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Enhancing Acquisition of Technical Vocabulary: An Intervention with Secondary School Students

Abstract. Learning technical vocabulary may be challenging, as it is often unknown in the first language, used infrequently and therefore difficult to remember. The aims of the study were to explore ways of enhancing acquisition of technical vocabulary among secondary education students, through offering a tailored, research-based intervention designed to maximize opportunities for learning, and through investigating the strategies students reported they used to memorize the target vocabulary. A quasi-experimental study with three student groups (n=36) and an individual case study were carried out. The methodology comprised pre-tests, a two-week intervention, post-tests, and a questionnaire on memorization techniques used by students. In addition, there was an interview with the individual student. Findings show strong positive impacts of the designed intervention on vocabulary learning, with students reporting techniques such as repetition and creating word lists in English and Polish to be effective. Insights for effective materials design and teaching are suggested.

Keywords: teaching techniques; optimizing technical vocabulary acquisition

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1. Introduction

Learning the specialized technical vocabulary of a particular professional community is important for understanding written documents and for communication. Unlike general vocabulary, specialist terms occur infrequently outside subject-specific texts (Nation, 2013), reducing the likelihood for acquisition through exposure (Coxhead, 2018). In discipline-specific texts, however, specialist terms

make up approximately 20–30% of the content (Nation, 2013; Lei & Liu, 2016), meaning that a reader will have difficulty if they do not know these terms, as it is accepted that 98% of the words in a text need to be familiar for comprehension to take place (Schmitt, Jiang & Grabe, 2011). There is therefore a need for specialist technical terminology to be taught, but questions remain as to how this can best be done in a classroom setting, and how students approach the task of memorizing such vocabulary.

2. Literature Review

2.1. Learning Vocabulary

The process of learning new words in a foreign language is complex, as “knowing” a word involves much more than being able to translate it into one’s first language (L1) (Nation, 2001). The student needs to be able to recognize and produce the word accurately both orally and in writing. This means being able to pronounce and spell the word. They also need to be aware of the different forms of the word and so be able to use it grammatically, manipulating, for example, from noun to adjective, positive to negative and so on. Next, there needs to be an understanding of how the word operates in context, when it can be used appropriately, what connotations it has and how it combines with other words (collocation).

Acquiring this depth of knowledge of a word is a process which takes place gradually over time, provided that there are repeated encounters with the word and that these require the conscious attention of the learner (Laufer & Rosovski-Roitblat, 2015). Learning a new word generally progresses from receptive recognition and understanding to more productive use, with the final stages being fluent use of the word in appropriate contexts. Comprehending information receptively involves the capacity to identify it when encountered or observed. This includes the ability to differentiate it from words that share similar forms and to learn whether the word’s pronunciation or appearance is accurate. On the other hand, productive knowledge covers an expansion of receptive knowledge. It involves understanding how to articulate the word, correctly spell and write it, and apply it in grammatically correct structures, in conjunction with words commonly associated with it (Nation, 2001). Productive knowledge also involves exercising discretion in the frequency of using the word, ensuring it is employed wisely and only in suitable contexts. The learner’s receptive knowledge of vocabulary will usually be greater than their productive ability (Laufer, 2005).

Learning vocabulary can take place in two main ways, through a conscious

focus on the new words (intentional learning), or acquisition through repeated exposure to the vocabulary, primarily when reading, but also from listening (Schmitt, 2008), where learning new words was not the learner's main motivation (incidental learning). When initially learning new words, first language (L1) has been found to help school age learners understand the meaning of the new items and memorize them (e.g. Ramachandran & Rahim, 2004). When the word is already known in the L1 the new "name" in L2 can be added to the existing entry in the learner's lexicon (Hall, 2002), and so in this way L1 may assist the memorization process. However, as meaning is only one aspect of "knowing a word", additional information about the L2 word will need to be added over time.

It is now generally agreed that engagement with a word supports its learning. Craik and Lockhart (1972) claimed that ease of memorization of a new word is associated with the attention given to it and amount of processing required in the exercises done with it. This is also related to the richness of the elaboration of the new word. If focus is given to many of its aspects, e.g. pronunciation, grammatical forms, spelling, use in context as well as meaning, then the word is processed more deeply, which makes it more memorable (Baddeley, 1997). Laufer and Hulstijn (2001) suggest that engagement involves three aspects, "need, search and evaluation" (p.14) connected with motivation and cognitive effort. These forms of engagement can be induced by tasks the learner is asked to do. For example, a gap-fill task creates a need for the learner to find the appropriate word to fill the gap in the text. If a selection of options are given, then the learner needs to operate a search to find out which word best fits, and why, which is a process of evaluation. The search process may, for example, involve them using a dictionary to check meaning, or a thesaurus to check collocation of other aspects of use. They may need to review teaching material they have been given, in this way increasing their depth of understanding of the word and increasing their number of exposures to it. The "involvement load" (Laufer and Hulstijn, 2001, pp.18–19) of tasks can be manipulated depending on the type of activity and the cognitive effort involved. The higher the loads on need/search/or evaluation, the greater the learners' retention of new words. In this way an open task, where learners are required to use the new word in a new, but appropriate context by writing a sentence, was found to be more effective for memorization of a word, than writing the word in a given sentence that was familiar to the learners (Joe, 1995, 1998 in Laufer and Hulstijn, 2001). In instructed settings one way to create a need to learn new words is for students to be aware that they will be tested on them (Schmitt, 2008). Preparing for a test pushes the learner to cognitively engage more with the new words, spending more time with them, and so increasing their exposure to them.

