



The Impact of Problem-Based Learning Supported by Interactive Whiteboards on Achievement of English Vocabulary Acquisition in Secondary School

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Abstract: Objectives: In the evolving landscape of digital pedagogy, the integration of interactive technologies and learner-centered strategies is vital for enhancing linguistic competencies. This study investigates the impact of utilizing Interactive Whiteboards (IWB) within a Problem-Based Learning (PBL) framework to address challenges in English vocabulary acquisition and learner psychological variables. **Methodology:** The primary objective was to examine the effectiveness of an IWB-integrated PBL approach. There are no sources in the current document compared to a traditional instructional setting. This study employed a quasi-experimental design featuring two distinct groups. The experimental group received an intervention combining IWB technology with PBL strategies, while the control group was taught using traditional whiteboard-based lecture methods without the PBL component. This clear distinction allows for an assessment of both the technological and pedagogical shifts. Furthermore, the study explored the role of learner self-efficacy as a mediating factor in achievement and motivation. **Results:** Statistical analysis indicates that the IWB-PBL intervention significantly outperformed the traditional method in enhancing vocabulary retention and student engagement. Notably, the findings reveal a strong correlation between the intervention and an increase in student self-efficacy, suggesting that the interactive nature of the IWB combined with the collaborative demands of PBL fosters a more resilient learning environment. **Conclusion:** These results emphasize the necessity of aligning digital tools with active learning methodologies to maximize educational outcomes in English language departments. **Recommendations:** It is imperative that teachers receive comprehensive training on the effective use of Interactive Whiteboards (IWBs). Infrastructure improvement initiatives.

Keywords: Educational technology, Interactive whiteboards, Achievement, English Vocabulary

أثر إستراتيجية التعلم المبني على المشكلة المدعوم بالسبورات التفاعلية على التحصيل الدراسي في اكتساب مفردات اللغة الإنجليزية لدى طلاب المرحلة الثانوية

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ملخص: الغرض: في مشهد الـبيداغوجيا الرقمية المتطور، بعد دمج التقنيات التفاعلية والاستراتيجيات التي تركز على المتعلم أمراً حيوياً لتعزيز الكفاءات اللغوية. تبحث هذه الدراسة في تأثير استخدام السبورات التفاعلية (IWB) ضمن إطار التعلم القائم على المشكلات (PBL) لمعالجة التحديات في اكتساب المفردات الإنجليزية والمتغيرات النفسية للمتعلمين. كان الهدف الأساسي هو فحص فعالية نهج PBL المدمج مع IWB مقارنة بالبيئة التعليمية التقليدية. **المنهجية:** استخدمت هذه الدراسة تصميمًا شبه تجريبي يضم مجموعتين متميزتين. تلقت المجموعة التجريبية تدخلاً يجمع بين تقنية IWB واستراتيجيات PBL، بينما تم تعليم مجموعة الضابطين باستخدام طرق المحاضرات التقليدية القائمة على السبورة البيضاء بدون مكون PBL. هذا التمييز الواضح يسمح بتقييم كل من التحولات التكنولوجية والتربوية. علاوة على ذلك، استكشفت الدراسة دور كفاءة المتعلم الذاتية كعامل وسيط في الإنجاز والدافع. النتائج والـخلاصة: تشير التحليلات الإحصائية إلى أن تدخل IWB-PBL تفوق بشكل ملحوظ على الطريقة التقليدية في تعزيز احتفاظ المفردات وتفاعل الطلاب. ومن الجدير بالذكر أن النتائج تكشف عن ارتباط قوي بين التدخل وزيادة كفاءة الطالب الذاتية، مما يشير إلى أن الطبيعة التفاعلية لبرنامج التفاعل مع المتطلبات التعاونية لبرنامج PBL تعزز بيئة تعلم أكثر مرونة. **الاستنتاجات:** تؤكد هذه النتائج على ضرورة موازنة الأدوات الرقمية مع منهجيات التعلم النشط لتعظيم النتائج التعليمية في أقسام اللغة الإنجليزية. **التوصيات:** من الضروري أن يتلقى المعلمون تدريباً شاملاً على الاستخدام الفعال للسبورات التفاعلية ومبادرات تحسين البنية التحتية.

الكلمات المفتاحية: تكنولوجيا التعليم، السبورات التفاعلية، التحصيل الدراسي، مفردات اللغة الإنجليزية

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Introduction

The landscape of English Language Teaching (ELT) in Iraq has undergone a significant transformation in recent decades. Within the current socio-economic climate, English proficiency is increasingly viewed by both parents and students as an essential tool for global communication and a prerequisite for competitiveness in the international job market (Ajaj, 2024). This heightened demand has led to a surge in early language enrollment, as stakeholders recognize that early acquisition often correlates with higher long-term proficiency and career readiness (Zaidi et al., 2022). Consequently, there is an urgent need for Iraqi secondary schools to adopt instructional methods that move beyond rote memorization toward practical, skill-based acquisition.

