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Effect of Technology-Integrated Interactive Activities on Vocabulary Development among Elementary Students in Wah Cantt

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Abstract: *Building up vocabulary is an essential element of developing literacy, understanding written texts, and doing well in school. However, primary school students in Pakistan often face challenges in expanding their vocabulary because most of the teaching methods used are passive and teacher-centered. This quantitative quasi-experimental study explored how technology-integrated interactive activities could enhance vocabulary development of primary school students in Wah Cantt, Pakistan. The research focused on not only the overall vocabulary enhancement but also the abilities of the students to identify, memorize, and implement the meanings of words they have learned through digitally supported interactive teaching. The participants consisted of two intact groups selected from the elementary level students of Federal Government Junior School No. 5, Wah Cantt: control group (n = 30) and experimental group (n = 30). A pretest-posttest nonequivalent control group design was conducted. The control group was taught through the traditional teaching method. A vocabulary test was given based on the digital story and the interactive vocabulary exercises. A pilot test was done to verify the reliability (Cronbach's alpha = 0.86). Pretest and posttest scores were collected, and descriptive and inferential statistics (independent-sample t-tests) were used for data analysis. Results revealed that the experimental group that used technology-integrated interactive activities was able to make a significant gain in vocabulary performance from pretest to posttest, while the control group, which used exposure method, recorded a slight increment. According to the independent-sample t-test, the two groups' posttest scores had a statistically significant difference. These findings suggest that technology-integrated interactive activities play a significant role in vocabulary acquisition for elementary school students. Besides teacher training for carrying out technology-integrated interactive teaching, the research also recommends change in curriculum such that digital vocabulary-building activities become a part of it. It also encourages the use of interactive technology tools by schools to foster vocabulary development.*

Keywords: Vocabulary Development, Technology-Integrated Interactive Activities, Technology Integration, Elementary Students.

Introduction

Language is a crucial way for people to understand and interpret their environment. It is the medium through which communities are linked to each other by means of verbal and nonverbal communication systems. Vocabulary is one of the building blocks of language besides grammar, syntax, phonology, and lexicon and is seen as the very basis of human communication that leads to academic achievements. Second language acquisition depends highly on vocabulary building because children find meanings of words as major obstacles in learning not only in the classroom but also during independent reading (Alqahtani, 2015).

Back in 2004, Biemiller indicated vocabulary as the primary factor determining reading comprehension and also as a dependable indicator of academic achievement. However, nowadays, elementary schools very often give little time to their students for systematic vocabulary development. Along with the other methods of vocabulary teaching, the use of technology in classrooms with interactive activities has been found to be an effective strategy in present day educational environments. The main idea behind technology-integrated interactive activities lies in combining the use of digital tools with learning methods which are not only interactive but also require active involvement of the students, teamwork, and discussions around the learning materials. Examples of such digital tools are interactive whiteboards, tablets, educational software, multimedia content, online vocabulary games etc. This method develops a vibrant learning atmosphere in which the students are introduced to the vocabulary through different modes pictures, sounds, and movement which results in better word identification, memorization, and use. Studies have shown that learning interactively with the help of technology enables students to stay both mentally and physically engaged, which greatly contributes to comprehension of the material and its retention over the long haul (Prince, 2004). Besides that, when interactive activities are integrated with properly designed technology, they not only engage the learners but also completely change the nature of the learning from being passive to active exploration, a characteristic that is very important in the teaching of vocabulary (Richards, 2021).

In a country like Pakistan, English is the official language and is, in fact, the language of instruction in most schools, yet, there is a persistent trend of very few vocabulary skills and weak English language abilities among elementary level students (Gul & Aziz, 2015). Gujjar, Naoreen, Saifi, and Bajwa (2010) also pointed out that the time given for instruction is very limited and, on top of that, not only are students familiarized with rote memorization but this is often the only method of learning to which they are exposed. Furthermore, teachers at the elementary level in Pakistan generally do not have knowledge of, or are simply unaware, of those vocabulary teaching strategies that are shown by research to be effective (Iqbal, Hassan & Ali, 2015). More specifically, in Wah Cantt, a garrison city in Rawalpindi district of Punjab province, one can observe a stark contrast between the presence of technological resources and their use in the pedagogical manner for vocabulary teaching. Federal Government Junior School No. 5, Wah Cantt, is an example of a public sector institution where the technology is there but they are hardly used for interactive vocabulary teaching. Therefore, identifying, implementing, and assessing evidence-based strategies such as technology-integrated interactive activities to develop vocabulary among young learners in Wah Cantt and Pakistan, in general, is of paramount importance.