In sum, (according to Schmitt, 2008) vocabulary teaching that leads to effective learning of vocabulary features:

1. Maximum amount of learner engagement with the new words;
2. Frequent and regular encounters with the new words;
3. A variety of vocabulary activities with different focuses: understanding meaning (input); using the words with a focus on meaning (output); using the words in a wider context with use of selected words (output); fluency in use and rapid, effortless, recognition of the new words.

The activities on vocabulary done in class, however, are not usually enough for learners to memorize new words, which is an effortful process for the individual. Each learner uses different strategies to memorize new words.

2.1.1. Memorization of New Vocabulary

Kotarski (2017) claims that the speed and endurance of acquisition of vocabulary depends on the individual's traits. Visual, auditory, and motor memory represent distinct facets of cognitive function. Visual memory centers on the retention and processing of visual stimuli, auditory memory on auditory information, and motor memory on the recollection of motor behaviors. The realms of verbal and pictorial memory intertwine with language acquisition. Verbal memory pertains to the comprehension of meaning and content, while pictorial memory is concerned with visual imagery. The Multimedia Theory (Mayer, 2009) suggests that presenting materials with both image and text strengthens memorization, as the word is processed by both channels.

2.1.2. Techniques for Learning Vocabulary

Numerous techniques exist for learning new words, yet not all approaches prove equally effective (Kotarski, 2017).

An example of the base sentence approach (Kotarski, 2017) in action could be a student studying history who, instead of simply memorizing facts, asks questions like "Why did this event happen?" or "How did it impact society?" This approach encourages a more thorough understanding of the subject matter. This technique offers the distinct advantage of enhancing one's lexicon while concurrently fostering comprehension of underlying principles and the development of logical thinking. Its emphasis is on comprehending the holistic process rather than memorizing isolated vocabulary components. Notably, this approach finds particular relevance in fields such as medicine, where a substantial portion of the nomenclature derives from Latin (Kotarski, 2017).

The subject-performed task or self-performed task (SPR) represents another technique to expedite the acquisition of vocabulary. This technique involves physically performing an activity related to a given vocabulary so that the memory trace is correlated with the given activity (Kotarski, 2017). The integration of physical activities into the learning material significantly reinforces the memory retention of information (Nyberg, 1993). However, with specialized terminology, this approach may demand a substantial investment of time and effort. It accentuates practical application, allowing learners not only to acquire vocabulary but also to cultivate practical skills concurrently, thus achieving a twofold benefit.

A complementary approach to facilitating the acquisition of new terminology is the “crash test” technique (Kotarski, 2017), which entails the continuous evaluation of one’s learning performance. Paradoxically, this technique proves beneficial not only in the later stages of memorization (recalling) but also in the initial stages (remembering). Its effectiveness is supported by research conducted by Hogan and Kintsch in 1971, as well as Roediger and Karpicke in 2006. Conversely, a study by Kane and Anderson in 1978 revealed that individuals encouraged to engage in self-directed learning and continual learning from their mistakes outperformed those who did not assess their knowledge.

The flashcards method represents one of the most effective and popular techniques for conquering challenging vocabulary. It includes the use of cards containing brief information on one side, usually a question or word, and the accompanying response or definition on the other. This strategy works well for active recall and self-assessment since it allows students to evaluate their knowledge and reinforce topics via repetition.

The distributed practice technique pertains not to the manner of learning but rather to the timing of learning sessions (Barrick, 2000). Spaced learning sessions yield superior results compared to clustered ones. The implication is that learning should be distributed over time, thereby mitigating learner fatigue during the acquisition of advanced vocabulary (Vlach & Sandhofer, 2012).

In addition to the technique or frequency of learning, the learning environment exerts a discernible impact, either positive or negative, on the pace of learning (Kotarski, 2017). An experiment involving several individuals from the University of Michigan (Smith et al., 1978) revealed that altering the learning environment resulted in an increase in memorization, from 15.9 to 24.4 words. This phenomenon may be attributed to the brain’s subconscious establishment of additional neural connections through environmental changes, thereby reducing fatigue. Furthermore, changes in the environment necessitate varying degrees of physical exertion, resulting in better oxygenation of the brain and consequently improved learning efficiency. An intriguing study conducted at Iowa State Uni-

versity in 1998 further underscored the significance of the learning environment (Grant et al., 1998). It demonstrated that individuals who studied in a noisy environment and took a test in the same noisy environment achieved results equivalent to those who studied in silence and took the test in silence. However, when individuals studied in silence and then took the test in a noisy environment, their performance suffered, and vice versa. This underscores the multifaceted nature of factors influencing learning outcomes, encompassing individual characteristics, learning frequency, location, and environment, among others.

