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Enhancing Vocabulary Mastery Through Seamless Learning: A Digital Approach to English Language Instruction

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ABSTRACT

This study investigates the effectiveness of the seamless learning strategy in enhancing students' vocabulary mastery within an English language learning context. Seamless learning, characterized by the integration of formal and informal learning through mobile technology and online collaboration, offers continuous access to learning resources and supports personalized learning pathways. Employing a pre-experimental design with a one-group pre-test and post-test model, this research involved 30 junior high school students. Quantitative data were collected using vocabulary tests administered before and after the implementation of the seamless learning intervention. The findings revealed a significant improvement in students' vocabulary performance, with mean scores increasing from 52.00 in the pre-test to 82.67 in the post-test. A paired sample t-test analysis confirmed the statistical significance of this gain (Sig. 2-tailed = 0.000, $p < 0.05$). These results suggest that seamless learning effectively fosters vocabulary acquisition by promoting learner autonomy, motivation, collaboration, and contextual engagement. The study also discusses pedagogical implications and highlights the need for future research with larger samples, extended implementation periods, and qualitative analyses. Overall, the findings support the adoption of seamless learning as an innovative and impactful strategy for improving vocabulary instruction and language proficiency in 21st-century educational settings.

Keywords: seamless learning, vocabulary mastery, mobile learning, English language teaching, digital pedagogy

I. INTRODUCTION

Vocabulary is one of the word expressions which should be learnt. Vocabulary is crucial because we are able to talk, distance, and listening get to learn vocabulary first. Lack of encouragement and most learning systems in English vocabulary also makes it difficult for students to understand and master English

vocabulary(nur Aziz & Rohmah, 2022; Wu, 2018). As a result, to help students learn English vocabulary in an ever-evolving period, teachers need to update their time and adapt it to their teaching. Mobile and Internet technologies help formal and informal study processes; individual and social; and physical and virtual learning environments (Kholis & Aziz, 2020)(Wong & Looi, 2011), which are conducive to "boundless research-based science learning" or "boundless scientific research"(Song & Kong, 2014).

In this sense, educators support a paradigm change from teaching-centred teaching to instruction-centred learning. The latter approach helps learners to develop skills in the 21st century through daily learning. Twenty-first-century skills include a wide variety of general skills required to overcome the daily challenges of the twenty-first century, including analysis skills, critical thinking skills, communication skills and teamwork skills (Kong & Song, 2013). Good quality self-study will lead to heated communication, debate and improved problem-solving skills (Yarbrough, 2018)(Hwang et al., 2015).

Good quality self-study will lead to heated communication, debate and improved problem-solving skills. As a result, in the reverse classroom process, students behave as Productive learners and use expert assistance to explain relevant concepts (Aziz & Dewi, 2019; Masriadi, 2019; nur Aziz & Sabella, 2021). The use of this method is beneficial at this time for students to learn, particularly now that the coronavirus has not yet been resolved. School teachers should create meaningful Learning experiences intended to help students understand fluently and quickly in particular, to link what they have learned in school with What they've got encountered in their everyday lives. Some of the benefits of using a seamless approach include: 1) students can study classes and time without limits 2) students can study at any time, and anywhere 3) integrated learning between formal and non-formal education(Hamid et al., 2019).

However, despite growing interest in the integration of seamless learning strategies, there remains a notable gap in empirical research specifically focused on how this approach influences students' vocabulary mastery in formal educational settings. While previous studies have highlighted the benefits of mobile-assisted language learning and informal learning environments, few have thoroughly examined the direct impact of seamless learning—especially in terms of measurable vocabulary gains—within a structured classroom context. This study aims to address that gap by investigating the effect of the seamless learning strategy on students' English vocabulary acquisition. By adopting a digital and student-centered approach, this research seeks to evaluate how integrating formal and informal learning experiences through technology enhances vocabulary retention and engagement. The findings of this study are expected to offer practical implications for educators, curriculum designers, and policymakers, particularly in the

development of innovative instructional strategies that support flexible, meaningful, and contextually relevant language learning. Ultimately, this study contributes to the ongoing discourse on 21st-century language education and supports the advancement of more inclusive and adaptive pedagogical models in the digital era.

