

Efficacy of Digital Tools for Students' Vocabulary Expansion

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Date received: May 1, 2025

Date revised: May 27, 2025

Date accepted: June 26, 2025

Originality: 95%

Grammarly Score: 99%

Similarity: 5%

Recommended citation:

Bocanegra, A., Sedillo, M.E., & Futralan, M.C. (2025). Efficacy of digital tools for students' vocabulary expansion. *Journal of Interdisciplinary Perspectives*, 3(7), 636-644. <https://doi.org/10.69569/jip.2025.346>

Abstract. This study aimed to determine the effectiveness of selected digital tools— such as Merriam-Webster's Word of the Day, Oxford English Dictionary (OED) App, Google Translate, Power Thesaurus, WordReference.com, and Wordnik— in enhancing students' vocabulary acquisition. A quasi-experimental research design with a comparative approach was employed. The respondents were the 120 students from NARRA National High School under the Division of Bayawan City. Each participant was randomly assigned to either of the two groups, and each was exposed to different digital vocabulary tools. A pre-test and post-test were administered to measure changes in vocabulary skills using a validated assessment tool to evaluate proficiency before and after the intervention. Statistical analyses included a paired sample t-test to compare pre-test and post-test scores within groups and an independent samples t-test to assess differences between the two groups. The study revealed a significant improvement in vocabulary skills after exposure to digital tools. However, results also indicated that in most areas, there was no significant difference between the post-vocabulary skills of the two groups. The mean post-test scores for both groups reached the "advanced" category (90% to 94%), confirming the overall effectiveness of digital interventions. Schools and educators are therefore encouraged to integrate these tools into traditional learning methods to optimize student engagement and support vocabulary development.

Keywords: Context-based learning; Digital tools; Educational technology; Language learning; Vocabulary expansion; Vocabulary retention.

1.0 Introduction

Vocabulary is a critical component of language learning that influences all the essential language skills, including speaking, listening, reading, and writing (Morales, 2024). However, many students struggle to acquire and retain vocabulary effectively due to outdated and disengaging instructional methods. An advanced vocabulary allows individuals to communicate effectively and comprehend information in daily life. In today's globalized world, understanding and using a wide range of words is essential for academic success, career advancement, and social interaction. Numerous studies show that vocabulary acquisition is foundational to language proficiency and remains a primary focus in language education (Tabassum & Naveed, 2024). As digital tools become increasingly integrated into education, the potential to revolutionize vocabulary instruction has expanded, offering new ways for learners to engage with and retain vocabulary (Babazade, 2024).

In the Philippines, the use of technology in education is on the rise, with over 70% of the schools incorporating digital tools and online platforms to aid learning (DepEd, 2022). However, these resources are not equally available, particularly in rural areas with limited technological infrastructure (Hardiek, 2024). Hence, despite the growing adoption of digital tools, many educational institutions continue to rely on traditional methods for

vocabulary instruction, such as memorization of word lists, which presents challenges for students who often struggle to engage in vocabulary learning meaningfully (Ergashev, 2024). These challenges emphasized the importance of exploring how technology can be leveraged to enhance vocabulary acquisition, particularly in settings where traditional methods may not be as effective (Hardiek, 2024).

While considerable research has been conducted on the traditional approaches to vocabulary teaching, the researcher sees a gap in the impact of digital tools on vocabulary learning, which, being a language teacher, she finds very necessary. Studies by Rasinski and Rupley (2019) and Ayong and Dimaano (2024) focused primarily on direct instruction and reading comprehension without addressing the potential role of technology in vocabulary acquisition. Similarly, although Tabassum and Naveed (2024) highlighted the significance of vocabulary, their work did not explore how digital platforms could enhance the learning process. This study aims to fill this gap by examining how digital tools can improve vocabulary learning and address the limitations of traditional methods in language education.

This study examined the effectiveness of digital tools in vocabulary instruction, focusing on student engagement. It explored technology integration in learning to enhance teaching practices and create a dynamic and inclusive education. This is aligned with SDG 4: Quality Education, notably Target 4.4.1, which emphasizes the proportion of youth and adults with information and communications technology (ICT) skills. The findings aim to provide practical recommendations for improving vocabulary instruction, especially where traditional methods fall short, to help schools develop more effective strategies for student learning.