Statement of the Problem

For a large part of elementary school teachers in Wah Cantt and whole Pakistan,

old-style, lecture-based teaching methods are the main choice giving more importance to students passively listening and memorizing rather than actively participating. When vocabulary teaching is done, it is more often than not disconnected, through just word lists and definitions without any meaningful interaction or application. Firstly, the elementary students have a limited vocabulary; secondly, they are poor in reading comprehension and thirdly their language skills for expression are quite weak. Although, technology-based interactive activities have been only recognized internationally as an effective method of vocabulary teaching, their impact has not been systematically assessed in the Pakistani elementary school context especially in Wah Cantt at Federal Government Junior School No. 5. So, present research was carried out to find out the effect of technology-based interactive activities on the vocabulary development of elementary level students in Wah Cantt, Pakistan.

OBJECTIVES OF THE STUDY

The research aimed to achieve the following specific objectives:

1. To compare the overall vocabulary development of elementary students taught using technology-integrated interactive activities with those taught using traditional methods.
2. To examine the effect of technology-integrated interactive activities on students' word recognition skills.
3. To investigate the effect of technology-integrated interactive activities on students' definition matching abilities.
4. To analyze the effect of technology-integrated interactive activities on students' contextual usage of vocabulary words.
5. To assess the effect of technology-integrated interactive activities on students' word application skills in novel sentences.

RESEARCH HYPOTHESES

The following null hypotheses were tested at the alpha level of 0.05:

H_o1: There is no statistically significant difference in overall vocabulary scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

H_o2: There is no statistically significant difference in word recognition scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

H_o3: There is no statistically significant difference in definition matching scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

H_o4: There is no statistically significant difference in contextual usage scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

H_o5: There is no statistically significant difference in word application scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

SIGNIFICANCE OF THE STUDY

This study is very important for the stakeholders of the educational system of Pakistan in various ways. The policymakers may use the evidence to support the integration of technology and interactive methods into the national curriculum standards. Developers of the curriculum may include computer-assisted vocabulary-building activities, interactional exercises, and technology-enhanced content in the English language textbooks for the

elementary level. Teacher training programs, both pre-service and in-service, may include training modules on technology integration and interactive modes of teaching, so as to develop the pedagogical competencies of teacher candidates and practicing teachers. Besides, elementary school teachers in Wah Cantt and other areas will greatly benefit by exposing themselves to effective, involving, and relying-on-evidence vocabulary instruction strategies. Also, school principals and parents may come to understand the need of the implementation of technology-enhanced language interactive learning for the development of language. Finally, developers of educational technology may find answers to the specific vocabulary learning challenges of Pakistani elementary students.

REVIEW OF RELATED LITERATURE

Vocabulary Development as a Core Component of Language Learning and Academic Success

Vocabulary development is a fundamental component of language acquisition and a key factor in academic success. Alqahtani (2015) said that vocabulary learning is important since the meanings of new and unfamiliar words are emphasized in both classroom instruction and reading materials, so vocabulary teaching becomes an indispensable part of language teaching and learning. Lack of solid vocabulary knowledge and proper use will prevent elementary students from successfully completing basic academic activities such as reading comprehension, written expression, and oral communication.

According to Min and Na (2016), teaching vocabulary is a very important part of English language instruction, especially at the elementary level; however, teachers still frequently voice that making the vocabulary learning process fun, meaningful, and enjoyable rather than dull and boring is a challenge.

Technology-Integrated Interactive Activities in Vocabulary Instruction

Technology-integrated interactive activities are those learning exercises that not only demand students' physical presence but also their active participation through the use of digital tools. Some of the examples of such activities are group work on tablets, exercises on interactive whiteboards, digital vocabulary games, online quizzes, watching a multimedia story, and doing a project with technology. Prince (2004) found that activity-based learning engages students both mentally and physically, leading to a significant increase in their understanding and memory of new facts. Technology-integrated interactive activities, in the case of vocabulary teaching, are a wonderful tool for the students to discover new words in a meaningful way, use words in different communication activities with the help of technology, get instant feedback from the technology items, and thoroughly learn the new words due to numerous encounters and diverse contexts of usage.

According to Richards (2021), classroom activities that are enhanced by technology and well-thought-out not only transform passive learning into active exploration a feature very much required for vocabulary development. By performing various language tasks such as manipulating words digitally, constructing sentences, participating in online word games, and working with others in technology-based vocabulary tasks, students go beyond simply recognizing word meanings to developing the ability to use the words effectively in communication. In their research, Sun, Lalsing, and Subratty (2009) showed that interactive activities enable students to practice different linguistic skills, have longer retention of the learned material, and be able to use their knowledge in other situations.