The “parrot fashion” (Kotarski, 2017), or “rote rehearsal” (Gu, 2003) technique represents a tool not only for memorizing vocabulary but also for achieving a deeper understanding of the material. It entails repeated yet stimulating repetition of the material to be learned. An experiment conducted by Ernst Rothkopf (1968) on 155 students revealed that when acquired material was repeated twice, the results closely resembled those of students who repeated it four times. However, those who repeated the material twice outperformed those who repeated it only once. Nonetheless, it is not only mental stimulation that leads to success in learning technical vocabulary.

The blocked practice technique Kotarski (2017) revolves around the establishment of a structured learning plan. The premise is to commence with the acquisition of easier vocabulary before progressing to more challenging terms. Advocates of this technique contend that a degree of monotony in practicing different elements contributes to their better memorization and the formation of a robust memory trace. In contrast, interleaved practice prescribes learning in a mixed order, where learners tackle both easy and difficult terms in succession. A 2014 study by Rohrer, Dedrick, and Burgess examined the effectiveness of block and interleaved learning in an educational setting, yielding results that indicated the traditional block-based learning system was less effective. The average percentage of correct answers for interleaved practice was 72%, compared to 38% for blocked practice. This suggests that intermixing more challenging vocabulary with easier terms is more advantageous than mastering the easy vocabulary first.

The technique of loci, also known as the Symonides-technique, (Kotarski, 2017) emerges as the most effective technique for memorizing a substantial volume of information, particularly within the field of medicine. A study by Qureshi, Rizvi, Syed, Shahid, and Manzoor in 2014 demonstrated the technique’s efficacy. The study divided subjects into two groups: the first group learned medical concepts through repeated reading, while the second group employed the “memory palace” technique (which involves associating the information to be remembered with specific locations or landmarks within a familiar place, such as a house or a route that is well-known). The students had no prior experience with memory palaces,

so instructors guided them in creating such structures based on the university curriculum. The first group achieved an accuracy rate of 81% in their answers, while the second group achieved an impressive 93.1%.

Marcin Kowalczyk, an authority on memory techniques and a record holder for solving Rubik's cubes with closed eyes on 14 occasions, asserts that the most effective method for learning not only technical vocabulary but also foreign languages is the association technique (Kowalczyk, 2019). This technique proves effective for both short-term memory (2–3 minutes) and long-term memory. It involves associating the word with an imaginative scenario or concept. When encountering difficulty recalling a word, the champion recommends envisioning a cause-and-effect sequence to establish as many neural connections as possible.

To sum up, research evidence suggests that the best results are achieved when the repetition of learned material occurs over an extended period, up to 30 days, with intervals, and in conjunction with a change of learning environment. Nevertheless, the choice of a noisy or quiet learning environment may hold little significance, given the uncertainty of the future application context for acquired vocabulary. Additionally, interweaving more complex technical terminology with simpler vocabulary proves more advantageous than prioritizing the acquisition of easy terms followed by challenging ones.

2.2. Technical Vocabulary

“Technical Vocabulary is the specialized vocabulary of any field which evolves due to the need for experts in a field to communicate with clarity, precision, relevance, and brevity” (Ragini, 2013, p. 1).

There are many reasons why people should learn technical vocabulary. Professional preparation, ease of communication with members of a specialist community, developing research skills, and developing subject knowledge through understanding texts and scientific literature are among the many reasons why acquiring advanced terminology is worthwhile for secondary school pupils. The problem of acquiring technical vocabulary in a foreign language with younger people is that very often they do not know these words in their first language (L1), meaning that learning the new words is cognitively challenging (Sweller, 1988). It would be hard even for some adults to be required to learn the word “thermocouple” (a traducer that converts thermal energy into electrical energy and is constructed by joining wires made from dissimilar metals to form a junction). Secondly, young individuals as yet unsure of their futures may feel learning specialized vocabulary it is not worthwhile. Learning technical vocabulary seems most applicable when the person is studying a particular field and knows that

knowledge of its associated terminology will be necessary for further development at work.

2.2.1. Research on Teaching Technical Vocabulary in Instructed Settings

There appears to be relatively little classroom-based research on the teaching of technical vocabulary conducted in vocational secondary schools, or with vocational students.

Yüksel, Mercanoğlu and Yılmaz (2020) studied the effect of use of digital flashcards created by the teacher on Quizlet for learning technical vocabulary when compared to use of a list of words. Participants were first-year students of Pharmacology in English at a Turkish university. The study used pre-and post-tests of the target items and found a significant positive effect for the use of digital flashcards over word lists. In a questionnaire on strategies used for learning, completed before the experiment, it was found that the most frequently used technique was learning words in a list, followed by use of mobile apps, and repetition of selected words. Strategies involving productive use of the words in sentences were less frequent. Although the setting was a university rather than a secondary school this study, like the other two which will be described, took learner engagement, frequency of exposure and regularity of contact with the new words as design principles.