One of the most persistent challenges for Iraqi secondary school students learning English is vocabulary acquisition, which negatively impacts both comprehension skills and communicative competence even for learners who otherwise perform well on language test (Adhikari et al., 2022). This challenge is built on an extensive issue of poor English proficiency which has been confirmed by national evidence, with very low average scores in English in recent preparatory exam results from the Iraqi Ministry of Education across all academic streams, which range from 41.18 in the literary stream to 57.59 in the applied stream and 60.18 in the scientific stream. These statistics suggest that shortcomings in English language proficiency are not confined to just one stream or sub-group of students but are indicative of a systemic weakness across the entire Iraqi secondary education system. This weakness is important because vocabulary is a fundamental component of language learning which directly

affects students' ability to communicate in spoken and written English (Khoiriyah & Husamah, 2018). This isn't an issue only for English and non-English majors; it's a systemic gap in current instructional practices, not a classroom-specific problem.

Although the Iraqi Ministry of Education still pays attention to the teaching of the English language, empirical information shows that the implementation of technology in classrooms is insufficient in practice. The actual application of modern teaching methods and technologies by teachers has been determined to reach a moderate degree only; traditional, memorization techniques still control instruction (Al-Janaydah, 2017). This gap between what is technologically possible and what is actually done in the classroom indicates that the reason for ineffective vocabulary teaching is not the unavailability of tools, but rather teachers' inability to convert the available technologies into pedagogically sound practices (Ajaj, 2024).

A significant portion of this gap may be attributed to existing vocabulary teaching practices that remain heavily dependent on rote learning and passive learning. These techniques have been widely criticized for their inadequate capacity to stimulate long term retention or practical application of vocabulary in authentic communicative contexts. To overcome this gap, this study proposes Problem-Based Learning (PBL) as an approach to design a more engaging and effective vocabulary instruction mainly through techniques that employ technology and active learning strategies (Ajloni, 2021).

This concern represents a component of a wider context. English has become increasingly important for Iraqi students and parents as a significant means of communication for different life situations (Sutrisna, 2021).

Despite the well-known necessity of English, the English proficiency level in Iraqi schools is not satisfactory (Nasution et al., 2024). This highlights the need for innovative teaching methodologies that can address vocabulary weaknesses in particular not English proficiency overall in broader terms.

This study addresses this gap by investigating the combined influence of IWB-supported PBL on English vocabulary acquisition and student self-efficacy. The novelty of this research lies in its integrated approach utilizing the IWB not just for media display, but as a collaborative platform to facilitate the PBL process. By situating this study in the Iraqi secondary education sector, it offers a timely contribution to the discourse on technology enhanced language learning (Almulla & Al-Rahmi, 2023). Ultimately, the findings aim to provide educators and policymakers with a replicable model for optimizing vocabulary instruction, ensuring that students are equipped with both the linguistic knowledge and the cognitive skills necessary for success in a globalized world

Research Questions

The objective of this study is to develop an efficient instructional approach for vocabulary education. The experiment's outcomes will assess improvements in student academic achievement in English courses. This study proposes to address the following question through testing and analysis. The research inquiries are as follows:

-What is the impact of utilizing the interactive whiteboard (IWB) with problem-based learning (PBL) on students' achievement in English vocabulary acquisition?

Research Hypotheses

H₁: Students taught with IWBs achieve significantly higher vocabulary scores than those taught traditionally

Research Background

Teaching English to primary and secondary school students has become critical in recent decades in Iraq. currently, both parents and students believe that English is a significant tool of communication in different life situations (Ahmad & Ali, 2019). The earlier the age starts to learn English, the other hand the students will be high level, and they will obtain good skills. For this reason, many parents send their children to English schools and even teach them English in courses. The parents anticipate their son or daughter will be capable of speaking in English and, they want to make sure that their sons can read, spell and pronounce words correctly so that students will have skills in English to compete favorably in employment or in the job market (Zaidi et al., 2022).

Researchers in this field have listed common problems encountered by students during English vocabulary learning. Studies have found that students have difficulties with memorizing new words and effective practice (Alobaid, 2020) These difficulties include poor timing with English practice, lack of teaching method quality, and poor expressiveness. These difficulties arise because students often spend a short time memorizing new vocabulary, which ultimately affects their achievement in English lessons (Teng et al., 2024)

Problem Statement

Vocabulary acquisition has been identified as a continuing weakness in the English language skills of Iraqi secondary students, despite the increasing importance of English. Traditional rote-memorization instruction has been demonstrated to be inadequate for developing long-term retention or practical vocabulary use (Ajaj, 2024). This weakness is not personal, since the preliminary research conducted in preparation for this study revealed that 65% of students scored below the pass mark in vocabulary tests and that large class sizes and repetitive instructional routines were compounding barriers to effective learning.

In order to confront these issues, the Iraqi Ministry of Education has invested in a wide distribution of Interactive Whiteboard (IWB) in schools to modernize pedagogical practice. However, the investment has yet to produce consistent classroom impact: teachers are still hesitant to implement IWBs fully, citing concerns about classroom distraction, limited class time and perceived inefficacy (Taat et al., 2020). The gap between the availability of technologies and their effective implementation suggests that the mere presence of tools like IWBs is not enough, without a pedagogical framework to guide their use towards specific learning outcomes, such as vocabulary retention.

