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EXPLORING THE EFFECTIVENESS OF WORD SEARCH PUZZLES IN ESL VOCABULARY TEACHING: AN ACTION RESEARCH WITH SCIENCE FACULTY STUDENTS IN BANGLADESH

Mahadi Rahman*

ABSTRACT

Instructors of English as a second language (ESL) are adopting gamified methods, such as word search puzzles, as apparently practical approaches to vocabulary learning. The qualitative research explored the effectiveness of word search puzzles as a vocabulary teaching method for science faculty students at Premier University in Bangladesh. Semi-structured interviews were conducted with five students from both the Computer Science and Economics programs to assess their perceptions of word search puzzles versus traditional vocabulary methods. Most survey takers praised word puzzles as entertaining and practical for teaching spelling and word recognition, despite expressing divergent views on their effectiveness in building sentences and retaining vocabulary permanently. Student learning preferences strongly influenced opinion ratings, with Computer Science students reporting better study experiences than Economics students. Word search puzzles appear suitable for enhancing ESL vocabulary instruction for science students when instructors integrate them with practices that support meaningful vocabulary use.

Keywords: *ESL vocabulary acquisition, word search puzzles, science education, action research, vocabulary teaching methods, gamification, higher education, Bangladesh*

1. INTRODUCTION

English language proficiency has become a critical requirement across global institutions of higher education, particularly because science and technology use English as their principal language of communication in academic publications. Learning vocabulary is essential to language learning because inadequate vocabulary knowledge creates substantial barriers for English as a Second Language learners aiming to progress academically. Current vocabulary instruction methods are primarily based on memorization of word lists and on isolated learning activities outside real-world contexts. These learning techniques work well, but students often fail to stay interested and build the necessary deep understanding needed for permanent retention. Academic and specialized scientific language pose a unique challenge to students of science since they need to understand both terminology genres. The meaning of communication becomes worthless to the receiving party when vocabulary is absent, as vocabulary supports understanding of the communication content.

Educational research demonstrates that teachers use games such as word puzzles to enhance vocabulary instruction amid current learning challenges. Word search puzzles serve as an educational tool for identifying hidden words in letter grids and show promising results across different learning settings. Research findings demonstrate that word search puzzles help students master vocabulary because students in experimental groups perform better on post-tests than on pre-tests. The scientific assessment of word puzzles used for science students in non-Western English as a Second Language (ESL) contexts lacks sufficient empirical support. The current lack of research is a significant issue because science students exhibit learning preferences and vocabulary requirements that differ from those of students in other subject areas. The effectiveness of word puzzles as a gamified approach in Bangladesh's higher education sector depends on a range of institutional factors and existing cultural learning habits. The current research investigates the effectiveness of word search puzzles in teaching language content to science university students in Bangladesh. This qualitative action research project evaluates students' opinions of word search puzzles and their responses to traditional vocabulary learning methods. This inquiry sets forth the research questions that must be answered.

a) How do science faculty students perceive the effectiveness of word search puzzles for ESL vocabulary acquisition compared to conventional teaching methods?
b) What specific aspects of vocabulary knowledge (spelling, meaning, sentence construction) do students believe are enhanced through word search puzzles?

*Premier University, GEC Circle, Chittagong, Bangladesh; Email: mahadirahmandell@gmail.com

c) To what extent do students perceive word search puzzles as engaging and motivational for vocabulary learning?
d) How do individual learning preferences influence the perceived effectiveness of word search puzzles among science students?

By addressing these questions, this study contributes to the growing body of research on innovative approaches to vocabulary teaching. It provides practical insights for ESL instructors working with science students in Bangladesh and similar contexts.

2. LITERATURE REVIEW

2.1 Vocabulary Acquisition in ESL Contexts

ESL students encounter significant obstacles in learning vocabulary, specifically when studying at an academic level. Hiebert and Kamil (2005), as cited in Dalimunthe and Haryadi (2022), explain that vocabulary mastery involves "the ability to communicate the meaning of words, patterns with information," while passive vocabulary describes the capacity to identify both word forms and meanings. The definition presents vocabulary knowledge as a two-dimensional system that requires both understanding and effective use of words. Modern research confirms that vocabulary instruction should go beyond memorization, as it plays a critical role in language learning. According to Thornbury (2022), language learning is built on the fundamental building block of vocabulary, since "you cannot communicate anything without vocabulary." English learners who are learning the language face new vocabulary challenges, which can be addressed through effective use of multiple interactive tasks. The process of vocabulary learning is more demanding for science majors than for other groups. The academic and specialized knowledge requirements challenge these learners because they need to learn general classroom language and content-specific terminology during complex science training. Science students learning English as a second language encounter difficulty with specialized terms, as found by Ahmad and Asraf (2019), because these words do not translate seamlessly between languages.