2.0 Methodology

2.1 Research Design

This study employed a quasi-experimental design, specifically a comparative experimental design, to examine the effectiveness and efficacy of digital tools for vocabulary expansion among Grade 9 and Grade 10 students at NARRA National High School, Bayawan City, Negros Oriental. The design is characterized by randomly assigning students into two distinct groups, ensuring that each group experiences different digital tools for vocabulary enhancement. These groups were exposed to various treatments under five key areas: encountering new words, acquiring word meaning, consolidating word forms, and using the words in practice.

The study began by assessing the students' vocabulary skills before using digital tools. This was identified based on their performance in the previous quarter. After completing the first step, the students used the selected digital tools that were easily accessible, user-friendly, and free of charge. There was also no need for email registration. The tools were categorized under specific stages: (1) encountering new words through Merriam-Webster's Word of the Day and Oxford English Dictionary (OED) App, (2) acquiring the word through Wordnik and Power Thesaurus, (3) understanding word meanings through Google Translate and WordReference.com, (4) consolidating vocabulary knowledge through Dictionary.com and Collins Online Dictionary (collinsdictionary.com), and (5) utilizing the vocabulary through WordHippo (wordhippo.com) and YourDictionary (yourdictionary.com)

The comparative design allowed for a detailed analysis of the changes in vocabulary skills before and after applying the digital tools and the effectiveness of each specific tool in enhancing vocabulary. This design is particularly suitable for determining whether there is an improvement in the students' vocabulary skills and which specific digital tools are more effective for the different stages of vocabulary acquisition. The study also included a control group to account for the impact of the other variables, which ensured that any observed effects could be attributed to the digital tools rather than other factors.

Furthermore, the study examined whether or not there are significant differences between the students' pre-vocabulary and post-vocabulary skills, which addressed the first two research questions. The third and fourth research questions were analyzed by comparing the vocabulary skill improvements across the different treatment groups, which allowed for an evaluation of the relative efficacy of each digital tool for vocabulary enhancement. This approach provided a well-developed framework for assessing the specific impact of digital tools on student vocabulary acquisition and retention, as well as practical usage of the words learned.

By utilizing a quasi-experimental design with randomized assignments and comparing pre- and post-test results, this study ensures reliable results that will contribute to understanding the role of digital tools in vocabulary expansion and academic performance improvement among students.

2.2 Research Locale

This study was conducted at NARRA National High School, located in an urban area of Bayawan City, Negros Oriental. The school is supervised by the Department of Education—Bayawan City Division and has access to modern educational infrastructure. The school has reliable internet connectivity, Wi-Fi access, and a computer laboratory supporting digital learning initiatives. Its urban location allows for better access to technological resources than rural schools in the division, making it a suitable site for implementing digital tools in education. Moreover, the research environment in the Bayawan City Division encompasses schools with varying levels of access to technological and instructional resources. These differences create a dynamic context for assessing the impact of digital tools on vocabulary development. Urban schools likely offer more opportunities for effectively integrating these tools, while rural schools may face challenges. This diversity allows a comprehensive understanding of how digital tools influence vocabulary acquisition across educational settings.

2.3 Research Participants

This study's research respondents are Grade 9 and Grade 10 students at NARRA National High School, Bayawan City Division. One hundred twenty students participated, 58 in Group 1 and 62 in Group 2. Inclusion criteria for participant selection included the following: students must (1) be currently enrolled in the English subject during the intervention period; (2) have regular attendance (at least 80%) based on school records; and (3) have access to a digital device (smartphone, tablet, or desktop) either at school or at home. These criteria ensured that all participants could meaningfully engage with the assigned digital tools and complete the assessments.

2.4 Research Instrument

This study utilized two primary research instruments: a validated vocabulary test and digital tools for vocabulary enhancement. The vocabulary test was the main instrument for assessing students' vocabulary skills before and after the intervention. It measured key domains such as word recognition, comprehension, and usage, providing a reliable basis for evaluating students' progress. The test underwent expert validation by three language education specialists and was pilot-tested with 30 non-participant students to ensure clarity and relevance. Its internal consistency reliability was calculated using Cronbach's alpha, yielding a value of 0.87, which indicates high reliability. This ensured that the test consistently measured vocabulary proficiency across the various stages of learning.