Literature Review

The overall objective of this study was to investigate the effect of problem-based Learning strategy with integrate one of technology tools (IWB) on the student's achievement, motivation and engagement in English vocabulary acquisition among secondary students, For this purpose, the review in this chapter is divided into three partitions, The first section of this literature

review provides an overview of the educational landscape in Iraq, highlighting the challenges and opportunities in integrating innovative teaching strategies such as problem-based learning (PBL) and technology tools like interactive whiteboards (IWBs) into the curriculum. Iraq's education system has faced significant obstacles, including limited resources, outdated teaching methods, and a lack of teacher training in modern pedagogical approaches. However, there is growing recognition of the need to adopt student-centered and technology-enhanced learning strategies to improve educational outcomes.

While detecting and interacting among students, individuals learn about appropriateness, benefits, and effects. Students act based upon their beliefs about their competences and the expected conclusions of procedures. Accordingly, Bandura's theory underlines the critical purposes of the self-efficacy processes in the achievement of activities and learning (Mayer, 2005). The activities described in the social cognitive theory are comparable to those developed in students during PBL implementation. PBL strategy progresses students' abilities to attack unstructured and compound problems close to the future situations they are probable to face. PBL improves students' education skills with student's engagement and can support students advance their school, career, and community willingness. PBL can be enjoyable and engaging for both students and teacher at the same time as it fits educational goals and objectives (Alshaikhi, 2019).

Students engaged in problem-based learning (PBL) decidedly improve their understanding by actively integrating knowledge through the exploration of pertinent issues, consistent with Bandura's (2005) social cognitive theory, which highlights the significance of observational learning and the interaction between individual and environmental factors.

This interaction cultivates a more profound approach to studying while enhancing their capacity to comprehend intricate concepts. (Tan et al., 2015) asserts that participants in PBL exhibit a genuine interest in the subject, perhaps leading to enhanced understanding and retention of the material. Problem-Based Learning (PBL) is an instructional methodology that emphasizes the needs and interests of students. It comprises an array of structured educational activities, including instructor-led discussions, collaborative projects, and meticulously designed issues that relate to real-world situations.

After going through a lot of literature related to describing problem-based learning and looking at this approach as the most consolidating of knowledge of any educational method during the current century (Khirbeet, 2024). On the other hand, many instructors in secondary schools believe that the employment of the problem-based learning strategy is the only solution to the problems confronted by them face during the learning procedure. This instructive strategy facilitates the teachers to add various strategies, including problem solving, collaborative learning, creative thinking, and independent study, to improve their traditional method of teaching.

According to (Schmitt & Schmitt, 2020), English expands its vocabulary because linguists and scholars are interested in vocabulary teaching and learning. Vocabulary learning is commonly associated with another person's knowledge of a term, but when examined closely, it combines a variety of actions and tasks. Vocabulary plays a vital role in learning the English lesson since mastery allows learners to progress easily toward the development of language abilities; once a term has been adopted, they can use it in communication. Furthermore, acquiring vocabulary is a multifaceted sort of teaching in

which students can recognize the meaning of a word, learn it, and then utilize it autonomously, demonstrating their productive skill.

Through the recent attention at English vocabulary teaching, teachers have begun to consider it as necessary as grammar and a must for active communication; hence, teacher has started to look for new and effective techniques of implementing it (Ajloni, 2021) The existing approaches are being practiced in classroom, but students look for more perfect ones since most students still have giant problems with the learning and acquisition of vocabulary; primary and secondary students need to increase the number of vocabulary they know to linguistic efficiency learning. Particularly, the secondary students need to progress to overcome the difficulty in communicating effectively. The prompt growth of technology and multimedia computer as knowledge has brought new chances to the design of second language learning and teaching.

Interactive whiteboards (IWB) are smart boards that may be utilized for various determinations. International researchers explore how the development of technological inventions is forming their method into classrooms which encourages collaboration among students, regarding the use of IWBs (Almulla & Al-Rahmi, 2023) The interactive white board is a pedagogical instrument which promotes creative instruction, facilitates conversation, and motivates students in learning information for knowledge (Ahmad & Ali, 2019).

Education in Iraq

The Ministry of Education (MOE) in Iraq has prioritized curriculum and system reforms as part of its overarching strategy to revitalize education report MOE in 2024. The education system in Iraq has undergone significant transformations, particularly since the early 2000s, marked by both reform efforts and considerable obstructions. However, the gains made in the past have been overshadowed by a deterioration in essential educational indicators over the last two decades. This decline is attributed to a series of conflicts, particularly the 2003 war, which, alongside other military processes and flawed policy decisions, has severely impacted the infrastructure and delivery of educational services (Ssemugenyi, 2023). In retention and study of an English vocabulary, appeared that IWBs impact learning in various method, including increase the level of pupil participation in a class, stimulating students and encouraging interest for learning (Stefani et al., 2021). IWBs support various learning methods, including providing students with hearing and image weakening and vulnerability. A second English learn indicated that students get good occasions for acquiring knowledge supported in part by the large screen. In a study by (Vu & Peters, 2021) revealed how an IWB can render learning more interesting and beneficial.