Ulmö (2018), in an unpublished MA thesis, compared implicit and explicit techniques for teaching vocabulary in an upper secondary vocational school in Norway, among students with an “Electrical Power” specialization. The classroom research study took place in two groups over a 6 week period with a cross-over design, with both approaches taught by the same teacher. A strong result was found for use of explicit techniques in class, with learners shown to learn more words and retain them longer than in the implicit treatment. Pupils also showed a preference for explicit teaching in data from interviews and questionnaires.

Wu and Chiang (2021), in a classroom study with vocational secondary school students over one school year in China, compared use of computer “keyboarding” activities for learning vocabulary with a traditional reading, writing and listening approach. The computer-based activities had presentation, memorization and review modes. First learners were presented with a word in English with its pronunciation and the Chinese translation, then they saw the translation and heard the English version, and were asked to type the English word. Finally they only heard the word in English and then had to type the English word. Points were awarded for correct answers, adding a gaming element. The activities formed only part of the class, which proceeded in the traditional format. The group using the computer activities were found to learn significantly more words than the

traditional group. Learners reported the keyboarding tasks were motivating and effective, but it was noted that their level of interest and weekly scores declined over time, suggesting there had been a novelty effect.

These three studies appear to indicate an advantage for including active vocabulary engagement tasks during class time which seemed to lead to enhanced memorization of the new words. The research project which will be described in the next section aimed to apply a principled research based approach to design and implementation of classroom activities to enhance acquisition of technical vocabulary in groups of secondary school learners in Poland.

3. Research Methodology

The research described here can be characterized as an experimental study of classroom language learning and teaching, with a focus on the acquisition of specialized vocabulary and instructional effectiveness. Pre- and post-tests were used to measure the effectiveness of a teaching intervention aimed at acquisition of technical vocabulary. The study design incorporated intact experimental groups (three groups of students) and a case study of one individual student for comparison. There was no control group. Initially, the baseline knowledge of the target vocabulary items among the students was measured through a pre-test. Subsequently, a carefully designed learning program, tailored to support vocabulary acquisition was implemented. The intervention involved teaching items of specialist vocabulary through various activities, and student memorization and learning outcomes were assessed through tests. Following the completion of the intervention, a post-test was administered to assess students' memorization of the target vocabulary items. By comparing the performance of students in the post-test with their initial pre-test scores, information was obtained about the efficacy of the learning program and the students' memorization strategies over time. A questionnaire was completed by the students regarding the techniques they used to memorize the target vocabulary.

The objectives of this study were to examine the effectiveness of a structured learning program in enhancing the acquisition of new specialist vocabulary and to explore individual learning strategies and preferences in vocabulary memorization. The aim was to provide insights into the process of acquisition of specialist vocabulary and strategies successfully used for memorization by students.

The study addressed the following questions:

1. What was the effect of the intervention on acquisition of the target specialist vocabulary?
2. What memorization techniques were most commonly used for acquiring specialized vocabulary in a foreign language by learners in these groups?
3. How did the individual student memorize the target vocabulary and what helped him?
4. What insights for the teacher were obtained from the experiment?

3.1. Participants

Three groups each of 12 students were included in the study, 23 female and 13 male students, all aged between 18 and 20, with a total of 36 participants. These students attended a private language school that the first author has contact with. The students came from different educational backgrounds: 14 attended general secondary school, 10 were from technical secondary school, and 12 were from a Stage 1 sectorial vocational school. Their specializations varied, with 9 students training as analyst technicians, 11 as crane equipment technicians, and 16 as programming technicians. The teaching and testing was conducted face-to-face by the first author.

The case study focused on an 18-year-old male, who has been individually taught by the first author for three years. This student attended a technical secondary school and was specializing as an analyst technician. Classes with him during the intervention were conducted individually by the first author.

It was explained to all students that this was an experiment conducted in preparation for the teacher's undergraduate diploma paper and they were asked to give their consent to participate. They were assured that all information collected would be reported anonymously.

3.2. Vocabulary Items Selected for the Study

Seven target vocabulary items were selected for the experiment. All the items are closely related to the field of mechatronics, which aligned with the students' areas of specialization. Acquiring knowledge of these terms was expected to enhance their proficiency and support their future professional development. The items (in Polish and English) were:

1. test obwodu elektrycznego — In-circuit testing (ICT)
2. wartość odniesienia — benchmark value
3. odbwód zastępczy — equivalent circuit

4. siłownik — actuator
5. zawór — valve
6. zderzaki bezpieczeństwa — safety bumpers
7. udźwig — weight capacity

3.3. Research Instruments

The research instruments included a pre-test; teaching activities (a worksheet, vocabulary games, reading materials, audio materials); a post-test and a questionnaire. Each of the tests consisted of 3 questions and each question had 7 sub-items.