Combined Effect of Technology-Integrated Interactive Activities

Powell, Driver, Roberts, and Fall (2017) observed that interactive digital tools can help students get around issues associated with unfamiliar or complex vocabulary. Sohn, Thomas, Greenberg, and Pollio (2017) found that activities enhanced by technology lead to a better grasp of the intended messages and a fuller understanding of word meanings by students. Nixon, Brooman, Murphy, and Fearon (2017) emphasized that digital tools provide clarity and consistency in vocabulary instruction through enhanced dialogue and feedback mechanisms. In the same vein, a digital vocabulary game may entail students identifying word-definition pairs, coming up with sentences with the target words, and even playing against their peers. All these serve as repeated and varied exposures that keep students interested.

The Pakistani Context and Wah Cantt

In Pakistan, English holds official language status and is widely used as the medium of instruction in both public and private schools. However, research consistently demonstrates that elementary-level students in Pakistan possess inadequate vocabulary knowledge and weak English language competencies (Gul & Aziz, 2015). Jamil, Majoka, and Khan (2014) raised concerns about building vocabulary in the English language curriculum at the elementary level. They pointed out that teaching methods in most cases revolve around word lists and memorization with little or no meaningful context or interaction.

Iqbal, Hassan, and Ali (2015) found out that most of the teachers in Pakistan are not aware of the latest and the most effective ways of vocabulary teaching in line with the research. Gujjar, Naoreen, Saifi, and Bajwa (2010) pointed out that the characteristics of teaching practice are short duration of instruction, monotonous delivery, and a focus on finishing the lesson rather than engaging in active learning. Together, these factors are the cause of the vocabulary deficiency seen in elementary students.

Wah Cantt being a garrison city situated in the Rawalpindi district of Punjab province mix of public and private educational institutions is what it hosts. It is a typical public sector school where technological resources such as interactive whiteboards, computer labs, and tablets are increasingly available, though their main usage for vocabulary instruction is still very limited, Federal Government Junior School No. 5, Wah Cantt, is such a school. Teachers are usually untrained in how to teach using technology for interactive vocabulary activities and textbooks hardly offer structured guidelines for technology-supported vocabulary instruction. Therefore, there is a considerable gap in the literature regarding the impact of technology-based interactive activities on vocabulary learning of primary school students in this particular setting.

METHODOLOGY

Research Design

The research employed a quantitative approach with a quasi-experimental design, specifically a pretest-posttest nonequivalent control group design. This design was considered appropriate mainly because students could not be randomly assigned to groups since the classrooms were intact and existing; therefore, two already-formed intact groups were appointed as control and experimental groups (Ary, Jacobs, Razavieh, & Sorenson, 2006). The pretest was administered to both groups prior to the intervention to establish baseline equivalence. The experimental group then received instruction using technology-integrated interactive activities, while the control group continued with traditional, lecture-based instruction without

technology integration or interactive activities. Following the intervention period, a posttest was administered to both groups to measure vocabulary gains.

Population and Sample

The target population comprised all elementary-level students (grades 4 and 5) enrolled in public schools in Wah Cantt, Punjab, Pakistan. The accessible population consisted of elementary students in Federal Government Junior School No. 5, Wah Cantt. Using convenience sampling—the most frequently applied sampling technique in educational settings for nonequivalent control group designs (Cohen, Manion, & Morrison, 2007)—two intact sections of grade 4 were selected. One section was assigned as the control group (n = 30), and the other as the experimental group (n = 30). The control group was taught through traditional teaching strategy. The total sample size was 60 students. All students were between nine and eleven years old and came from similar socioeconomic and linguistic backgrounds.

Research Instrument

We made a vocabulary test just for our study. It had forty questions multiple-choice and matching to test students vocabulary in four different ways: recognizing words, matching words with definitions, using words correctly in context, and doing word-related tasks. Most of the vocabulary words for the test were taken from the grade 4 English textbook as well as from the digital story-based content that we used for our intervention. A few examples of words are explore, discover, invent, solution, communicate, collaborate, digital, interactive, multimedia, and pronunciation.

Problem validity was assessed by a review from three people who are experts in the field: two university professors who specialize in English language teaching and one elementary school teacher who has 15 years of teaching experience. Using their comments, the authors corrected or discarded the confusing test items. The test that we ended up with has forty questions.

Reliability was established through pilot testing with twenty elementary students from a similar school in Wah Cantt who did not participate in the main study. The pilot test was administered twice with a two-week interval. Internal consistency was calculated using Cronbach's alpha, which yielded a coefficient of 0.86, indicating good internal consistency and reliability.

Procedure of Data Collection

Prior to the intervention, permission was obtained from the school administration of Federal Government Junior School No. 5, Wah Cantt, and informed consent was secured from parents or guardians of all participating students. Students were assured of confidentiality and their right to withdraw at any time without penalty.

Pretest Phase: The vocabulary assessment test was administered to both the control group (n = 30) and the experimental group (n = 30) under standardized conditions. Students were given forty minutes to complete the test. Answer sheets were collected and scored by the researcher.