Implementation of (PBL) in Classroom

Iraq's education system has long relied on traditional, teacher-centered methods that highlight rote memorization and passive learning (Inayah et al., 2021). While these methods were effective in promoting basic literacy and content knowledge in the past, they are ill-suited to the demands of the 21st century, where critical thinking, collaboration, and adaptability are essential skills (Nagodavithana & Premarathne, 2021). Through Encouraging active learning and student engagement.

Promoting critical thinking and problem-solving skills. Connecting classroom learning to real-world challenges. Fostering collaboration and communication among students (Chen et al., 2021). For Iraqi students, particularly in subjects like English, PBL can make teaching more relevant and engaging, helping them acquire not only vocabulary but also the capability to use language in meaningful contexts.

Relationship between PBL and Students' Motivation

Problem-based learning (PBL) strategy is thought to improve students' ability to be motivated (Nasution et al., 2024). Other studies have found that employing PBL in the classroom enhances high school students' ingenuity in problem solving and motivation to succeed. (Alamri, 2021) reveal that PBL has a good impact on the development of students' self-efficacy, resulting in improved achievement, whereas (Sukriyatun et al., 2023) demonstrate that problem-based learning is effective in teaching and enhancing achievement and engagement. As a result, the authors performed research on the development of the PBL learning strategy to improve motivation among Iraqi high school students.

Employing the PBL learning strategy in English language subjects significantly promotes achievement motivation compared to traditional learning for high school students in Iraq. According to Funa & Prudente (2021). an instructional approach that involves students solving a problem through the stages of the scientific method allows students to learn knowledge about the problem while also developing problem-solving skills. Similarly (Wang et al., 2023), research found that recurring achievement motivation can refresh the mind, improve motivation, work hard, and remain passionate about having problem-solving ideas.

Self-efficacy and Interactive Whiteboard

Today, it has become very significant to reach the information in the shortest and fastest method. In line with this condition, many projects in various countries are being implemented to employ information technologies in instructional settings and to integrate such technologies into teaching procedures (Amin et al., 2024). Previously, some teaching materials such as chalkboard, books and maps were employed in the learning process. However, these materials and tools are now being replaced by information technologies (Shi et al., 2015)

Through projects as mentioned above, schools have had high-level access to ICT, such as interactive whiteboards, tablets, laptops, projectors, and software, Internet setup and various equipment (Taat et al., 2020). Such changes and developments in instructional technologies have created new attitudes, new functions and roles for students and increased their self-efficacy in the learning process. In order to meet the needs of the information societies and to prepare the students better for the future, it is essential to teach them well on how they will learn, how they will think and how they will use the necessary teaching technologies (Ahmad & Ali, 2019). Students' ability to perform their duties effectively in learning processes depends on their self-efficacy. More qualified students can be educated more easily.

Methodology

This study endeavors to adopt a quantitative method, prioritizing the collection and analysis of numerical Independent Variables PBL and IWB. Dependent variables achievement moderator variables self-Efficacy data. The focus of the quantitative research is to understand the acquisition of vocabulary

achievement of the sample group after using the interactive whiteboard in PBL approach.

The research is underpinned by a quasi-experimental design, Within the purview of this study, the group engaged with the interactive whiteboard (IWB) is designated as the experimental cohort, while the group exposed to the traditional strategy constitutes the control group. Both groups undergo pre-testing, treatment, and post-testing phases. Table 1 illustrates the intricate schematic of the experimental design utilized in this study

Table 1: Quasi-Experimental Research Design

Group	Pre-test	Treatment (Independent Variable)	Post-test
Experimental (G1),	O1	PBL + Interactive Whiteboard (X)	O2
Control (G2)	O3	Traditional Instructional Strategy(PBL -non IWB)	O4
Keys:			
pre-test	(O-1)	(X).	
post-test	(O-2)		
impact of the treatment			

Population

The population is defined as all individuals in the subject of the study who share common characteristics, and this is the main goal of the study as the researcher generalizes the findings (Creswell & Creswell, 2017). The sample chosen by the researcher is only a tool for studying the characteristics of society. Therefore, the sample is part of the study population and represents it, and it was chosen in several ways. The sample must be representative of the original community and appropriate, and the researcher's control over

the sample size must lead to more reliable results. The size of the sample is mainly determined by the size of the study population. The larger the population size and the more heterogeneous (unequal) the population size, the larger the sample size.

The target population for this study comprises 325 male students from 11th-grade students within the age from 16 to 17 years old who study the English language, which is considered the main curriculum in secondary schools. In Iraq, the English language is a compulsory subject, and every student must pass in English language examination in the schools in south of Baghdad Al-Mahmoodia district, working under the administration of Al-Karkh II Directorate of Education, Baghdad. The sample selection of these areas and schools was taken through 60 participants. The organized of the sample taken for those two groups (control and experiment group) is given in the following table2.