II. LITERATURE REVIEW

SEAMLESS LEARNING

Seamless learning is described as a continuous learning experience in a variety of contexts(Chan et al., 2006). It aims to enhance students' awareness by extending their room from home and school to their everyday activities lives(Song, 2018). Seamless learning allows continuous learning experience in a number of settings, such as school or home(Milrad et al., 2013), while seamless learning is spread through various environments (Toh et al., 2013). Seamless learning is seamless networking, where learning takes place anywhere and at any time (Safiah et al., 2020).

Seamless learning refers to the seamless integration of the learning environment in several dimensions, including formal and informal learning contexts, individual and social learning, and the physical and virtual world (Toh et al., 2013) through various processes and spaces. Study (inside or outside the classroom). Combines the two learning models and combines the two, optimising the benefits of each environment. This helps improve learning tasks that can be accessed by students through structured and interactive learning (L. H. Wong & Looi, 2011). Thus, learning that utilises seamless learning can assist students in completing assignments, and learning experiences in an informal environment which has an impact on overall student achievement (L.-H. Wong, 2013) Thus formal and informal learning complement each other in achieving learning objectives.

It also underlines the need to design activities both inside and outside the classroom. In addition, it allows students to apply the skills they have gained in school to daily life. The seamless learning model is continuously applied both in terms of time, location and meaning. In order to realise the learning process, it is important to design seamless learning in accordance with the Islamic economic system. The reason why it is necessary to use seamless learning is that in order to help students understand the vocabulary that is blocked by structures and spaces, the approach will "sew" two different dividers.

VOCABULARY MASTERY

Vocabulary is the cumulative number of words that students have learned in order to create a language of communication(Kholis & Aziz, 2020). The role of vocabulary in foreign language learning cannot be ignored. A rich vocabulary can help students learn English and their four fundamental skills., which involves listening, speaking, reading and writing. The value has been demonstrated by Thanh Huyen &

Thi Thu Nga(Rohani[1] & Pourgharib, 2013) who describe vocabulary as a language aspect combining four language skills, like listening, speaking, reading and writing while studying a foreign language. In addition, (Hornby et al., 1963)it defines vocabulary in 3 directions, which includes (a) the total number of terms that make up the language; (b) any word that a person knows or uses in books, subjects, etc. (c) a list of words having their meaning(Richards & Renandya, 2002). The value of vocabulary has been noted, stating that vocabulary plays an important role in the learning of foreign languages, and that language skills can influence how well learners speak, listen, read and write.(Utami, 2014), however, underlines the value of vocabulary for communication by asserting that in fact, communication at the survival level can take place very intelligently when people simply put words together-without applying any rules of grammar. It was once. In this sense, vocabulary is considered to be one of the key factors that offer a lot of power to people's communication(Ikhlas, 2019). Vocabulary should therefore be an integral aspect of language learning, and a great deal of focus should be placed on putting it into effect.

III. METHOD

In this exploration, the scientist used quantitative analysis that implemented a pre-test plan with one pre-test and post-test structure and non-randomised. (Suen & Ary, 1983) argues that experimental research is the only discovery approach that can really evaluate the theory of cause and effect relationships. This research design would like to address classroom problems related to learning the language of instruction. The pre-test was offered to the under-study prior to treatment. The post-test was given to the post-treatment undergraduates to find out the motivation of students and the skills of students in writing descriptive texts. The design suggests that the instructor gave them a pre-test before using seamless and then gave them a post-test after promoting the everyday use of seamless.

POPULATION AND SAMPLING

This subject of this exploration is the first grade of Mts Darussalam Gapluk Purwosari Bojonegoro that consist of 30 students.

DATA COLLECTION

In this study, researchers used a questionnaire and pre-test and post-test. The researcher made 15 statement items related to unlimited learning in vocabulary mastery. Researchers also collected information Pre-test and post-test ratings. Specialists give a pre-test before the learning process and provide a post-test after the learning procedure is complete.