Intervention Phase: The intervention was delivered over a period of eight weeks, with two forty-minute sessions per week, for a total of sixteen instructional sessions.

Experimental Group Instruction: Students in the experimental group received vocabulary instruction through technology-integrated interactive activities. Each session included the following components: an interactive whiteboard introduction where the teacher introduced eight to ten new vocabulary words using an interactive whiteboard, displaying each word alongside a relevant image, audio pronunciation, and a sample sentence while inviting students to come to the whiteboard to match words with images, complete sentences, or circle correct

definitions; a digital vocabulary game segment where students engaged with vocabulary games on tablets using educational applications such as Kahoot! and Quizlet, including games that required matching words to definitions, completing sentences with the correct word, and identifying synonyms or antonyms with immediate feedback; a collaborative technology-integrated interactive activity where students worked in small groups of four to five students on tasks such as creating digital word maps, recording themselves using new words in sentences via tablets, or participating in vocabulary-based digital scavenger hunts; and a multimedia story exposure segment where students watched a short animated story or video clip that incorporated the target vocabulary words in context while the teacher paused the video to highlight and discuss target words. The teacher played a largely facilitative role throughout the intervention. He/she gave the students necessary guidance, encouragement, and feedback on the rewriting of the text when needed.

Control Group Instruction: Students in the control group underwent vocabulary instruction through old-style, lecture-based methods without any kind of technology or interactive activities. The control group was taught by a traditional teacher. Each session followed this pattern: the teacher wrote eight to ten vocabulary words on the blackboard, gave the students the Urdu translations of each word, asked them to copy the words and meanings into their notebooks, and assigned memorization of the word list for homework. There were no technology-integrated interactive activities, group work, games, or digital tools used in the control group.

Posttest Phase: After the intervention that lasted for eight weeks, the identical vocabulary assessment test (items were reordered to reduce recall effects) was given to the two groups separately but under the same conditions. The students were allotted forty minutes to finish the test. Answer sheets were gathered and scored by the researcher using the same scoring rubric as the pretest.

Data Analysis Technique

Analysis of data was carried out using the Statistical Package for Social Sciences (SPSS) version 25. Descriptive statistics such as means and standard deviations were calculated for pretest and posttest scores of both groups. Inferential statistics, particularly independent-sample t-tests, were used for posttest-score comparisons between experimental and control groups. The alpha level for statistical significance was set at $p < 0.05$ for rejection of null hypotheses.

RESULTS

Demographic Characteristics of the Sample

The total sample comprised sixty elementary students, with thirty students in the control group and thirty students in the experimental group at Federal Government Junior School No. 5, Wah Cantt. Both groups were balanced in terms of grade level (all grade four), age range (nine to eleven years), and socioeconomic background (lower-middle to middle class). No statistically significant differences were found between the two groups on any demographic variable at baseline.

Testing of Hypothesis $H_0 1$

Null Hypothesis ($H_0 1$): There is no statistically significant difference in overall vocabulary scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

Table 1: Independent-Sample t-Test for Overall Vocabulary Development (Posttest)

Group	N	Mean	Standard Deviation	t	Df	p
Control Group	30	21.30	4.12	10.84	58	0.000
Experimental Group	30	31.80	3.45			

Interpretation of Table 1: An independent-sample t-test was conducted to compare the overall vocabulary posttest scores of the experimental group and the control group. Experimental group members (M = 31.80, SD = 3.45) scored greatly higher than the control group members (M = 21.30, SD = 4.12). The t-statistic came out to 10.84 with 58 degrees of freedom. The p-value was 0.000, which is lower than the significance level of 0.05. Hence, the null hypothesis (H_o1) is rejected. This means that overall there is a significant statistical difference between the vocabulary scores of elementary students who were taught using technology-integrated interactive activities and those who were taught using traditional methods, in light of the evidence. Students who got teaching through technology-integrated interactive activities exhibited notably better overall vocabulary growth.

Testing of Hypothesis H_o2

Null Hypothesis (H_o2): There is no statistically significant difference in word recognition scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

Table 2: Independent-Sample t-Test for Word Recognition Skills (Posttest)

Group	N	Mean	Standard Deviation	t	Df	p
Control Group	30	5.90	1.34	8.45	58	0.000
Experimental Group	30	8.60	1.12			

Interpretation of Table 2: An independent sample t-test was performed to compare word recognition posttest scores between the experimental group and the control group. The experimental group (M = 8.60, SD = 1.12) significantly outperformed the control group (M = 5.90, SD = 1.34). The computed t-value was 8.45, with 58 degrees of freedom. The p-value was 0.000, which means it was less than the 0.05 alpha level. So, the null hypothesis (H_o2) is rejected. This finding demonstrates that there is a statistically significant difference in word recognition scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods. Technology-integrated interactive activities significantly enhance students' ability to correctly identify and recognize vocabulary words.