The pre-test, designed to assess students' initial knowledge of the target vocabulary, included a matching task with words in Polish to match with their English equivalents (the 7 items listed above), a task necessitating the selection of the appropriate English equivalent from a set of three options (the same 7 items), and a matching task featuring English words to be aligned with their corresponding definitions in English (the same 7 items) (see Appendix 1). During the pre-test, students expressed concerns about their unfamiliarity with the tested vocabulary. It was explained that the test was for diagnostic purposes. Reassurance was provided, and they were told that they would be working on the words during 4 lessons.

3.4. Procedure

The intervention spanned from January 15th to January 26th, 2024 and comprised four one-hour sessions taught over two weeks. Classes focused on introducing the new vocabulary through interactive methods such as reading, listening exercises, verbal practice, educational games, and sentence construction with the newly introduced words.

The following activities were used:

Worksheets: There were 5 exercises including the 7 items from the list of words, as follows: match the following words with their Polish equivalents; fill in the blanks in a short text with appropriate words; decide whether statements are true or false; describe a scenario where each of the vocabulary words might be used in a practical context; choose the correct answer (3 option multiple choice).

Vocabulary Games: Activities or games designed to engage students and help them learn new words in an interactive manner were introduced. These included, for example, a memory game and “taboo” game with the new words.

Reading Materials: Short texts or passages were selected to expose students to the new vocabulary in context.

Audio Materials: Recordings or audio resources used to help students practice listening to and pronouncing the new words. For example, listening comprehension with options to choose and listening prepared for better pronouncing of the new words.

Following the intervention, on January 26th, a post-test and questionnaire were administered, aiming to evaluate the role of memorization techniques in acquisition of the specialized vocabulary. The post-test included the same vocabulary items, in the same format, as those administered in the pre-test. Students were also asked to complete a questionnaire. This consisted of one closed question with a list of vocabulary learning techniques for students to choose from (see Appendix 2) and one open answer where they could write any other techniques that they used while learning the new words. This was used to check the techniques most commonly used by the participants to memorize the new words. The individual case study followed the same procedure as the group classes, except that after completing the post-test and questionnaire, there was also a structured interview.

4. Results

4.1. Pre- and Post-tests

The pre- and post-tests each consisted of a total of 21 items, each allocated one point, making a possible maximum score of 21. Tests were marked and descriptive statistics calculated (mean score, standard deviation) for each group separately (see Table 1).

Table 1. Test scores: pre- and post-tests

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)
Pre-test scores	M 4.17 (SD 1.93)	M 4 (SD 1.27)	M 3.92 (SD 0.67)
Post-test scores	M 19.67 (SD 0.89)	M 19.08 (SD 1.08)	M 19.25 (SD 1.05)

Note: M is mean, SD is standard deviation

Source: Own work

While some differences were noted in the range of scores in the different groups, one-way analyses of variance (ANOVAs) showed no significant differences between the group scores at either the pre- or the post-test at the $p < .05$ level. This

suggests that the intervention worked well in each of the groups. A significant increase was found between the pre- and post-test scores in each of the groups, calculated by means of a paired *t* test, as shown in Table 2. This indicates that the number of test items the students scored significantly increased after the two week intervention.

Table 2. Test for significance of differences between pre- and post-test scores

	Group 1 (n=12)	Group 2 (n=12)	Group 3 (n=12)
Paired t test	$t = 45.98^* (p < .05)$	$t = 34.2^* (p < .05)$	$t = 43.15^* (p < .05)$

Source: Own work

Each of the 36 students substantially increased their test scores between the pre- and post-test. The differences in scores within groups 1 and 2 were found to decrease, as indicated by the lower standard deviation (SD) scores on the post-test (see Table 1), however, in Group 3 there was less uniformity in the post test scores than during the pre-test, as the range of scores was slightly wider (3–5 on the pre-test but 18–21 on the post-test). The lower SD scores suggest that all the students had similar, high, scores on the post test, indicating the positive outcome of the intervention. Even though the range of scores in Group 3 was wider, they were still all high scores.