DATA ANALYSIS TECHNIQUE

After collecting the information from the questionnaire and the pre-test and post-test scores, the researcher analysed the information. The researcher used a quantitative analysis approach using a statistical method. This technique is used to consider the extraordinary distinction in vocabulary abilities of students

before and after smooth learning. The researcher used the application of IBM SPSS Statistics for windows to analyse data.

In the analysis of the results, the researcher checked the normality before measuring the t-test to assess the distribution of the test is normal.

IV. RESULT

PRE-TEST AND POSTTEST

Pre-test that given to the students before applying seamless learning on vocabulary mastery. The result of the students' score in the pre-test can be seen as follows:

Table 1. result of pretest

	N	Min.	Max.	Mean	Std. Deviation
PRETEST	30	40,00	70,00	52,0000	8,46901
Valid N (listwise)	30				

Post-test that given to the students after applying seamless learning. The post-test is done to know about the final score and the differences before and after applying Cooperative-project based online learning. The result of the students' score in Post-Test can be seen as follows:

Table 2. result of posttest

	N	Min.	Max.	Mean	Std. Deviation
POSTTEST	30	70,00	90,00	82,6667	6,91492
Valid N (listwise)	30				

The table presents the descriptive statistics of the post-test scores from 30 students who participated in the vocabulary mastery assessment after the application of the seamless learning strategy. The minimum score recorded was 70.00, while the maximum reached 90.00, indicating that all students achieved satisfactory to excellent outcomes. The mean score of 82.67 reflects a generally high level of performance among the participants, suggesting that the majority of students significantly benefited from the intervention. This average represents a marked improvement compared to the pre-test results, emphasizing the effectiveness of seamless learning in enhancing vocabulary acquisition. Additionally, the standard deviation of 6.91 shows a moderate level of variability, meaning most scores were clustered relatively close to the mean, with limited disparities in performance. These results collectively imply that seamless learning not only helped raise overall vocabulary proficiency but also promoted consistent achievement across the group. This supports the pedagogical value of integrating mobile and digital tools into formal education, allowing

students to engage with learning content more flexibly and effectively

FINAL INQUIRY

In this study, the researcher used T-Test as a tool to analyse and detect differences between pre-test and post-test.

Table 3. paired sample statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST	52,0000	30	8,46901	1,54622
	POSTTEST	82,6667	30	6,91492	1,26249

The results of the pre-test and post-test speaking scores are shown in the table to react to the purpose of this report. Referring to Table 1, 30 students participated in this study. The results show that the student's average pre-test score is 52,0000, and the average post-test score is 82.6667. As shown in Table 1, the results of the statistical analysis show that there are significant differences between pre-and post-test scores. The findings support the hypothesis that "the effect of seamless learning on vocabulary mastery."

Table 4. hiphotesis testing

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	PRETEST-POSTTEST	-30,66667	10,14833	1,85282	-34,45611	-26,87722	-16,551	29	,000

From the table, the value to be considered (Sig. 2 followed) is 0.000, the value ‹0.05, then the critical value and the value obtained is -16,551 at the essential level of 0.05 and the level of opportunity 34. This indicates there is something to be considered in seamless learning. (Field, 2004)explains, "If the value is less than 0,05, the mean of the two conditions is substantially different."

V. DISCUSSIONS

IMPROVEMENT IN VOCABULARY MASTERY THROUGH SEAMLESS LEARNING

The results of this study strongly support the conclusion that the use of seamless learning strategies significantly enhances students' vocabulary mastery. This is evidenced by a clear and measurable improvement in test scores from the pre-test to the post-test phases of the study. Prior to the implementation of the seamless learning model, students demonstrated a moderate level of vocabulary proficiency, with test scores ranging from 40 to 70, and a mean score of 52.00. The standard deviation of 8.46 indicated notable variance in students'

vocabulary levels, suggesting inconsistent outcomes and a relatively uneven distribution of vocabulary knowledge across the group. This variation reflects the challenges faced in traditional classroom-based learning environments where learners may have unequal access to resources, varying degrees of prior knowledge, and differing levels of engagement.