Table 2 Sample size in Al-Latifia school

Groups	Al-Lateefia school (N= 60)		Total
	Pre-test and Post-test		
	Contral group	Experimental group	
Total	30	30	60

Sample

The target population for this study comprises secondary school students in Al-Lteafia school, south of Baghdad, Iraq. This demographic was selected because the secondary level is a critical stage for

vocabulary development and the transition toward more complex language use (Chen et al., 2021). To ensure the validity and feasibility of the experimental intervention, this study utilizes a purposive sampling technique. As defined by (Morgan, 1970), purposive sampling allows the researcher to use professional judgment and insight to select a sample that is most likely to provide productive data for the research objectives. This technique is particularly appropriate for quasi-experimental research where the integration of specific technology (IWBs) and pedagogy (PBL) requires a setting that already possesses the necessary infrastructure. Research Instruments

The instruments were utilized to gather data for this study is the achievement Test that Utilized to gauge the overall Achievement of students' vocabulary, this test was adapted from instruments used by (Alshaikhi, 2019).

Procedure

Currently, there is only one English language curriculum called (English for Iraq) implementation from 6th to 12th grade in the institutions working under the umbrella of Iraqi Ministry of Education. This book consists of eight chapters. All curricula consist of six chapters (Chapter 1, 2, 3, 5, 6 & 7) consider main subject and two chapter (4 & 8) is considered revision. This research study emphasizes on the educational objectives for 2 months course on the subject of "English Language" for 11th grade. The research study was conducted before the mid-year vacation, so the chapter (5,6) was left out and the four chapters (1,2,3,4,7,8) were taken as educational material for problem-based learning strategy integrate the interactive whiteboard strategy to teach vocabulary acquisition. These two chapters were: Food and healthy food (Chapter 1) and Cultures and Other countries (Chapter 2)

Students' academic achievement is the fruit of long-term education. Both groups are examined by conducting pre-tests and post-tests. The researcher places more than 100 items in one test and the students answer the pre-tests to measure their original level. Then, after eight weeks has passed since the treatment was given new words, the post-test is conducted after the teacher began giving vocabulary lessons through the interactive whiteboard in the classroom and through the problem-based learning strategy to ensure students' achievement to participate and communicate within the classroom by memorizing the vocabulary while displaying it on the blackboard and hearing the correct pronunciation (Ajloni, 2020). There is no doubt that this treatment increases students' academic achievement because of their focus on all available technology means. It is considered enjoyable for all students and learning is active (L.& Duyen, 2021) Therefore, the extent of their understanding of the problem and support for learning based on the interactive whiteboard is measured, as well as the quantity and quality of vocabulary that was memorized and used by the control group throughout the study period to achieve the goal.

Content Reliability of the pre- and post-test

Reliability involves measuring the degree of consistency of a test in measuring the specific variable (Amin et al., 2024). The internal consistency reliability test was done in this study to measure the consistency of the pretest and posttest items in measuring the vocabulary achievement of the students. As (Almulla & Al-Rahmi, 2023). reveal in their study, there is approach for checking the internal consistency reliability, which is Cronbach's Alpha points out that Cronbach's alpha has significant advantages and is easy to calculate. It is suitable for multiple-choice and

rating scales and is particularly well-suited for Likert scales. The assessment of internal consistency can be considered. Therefore, this study focuses on using Cronbach's alpha to test the validity of the scale. To ensure the reliability of the evaluation, the ratings provided by the three experts were analyzed using Kendall's ω (coefficient of concordance), which yielded a substantial value of .80. The chi-square statistic was calculated as 547.05 with a corresponding p-value of .00, indicating a statistically significant inter-rater reliability. The final score for each student's achievement was determined by averaging the scores assigned by the three experts. For the related content, please refer to Table 3.

Table 3 Instrument Internal Reliability

Text	Reliability Coefficient
Questionnaire For Achievement Test	0.815

Data Analysis

The Statistical Package for Social Sciences (SPSS) was utilized to process and analyze the collected data. All statistical tests were performed at a predetermined significance level of 0.05. The scope of analyses included descriptive statistical analysis to summarize the data, reliability analysis to assess the consistency of the measures, and both one-way analysis of covariance (ANCOVA) and one-way analysis of variance (ANOVA) to examine differences across groups and conditions. Table 4 provides a detailed overview of the data analyses conducted.

Table 4 Detailed overview of the data analyses

Results

The present study highlighted the research problem, conducted an initial investigation, analyzed the relevant literature, and articulated the approach individually. This section addresses the analysis and presentation of data

concerning several facets of the investigation. The data obtained from the pre-test and post-test, which assessed the students' achievement and self-efficacy, was analyzed using descriptive statistics and inferential analysis. In the initial phase, the data undergoes descriptive analysis. In inferential statistical analysis, data were examined using the Statistical Program for Social Sciences (SPSS) software, and hypotheses were evaluated by mean, ANOVA, ANCOVA, and independent sample t-tests. The findings were subsequently appreciated through utilization. The results, along with their analysis and interpretation, are described in the subsequent pages.

Table 3 shows descriptive statistics for the 60 participants and a clear improvement in achievement from pretest to posttest assessments. Pretest scores ranged from 35 to 91 with a mean score of 53.52 (SD = 11.428) while posttest scores ranged from 50 to 98 with a mean score of 66.30 (SD = 13.730). This is a mean gain of 12.78 points from pretest to posttest. The posttest mean is higher and the scores are relatively closer to the mean indicating a significant improvement in the performance of the participants after the intervention. Overall, these results suggest that the educational approach used in the interval between the two assessments was effective in facilitating learning and skill acquisition among the participants.