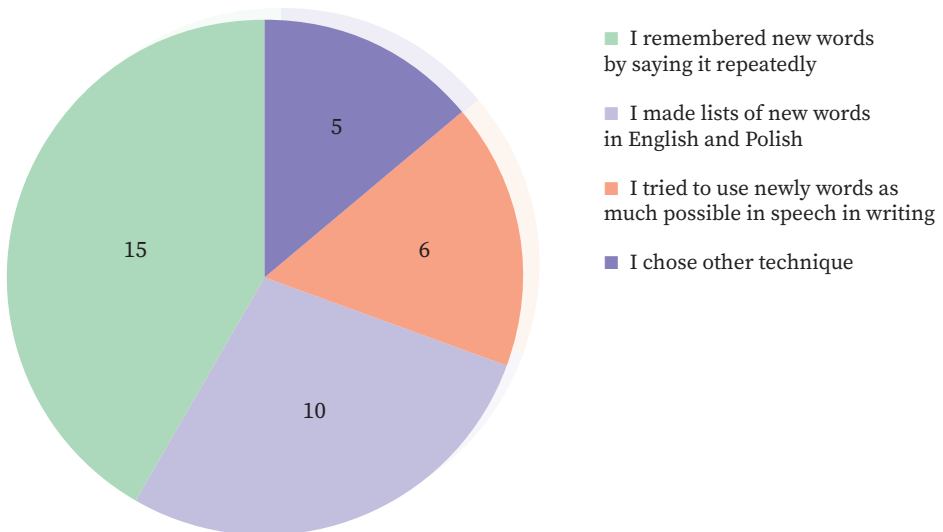


Figure 1. The most common techniques for the memorizing new words chosen by students

Source: Own work

4.2. Questionnaires

In the questionnaire students were asked to indicate how they memorized the new words from the intervention, selecting from a list of 18 possibilities. Figure 1 shows how the 36 students utilized various techniques to memorize the new words. Four distinct choices are depicted. The largest number (15) chose the technique of repetitively saying new words. Following this was the strategy of making lists of new words in both English and Polish, chosen by 10 students. In contrast, a smaller number (6) chose the technique of actively using newly acquired words in speech and writing. Lastly, five students chose other memorization techniques, which they did not specify.

As illustrated in Figure 1, the most commonly used technique was remembering new words by saying them repeatedly.

5. Discussion and Conclusions

Each of the research questions will be discussed in turn.

5.1. What Was the Effect of the Intervention on Acquisition of the Target Specialist Vocabulary?

The intervention was found to have had a significant positive effect on the acquisition of the target specialist vocabulary. Despite differences in initial knowledge among the groups, all groups showed clear improvement in their results after the experiment. Students across all groups significantly improved their skills, indicating successful acquisition of the target specialist vocabulary. Analyzing individual scores, a significant increase in each student's scores can be seen between the pre-test and post-test. Some participants improved their results by more than 15 points, proving the effectiveness of their learning techniques.

In line with Sweller's findings (1988), as learners mostly did not know the target terms in their first language at beginning of the experiment, they needed to understand the meaning and use of the technical vocabulary in both their first language and in English. This dual learning process can be time-consuming and cognitively demanding. Despite the potential difficulty in learning the technical words, after the intervention all of the students in the experiment improved their post-test results compared to the pre-test. This improvement appears to have been facilitated by visualization of the words and lessons filled with teaching activities such as exercise worksheets, vocabulary games, reading materials, and audio

resources aimed at facilitating vocabulary learning through various interactive methods such as reading, listening, speaking, and games.

The principles applied in the design of the intervention were to expose learners to the new words, offering opportunities to first recognize and understand them in isolation, with the support of both visuals and L1 Polish, and then gradually to encounter them in sentences and short texts. At this stage, active engagement with the terminology was encouraged through a variety of exercises, which became increasingly more demanding over time. Learners moved from more receptive tasks, which required them to complete missing words in a text from a list of possible options, to more productive tasks where they had to recall and reproduce the words to complete gaps in a text without support, and ultimately to full production, where they were asked to write short open texts ('scenarios') where they described how the words could be used in a real-life context. This design followed Laufer and Rozovski-Roitblat (2015) who found that "gradual increase in exposure to new words produces best gains in learning when words are practiced in word-focused activities" (p.707). Audio material ensured that the learners became familiar with the pronunciation of the new words and linking audio with written texts helped create strong connections between spoken and written forms of the words, and so consolidated accuracy of spelling. To keep the students' attention and increase motivation, games were also introduced which allowed elements of fun, creativity and competition. In all, as emphasized by Laufer and Hulstijn (2001), the principle was to involve the learners as actively as possible with the new words, cognitively, with attention and effort and so motivate them to memorize the target vocabulary. The intervention planned to offer rich, frequent and varied encounters with the new target language, ensuring intense and memorable input. As indicated by the post-test scores, it would appear that the research-based design features of the intervention seem to have been successful.

5.2. What Are the Most Commonly Used Memorization Techniques for Acquiring Specialized Vocabulary in a Foreign Language in These Groups?

Concerning the whole intervention, the most commonly used memorization techniques for acquiring specialized vocabulary in a foreign language among these groups were reported to be a repetitive saying of new words and the making of lists of new words in both English and Polish. These techniques appear to be preferred due to their effectiveness and practicality in aiding vocabulary acquisition and retention. However, the active use of newly acquired words in speech and writing also holds significance, emphasizing the importance of practical appli-

cation in language learning. The “parrot fashion learning technique” serves not just to memorize vocabulary but also to grasp the content more profoundly. It involves engaging repetition of the material to be learned. Ernst Rothkopf’s study (1968) with 155 students showed that orally repeating acquired material twice gave similar results to repeating it four times. However, in Rothkopf’s study those who repeated acquired vocabulary twice performed better than those who repeated it just once. The dominance of techniques like “parrot fashion” in the students’ choice of memorization strategy could be attributed to their effectiveness in reinforcing learning. By repeating information orally or through tasks, learners strengthen memory, making recall more efficient and actively engage with the material which enhances comprehension and retention. These techniques also allow for various learning styles and contexts.