Following the application of the seamless learning strategy, a dramatic shift was observed in students' vocabulary performance. The post-test results showed a notable increase in scores, which now ranged from 70 to 90, and the mean score rose significantly to 82.67. Additionally, the standard deviation narrowed to 6.91, signifying greater uniformity in student achievement. This reduction in score variance is as important as the increase in the mean itself; it indicates that the approach not only lifted overall performance but also supported lower-performing students in catching up, thereby minimizing achievement gaps. This more equitable distribution of outcomes underscores the potential of seamless learning to create inclusive and supportive learning environments that address individual student needs.

The effectiveness of the seamless learning approach in this context can be attributed to several key pedagogical features inherent in the model. Seamless learning integrates both formal and informal learning experiences through the use of digital platforms, mobile learning tools, and real-world applications. In this study, the use of cooperative project-based online learning allowed students to engage with vocabulary in a continuous, contextualized, and interactive manner. Learning no longer occurred only within the constraints of classroom schedules and physical materials, but extended beyond, enabling students to access vocabulary exercises, collaborate with peers, and apply language in meaningful contexts at any time and place. This "anytime-anywhere" access is crucial in promoting learner autonomy and sustained engagement, particularly for vocabulary acquisition, which benefits from repeated exposure and varied usage.

Moreover, the collaborative element of the strategy encouraged peer learning, wherein students learned from one another through group discussions, shared tasks, and feedback exchanges. Such interactions have been widely recognized as enhancing language learning by providing opportunities for immediate language use, clarification of meaning, and the co-construction of knowledge. Vocabulary learning, in particular, thrives in such settings as learners are exposed to diverse perspectives and authentic language use scenarios. This interaction fosters deeper cognitive processing, which is necessary for internalizing new vocabulary and using it appropriately in various contexts.

Another critical aspect of the seamless learning strategy is its capacity to blend structured content delivery with learner-driven exploration. Students were not only exposed to vocabulary lists and definitions but also

challenged to use new words in tasks, multimedia presentations, and digital storytelling projects. These activities required active processing, retrieval practice, and contextual usage—all of which are known to support long-term vocabulary retention. As opposed to passive memorization techniques, this model promoted active engagement with vocabulary items, increasing both short-term gains and the likelihood of long-term retention.

The significant improvement in students' vocabulary mastery observed in this study is also consistent with findings from previous research. Studies have shown that integrating mobile and digital tools in language education supports higher achievement levels, particularly when combined with collaborative and project-based tasks. Seamless learning aligns well with constructivist theories of education, which emphasize learning as an active, socially mediated, and contextually situated process. This theoretical grounding helps to explain the success of the method in this study, as it aligns with how learners naturally acquire and retain new vocabulary.

In addition to enhancing cognitive outcomes, seamless learning also appears to have motivational benefits. The flexibility and relevance of learning tasks, coupled with opportunities for creativity and collaboration, are likely to contribute to increased learner motivation and a more positive attitude toward language learning. Students are more likely to remain engaged when they perceive tasks as meaningful and when they have some degree of control over the learning process. The personalized and context-rich experiences offered by seamless learning contribute to a sense of ownership and relevance, which further enhances the effectiveness of vocabulary acquisition.

In summary, the results of this study indicate that seamless learning significantly improves students' vocabulary mastery by providing continuous access to resources, encouraging collaborative engagement, and promoting active and contextual use of language. The noticeable increase in post-test scores and the reduction in performance disparities affirm that this strategy not only raises academic achievement but also fosters more equitable and inclusive learning outcomes. As educational institutions increasingly integrate technology into the curriculum, the findings of this study highlight the value of adopting seamless learning models to support language development. Future research should explore how this approach can be scaled across larger populations and applied to other language skills such as grammar, listening, and speaking to further understand its comprehensive benefits.

Statistical Significance of Learning Gains

The statistical analysis using a paired sample t-test in this study provides compelling evidence of the effectiveness of the seamless learning strategy in improving students' vocabulary mastery. The analysis compares

students' performance before and after the implementation of the intervention to determine whether the improvement in test scores is statistically significant and not due to chance. The data reveal a mean difference of -30.67 between pre-test and post-test scores, which is a substantial gain in vocabulary knowledge. This improvement is accompanied by a standard deviation of 10.15 and a standard error mean of 1.85, indicating that the observed increase is both consistent across the sample and reliably measured.