Testing of Hypothesis H_o3

Null Hypothesis (H_o3): There is no statistically significant difference in definition matching scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

Table 3: Independent-Sample t-Test for Definition Matching Abilities (Posttest)

Group	N	Mean	Standard Deviation	T	Df	p
Control Group	30	5.60	1.48	7.92	58	0.000
Experimental Group	30	8.20	1.05			

Interpretation of Table 3: An independent-sample t-test was conducted to compare the definition matching posttest scores of the experimental group and the control group. The experimental group (M = 8.20, SD = 1.05) demonstrated superior performance compared to the control group (M = 5.60, SD = 1.48). The t-value was 7.92 with 58 degrees of freedom. The p-value was 0.000, which is less than the alpha level of 0.05. Therefore, the null hypothesis (H_o3) is rejected. This indicates that there is a statistically significant difference in definition matching scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods. Technology-integrated interactive activities significantly improve students' ability to match vocabulary words with their correct meanings.

Testing of Hypothesis H_o4

Null Hypothesis (H_o4): There is no statistically significant difference in contextual usage scores between elementary students taught using technology-integrated

interactive activities and those taught using traditional methods.

Table 4: Independent-Sample t-Test for Contextual Usage (Posttest)

Group	N	Mean	Standard Deviation	T	Df	p
Control Group	30	5.10	1.62	7.23	58	0.000
Experimental Group	30	7.90	1.20			

Interpretation of Table 4: An independent-sample t-test was conducted to compare the contextual usage posttest scores of the experimental group and the control group. The experimental group (M = 7.90, SD = 1.20) outperformed the control group (M = 5.10, SD = 1.62) by a considerable margin. The t-value was 7.23 with 58 degrees of freedom. The p-value was 0.000, which is less than the alpha level of 0.05. Consequently, the null hypothesis (H_o4) is rejected. This finding reveals that there is a statistically significant difference in contextual usage scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods. Technology-integrated interactive activities significantly enhance students' understanding of how vocabulary words function in grammatical and semantic contexts.

Testing of Hypothesis H_o5

Null Hypothesis (H_o5): There is no statistically significant difference in word application scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods.

Table 5: Independent-Sample t-Test for Word Application Skills (Posttest)

Group	N	Mean	Standard Deviation	t	Df	p
Control Group	30	4.70	1.52	6.45	58	0.000
Experimental Group	30	7.10	1.30			

Interpretation of Table 5: An independent-sample t-test was conducted to compare the word application posttest scores of the experimental group and the control group. The experimental group (M = 7.10, SD = 1.30) achieved significantly higher scores than the control group (M = 4.70, SD = 1.52). The t-value was 6.45 with 58 degrees of freedom. The p-value was 0.000, which is less than the alpha level of 0.05. Therefore, the null hypothesis (H_{o5}) is rejected. This indicates that there is a statistically significant difference in word application scores between elementary students taught using technology-integrated interactive activities and those taught using traditional methods. Technology-integrated interactive activities significantly promote generative word knowledge, enabling students to apply vocabulary words in novel sentences.

Summary of Hypotheses Testing

Table 6: Summary of Independent-Sample t-Test Results for All Hypotheses

Hypothesis	Variable	T	df	p	Decision
H_o1	Overall Vocabulary Development	10.84	58	0.000	Rejected
H_o2	Word Recognition Skills	8.45	58	0.000	Rejected
H_o3	Definition Matching Abilities	7.92	58	0.000	Rejected
H_o4	Contextual Usage	7.23	58	0.000	Rejected
H_o5	Word Application Skills	6.45	58	0.000	Rejected

Interpretation of Table 6: The summary table presents the results of all five independent-sample t-tests conducted to evaluate the null hypotheses. Regardless of the specific dependent variable, total vocabulary growth, word recognition, definition matching, contextual usage, or word application skills, the experimental group outperformed the control group by a large margin. The size of the t-values was quite large (from 6.45 to 10.84), while the p-values for all this data were 0.000, which is far below the alpha level of 0.05. Therefore, all five null hypotheses (H_o1 to H_o5) were rejected. These findings together demonstrate that technology-supported interactive sessions significantly improve vocabulary development in elementary students from Federal Government Junior School No. 5, Wah Cantt, in all the domains that were assessed.

DISCUSSIONS

Findings of the study strongly support the view that technology-integrated interactive

activities can significantly promote the vocabulary of elementary students of Wah Cantt, Pakistan. The large difference in the overall vocabulary posttest scores of the experimental and control groups shows that technology-integrated interactive activities can be a very effective method of language instruction compared to the conventional lecture-based approach.