To further analyze the data, the standard deviations of the pretest and post-test scores were examined. The SD for the post-test scores (13.730) is slightly higher than that of the pretest scores (11.428). This increase in standard deviation may suggest a greater variability in the posttest scores, indicating that while the overall achievement was enhanced, there were participants who performed meaningfully better than others. This variability may justify further investigation into

the factors contributing to the differences in post-test academic achievement, such as individual learning styles, prior knowledge, or interactive with the educational material.

Additionally, the range of scores provides further insights into the performance dynamics of the participants. The posttest scores exhibited a wider range, with scores spanning from 50 to 98, compared to the pretest scores, which ranged from 35 to 91. This broader range in posttest scores may indicate that the intervention not only improved the scores of lower-performing participants but also allowed higher-performing participants to achieve even greater success. Such findings could have implications for future instructional design, suggesting that differentiated strategies may benefit learners across the entire spectrum of achievement.

The data suggests that the intervention had a positive impact on participants' understanding and application of the material assessed. The increase in mean scores, coupled with the wider range and increased standard deviation in posttest scores, underscores the potential effectiveness of the instructional strategies employed. These results are consistent with existing literature that emphasizes the importance of targeted interventions in enhancing educational outcomes.

Overall, the descriptive statistics presented in Table 4 provide compelling evidence of improvement from pretest to posttest scores. The increase in the mean score, the slight rise in standard deviation, and the expanded range of scores collectively suggest that the instructional intervention was successful in promoting learning and skill development among participants. Future analyses will explore the underlying factors contributing to the observed variability in posttest performance and examine the long-term effects of the

intervention on participants' academic achievement.

Table (4) Descriptive statistics on mean Pretest & Posttest achievement.

	Group	N	Mean	Std. Deviation
Pretest	Experimental Group	15	57.47	13.147
	Control Group	15	60.13	14.837
Posttest	Experimental Group	15	63.40	11.031
	Control Group	15	60.33	12.228

time points: the pretest) and (post-test). The analysis focuses on the mean scores, standard deviations, and sample sizes for each group at both time points, as well as the observed changes in scores from pretest to posttest.

Addressed the First Research Question:

What is the effect of using the interactive whiteboard (IWB) with problem-based learning (PBL) on students' achievement in English vocabulary acquisition?

This section of the study presents a thorough and detailed comparative analysis of both pre-test and post-test results, specifically designed to assess the impact that Interactive Whiteboards (IWBs) have on students' vocabulary achievement. This analysis aims to determine whether the integration of this technology into the learning environment has had a significant effect on students' ability to acquire and use vocabulary effectively.

The data demonstrates that students in the experimental group not only improved their vocabulary but did so in a way that was statistically significant when measured against the control group, who did not receive the same level of targeted instruction and practice. Overall, this analysis underscores the importance of implementing structured vocabulary activities in educational settings, as they can lead to substantial improvements in vocabulary skills and ultimately enhance students' learning outcomes.

The results of this study are presented in terms of group statistics for both the experimental and control groups at two distinct

Table (5): Difference of Experimental groups

	Group	N	Mean	Std. D	Std. Error Mean	F
Pretest	Experimental Group	30	55.50	13.574	2.478	3.621
	Control Group	30	51.53	8.561	1.563	
Posttest	Experimental Group	30	73.27	14.424	2.634	12.219
	Control Group	30	59.33	8.664	1.582	

The table (5) show, At the pretest stage, the experimental group (N = 30) recorded a

mean score of 55.50 with a standard deviation of 13.574. In comparison, the control group (N = 30) exhibited a lower mean score of 51.53 and a standard deviation of 8.561. These initial scores indicate that the experimental group had a marginally higher baseline performance relative to the control group before and after treatment

Upon conducting the posttest, significant changes in mean scores were observed. The experimental group achieved a mean score of 73.27 (SD = 14.424), while the control group attained a mean score of 59.33 (SD = 8.664). The results demonstrate that the experimental group not only outperformed the control group at the posttest but did so with a substantial margin. The mean score difference between the two groups at this stage was 13.94 points, indicating a significant enhancement in performance attributable to the intervention applied to the experimental group

To quantify the improvement from pretest to posttest, the experimental group exhibited an increase of 17.77 points, whereas the control group showed a more modest increase of 7.80 points. This disparity in score improvement is notable and suggests that the intervention had a pronounced effect on the learning outcomes of the experimental group.

Statistical analysis, including t-tests, confirmed the significance of the differences observed. The increase in the experimental group's mean score was statistically significant when compared to the control group, affirming the efficacy of the intervention. The effect size, calculated using Cohen's d, further supports the practical significance of these findings, indicating a large effect of the experimental treatment.

Hence, the results indicate that the experimental group not only had a higher pretest score but also experienced a significantly greater increase in scores from pretest to posttest compared to the control group. These findings underscore the effectiveness of the intervention implemented in the experimental group and suggest that similar approaches may yield beneficial outcomes in other educational contexts.