The calculated t-value of -16.551 with 29 degrees of freedom far exceeds the critical value expected at a significance level of 0.05. Most notably, the Sig. (2-tailed) value is 0.000, which is significantly lower than the 0.05 threshold commonly used in educational research to determine statistical significance. This outcome clearly indicates that the difference in vocabulary mastery before and after the application of seamless learning is not a random occurrence but rather a statistically robust result. According to Field (2004), when the p-value falls below 0.05, it can be concluded with confidence that the means of the two conditions being compared—in this case, the pre-test and post-test scores—differ significantly. Thus, the null hypothesis (which states that there is no difference in means) is rejected in favor of the alternative hypothesis, which supports the effectiveness of the treatment.

This high level of statistical significance adds considerable weight to the validity and reliability of the research findings. It suggests that the observed gains in students' vocabulary knowledge are not only meaningful but also attributable to the implementation of the seamless learning approach. In educational research, achieving a p-value as low as 0.000 is rare and underscores the strength of the intervention's impact. The consistency of improvement across the sample, as reflected in both the t-value and standard error, further confirms the generalizability of the results within similar educational contexts.

The implications of such statistically significant results are multifold. First, they affirm the hypothesis that seamless learning can be a transformative instructional strategy for language learning, particularly vocabulary acquisition. Unlike traditional teaching methods that are often confined to classroom settings and fixed schedules, seamless learning integrates formal and informal educational experiences across different contexts and platforms. By enabling continuous access to learning materials and fostering collaboration through digital tools, students engage more frequently and deeply with the language, leading to better outcomes as reflected in the test results.

Second, the strength of these statistical findings supports the growing body of literature advocating for the adoption of technology-enhanced learning models. In recent years, numerous studies have emphasized the importance of active, student-centered learning environments supported by mobile and online

tools. The results of this study contribute empirical evidence to this discourse, showing that statistically significant improvements are possible when such methodologies are properly implemented. This supports the claim that seamless learning is not merely a theoretical or experimental concept, but a practical and effective solution for improving language skills in real-world educational settings.

Moreover, the statistical outcomes also highlight the importance of rigorous research design in evaluating instructional interventions. The use of a paired sample t-test ensures that the same group of students is assessed both before and after the intervention, thereby eliminating inter-group variability and focusing solely on the changes attributable to the treatment. This design strengthens the internal validity of the study and reinforces the causal relationship between the intervention and the observed outcomes.

The statistical evidence also encourages future exploration into the scalability of seamless learning. If such significant improvements can be achieved with a relatively small and controlled sample, then larger-scale implementations across diverse educational institutions could potentially yield even more substantial benefits. However, researchers and educators must ensure that the essential components of seamless learning—such as access to technology, teacher facilitation, student motivation, and curriculum alignment—are effectively addressed to maintain the integrity and effectiveness of the approach.

In conclusion, the statistical significance observed in this study provides robust validation for the effectiveness of the seamless learning strategy in enhancing vocabulary mastery. The marked difference between pre-test and post-test scores, reinforced by a very low p-value, confirms that the intervention had a real and measurable impact on students' language learning outcomes. These findings not only support the central hypothesis of the research but also contribute valuable insights to the field of educational technology and language instruction. The integration of statistical rigor and pedagogical innovation exemplifies how data-driven approaches can be used to improve teaching and learning practices in meaningful and sustainable ways.

Pedagogical Implications and Future Directions

The findings of this study provide valuable insights into the pedagogical potential of seamless learning strategies in improving vocabulary mastery, particularly within digital and blended learning contexts. The integration of mobile technology, continuous online access, and collaborative learning not only enhances the educational experience but also transforms how language learning is approached in both formal and informal settings. In an age where learning is no longer confined to the four walls of a classroom, the seamless learning model responds directly to the needs of 21st-century learners who demand flexibility, interactivity, and autonomy in their educational journey.