As for the first purpose, the experimental group's enhanced performance in overall vocabulary development matches with the findings of Prince (2004), who proved that student engagement through activity-based learning, both mentally and physically, results in better comprehension and memory. Students engaging with vocabulary actively such as through digital games, technology-based collaborative tasks, and multimedia content, get more exposure to word meanings and are more likely to remember them, rather than just passively writing down word lists. Besides that, the large change in the experimental group's average compared to the very small change in the control group highlights the extraordinary impact of technology integration. This outcome is also in line with Richards' (2021) assertion that technology-enhanced interactive activities, if well architectured, lead to a change whereby passive learning is replaced by active discovery, and hence, were the foundation for the development of these materials. The dismissal of $H_0 1$ confirms that technology-integrated interactive activities significantly yield better overall vocabulary results than traditional methods.

With regard to the second and third objectives, the superior performance of the experimental group in the recognition of words and matching of definitions suggests that technology-based interactive activities enabled the students to correctly identify the words and link them with their meanings. This result supports Hwang, Shih, Ma, Shadiev, and Chen (2016) who concluded that technology-supported learning environments greatly enhance students' vocabulary recognition and listening skills. The digital vocabulary games that provided instant feedback enabled the students to make corrections as they went along, thus strengthening the accurate connections between the words and their meanings. Besides, the visual and auditory resources that are part of technology integration give the learners various clues in recognizing words in the form of pictures, recordings of pronunciations, animations, and videos. As Rodero (2018) stated, digital resources offer pronunciation models that are both clear and audible, and these assist the students in correctly recognizing and producing words that are new to them."

The conventional control group, on the other hand, got their exposure only to written words and Urdu translations, while the multimodal supports that lead to deeper processing were missing in their case. The dismissal of $H_0 2$ and $H_0 3$ further establishes that technology-based interactive activities lead to a significant enhancement of both word recognition and definition matching skills.

When we talk about the fourth and fifth objectives, it is quite significant that the experimental group has been picked as the best in contextual usage and word application because these areas measure the depth of word knowledge at the generative level rather than mere recognition. For contextual usage, students are required to know how words work in sentences, whereas for word application, students have to come up with new sentences using the target vocabulary. Both these skills are needed for good reading comprehension and for communication that is expressive. This is in line with what Adams (2017) has also pointed out that technology, when integrated, enables more frequent exposures to vocabulary through different modalities and thus effectively supports word learning. Exposure to the multimedia story part of the intervention gave students the chance to come across target words in contexts that

were both rich and meaningful. At the same time, the collaborative technology-integrated interactive activities had the students actively using the words in speaking and writing tasks. For example, Sohn, Thomas, Greenberg, and Pollio (2017) have emphasized that students understand the ideas and meanings of words better through technology-enhanced activities. That the contextual usage was the one that showed the most significant absolute difference between groups also signifies that technology-integrated interactive activities are outstandingly effective in teaching how words are used in real-life contexts. This is in line with Nixon, Brooman, Murphy, and Fearon (2017) who pointed out that digital tools help making vocabulary instruction clearer and more consistent through improved dialogue and feedback mechanisms. The fact that H_o4 and H_o5 were rejected indicates that technology-integrated interactive activities are a very effective way of promoting both contextual usage and word application skills.

Even a long period with the teacher was not able to bring the control group to a satisfactory level of progress, which confirms that traditional lecture-based methods of vocabulary instruction have serious limitations. Laying down word lists, writing definitions, and memorizing translations without any meaningful interaction or context results in very superficial knowledge of words that is most likely to be forgotten quickly. The above view also agrees with Gujjar, Naoreen, Saifi, and Bajwa (2010) who found that the traditional teaching practices in Pakistan are dominated by a monotonous delivery and an emphasis on finishing the lessons rather than on the students actively learning.

Conversely, the profound improvement of the experimental group indicates that interactive activities enhanced with technology can counteract the drawbacks of the traditional methods by offering engagement, repetition, multimodal input, instant feedback, and chances for active use. This outcome could be quite impactful for elementary education in Wah Cantt and throughout Pakistan, where technology resources are becoming more accessible but their use for vocabulary instruction is probably very minimal (Iqbal, Hassan & Ali, 2015).

These results, in fact, have great significance for Federal Government Junior School No. 5, Wah Cantt, and other public sector schools of a similar kind where the technology infrastructure is present but the teaching practices are lagging behind. The experimental intervention not only included teacher-created interactive whiteboard activities but also made use of free digital tools like Kahoot! and Quizlet. This demonstrates that effective technology integration does not necessarily have to entail expensive software or technical expertise. What is most required is a solid knowledge of the teaching methods, a little time for planning, and an openness to moving towards active, student-centered learning.