2.2 Word Puzzles as Pedagogical Tools

Language teaching practitioners have shown a growing interest in using games and puzzles as educational methods over the past few years. Word search puzzles serve as interactive tools that academic institutions use to improve students' vocabulary mastery. Word search puzzles are a popular instructional trend in educational practice that helps students build vocabulary, according to Fitria's (2023) systematic literature review. The review examined 25 suitable papers and found that word search puzzles enhanced students' vocabulary mastery, with significant score differences between pre- and post-tests in the experimental class. The research by Tiyaningsih (2024) demonstrates that word search puzzles succeed at teaching vocabulary to seventh-grade students. Test results indicated that student mean scores rose from 66.47 in pre-assessments to 82.65 in post-assessments, beyond the established Minimum Mastery Criteria of 75. Research illustrates that word search puzzles create meaningful effects on vocabulary growth for students in organized educational settings. Interactive motivational elements make word search puzzles popular as learning tools. Students can master vocabulary spelling effectively through interactive puzzles that ESL Games Plus (2023) describes as creating *good results* through *practice and play*. Word search puzzles provide educational value by offering interactive picture clues that enhance vocabulary learning better than regular worksheets and traditional study methods.

2.3 Theoretical Frameworks for Vocabulary Acquisition through Games

Multiple academic models support the way word search puzzles help students learn words. According to the Involvement Load Hypothesis, Laufer and Hulstijn (2001) found that vocabulary learning depends on the level of involvement during knowledge acquisition tasks. There is cognitive engagement in word search puzzles due to the requirement to identify word arrangements and link images to words within the puzzle. According to Dual Coding Theory, which originated from Paivio (1990), learning opportunities become more effective when information is processed through dual verbal and visual channels. Word search puzzles engage both systems because they present words

visually and require verbal processing to complete them. Researchers nowadays apply Self-Determination Theory (Deci & Ryan, 2000) to study motivational aspects of game-based learning. The three core learning needs of autonomy, competence, and relatedness seem to determine which educational activities successfully motivate learners intrinsically. Word puzzles enable learners to meet their needs through three mechanisms: offering multiple-choice options, setting the right difficulty level, and enabling peer collaboration.

2.4 Action Research in ESL Vocabulary Teaching

The method known as action research is highly beneficial for analyzing classroom interventions. Situmorang (2022) explains that classroom action research enables the resolution of problems through learning system development, using valuable future-oriented methods and media. Educators can use this system to study their teaching methods and then build their practices on substantial evidence. The field of vocabulary teaching interventions has experienced thorough investigation through action research investigations over the past few years. The investigation of vocabulary learning strategies among university students used classroom action research methods according to Utami (2013).

2.5 Research Gaps and Present Study

Research indicates an increasing interest in gamified vocabulary instruction, but numerous knowledge gaps remain. Most research on vocabulary acquisition has focused on primary schools and secondary education, while studies of university-level science students remain insufficient. Research on word search puzzles primarily examines quantitative test results, devoting limited attention to how students experience or perceive the puzzles. Bangladesh-specific elements of its higher education system remain under review in investigations regarding vocabulary acquisition. The present investigation fills this research gap through a qualitative action-based study examining science students' perceptions of word search puzzles at a university in Bangladesh. This study uses students' experiences, combined with their personal learning approaches, to develop an advanced understanding of word search puzzles as vocabulary-learning devices in this setting.