To assess improvement, the test was administered as both a pre-test and a post-test, enabling a comparative analysis of vocabulary growth over the intervention period. Various digital applications were integrated into instruction to enhance vocabulary acquisition. These applications provided structured and interactive learning experiences that allowed students to encounter new words, understand their meanings, and apply them in context. The selected tools—including Merriam-Webster's Word of the Day, Oxford English Dictionary (OED), Wordnik, Power Thesaurus, Google Translate, WordReference.com, Dictionary.com, Collins Online Dictionary, WordHippo, and YourDictionary—were chosen based on their accessibility, usability, and capacity to support vocabulary development across different learning stages. The study systematically measured the impact of technology-enhanced instruction by combining a validated, reliable assessment instrument with interactive digital learning tools. The results gathered from the pre-test and post-test scores provided quantifiable evidence of the effectiveness of digital interventions in improving students' vocabulary proficiency.

2.5 Data Gathering Procedure

Following the design hearing, the researcher incorporated all corrections and feedback provided by the panel members. A letter of request to conduct the study was then submitted to the Dean of Foundation University Graduate School for endorsement to the Schools Division Superintendent of the Division of Bayawan City. The approved endorsement was presented to the District Office of Bayawan City District 5. Upon securing consent, the letter was forwarded to the school head of NARRA National High School and the respective students' advisers. During the distribution of the questionnaires, the researcher explained the purpose and significance of the study to the student respondents. They were informed that their participation was voluntary and that all responses would remain confidential. The selected digital tools used in the study were chosen to be free, easily accessible,

and student-friendly. They also do not require sign-ups or the use of an email address. The questionnaires were retrieved immediately after completion. The collected data were then tallied using MS Excel and processed, evaluated, and interpreted.

2.6 Ethical Considerations

Research ethics were primarily observed and maintained throughout the study. Ethical approval was obtained from the Ethics Committee of the Foundation University Research Office, and ethical clearance was secured from the Department of Education (DepEd) Division Office. Consent was obtained from the school head following the endorsement of the Schools Division Superintendent (SDS) of the Bayawan City Division and the Public Schools District Supervisor of District 5. Informed consent forms were distributed to the participants and their guardians to ensure they understood the nature and scope of the study. It was explained to them that their participation was voluntary, and they were also informed of their right to withdraw at any time without any consequence. All collected data were kept strictly confidential and used solely for academic purposes. Moreover, the participants' rights to self-determination, confidentiality, and anonymity, as well as the benefits and risks of the study, were communicated.

3.0 Results and Discussion

Table 1 illustrates students' vocabulary skills before utilizing various digital tools for vocabulary expansion. The results show that before employing different digital tools for vocabulary expansion, the students in both Group A and Group B exhibited various levels of vocabulary skills. Group A, which consists of 60 students, has an average score ($\bar{x}$) of 64.70 for encountering new words, which indicates that their vocabulary skill in this area is categorized as "Did Not Meet Expectations" (DNME). Group B, on the other hand, has an average of 65.64 in this category, which is slightly higher than that of the other group but still falls under the same rating of DNME. Both groups exhibit a similar trend across all other areas of vocabulary expansion, with Group A having an average of 66.33 for retrieving words, 68.33 for understanding word meanings, 66.31 for consolidating word forms, and 66.83 for using words. Group B students have averages of 64.83, 72.11, 70.39, and 64.92, respectively, and fall within the DNME category.

Areas of Vocabulary Expansion		n	$\bar{x}$	VD	SD
For encountering new words					
Group A		60	64.70	DNME	5.65
Group B		60	65.64	DNME	4.76
For getting the word from					
Group A		60	66.33	DNME	5.65
Group B		60	64.83	DNME	4.22
For getting the word meaning					
Group A		60	68.33	DNME	8.38
Group B		60	72.11	DNME	8.49
For consolidating word form and meaning from memory					
Group A		60	66.31	DNME	9.18
Group B		60	70.39	DNME	7.95
For using the word					
Group A		60	66.83	DNME	6.74
Group B		60	64.92	DNME	6.11
Note:					
Rating		Verbal Description (VD)			
95% - 100%		Outstanding (O)			
90% - 94%		Advanced (A)			
85% - 89%		Very Satisfactory (VS)			
80% - 84%		Satisfactory (S)			
75% - 79%		Fairly Satisfactory (FS)			
74% and below		Did Not Meet Expectations (DNME)			

The results indicate that students generally struggled with vocabulary skills before implementing digital tools for vocabulary development. The prerequisite and fundamental knowledge in vocabulary had not been acquired or developed adequately to aid understanding (DepEd Order No. 8, s. 2015), particularly in recognizing and applying new words effectively.