CONCLUSIONS

On the basis of the findings and discussion presented above, the following conclusions are drawn:

Overall Vocabulary Development

Technology-integrated interactive activities significantly contribute to overall vocabulary development among elementary students. Students who received instruction through technology-integrated interactive activities achieved substantially higher vocabulary scores than students who received traditional lecture-based instruction. The large gain in the experimental group compared to the minimal gain in the control group confirms that technology-integrated interactive activities are far more effective than

traditional methods for vocabulary development.

Word Recognition Skills

Technology-integrated interactive activities significantly enhance students' ability to recognize and identify vocabulary words correctly. The experimental group's superior performance on word recognition indicates that multimodal digital supports—including images, audio pronunciations, animations, and games—facilitate faster and more accurate word identification compared to traditional word lists and translations.

Definition Matching Abilities

Technology-integrated interactive activities significantly improve students' ability to match vocabulary words with their correct meanings. The experimental group's higher scores on definition matching suggest that digital games and interactive exercises that require repeated word-meaning associations lead to stronger semantic connections than rote memorization of translated definitions.

Contextual Usage

Technology-integrated interactive activities are particularly effective for teaching students how to use vocabulary words appropriately in sentence contexts. The experimental group's superior performance on contextual usage indicates that exposure to target words through multimedia stories and interactive sentence-completion activities enhances understanding of grammatical and semantic constraints on word usage.

Word Application Skills

Technology-integrated interactive activities promote generative word knowledge, enabling students to apply vocabulary words in novel sentences. The experimental group's higher scores on word application demonstrate that active use of words in speaking and writing tasks—facilitated by collaborative technology-integrated interactive activities and digital recording tools—leads to deeper, more flexible word knowledge than passive copying of definitions.

Summary of Conclusions

This study unequivocally demonstrates that technology-integrated interactive activities have a profound, strong, and positive effect on vocabulary development among elementary students at Federal Government Junior School No. 5, Wah Cantt, Pakistan. Students taught using technology-integrated interactive activities achieved substantially higher vocabulary scores than students taught using traditional lecture-based methods across all measured domains. All five null hypotheses (H_o1 through H_o5) were rejected, confirming the effectiveness of the intervention. The findings provide compelling evidence that elementary school teachers in Wah Cantt and across Pakistan should integrate technology-integrated interactive activities into their vocabulary instruction to enhance student learning outcomes.

IMPLICATIONS AND RECOMMENDATIONS

Implications for Teachers

The findings of this study carry several important implications for elementary school teachers. Teachers are strongly encouraged to move beyond traditional lecture-based, word-list approaches to vocabulary instruction and deliberately incorporate technology-integrated interactive activities into their daily lessons. Specifically, teachers should utilize interactive whiteboards to introduce vocabulary with images, audio, and interactive matching exercises, as this multimodal approach facilitates deeper processing and stronger retention. Teachers should incorporate digital vocabulary games such as Kahoot! and Quizlet to provide engaging, repetitive practice with immediate feedback, which allows students to correct

errors in real time and reinforces accurate word-meaning associations. Teachers should use multimedia stories, animated videos, and digital storybooks to expose students to vocabulary in rich, meaningful contexts, thereby enhancing understanding of how words function in authentic communication. Teachers should design collaborative technology-integrated interactive activities such as digital word maps, group vocabulary challenges, and tablet-based sentence creation tasks, as these activities require active word use and promote generative word knowledge. Teachers should provide students with opportunities to use vocabulary actively through digital recording tools, online discussions, and interactive presentations. Teachers may allow students sufficient freedom to explore and interact with digital vocabulary tools, as research demonstrates that students perform better and express their creativity more freely in a relaxed, engaging, technology-enhanced classroom atmosphere rather than a rigid, lecture-dominated environment. Teachers should also give individual attention to students who struggle with vocabulary, using technology tools to provide differentiated support and personalized practice.

Implications for School Administrators

School administrators in Wah Cantt and across Pakistan play a crucial role in enabling effective technology integration. Administrators should ensure that elementary classrooms are equipped with necessary technology infrastructure, including interactive whiteboards, tablets or computers, reliable internet connectivity, and projection equipment, as the absence of such resources prevents teachers from implementing technology-integrated interactive activities. Administrators should organize regular training workshops and professional development sessions for teachers on effective integration of technology and interactive activities for vocabulary instruction, because teacher competence in using digital tools is a prerequisite for successful implementation. Administrators should create schedules that allocate sufficient time for activity-based, technology-enhanced learning rather than rushing through content to complete syllabi, as meaningful technology-integrated interactive activities require adequate instructional time. Administrators should foster a school culture that values active, interactive, technology-enhanced learning over passive listening and rote memorization, as institutional support is essential for sustained pedagogical change. Administrators should establish peer mentoring systems where teachers skilled in technology integration can support colleagues who are less experienced with digital tools, thereby building internal capacity for technology-enhanced instruction. Additionally, the management of Federal Government Junior School No. 5, Wah Cantt should therefore, lead by example for other public schools in the area, through first-hand documentation and sharing of best practices in technology-integrated interactive activities for vocabulary teaching.