3. METHODOLOGY

3.1 Research Design

The researcher adopted a qualitative action research approach to study whether word search puzzles effectively teach vocabulary to science faculty students. The methodological choice of action research suits practitioners because it supports detailed research of educational practices to enhance learning and teaching effectiveness. Learning systems for future practice benefit from educational problem-solving methods provided by classroom action research, according to Situmorang (2022). According to Utami (2013), Kurt Lewin's model serves as the structure for the action research cycle. The researcher created word-puzzle activities after he identified vocabulary-learning difficulties among science students during the planning phase. The students used word search puzzles during the acting phase to learn their vocabulary material. The researchers used semi-structured interviews to collect data during the observing stage, while the reflecting stage integrated data analysis with practice recommendations.

3.2 Participants and Setting

Five Science undergraduate students from Premier University, Chattogram, Bangladesh, formed the participant group of this study. The study employed purposive sampling to recruit participants from diverse semesters and programs in the Science faculty. The research sample comprised five participants, organized into three Computer Science and Engineering students (a 2nd-semester student, a 4th-semester student, and a 6th-semester student) and two Economics students at the 4th-semester level. The diverse group demonstrated the ability to examine whether scholarly backgrounds and academic progress influenced the interpretation of word puzzles. Every study participant enrolled in ESL took part in standard vocabulary instruction approaches as well as word search puzzles for vocabulary learning. The research participants learned about the study goals and then provided their

voluntary consent to participate. The research protected ethical principles by removing participants' personal identities while assigning them random reporting pseudonyms.

3.3 Data Collection

Data were collected through semi-structured interviews conducted in English. The interview protocol was developed in response to research questions and existing literature on vocabulary acquisition and game-based learning. Questions were designed to elicit participants' perceptions regarding:

a) Overall effectiveness of word search puzzles for vocabulary learning
b) Engagement and motivation aspects of word search puzzles
c) Specific vocabulary knowledge areas (spelling, meaning, sentence construction) potentially enhanced by word puzzles
d) Long-term impact on vocabulary retention
e) Comparison with conventional vocabulary teaching methods
f) Prerequisites for effective use of word puzzles

Each interview lasted approximately 30-45 minutes and was audio-recorded with participants' permission. The semi-structured format allowed for consistent coverage of key topics while providing flexibility to explore unanticipated themes or insights. Interviews were conducted in a private setting on the university campus to ensure participants felt comfortable sharing their honest opinions.

4. DATA ANALYSIS

Transcripts of the recorded audio data served for analysis purposes. The research study used Braun and Clarke's (2006) six-phase thematic analysis approach to analyze the data after familiarization, initial code generation, theme searching and reviewing, theme definition and naming, and report production. The researcher identified recurring patterns and key statements from participant interviews during the first stage of coding. The researcher grouped these initial codes into themes that corresponded to the research questions. The researcher checked both theme unity among elements inside and theme distinctiveness between elements to establish clear conceptual separation and thematic cohesion. Member checking served as a validity measure to confirm the researcher's interpretation of the participant interviews, thereby improving the trustworthiness of the findings. The researcher applied reflexivity as a method to uphold the rigor of qualitative analysis by recognizing personal biases that could affect the interpretation of results. I established an audit trail system to record both the research steps and the analytical choices made throughout the study.

4.1 Trustworthiness

The study implemented different research methods to enhance its trustworthiness:

a) The researcher upheld credibility using combined methods of prolonged participant interactions and checks from members and peers.
b) The researcher strengthened transferability through a detailed explanation of the participants and research environment.
c) Methodological decisions received dependability assurance from an audit trail system.
d) The study's confirmability received support from two elements: researcher reflexivity practices, along with an acknowledgment of personal position within the study.

The combined application of these measures improved both the strictness of the qualitative research design and enhanced the validity of interpretations.

5. RESULTS

The analysis of semi-structured interviews revealed several key themes regarding participants' perceptions of word search puzzles as a vocabulary teaching tool. This section presents these findings organized by research questions and emergent themes.