The struggles noted before integrating digital tools suggest that traditional methods might fall short in helping students acquire and use vocabulary effectively. This aligns with the findings of Bayabel and Tahir (2024), who explored the effects of different vocabulary learning strategies on students' vocabulary development and motivation. Students who relied solely on traditional methods, such as rote memorization and dictionary use, exhibited lower vocabulary retention, difficulty using words in context, and reduced motivation. Similarly, Phung (2021) investigated the students' vocabulary acquisition and found that their limited vocabulary knowledge was mainly due to their dependence on traditional strategies like memorization and repetitive drills, highlighting the limitations of traditional approaches in supporting effective vocabulary growth.

Table 2 presents students' vocabulary skills after employing digital tools, which reveal improvement across all areas. Both Group A and Group B achieved an Advanced level in most categories. Specifically, for encountering new words, students who used Merriam-Webster's Word of the Day (Group A) and the Oxford English Dictionary (OED) App (Group B) achieved mean ratings of 93.31 and 93.28, respectively. Similarly, in getting the word form from context, Group A (Wordnik) scored 93.11, while Group B (Power Thesaurus) scored 95.06. The effectiveness of Google Translate (Group A) and WordReference.com (Group B) in helping students get word meanings is evident in their mean scores of 94.45 and 94.14, respectively. Moreover, Group A (Dictionary.com) scored 93.70 and Group B (Collins Online Dictionary) scored 94.28 in consolidating word form and meaning from memory. Finally, Group A (WordHippo) achieved a mean of 93.61 in using the word. In contrast, Group B (YourDictionary) achieved 94.50, demonstrating the effectiveness of these digital tools in enhancing the students' ability to apply vocabulary in context.

Table 2. *Vocabulary Skills of the Students after Employing the Different Digital Tools for Vocabulary Expansion*

Areas of Vocabulary Expansion	n	$\bar{x}$	VD	SD
For encountering new words				
Group A (Merriam-Webster's Word of the Day)	60	93.31	A	3.93
Group B (Oxford English Dictionary (OED) App)	60	93.28	A	4.72
For getting the word form				
Group A (Wordnik)	60	93.11	A	3.91
Group B (Power Thesaurus)	60	95.06	O	3.78
For getting the word meaning				
Group A (Google Translate)	60	94.45	A	5.59
Group B (WordReference.com)	60	94.14	A	4.42
For consolidating word form and meaning from memory				
Group A (Dictionary.com)	60	93.70	A	3.14
Group B (Collins Online Dictionary)	60	94.28	A	4.93
For using the word				
Group A (WordHippo)	60	93.61	A	4.41
Group B (YourDictionary)	60	94.50	O	3.46
Note:				
Rating	Verbal Description (VD)			
95% - 100%	Outstanding (O)			
90% - 94%	Advanced (A)			
85% - 89%	Very Satisfactory (VS)			
80% - 84%	Satisfactory (S)			
75% - 79%	Fairly Satisfactory (FS)			
74% and below	Did Not Meet Expectations (DNME)			

The students' performances exceeded the Advanced proficiency level or vocabulary performance requirement based on DepEd criteria (DepEd Order No. 8, s. 2015), with a numerical equivalent of 90% to 94%. Students at this level performed well in vocabulary exams with mostly accurate responses. This indicates a strong understanding of word meanings, usage, and relationships, with only minor errors.

Research shows that digital tools significantly enhance vocabulary acquisition by increasing student motivation and engagement. Hashemi (2021) found that using interactive applications, visual aids, and multimedia resources in vocabulary instruction led to better vocabulary retention and understanding, creating a more engaging and student-centered learning environment. Rafiq et al. (2024) emphasized the positive effects of digital tools and online learning platforms—such as apps, quizzes, and multimedia content—on students' vocabulary

development. Their findings revealed that these tools boosted motivation and participation and offered a more personalized and flexible learning experience, enhancing vocabulary performance.