Table (6) One-way ANOVA of Achievement

		SS	Df	Mean Square	F	Sig.
Pretest	Between Groups	236.017	1	236.017	1.833	.181
	Within Groups	7468.967	58	128.775		
	Total	7704.983	59			
Posttest	Between Groups	2912.067	1	2912.067	20.571	.000
	Within Groups	8210.533	58	141.561		
	Total	11122.600	59			

Table 6 shown posttest results are in contrast, the ANOVA results for the posttest scores reveal a significant difference between the experimental and control groups. The between-groups sum of squares for the posttest was calculated to be 2912.067, with 1 degree of freedom, leading to a mean square of 2912.067. The F-statistic for the posttest was determined to be 20.571, with a significance level of $p < 0.001$. This statistically significant result indicates that the experimental group outperformed the control

group in the posttest assessments, providing strong evidence that the intervention implemented was effective in enhancing the participants' scores. The within-groups sum of squares for the posttest was 8210.533, with 58 degrees of freedom, resulting in a mean square of 141.561. The substantial difference in the mean squares between the groups at posttest compared to pretest underscores the impact of the intervention. The high F-statistic value further reinforces the conclusion that the treatment applied to the experimental group led to a meaningful improvement in achievement relative to the control group

Table (7): Descriptive statistics of Self-efficacy Test

		N	Mean	Std. Deviation	Std. Error			Minimum	Maximum
						Lower Bound	Upper Bound		
Pretest	High self-efficacy	30	87.21	5.454	1.013	85.13	89.28	75	96
	Low self-efficacy	30	57.55	8.524	1.531	54.42	60.67	40	70
	Total	60	71.88	16.566	2.139	67.60	76.16	40	96
Posttest	High self-efficacy	30	90.21	6.966	1.294	87.56	92.86	74	98
	Low self-efficacy	30	73.87	14.456	2.596	68.57	79.17	50	98
	Total	60	81.77	14.038	1.812	78.14	85.39	50	98

Table 7 shows the full statistical description of the self-efficacy questionnaire for 60 students who were tested simultaneously with the pre-test of academic achievement to determine the students' levels and self-efficacy. The control group and the experimental group were formed based on the results of the self-efficacy test to ensure equal distribution of students within the groups, as in Figure 4.1. The results show item (I believe I will receive an excellent grade in this class) has a mean =3.37, St. Deviation 1.414 (The highest one), and item 5 (I'm confident I can do an excellent job on the assignments and tests in this course) mean =2.90 and Std 1.559.

The results of the ANCOVA analysis, as illustrated in Table 7, indicate significant differences in achievement scores between students categorized into high and low self-efficacy groups, both at pretest and posttest stages. The analysis reveals that students with high self-efficacy demonstrated superior performance in English vocabulary assessments compared to their low self-efficacy counterparts. In the pretest

The questions addressed in the subsidiary research questions are:

To what extent does PBL with IWB affect students' achievement based on their high self-efficacy? To what extent does PBL with IWB affect students' achievement based on their low self-efficacy?

assessment, the high self-efficacy group exhibited a mean score of 87.21 (SD = 5.454), significantly higher than the low self-efficacy group's mean score of 57.55 (SD = 8.524). This notable disparity in pretest scores suggests that students with higher self-efficacy possess a stronger foundational knowledge of English vocabulary prior to engaging in the learning process. Such a foundational advantage may enable these students to more effectively interact with problem-based learning (PBL) strategies, which often require a robust understanding of the subject matter to facilitate critical thinking and problem-solving skills.

The posttest results further elucidate the impact of self-efficacy on learning outcomes. The high self-efficacy group achieved a mean posttest score of 90.21 (SD = 6.511), reinforcing the notion that their initial confidence and knowledge base positively influenced their ability to learn and retain new vocabulary. In contrast, the low self-efficacy group showed a commendable improvement, with a mean posttest score of 73.87 (SD = 14.45). This increase in scores from pretest to posttest for the low self-efficacy group suggests that the interactive whiteboard and PBL approach employed in this study may have effectively created a supportive learning environment. Such an environment likely facilitated vocabulary acquisition, allowing students with initially lower confidence levels to engage more meaningfully with the content.

as shown in Figure (1): show different scores between pretest and posttest



Limitations and Recommendations for Further Research

While the study possessed strengths, its scope was limited to a secondary school in a small Iraqi city. Future studies should expand to involve a more diverse range of secondary schools, particularly primary schools across various geographic regions, to more accurately generalize the results. The study examined how IWBs and PBL create an educational environment that fosters the comprehensive development of students' vocabulary acquisition potential, including achievement, engagement, and motivation. Future research could explore how technology relates to other education-related perceptions, potentially through separate studies. Likewise, an absence of an in-depth examination of teachers' attitudes and beliefs regarding this technological integration. The effectiveness of any educational technology, including IWBs, is not solely dependent on its inherent features or pedagogical design, but also critically influenced by the attitudes, beliefs, and pedagogical approaches of the teachers who implement it. Previous research consistently highlights the pivotal role of teacher beliefs in shaping technology integration practices. Teachers' perceptions of technology's usefulness, ease of use, and configuration with their pedagogical philosophies directly impact their willingness to adopt and effectively utilize new tools in the classroom.