Implications for Curriculum Developers and Policymakers

Provincial and national-level curriculum developers and educational policymakers must understand that technology-integrated interactive activities help to clarify vocabulary terms and at the same time they facilitate the development of a deeper, more lasting knowledge of words. Those who develop curriculum should amend the national and provincial standards for English language in elementary schools to clearly identify technology-integrated interactive vocabulary instruction as a mandatory element rather than an optional supplement. Curriculum designers should produce teacher manuals that offer teachers step-by-step, practical examples of how to use technology-integrated interactive activities for vocabulary development that

are in line with the content of the textbooks since teachers generally do not have the time or expertise to create such activities from scratch. Curriculum designers should also include digital vocabulary-building activities, QR codes linking to multimedia content, and ideas for interactive games in elementary English language textbooks, thereby bringing technology integration into the classroom in a way that is both easy and available to all teachers.

Meanwhile, policymakers need to set aside separate funds for building technology infrastructure in public schools, especially in the most deprived areas of Wah Cantt and other districts, in order to provide equal access to technology-enhanced learning opportunities. They should also create a single, central digital repository of technology-integrated interactive vocabulary activities, multimedia stories, and assessment materials that teachers can use and modify at no cost, which will lessen the load on teachers individually and lead to profuse adoption of good practices. Furthermore, policymakers should make it compulsory for technology integration and the designing of interactive activities to be part of the competencies for teacher licensing and certification.

Implications for Teacher Training Programs

University and college teacher education programs should work hand in hand with in-service professional development programs to comprehensively train teachers on the use of technology to facilitate vocabulary instruction. Besides requiring educational technology integration courses, such courses should include modules on technology-integrated interactive vocabulary instruction using digital tools, as teacher learners cannot be expected to implement practices that they have never been exposed to. They should also provide hands-on training using interactive whiteboards, vocabulary game platforms, multimedia story creation tools, and student response systems. It will help them have both theoretical and practical knowledge and skills before they graduate. Current elementary teachers should be given the opportunity to have in-service training through workshops, online courses, school-based coaching on implementing technology-integrated interactive activities for vocabulary development, as many teachers may have completed their initial training before technology integration was a priority.

In-service programs should adopt a train-the-trainer approach, equipping master teachers to provide assistance and support to others in their school. Teacher educators themselves need to be trained so that they may demonstrate powerful technology integration in their teaching, and therefore be models for prospective teachers, since teacher candidates not only learn from formal course content but also from observing their instructors. Ongoing professional development should be provided as technology tools change, so that teachers are up-to-date at all times with effective practices, and it should also offer avenues through which teachers can share with each other their successful strategies and resources.

Recommendations for Future Research

This research makes a good case for several significant future research directions. One recommendation for future researchers is to replicate the study in different regions of Pakistan, including rural areas and other provinces like Sindh, Khyber Pakhtunkhwa, and Balochistan, to see if the results hold true in different cultural, linguistic, and socioeconomic settings.

Another avenue for future researchers could be conducting longitudinal studies over a period of six months or one year after the intervention to determine if the vocabulary improvements obtained through technology-integrated interactive activities are

maintained over time and if students use vocabulary knowledge in reading comprehension and writing tasks. Future researchers may also want to consider using larger sample sizes and random assignment, whenever possible, to improve the internal validity of the study and allow for more advanced statistical analyses, such as multilevel modeling, to take into account classroom-level variables. Future researchers should investigate the comparative effectiveness of different types of technology tools, comparing gamification platforms against multimedia stories against digital flashcards to identify which tools or combinations of tools are most effective for specific vocabulary learning outcomes. Future researchers should examine the impact of technology-integrated interactive activities on other language skills, including reading comprehension, writing quality, speaking fluency, and listening comprehension, to understand the broader linguistic benefits of technology-enhanced vocabulary instruction. Future researchers should explore the effect of technology-integrated interactive vocabulary instruction on student motivation, engagement, attitudes toward English language learning, and self-efficacy beliefs, as affective factors may mediate or moderate vocabulary learning outcomes. Future researchers should investigate potential moderators of effectiveness, such as gender, prior vocabulary knowledge, socioeconomic status, access to technology at home, and teacher experience level, to identify for whom and under what conditions technology-integrated interactive activities are most effective. Future researchers should conduct qualitative studies, including classroom observations, teacher interviews, and student focus groups, to understand the processes and mechanisms through which technology-integrated interactive activities facilitate vocabulary learning and to capture the lived experiences of teachers and students implementing these approaches in Pakistani classrooms.

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