Table 3 reveals a significant improvement in the vocabulary skills of Group A students after the intervention. The post-test mean scores in all areas – encountering new words, getting the word from context, understanding word meaning, consolidating word form and meaning from memory, and using the word – are considerably higher than their pre-test mean scores. The p-values for all topics are less than 0.001, which leads to rejecting the null hypothesis (Ho1) and confirms that the improvement is statistically significant. Moreover, the effect sizes, ranging from 2.840 to 4.968, indicate a considerable effect, which signifies the intervention's substantial impact. Notably, the highest effect size (4.968) was observed in encountering new words through Merriam-Webster's Word of the Day. This indicates that this strategy substantially impacted the students' ability to recognize and engage with new words. These findings suggest that the vocabulary-building strategies implemented in Group A resulted in a strong and meaningful enhancement of the students' vocabulary skills.

Table 3. *Difference between the Pre-Vocabulary and Post-Vocabulary Skills of the Students in Group A (n = 60)*

Areas	$\bar{x}$	t	p	Decision	Remark	Effect Size
For Encountering New Words (Merriam-Webster's Word of the Day)						
Pretest	64.70	28.61	<.001	Reject Ho1	Significant	4.968
Posttest	93.31					
For getting the word from (Wordnik)						
Pretest	66.33	26.78	<.001	Reject Ho1	Significant	3.988
Posttest	93.11					
For getting the word meaning (Google Translate)						
Pretest	68.33	26.42	<.001	Reject Ho1	Significant	2.840
Posttest	94.45					
For consolidating word form and meaning from memory (Dictionary.com)						
Pretest	66.31	27.39	<.001	Reject Ho1	Significant	3.091
Posttest	63.70					
For using the word (Dictionary.com)						
Pretest	66.83	26.78	<.001	Reject Ho1	Significant	3.816
Posttest	93.61					
Classification	Cohen's d Effect Size;		t-test for dependent data at 0.05 level of significance			
Ignored	0.00 < d ≤ 0.19					
Small Effect	0.19 < d ≤ 0.49					
Medium Effect	0.49 < d ≤ 0.79					
Large Effect	0.79 < d ≤ 1.29					
Very Large Effect	d > 1.29					

The results in Table 3 demonstrate that Group A significantly improved their vocabulary skills after utilizing various digital tools. This finding is supported by Ayeni et al. (2024), who emphasized the role of personalized learning in digital environments. They noted that tools like Merriam-Webster and OED enabled learners to engage with vocabulary at their own pace and based on their needs, reinforcing vocabulary knowledge over time. Similarly, Babazade (2024) found that students who used gamified digital tools exhibited significantly better vocabulary retention than those who used traditional methods. Learners described these tools as engaging and motivating, contributing to improved performance. Although challenges such as distractions and limited access were acknowledged, the overall results confirm the effectiveness of digital tools in enhancing vocabulary acquisition.

Table 4 reveals that Group B students' pre-test and post-test mean scores show marked increases in all areas, with p-values below 0.001. These figures confirm the statistical significance of the results. The effect sizes for Group B range from 2.683 to 6.126, which indicates a significant impact of the vocabulary intervention. The highest effect size (6.126) is observed in deriving the word from context using Power Thesaurus, and this suggests that this strategy is particularly effective in helping students recognize and understand words. The findings imply that using various vocabulary-building tools effectively enables students to improve their vocabulary skills.

Table 4. *Difference between the Pre-Vocabulary and Post-Vocabulary Skills of the Students in Group B*

Areas	$\bar{x}$	t	p	Decision	Remark	Effect Size
For Encountering New Words (Oxford English Dictionary (OED) App)						
Pretest	65.64	34.44	<.001	Reject Ho1	Significant	4.447
Posttest	93.28					
For getting the word from (Power Thesaurus)						
Pretest	64.83	47.45	<.001	Reject Ho1	Significant	6.126
Posttest	95.06					
For getting the word meaning (WordReference.com)						
Pretest	72.11	20.78	<.001	Reject Ho1	Significant	2.683
Posttest	94.14					
For consolidating word form and meaning from memory (Collins Online Dictionary)						
Pretest	70.39	22.13	<.001	Reject Ho1	Significant	2.857
Posttest	94.28					
For using the word (YourDictionary)						
Pretest	64.92	33.24	<.001	Reject Ho1	Significant	4.292
Posttest	94.50					
Classification	Cohen's d Effect Size;		t-test for dependent data at 0.05 level of significance			
Ignored	0.00 < d ≤ 0.19					
Small Effect	0.19 < d ≤ 0.49					
Medium Effect	0.49 < d ≤ 0.79					
Large Effect	0.79 < d ≤ 1.29					
Very Large Effect	d > 1.29					