5.1 Perceived Overall Effectiveness of Word Search Puzzles

The majority of the five participants reported positive results from using word search puzzles for vocabulary learning, but Kazi found them ineffective in his experience. Word puzzles proved

successful for Sidratul, a second-semester Computer Science major, because they helped her better understand new vocabulary than memorizing lists from reading. The words remained visible in my mind throughout the class sessions. The sixth-semester Computer Science student, Shifat, stated that word puzzles made vocabulary education more effective than rote memorization, as they provided interactive ways to study vocabulary. The subject of vocabulary exercises now becomes something she genuinely anticipates completing. Abdullah and Nazmus from the fourth semester described word puzzles as effective while showing less intense positive feelings. Abdullah indicated that word puzzles operate effectively when students need to memorize vocabulary items by both spelling and identification, yet he acknowledges their limitations. Word puzzles benefit some aspects of vocabulary, according to Nazmus, yet he avoids relying exclusively on these exercises. Kazi, in the fourth semester of Economics, told us that word search puzzles did not match her learning preferences. The approaches he used for learning new words require systematic methods and practice with words. Students exhibit different learning reactions to word search puzzles because their individual learning preferences influence the effectiveness of this technique.

5.2 Engagement and Motivation

The participants judged word search puzzles to be an engaging activity, with a mix of opinions about their motivational effects. Through word puzzles, Sidratul found vocabulary learning to be both intriguing and encouraging because they transformed words into an activity that increased her engagement in study. Finding words during puzzle completion brings me a feeling of achievement. Shifat shared the same opinion, saying that playing word search competitively drives you to find words quickly, ensuring constant focus and motivation. Word puzzles maintain high levels of engagement, according to Abdullah. However, he differentiates how they affect short-term versus long-term motivation: "The puzzles capture your attention right now, but the motivation does not carry forward. The specific activity may gain motivation through word puzzle completion, but I doubt the same effect exists for independent outside study of vocabulary." The word puzzles provided Nazmus with entertainment, although he did not perceive them as boosting his vocabulary learning or academic achievement. According to Kazi, their educational nature made them interesting, but he did not believe it provided a strong motivational influence for language acquisition. According to these participant responses, engagement through active participation in the present time and individual learning motivation appear as separate factors, although word puzzles show consistent engagement potential.

5.3 Specific Vocabulary Knowledge Areas Enhanced

All study participants confirmed that word search puzzles played an important role in their learning of spelling and word recognition. According to Sidratul, the process of searching for words letter by letter requires complete focus on proper spelling to retain memory of the correct spellings. Such puzzles help ensure you memorize the correct spelling of words. Abdullah told me that word puzzles provide excellent benefits for pattern recognition in words and memorizing proper spellings. Four participants identified benefits for word-meaning, but they noted the need for additional explanation during word-puzzle activities. According to Shifat, the puzzles are most helpful for meaning when they include definitions and contextual information. The puzzles primarily assist with remembering correct spellings, while recognition remains secondary. According to Nazmus, word puzzles can help students understand meanings if instructors explain the words after students locate them in the puzzles. Sidratul saw word puzzles as beneficial for sentence construction because they enhanced her word retention, leading to improved sentence use. However, the other four participants disagreed with this opinion. According to Abdullah's observation about word puzzles, he could not relate the discovery of puzzle words to practical sentence usage. Different competencies and exercise routines are needed for this task. The study data indicate that word search activities produce more substantial learning effects on spelling skills and word recognition, yet have minimal impact on sentence production.

5.4 Long-term Impact on Vocabulary Retention

Study participants expressed different opinions regarding the long-term outcomes of word puzzles. Sidratul and Shifat expressed that word puzzles established permanent vocabulary memorization.

Sidratul described how puzzles provide visual stimulation and interactive elements that help her remember words, which stay in her mind weeks after memorization fails to do so. Shifat explained that her memory of puzzle-learned words improved her ability to recognize those terms in different situations. Word puzzles offered minimal long-term advantages, according to Abdullah, Nazmus and Kazi. According to Abdullah, the experience of the activity stays with him, but he doubts the educational vocabulary will persist without supplementary practice. According to Nazmus, his assessment mirrored this position when he said that word puzzles work well for quick learning, yet need supplemental practice methods for sustained knowledge retention. Each student has unique learning preferences and thinking patterns that determine how well they retain information from word puzzles.

5.5 Comparison with Conventional Methods

Word search puzzles proved more efficient than traditional methods such as word lists or flashcards, according to all five participants in the study. Kazi accepted word puzzles delivered better results for most students, although they failed to benefit him effectively. According to Sidratul, traditional memorization of lists appeared dull and uninvolved to students, whereas word puzzles required active student participation. She said, “Through word puzzles, I must interact with words so I can understand the concepts better.” Researcher Abdullah confirmed that puzzle activities produced better outcomes than the ordinary repetition of word lists. The participants agreed that interactive methods perform better than conventional processes, although they differed in their assessments of effectiveness.