This study, while contributing valuable insights into the integration of (IWBs) in vocabulary learning and acquisition, acknowledges a significant limitation, the absence of an in-depth examination of teachers' perspectives and beliefs regarding this technological integration. The effectiveness of any educational technology, including IWBs, is not solely supported by its inherent features or educational design, but also critically influenced by the attitudes, beliefs, and educational methods of the teachers who implement it. Previous research consistently highlights the essential role of teacher beliefs in determining technology integration practices. Teachers' perceptions of technology's usefulness, affluence of use, and placement with their pedagogical philosophies directly impact their preparedness to adopt and successfully utilize new tools in the classroom.

Discussion and Conclusion

The findings from the ANOVA analysis indicate a clear trajectory of improvement attributable to the intervention. The lack of significant differences in pretest scores suggests that both groups started from a similar baseline, allowing for a fair comparison of

the effects of the intervention. The marked improvement in the experimental group of the posttest scores, evidenced by the significant F-statistic and low p-value, supports the hypothesis that the intervention had a positive effect on participants' learning outcomes.

These results align with previous research that highlight the importance of targeted interventions in educational settings. The significant difference observed at posttest reinforces the notion that structured and well-designed interventions can lead to substantial gains in knowledge and skill acquisition. Furthermore, the results contribute to the growing body of literature advocating for the implementation of evidence-based practices in educational curricula.

In brief, the ANOVA results clearly demonstrate that while there was no significant difference in scores prior to the intervention, the posttest results indicate a robust and statistically significant improvement in the experimental group. This supports the effectiveness of the applied intervention and suggests potential avenues for further research and application in similar educational contexts. The implications of these findings are significant, as they provide empirical support for the integration of effective teaching strategies aimed at enhancing student performance

Based on these data, it was determined that students instructed utilizing the IWB

outperformed those taught with the TWB in terms of accomplishment, especially among those with high self-efficacy. Consequently, utilizing the Interactive Whiteboard for all English class activities in the acquisition of vocabulary is recommended as potentially more successful for students' achievement, encompassing areas of English language learning at the higher secondary level examined in this study.

Influence of Interactive Whiteboards on Student Achievement in Higher Education. The hypothesis that there is no difference in vocabulary acquisition between students taught using traditional whiteboards and those taught using interactive whiteboards at the secondary level was rejected. The investigation demonstrated that the implementation of IWB significantly influenced students' achievement in English vocabulary acquisition. The findings align with those of ([Ahmad & Ali, 2019](#)) and ([Alobaid, 2020](#)), whose research confirmed that the IWB provides innovative assistance for vocabulary development. also corroborated the data that Interactive Whiteboards enhance student outcomes across varying levels of self-efficacy. Corroborated with their findings that Innovative Work Behavior (IWB) favorably influenced students' achievement and education.

The findings presented in this study reveal significant differences in achievement scores between high and low self-efficacy groups, particularly in the context of problem-based learning (PBL) facilitated by interactive whiteboards for English vocabulary acquisition among secondary students in Iraq. The descriptive statistics and ANCOVA results underscore the positive impact of self-efficacy on learning outcomes, as evidenced by the pretest and posttest scores. The high self-efficacy group demonstrated a notable

pretest mean score low, which increased high in the posttest, indicating a substantial improvement in their vocabulary acquisition. In contrast, the low self-efficacy group started with a mean score of 50% which rose less by the posttest. These results highlight the effectiveness of PBL in improving students' vocabulary acquisition, particularly for those with higher self-efficacy. The consistent improvement in both groups suggests that while self-efficacy may influence initial achievement levels, the implementation of PBL strategies can foster growth in all learners.

Hence, this study emphasizes the importance of fostering self-efficacy among students to maximize the benefits of innovative teaching methods like problem-based learning. The integration of interactive whiteboards in the learning process not only enhances vocabulary acquisition but also promotes a learning environment, particularly for students who may struggle with self-efficacy. Future research should explore additional strategies to promote self-efficacy and investigate long-term impacts on vocabulary retention and overall academic achievement.

Disclosure Statement

The authors declare that they have no relevant or material financial interests that relate to the research described in this paper.

Ethical approval and consent to participate:

Ethical approvals were got from the Scientific Research Ethics Committee of Baghdad University. Informed consent in English has been fulfilled, as participation in this research was voluntary. Information about the purpose of this study was provided to the participants. They have also been informed

that they could withdraw from a study at any time without any punishment.

Availability of data and materials:

The datasets used and/or analyzed during the current study is available from the corresponding author upon reasonable request.

Author contribution:

All authors listed have contributed to the work and approved it for publication. The authors have worked in an organized manner. N.R, R.K & M.S. supervised the work. N.R & M.S. designed the study, communicated with the key people, and wrote the manuscript. R.K & N.R. collected the data and did the qualitative analysis. N.R, & M.S, have reviewed the data and the final manuscript for approval. The author(s) read and approved the final manuscript.

Conflict of interest: The authors confirm that the references in this study was organized using a Mendeley-certified reference management programme. And The authors declare that they have no competing interests.

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List of Abbreviations:

- PBL** problem-based learning
IWB Interactive whiteboard
ELL English language learning
MOE Ministry of education
O1 Experimental group
O2 Control group

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