Contextual learning is a powerful method for vocabulary development, as it enables students to make meaningful connections between words and their usage in real-life situations. Yeganehpour and Zarfsaz (2021) emphasized that teaching vocabulary within context significantly enhances both short-term understanding and long-term retention. The Power Thesaurus app, which offers contextual examples and synonyms, likely played a crucial role in helping students grasp the nuanced meanings of words and understand how they are applied in different contexts. Interactive digital tools, like the Power Thesaurus, encouraged active engagement, which makes the learning experience dynamic and participatory.

Additionally, the effectiveness of digital tools like Power Thesaurus can be attributed to their ability to provide personalized learning experiences. As Ayong and Dimaano (2024) found, interactive digital tools engaged students by offering context-rich content that facilitates deeper learning and vocabulary acquisition. These tools enable students to explore words in various contexts and understand their applications. Moreover, Ayeni et al. (2024) emphasized that personalized learning technologies, such as those integrated into the Power Thesaurus, adapt to individual learner needs, ensuring that vocabulary instruction is tailored to each student's proficiency level. This approach is a key factor in the significant improvements observed in Group B's vocabulary skills, as it ensures that learners can progress at their own pace while receiving targeted support for vocabulary development.

Table 5 presents the data to determine whether there is a significant difference between the vocabulary skills of Group A and Group B students after the intervention. The results indicate no significant difference between the post-test vocabulary skills of the two groups of students in most areas. The p-values for encountering new words, getting the word meaning, consolidating word form and meaning from memory, and using the word all exceed 0.05. This leads to the failure to reject the second null hypothesis (H_{02}). This suggests that both vocabulary-building tools are equally effective in these aspects. However, a significant difference is observed in getting the word from context. Group B (using Power Thesaurus) outperformed Group A (using Wordnik) with a p-value of 0.007. The effect size for this comparison is 0.505, indicating a medium effect. This indicates that Group B had a moderate advantage in recognizing and understanding words. The other effect sizes remain small or negligible, reinforcing the conclusion that both groups benefited similarly from their respective interventions.

Table 5. *Difference between the Post-Vocabulary Skills of the Students after the Utilization of Each of the Vocabulary Building Strategies*

Areas of Vocabulary Expansion	$\bar{x}$	t	p	Remark	Effect Size
For encountering new words					
Group A (Merriam-Webster's Word of the Day)	93.31	0.034	0.971	Not significant	0.007
Group B (Oxford English Dictionary (OED) App)	93.28				
For getting the word out					
Group A (Wordnik)	93.11	2.769	0.007	Significant	0.505
Group B (Power Thesaurus)	95.06				
For getting the word meaning					
Group A (Google Translate)	94.45	0.664	0.508	Not significant	0.121
Group B (WordReference.com)	94.14				
For consolidating word form and meaning from memory					
Group A (Dictionary.com)	93.70	0.774	0.442	Not significant	0.141
Group B (Collins Online Dictionary)	94.28				
For using the word					
Group A (WordHippo)	93.61	1.227	0.221	Not significant	0.225
Group B (YourDictionary)	94.50				
Classification	Cohen's d Effect Size; t-test for dependent data at 0.05 level of significance				
Ignored	0.00 < d ≤ 0.19				
Small Effect	0.19 < d ≤ 0.49				
Medium Effect	0.49 < d ≤ 0.79				
Large Effect	0.79 < d ≤ 1.29				
Very Large Effect	d > 1.29				

The medium effect size observed for Power Thesaurus highlights the significant impact of context-based vocabulary strategies, which are known to improve vocabulary learning and retention. It likely provided students with clearer examples and a wider range of contextual information, thereby developing a deeper understanding of word meanings and usage. This aligns with research showing that vocabulary learned in meaningful contexts is better retained (Yeganehpour & Zarfsaz, 2021). The app may have allowed students to connect words to real-world applications by providing synonyms, example sentences, and alternative meanings, supporting more active learning. In the current study, Power Thesaurus provided a richer, context-based learning experience, which aligns with previous research that highlights the positive impact of context in vocabulary retention (Zhao & Poot, 2023). This also suggests that learning words through exposure to diverse contexts can significantly enhance students' understanding and use of vocabulary.