5.3. How Did the Individual Student Memorize the Target Vocabulary and What Helped Him?

In the individual case study, the student employed a multifaceted approach to memorize the target vocabulary. Motivational strategies were found to play a crucial role in the learning process. The student indicated that if he had to memorize language “I try to motivate myself, try to think how these vocabulary words can be useful to me in the future and relate them to topics of interest to me”. The primary technique he employed was creating a list of vocabulary words in both Polish and English, followed by regular repetition and sentence creation: “I used the technique I use most often, which is to simply make a list of vocabulary words in Polish and English and repeat them and create sentences with them in a notebook”, “I repeated it 2 times a day and created sentences 1 time a day for two weeks”. The student showed awareness of the need for frequent and regular encounters with the new words and for both receptive and productive tasks to engage with the vocabulary. As a visual learner, he mentioned that visualizing the words through pictures was crucial. This combination of techniques facilitated effective memorization. According to Arabski (1996), recognizing the various elements that impact how quickly people learn new words is vital for developing successful teaching methods. This is crucial for specialized language because it is typically encountered infrequently, which makes it much harder to recall.

5.4. Insights for the Teacher Were Obtained from the Experiment?

Feedback from students provided the teacher-researcher with valuable insights into the effectiveness of the teaching methods used and suggested the positive

impact of trying out new techniques on the students' learning process. Feedback analysis showed that different groups of students may react differently to different teaching techniques, which emphasizes the need for an individual approach to teaching. Additionally, collecting information from students helped the teacher better understand how students perceived the importance and usefulness of learning new vocabulary in the context of their everyday lives or future career aspirations.

It would seem that offering a variety of ways to actively engage students with target language in class time can bring positive learning outcomes. While creating the materials and activities entailed time and effort on the part of the teacher, this proved a worthwhile investment. Moving away from course book focused tasks and offering a strategically designed progression of vocabulary-focused activities in context, which required the use of the skills of reading, writing, speaking and listening appeared to motivate the learners effectively. Vocabulary acquisition became part of the course, instead of being relegated to an individual activity to do at home. This change may explain how it was possible for all the students to show such strong gains between the pre- and post-tests. Engaging in vocabulary-focused activities in class may have encouraged individual learning at home.

It is hoped that these findings may encourage other teachers to adapt their teaching methods to the needs and expectations of different groups of students.

5.5. Limitations and Suggestion for Further Research

Establishing the validity and reliability of the instruments utilized to measure vocabulary acquisition is paramount. In the absence of piloting of the pre-test, post-test to test their suitability, there exists a risk that the results may not accurately capture the true impact of the teaching intervention, and so undermine the study's credibility.

In the design of the questionnaire more questions could have been included to elicit information about how students memorized vocabulary, which would have enriched the study. A question concerning the time that each student in the group spent on learning the new technical words should have been added. With this information it would have been possible to write about frequency of the repetition of all of the students from all groups, not only on the basis of the one individual student. In addition, two questions for students to rate their engagement in the learning process, and the perceived relevance of the technical vocabulary for them would have added new perspectives. This would have allowed comparison of students' results on the tests taking into account their engagement during the learning process and the perceived importance they attached to the technical vocabulary.

With regard to the whole intervention there are further research questions that could have been asked, such as “What is the most effective memorization technique” and “How do various learner factors, engagement and perceived relevance of specialized vocabulary, affect the success of different memorization techniques?”. These would be interesting questions for further research.

The research suggested that tracking the time each student spends on learning new technical words could enhance the understanding of the frequency of repetition across different groups. Implementing this in a future study would offer a more detailed picture of how time allocation affects vocabulary retention and mastery.

Conducting longitudinal studies to track students’ progress over an extended period would offer valuable insights into the long-term effectiveness of memorization techniques. This would allow researchers to assess retention rates and identify any changes in students’ engagement and the perceived relevance of technical vocabulary over time.

6. Conclusions

The intervention appeared to have a significant positive impact on the acquisition of specialized vocabulary. All participant groups showed improvement, irrespective of their initial knowledge levels. Utilizing visualization and interactive learning techniques to enhance engagement, frequency and quality of encounter appears to have been effective in facilitating vocabulary acquisition.

Commonly used memorization techniques employed by students included repetition of new words and creating lists of words in English and Polish, which may have been preferred for their practicality and effectiveness.

The qualitative individual case study on memorization strategies showed use of a multifaceted approach was employed, integrating motivation, repetition, and visual aids. Key strategies included creating vocabulary lists, regular repetition, and visualization, with recognition of individual learning style and preferences deemed crucial for successful memorization.