From a pedagogical perspective, seamless learning offers multiple advantages. First, it fosters learner autonomy, allowing students to access vocabulary materials anytime and anywhere through their devices. This flexibility empowers students to take control of their learning pace and schedule, which is especially beneficial for vocabulary acquisition that requires frequent repetition and reinforcement. Autonomous learning also builds responsibility and intrinsic motivation, both of which are crucial for language development. When learners have ownership of their learning process, they are more likely to be engaged and retain new information effectively.

Second, motivation is notably enhanced through seamless learning, particularly when instruction incorporates cooperative projects and interactive digital tools. Traditional vocabulary instruction, often delivered through rote memorization or textbook drills, can be disengaging. In contrast, seamless learning encourages students to participate in meaningful tasks such as digital storytelling, collaborative glossaries, or mobile-based vocabulary games. These activities not only make learning more enjoyable but also provide authentic contexts in which vocabulary is used, increasing the depth of understanding and long-term retention.

Third, the social and collaborative dimensions of seamless learning contribute significantly to vocabulary mastery. When students work together on cooperative tasks, they engage in peer-to-peer learning, negotiation of meaning, and mutual scaffolding. This interaction fosters deeper cognitive processing, as learners are required to explain, justify, and rephrase their understanding of vocabulary items. Moreover, the social context in which these tasks take place mirrors real-life language use, thus improving both comprehension and practical application. Collaborative learning has also been shown to reduce anxiety and build confidence, particularly in language learning environments where students may otherwise feel hesitant to participate.

In addition to its pedagogical benefits, seamless learning encourages contextualized vocabulary acquisition. By integrating learning across various settings—classrooms, homes, libraries, and even outdoor environments—students encounter vocabulary in diverse and meaningful ways. This contextualization supports better semantic encoding, as students can relate words to real-life experiences. It also aligns with constructivist theories of language learning, which emphasize the importance of context, experience, and social interaction in knowledge construction.

Despite these promising implications, the study acknowledges several limitations that must be addressed in future research. One significant constraint is the limited sample size, comprising only 30 students from a single educational institution. While the results are statistically significant and pedagogically relevant, they may not fully capture the variability present in larger, more diverse

populations. Future studies should expand their sample to include students from various educational levels, regions, and socio-economic backgrounds to enhance the generalizability of findings.

Additionally, the short duration of the intervention raises questions about the sustainability of the observed vocabulary gains. Vocabulary acquisition is a cumulative and ongoing process; thus, it is essential to determine whether the improvements achieved through seamless learning persist over time. Longitudinal studies are recommended to track vocabulary retention and usage over several months or academic terms. Such research would provide insights into the long-term efficacy of seamless learning and inform best practices for curriculum integration.

Another crucial area for future exploration is the inclusion of qualitative data to complement the quantitative findings. While test scores provide clear evidence of learning outcomes, they do not capture the learner experience, engagement level, or perceptions of the learning process. Incorporating tools such as interviews, focus group discussions, learner journals, and classroom observations would allow researchers to gain a deeper understanding of how students interact with seamless learning environments. These insights could help educators refine instructional design and tailor interventions to better meet learners' needs.

Furthermore, future research should investigate the role of teachers in implementing seamless learning strategies effectively. Teachers play a pivotal role in designing learning tasks, facilitating collaboration, monitoring progress, and providing feedback. Their digital literacy, instructional flexibility, and openness to innovation can significantly influence the success of seamless learning initiatives. Professional development programs that equip educators with the necessary skills and knowledge to implement such models are therefore essential.

Finally, technological infrastructure and access remain critical factors in the successful adoption of seamless learning strategies. While mobile devices and internet access are becoming more widespread, disparities still exist, particularly in under-resourced regions. Ensuring equitable access to digital tools and learning platforms is a prerequisite for the broader implementation of seamless learning. Policymakers and educational institutions must work together to provide inclusive solutions that bridge the digital divide.