While Power Thesaurus may have been slightly more effective in certain areas, both tools contributed positively to vocabulary development. Ayeni et al. (2024) noted that digital tools, even those with different delivery methods, can be equally effective if they provide consistent and targeted vocabulary exposure. The improvements observed in both groups highlight that various tools, when aligned with the goals of vocabulary acquisition, can help students strengthen their language skills.

In addition to the mentioned tools, other digital resources have also shown effective results in supporting vocabulary acquisition. For instance, Duolingo, a widely used language-learning app, combines adaptive learning and gamification to reinforce vocabulary through repetition and spaced learning, which has been shown to significantly enhance retention and learner engagement (Ajisoko, 2020). Similarly, Quizlet enables students to create and practice digital flashcards, promoting active recall and immediate feedback, which is crucial for vocabulary building (Alzahrani & Alhomyani, 2023). When used effectively, these tools cater to various learning styles and preferences, thus enhancing learner autonomy and vocabulary development in diverse educational settings.

4.0 Conclusion

This study revealed that the integration of digital tools—particularly those supporting context-based learning and interactive vocabulary instruction—significantly enhanced the vocabulary skills of junior high school students. However, these findings point to a deeper pedagogical insight, rather than merely affirming statistical improvements. When strategically aligned with instructional content and learner needs, digital tools can effectively bridge the gap between traditional vocabulary learning and 21st-century educational demands. Drawing from the Technological Pedagogical Content Knowledge (TPACK) framework, the results demonstrate

that vocabulary instruction is most effective when educators possess strong content and pedagogical knowledge and the ability to integrate technology seamlessly. Tools like Power Thesaurus and WordReference did not just deliver vocabulary lists; they created immersive, context-rich environments where learners could construct meaning actively. This reinforces the theoretical claim that meaningful learning arises at the intersection of technology, pedagogy, and content.

In practice, the study highlights the critical role of teacher facilitation and tool selection in maximizing the benefits of educational technology. Teachers must be empowered and trained to curate tools that promote autonomy, personalized learning, and active engagement. For students, diverse and interactive applications promote deeper vocabulary retention and practical application skills necessary for academic success, real-world communication, and lifelong learning. This study opens pathways for future researchers to investigate long-term retention, tool adaptability across different languages or disciplines, and the effects of combining multiple digital strategies over time. It also invites exploration into how digital tools can support inclusive education, especially in resource-limited contexts, by providing equitable access to engaging, learner-centered vocabulary instruction. Ultimately, the research contributes to the growing body of evidence supporting the thoughtful integration of technology in education. It confirms that with the right blend of theory-informed practice and user-friendly tools, digital innovations can transform vocabulary learning into a more dynamic, meaningful, and sustainable process for diverse learners.

5.0 Contributions of Authors

The authors contributed equally to all sections and have reviewed and approved the final version of the work.

6.0 Funding

No specific funding agency supported this work.

7.0 Conflict of Interests

The authors confirm that they have no conflicts of interest regarding the publication of this paper.

8.0 Acknowledgment

The researcher extends her heartfelt gratitude to her adviser, Dr. Eugenia N. Sedillo, for invaluable guidance and expertise; statistician Dr. Maria Chona Z. Futral for her exceptional assistance; panel members Dr. Erlinda N. Calumpang, Dr. Romario Ybanez, Dr. Roullette P. Cordevilla, and Ms. Angela Gabrielle B. Bacang for their insightful feedback; her family for unwavering emotional and financial support; dear friends and research companions Crisme, Jandy Boy, Ariel, and Xander for their steadfast support and hospitality; former and current school heads, Ma'am Angeles Graciadas and Ma'am Warlie Jean Arrogante, for their encouragement; respondents from Grade 9 and 10 of NARRA National High School for their participation; and above all, to Almighty God, whose guidance and grace made this endeavor possible.

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