Author contributions

Author 1: Conceptualization, Methodology, Investigation, Formal analysis, Writing original draft. **Author 2:** Conceptualization (supporting), Formal analysis, Supervision, Validation, Writing — reviewing and editing. Both authors have read and agreed to the submitted version of the manuscript.

Appendix 1. Test Material Used for Pre- and Post-tests

1. Match words.

- | | |
|------------------------------|-----------------------------|
| 1) Udźwig | A. In-circuit testing (ICT) |
| 2) Siłownik | B. Benchmark value |
| 3) Wartość odniesienia | C. Equivalent circuit |
| 4) Zderzaki bezpieczeństwa | D. Actuator |
| 5) Zawór | E. Weight capacity |
| 6) Test obwodu elektrycznego | F. Safety bumpers |
| 7) Obwód zastępczy | G. Valve |

2. Circle correct answer.

1) Udźwig

*Abrade *Annular *Weight capacity

2) Test obwodu elektrycznego

*Batchmeter *Bender *In-circuit test

3) Siłownik

*Aircscrew *Actuator *Angle lever

4) Wartość odniesienia

*Benchmark value *Baler *Autobody sheet

5) Zawór

*Valve *Alloy *Beam

6) Zderzaki bezpieczeństwa

*Angle lever *Band saw *Safety bumpers

7) Obwód zastępczy

*Baler *Equivalent circuit *Bleed valve

3. Match words to the definitions.

- A. is an example of white box testing where an electrical probe tests a populated printed circuit board (PCB), checking for shorts, opens, resistance, capacitance, and other basic quantities which will show whether the assembly was correctly fabricated.

- B. means the Performance Fee High Watermark adjusted by any return.
- C. refers to a theoretical circuit that retains all of the electrical characteristics of a given circuit.
- D. a device that causes a machine or other device to operate.
- E. a device for controlling the passage of fluid or air through a pipe, duct, etc., especially an automatic device allowing movement in one direction only.
- F. a mechanical device consisting of bars at either end of a vehicle to absorb shock and prevent serious damage.
- G. weight or mass is used to measure how heavy something is:
 - 1) Weight capacity
 - 2) Equivalent circuit
 - 3) In-circuit testing
 - 4) Actuator
 - 5) Safety bumpers
 - 6) Benchmark value
 - 7) Valve

Appendix 2. Memorization Techniques in the Questionnaire

Which techniques did you use to remember the new specialist words? You can choose more than one. Circle the letter if you used this technique.

- a. I looked for phrases or set expressions that go with the new word.
- b. I used an app to learn or consolidate my vocabulary.
- c. I created a test on an app using the new words in English with a translation.
- d. I remembered a new word by saying it repeatedly.
- e. I read the material many times to help me remember the new words.
- f. I made up my own sentences using the words I just learned.
- g. I copied out the sentences with the new words.
- h. I tried to use the newly learned words as much as possible in speech and writing.
- i. I tried to use newly learned words in real situations.
- j. I learned the new words by relating them to myself or my personal experience.
- k. I physically performed actions strictly associated with the given vocabulary.
- l. I constantly evaluated myself through creating tests.
- m. I made flashcards with a new word on one side and a small amount of information on the other side and tested myself with them.

- n. I gradually expanded my vocabulary range by starting with basic words and continuing with more sophisticated ones.
- o. I imagined a picture of a place and put the new words in specific locations in the picture to help me remember them.
- p. I made lists of the new words in my notebook in English.
- q. I made lists of the new words in English and Polish.
- r. Other technique(s) you used, what?

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Wzmocnienie przyswajania słownictwa technicznego: Badanie wśród uczniów szkół średnich

Streszczenie. Nauka słownictwa technicznego może stanowić wyzwanie, ponieważ jest ono często nieznanne w ojczystym języku, używane rzadko i dlatego trudne do zapamiętania. Celem pracy było zbadanie sposobów zwiększenia efektywności przyswajania słownictwa technicznego wśród uczniów szkół średnich. Zastosowano badanie interwencyjne, ułożone z myślą o maksymalizacji możliwości uczenia się. Zanalizowano również strategie wskazane przez uczniów jako te, które wykorzystywali do zapamiętywania docelowego słownictwa. Badanie quasi-eksperymentalne odbyło się z udziałem trzech grup uczniów (n=36). Analizie poddano również pojedynczy przypadek. Metodologia obejmowała testy wstępne, dwutygodniową interwencję, testy końcowe i kwestionariusz dotyczący technik zapamiętywania stosowanych przez uczniów. Ponadto przeprowadzono wywiad indywidualny. Wyniki pokazują silny pozytywny wpływ przeprowadzonej interwencji na naukę słownictwa, przy czym uczniowie zgłaszali, że techniki takie jak powtarzanie i tworzenie list słów w języku angielskim i polskim okazały się efektywne. Odnotowano spostrzeżenia dotyczące skutecznego tworzenia materiałów i nauczania.

Słowa kluczowe: techniki nauczania, optymalizacja przyswajania słownictwa technicznego

