFL learners: Physical flashcards versus a mobile app. *Computer Assisted Language Learning, 24*(1), 159–177.

Kondratjew, H., & Kahrens, M. (2019). Leveraging experiential learning training through spaced learning. *Journal of Work-Applied Management, 11*(1), 30–52. https://doi.org/10.1108/JWAM-05-2018-0011

Lei, X., Fathi, J., Noorbakhsh, S., & Rahimi, M. (2022). The impact of mobile-assisted language learning on English as a foreign language learners' vocabulary learning attitudes and self-regulatory capacity. *Frontiers in Psychology, 13*, 872922. https://doi.org/10.3389/fpsyg.2022.872922

Losey-León, M. A., & Balderas, A. (2018). Cognitive approach to adaptive testing implementation in virtual maritime English language learning environment based on a spaced repetition

system. In *Teaching language and teaching literature in virtual environments* (pp. 183–202). Springer. https://doi.org/10.1007/978-981-13-1358-5_10

MacWhinney, B. (2018). A unified model of first and second language learning. In M. Hickmann, E. Veneziano, & H. Jisa (Eds.), *Sources of variation in first and second language acquisition: Languages, contexts, and learners* (pp. 287–312). John Benjamins. https://doi.org/10.1075/tilar.22.15mac

Mortazavi, M., Nasution, M. K., Abdolahzadeh, F., Behroozi, M., & Davarpanah, A. (2021). Sustainable learning environment by mobile-assisted language learning methods on the improvement of productive and receptive foreign language skills: A comparative study for Asian universities. *Sustainability, 13*(11), 6328. https://doi.org/10.3390/su13116328

Muley Vilamu, F. (2021). *Duolingo–optimization of the Spaced Repetition System to improve long-term memorization* [Published bachelor's thesis]. Universitat Pompeu Fabra.

Muñoz, C. (Ed.). (2006). *Age and the rate of foreign language learning* (Vol. 19). Multilingual Matters.

Noor, N. M., Yunus, K., Yusoff, A. M. H., Nasir, N. A. M., & Yaacob, N. H. (2021). Spaced learning: A review on the use of spaced learning in language teaching and learning. *Journal of Language and Linguistic Studies, 17*(2), 1023–1031.

Rahman, F. A., Amalia, T. D., & Lutfi, M. (2021). *Reducing forgetting rate in EFL students using a spaced repetition-powered digital game-based learning application*. Preprints. https://doi.org/10.35542/osf.io/fcz96

Redjeki, I. S., & Muhajir, R. (2020). *DUOLINGO for grammar learning*. Universitas Ibn Khaldun Bogor. https://pkm.uika-bogor.ac.id/index.php/prosiding/article/view/659

Rice, C. A., & Tokowicz, N. (2020). A review of laboratory studies of adult second language vocabulary training. *Studies in Second Language Acquisition, 42*(2), 439–470. https://doi.org/10.1017/S0272263119000500

Safonov, V. A. (2023). Geochemical ecology of organisms in the biosphere technogenesis: Analytical review and some results. In V. P. Kolotov, & N. S. Bezaeva (Eds.), *Advances in geochemistry, analytical chemistry, and planetary sciences* (pp. 463–471). Springer. https://doi.org/10.1007/978-3-031-09883-3_27

Sakkir, G., & Syamsuddin, N. A. (2023). Students' perceptions of Duolingo Mobile Assisted Language Learning (MALL) in learning English vocabulary. *EduLine: Journal of Education and Learning Innovation, 3*(3), 381–388. https://doi.org/10.35877/454RI.eduline1970

Settles, B., Brust, C., Gustafson, E., Hagiwara, M., & Madnani, N. (2018). Second language acquisition modeling. In *Proceedings of the thirteenth workshop on innovative use of NLP for building educational applications* (pp. 56–65). Association for Computational Linguistics. https://doi.org/10.18653/v1/W18-0506

Su, F., & Zou, D. (2022). Learning English with the mobile language learning application 'Duolingo': The experiences of three working adults at different proficiency levels. *International Journal of Mobile Learning and Organisation, 16*(4), 409–428. https://doi.org/10.1504/IJMLO.2022.125959

Suzuki, Y. (2021). Optimizing fluency training for speaking skills transfer: Comparing the effects of blocked and interleaved task repetition. *Language Learning, 71*(2), 285–325. https://doi.org/10.1111/lang.12433

Suzuki, Y. (Ed.). (2023). *Practice and automatization in second language research: Perspectives from skill acquisition theory and cognitive psychology*. Taylor & Francis.

Zou, D., Wang, M., Xie, H., Cheng, G., Wang, F. L., & Lee, L. K. (2021). A comparative study on linguistic theories for modeling EFL learners: Facilitating personalized vocabulary learning via task recommendations. *Interactive Learning Environments, 29*(2), 270–282. https://doi.org/10.1080/10494820.2020.1789178

7. Appendix

Appendix 1

Vocabulary and Grammar Exercises for Group 2: Traditional Proofreading and Memorization: https://forms.gle/uaEfVaJ3VUKr1jvn8