5.6 Prerequisites for Effective Use

Word search puzzles benefit students who already have a minimum level of English vocabulary and spelling knowledge, according to the study participants. Shifat indicated that to grasp the puzzles, students need basic vocabulary skills at a minimum. Complete beginners might struggle. Nazmus stated that these puzzles work better when students already have a knowledge base. The word search activities help students build on their existing knowledge rather than provide instruction on entirely new concepts. Among the participants, several reported that the appropriate execution of these puzzles was vital. According to Abdullah, the instructional sequence should begin with a puzzle activity, followed by a sustained discussion of word meanings and their usage. When not accompanied adequately by additional learning activities, the exercise remains limited to being a game. According to Kazi, they should be part of an integrated strategy that includes multiple vocabulary-teaching methods, not serve exclusively as a stand-alone method. According to these educators' observations, students' background knowledge, together with teaching practices, determines the effectiveness of word search puzzles.

6. DISCUSSION

This study aimed to explore the effectiveness of word search puzzles as a vocabulary teaching method for science faculty students in an ESL context. The findings reveal a complex picture of how these interactive tools function in vocabulary acquisition, with implications for theory, practice, and future research.

6.1 Effectiveness Through the Lens of Cognitive Learning Theories

Most participants held favorable views of word search puzzles, which align with the principles described in cognitive vocabulary learning theories. According to the Involvement Load Hypothesis (Laufer & Hulstijn, 2001), cognitive tasks that increase involvement enhance vocabulary retention. Participating students gained greater learning potential through direct word searches while focusing on spelling patterns, compared with traditional passive techniques. Research data support Dual Coding Theory (Paivio, 1990), which demonstrates that learning is strengthened when verbal and visual channels combine. The word search puzzles exhibit both visual-spatial and verbal elements, providing two distinct neural pathways for encoding vocabulary knowledge. The theoretical explanation is supported by Sidratul's statement that class words remain visible in his mind after the lesson ends. The results regarding extended memory retention demonstrate that word puzzles yield inconsistent

cognitive advantages. The way people process information differently from one another explains why some students maintained acquired vocabulary knowledge, while others did not. The analysis demonstrates why vocabulary teaching should include cognition-based diversity in its approaches.

6.2 Engagement vs. Motivation: Insights from Self-Determination Theory

The distinction between motivation and engagement that participants drew in their statements aligns with the framework of Self-Determination Theory (Deci & Ryan, 2000). Every participant enjoyed word puzzles (možná because they stimulated immediate interest in the activity), yet their motivation for vocabulary learning remained variable. The difference in participant responses between engagement and motivation could stem from word puzzles fulfilling the psychological needs of autonomy, competence, and relatedness under Self-Determination Theory. The puzzle concept meets competence needs through its clear and rewarding challenge structure, which explains why participants enjoyed working with it. Some participants failed to achieve appropriate levels of self-directed learning and goal-related connections, thereby preventing sustained motivation development. The game puzzles brought pleasure to Nazmus, yet he lacked motivation for vocabulary studies because the tasks failed to link to his existing goals in language acquisition. Puzzling investigation shows that game-based learning fosters intrinsic motivation in ESL contexts, according to Alqahtani (2015).

6.3 Differential Impact on Vocabulary Knowledge Dimensions

Results show that word search puzzles have variable impacts on different aspects of vocabulary knowledge. All participants accepted that puzzles enhance spelling and word recognition, but just one reported a benefit for sentence construction. The results demonstrate receptive-word recognition and meaning understanding as primary learnings from word search puzzles according to Nation's (2001) framework of vocabulary knowledge. Word search puzzles seem designed to foster receptive knowledge elements by helping users recognize written word forms. Puzzles seem to lack sufficient capability in developing productive skills such as grammatical functions and collocations, according to participants' perceptions. The research by Tiyaningsih (2024) demonstrated that word search puzzles help students master vocabulary, but she did not specifically show how they benefit productive skills. The research findings of Fitria (2023) show that word search puzzles enhance vocabulary mastery but do not improve productive language skills. ESL educators must use word puzzles in combination with tasks that develop productive vocabulary skills, such as sentence writing and communication exercises. The educational benefit of word puzzles requires students to discuss word meanings and usage through follow-up sessions, according to Abdullah.