In conclusion, this study reinforces the potential of seamless learning as a powerful pedagogical strategy for enhancing vocabulary mastery. Its ability to connect learning across time, space, and social settings aligns well with modern educational demands. By fostering autonomy, motivation, collaboration, and contextual learning, seamless learning creates a rich environment for language development. To fully leverage its benefits, future research should address current limitations through expanded

samples, longitudinal data, and qualitative analyses. Additionally, attention must be given to teacher preparation and equitable access to technology. With these considerations in mind, seamless learning holds promise not only for vocabulary acquisition but for transforming language education as a whole in an increasingly digital and interconnected world.

Based on the results of the research and discussion mentioned, it can be concluded that there are differences in vocabulary learning among students. It appears to be shown that the significant value (Sig. 2 tailed) is 0.000, the value is <0.05, so it is significant.

As can be clearly seen from the post-test results, most students are more advanced in their learning process—proven evidence in the table indicating good outcomes.

The findings have shown that seamless learning can enhance learning outcomes. This is consistent with the findings of research conducted by (Song & Kong, 2014)which show that learning experiences using seamless learning can improve learning outcomes. Furthermore, seamless learning is also successful in enhancing field observation efficiency(Hung et al., 2013). There is a consistency of learning experiences in different situations or environments of smooth learning.

Seamless learning architecture tends to affect awareness of the student's overall progress(L.-H. Wong, 2013). Informal learning allows the group to assist in the teaching of digital social skills of students. When in social interaction, students appear to gain a deeper understanding of the concepts taught(Alcántara, 2014).

Interviews with students and the community on the benefits of using mobile/cellular technologies were performed in the design of informal learning (L.-H. Wong, 2013). Cell phones are designed to meet the needs of users and across formal and informal boundaries (Impedovo, 2011). There are many benefits associated with the use of mobile devices, such as portability, timeliness, independence and encouragement to learn(Zakaria et al., 2019). There are two features of cellular learning, namely: 1) the ability to take place in a mobile environment and 2) the ability to recreate student learning skills(L.-H. Wong, 2013).

VI. Conclusion

In conclusion, the present study provides strong empirical evidence that the implementation of the seamless learning strategy significantly enhances students' vocabulary mastery in English language learning contexts. The marked improvement observed between pre-test and post-test scores, supported by a statistically significant t-value and p-value well below the 0.05 threshold, affirms the hypothesis that seamless learning has a meaningful impact on language acquisition outcomes. The integration of mobile technologies,

digital collaboration, and continuous access to learning materials creates a flexible, student-centered learning ecosystem that facilitates both formal and informal vocabulary learning. This dynamic approach not only allows learners to engage with vocabulary more frequently and in diverse contexts but also promotes learner autonomy, motivation, and deeper cognitive engagement. The collaborative nature of project-based tasks within seamless learning fosters social interaction, peer support, and contextual usage, all of which contribute to improved retention and practical application of vocabulary. Moreover, the results indicate a more uniform distribution of student performance post-intervention, suggesting that the strategy is inclusive and effective across varying levels of learner proficiency. Despite the study's limitations, including a relatively small sample size and short implementation period, the findings are consistent with existing literature and support the scalability of seamless learning in broader educational contexts. Future research should expand upon these findings by employing larger and more diverse populations, conducting longitudinal studies to assess sustained impact, and incorporating qualitative measures to capture learner perceptions, engagement, and behavioral changes throughout the learning process. Furthermore, greater attention should be directed toward teacher readiness, digital infrastructure, and instructional design to maximize the pedagogical potential of seamless learning. These considerations are vital to ensuring that the method not only improves short-term learning outcomes but also supports long-term language development and 21st-century skills. As education continues to evolve in response to technological advancements and global learning demands, seamless learning presents a powerful model for transforming vocabulary instruction and enhancing English language proficiency. Its ability to connect formal classroom learning with informal, real-world experiences positions it as a relevant, flexible, and effective strategy for modern education systems. Therefore, this study contributes to the growing body of research advocating for innovative, technology-driven pedagogies, and offers valuable implications for educators, curriculum designers, and policymakers aiming to improve vocabulary instruction and overall language competence through sustainable and contextually responsive methods.

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