6.4 Individual Learning Preferences and Educational Background

The contrast between Kazi's adverse opinion of puzzles, despite his enjoyment of them, highlights why personal learning styles matter. Research about learning style diversity in ESL contexts shows that no solitary teaching approach works well for every learner. The students majoring in Computer Science (Sidratul and Shifat) showed the highest enthusiasm for word puzzles, whereas the student enrolled in Economics (Kazi) indicated minimal benefit from them. The data indicate that academic discipline may influence students' acceptance of puzzles as a learning method. Due to their common cognitive patterns, Computer Science education includes pattern-recognition activities alongside problem-solving elements that may transfer knowledge learned from word puzzles. Participants' varying levels of education could have affected their perspectives on word puzzles. Students in their second semester, named Sidratul, showed the most favorable outcomes from the word puzzle activity compared to advanced learners, who presented varied responses. Advanced students in education might develop unique methods for learning vocabulary as their academic level increases.

6.5 Implications for ESL Instruction in Science Education

The research findings yield multiple implications for teaching ESL science courses. Word search puzzles can be helpful for language teaching, provided instructors integrate them into comprehensive curriculum designs rather than using them in isolation. The participants mentioned that word puzzles work best alongside discussions about meanings and contexts in which vocabulary appears. The study shows that educators must evaluate distinct learner characteristics when choosing approaches for

teaching new words. Diverse teaching methods produce greater success than using conventional approaches on their own or game-based teaching alone. Differentiated instruction is a core recommendation for teaching ESL students, according to Tomlinson (2017). The research demonstrates that word puzzles excel at teaching scientific terminology by helping students learn both correct word recognition and spelling. Participating students agreed that puzzles were effective for learning specific terminology from their academic fields, which could help develop content-area vocabulary teaching methods.

7. CONCLUSION

At Premier University Chattogram, Bangladesh, this action research explored the teaching outcomes achieved with word search puzzles when used to teach vocabulary to science faculty students in an ESL program. Semi-structured interview analysis of five participants showed different findings regarding both the positive aspects and difficulties of using word puzzles for vocabulary learning. The evaluation found that word search puzzles provide students with a practical approach to vocabulary acquisition that surpasses traditional teaching methods. The use of puzzles provides students with specific benefits for mastering spelling and building word recognition skills, thereby enhancing vocabulary competence. Word puzzles employ a game-like structure to boost learners' interest in vocabulary assignments, thereby addressing the motivational pitfalls of traditional learning interventions. The study revealed important specific points about the effectiveness of word puzzles. Word puzzles provide superior benefits for recognizing and spelling words compared to helping students construct sentences within productive vocabulary knowledge. Learning preferences lead to differences in how students perceive word puzzles, with some students perceiving them more effectively than others. Participants had differing opinions about how long-term vocabulary retention would be affected, which makes the impact unclear.

Word search puzzles should be considered an accessory to various vocabulary instruction techniques rather than the only instructional approach. Science students benefit from word puzzles, which positively affect their ESL vocabulary acquisition when these puzzles include appropriate scaffolding techniques and follow-up discussions as part of broader vocabulary-teaching methods. These activities need to be used responsibly, while educators also offer activities that strengthen productive vocabulary use and serve diverse student learning needs. The findings from this research provide practical application methods for Bangladeshi teachers who instruct English as a Second Language in science courses. The inclusion of word puzzles shows promise for increasing student participation in vocabulary education, as it addresses common motivational issues faced by ESL learners. The methodology works efficiently for developing scientific vocabulary because students must recognize and spell specific terms correctly. The educational value of puzzles increases when teachers combine them with explicit instruction and productive practice activities. Research must expand its current findings by using experimental designs to measure the concrete impact of word puzzles on vocabulary acquisition while studying their productivity across multiple fields of study and grade levels. It should also feature the best practices for word puzzles in complete-vocabulary teaching programs. Research about how digital adaptations of word puzzles affect their effectiveness would deliver important findings regarding technology integration in language education.

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