THE ACQUISITION OF SPECIALIZED TERMINOLOGY AS THE BASIS AND KEY TO FACILITATE ASSIMILATION OF THE MATERIAL AND DEVELOP STUDENTS' SCIENTIFIC THINKING

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Abstract: *due to the improvements in science and technology, a lot of information today contains specific terminology that may be unfamiliar for students. The lack of scientific terminology causes difficulties in mastering scientific language as well as assimilating the material in disciplines such as physics, chemistry, biology, and computer science.*
Surveys among learners were done based on the project's focus, and the students' development in learning scientific terminology in English was examined.
In the project:
- The problems in learning themed vocabulary in English among students were identified.
- Terminologies and associated assignments were gathered and organized so that students were able to effectively learn sciences in English.
- The results of the students after the experiment were collected and analyzed to summarize and determine the effectiveness of the chosen methodology.
In the project, the students' problems in studying scientific terminology and using it in their studies were identified and solved with the help of numerous research methods.
The aforementioned research methods include, but are not limited to surveys, statistics, exercises created specifically for the project.
Keywords: specialized vocabulary, CLIL methodology, Bloom's taxonomy, scientific thinking, website, English, scientific vocabulary, statistics.

Literature review

1.1.1 Scientific thinking

It is estimated 98% of all scientific publications being produced, English is beyond a doubt the primary language of contemporary scientific communication of international science. English has successfully cemented its position as the language of science by the middle of the 1990s. Anyone who wishes to express the ideas they have now publish mostly in English. Studying science in English is an effective way to get prepared for a career in science, partially because the terms can often be unavailable in other languages [1]. The way that contemporary society perceives the world has been greatly impacted by the development of science and technology. From a linguistic perspective, the public has a continual need for understanding of the language of science, which is primarily spoken in English, as a result of the ongoing expansion of scientific research [2].

The peculiar nature of the language learning process, however, is one of the main challenges because as students advance, their pace of growth appears to slow down. Many students find it easier to learn in bursts compared to in a neat and step-by-step approach. This phenomenon is called *plateaus* [3]. Students who regularly study a language but do not make any additional improvements in their studies appear to remain at the same level. This is why it is essential to learn scientific terms. Students can develop from a daily and intermediate level to an advanced and scientific one.

Nevertheless, some students can struggle with using new terminology while studying a subject. This may occur if a word has several meanings or if students interpret a word differently than they ought to.

For instance, students are often required to "estimate," "measure," "observe," and "describe" things in scientific studies. Not all students comprehend exactly what these phrases demand them to perform or have developed linguistic skills that make this possible. Also, words "weight" and "mass" do not have the same meaning [4].

In order to avoid misunderstandings in the future and effectively accomplish research, students should better comprehend the terminology that will be valuable for them in the learning processes.

1.1.2 CLIL methodology in enrichment of scientific vocabulary range

CLIL is a method for teaching and learning language and content jointly. By assuming that students would study various disciplines in English rather than their native tongue, CLIL enables them quickly to recall the terminology and other vocabulary required for the course of study. Consequently, students are immersed into the scientific environment while also improving their language skills without any difficulty in comprehending the subject matter. For instance, it is

necessary to be familiar with simpler phrases which are related to the subject of biology to study medical terms that are on the list of the most frequently used. The term as **"Gland"** is defined by the sentence "A tissue or organ which produces a liquid for a certain purpose." [5]. To understand the meaning of the word "Gland" which may be used during medicine classes, students should understand what "Tissue" and "Liquid" words mean. Therefore, students that work and study in scientific fields need to acquire specific terminology, which is incorporated into the subject matter processes.

CLIL method has many benefits for both students and teachers. Students' motivation is increased by CLIL, because they consider language as a way to learn new, fascinating information. Through the acquisition of new vocabulary and cross-cultural communication abilities, this approach also helps students improve their language skills. Additionally, it provides a "real-life" experience [6].

According to Coyle, Hood, and Marsh, the development of knowledge, skills, and content understanding results in the integration of the four components of learning—content, communication, cognition, and culture [7]. Future language learning will require the learner to comprehend and apply the four main elements (or "4C").

Content: skills, knowledge, and comprehension development in connection to curriculum elements.

Communication is the process of acquiring a language while also using it to communicate.

Cognitive development is the method by which thinking skills link language, comprehension, and the formation of abstract and concrete notions.

Culture: exposure to conflicting ideas and common convictions that deepen one's awareness of self and other [8].

However, some teachers may experience difficulties while applying this method in class. While teaching students the subject might be confusing for language teachers, it can be challenging for content teachers to teach students in a foreign language [6].

In this situation, it is necessary to create a useful integrated learning system that is applicable for both students and teachers in order to facilitate quick and effective acquisition of the material.

1.1.3 The effectiveness of CLIL

In a thorough study conducted with 1033 CLIL students and 991 EFL learners in 53 public, private, and charter schools situated throughout twelve Spanish regions, Perez Canado concluded that there is unquestionably a difference in the language proficiency between CLIL and non-CLIL learners. At the last year of primary school, CLIL students succeeded in significantly higher test scores. By the end of middle school, the CLIL learners had significantly improved results in all linguistic domains, including writing, reading, speaking, and others.

Further investigation by Graaff et al. revealed that all students benefit from the growth of language compensating techniques as a result of the CLIL teaching approaches. A study written by Várkuti has confirmed similar aspects of the application of CLIL. According to a review of the data gathered for that study, the group using CLIL achieves language fluency outcomes 24% more favorably than the group that did not use CLIL, both in terms of academic and everyday vocabulary in English [9].

1.1.4 Bloom's taxonomy

A framework called Bloom's Taxonomy divides human cognition into six categories. These domains are listed in order of difficulty increasing, starting with the most basic level remembering information and ending with the most abstract and hardest level evaluating and making conclusions. The six levels are remembering, understanding, applying, analyzing, evaluating, and creating. Using Bloom's Taxonomy, teachers are able to create successful lesson plans and evaluations that will encourage students to learn and think critically.

Based on studies by Bloom and his team, 95% of the exam questions that students are given merely ask them to think at the most fundamental level. They consequently developed the taxonomy to provide guidance to teachers on how to aid students in the development of their cognitive capacities. The application of knowledge and abilities to a range of tasks and situations is encouraged by the usage of Bloom's taxonomy. This is because of its distinction between cognitive abilities and attraction of concentration to learning goals requiring higher order thinking abilities [10].

Universities and businesses that provide educational or employment opportunities expect their applicants to possess advanced abilities and knowledge of terminology that will be used in the areas they work in. Students must get started learning as soon as possible in order to develop them to a level that is sufficient.

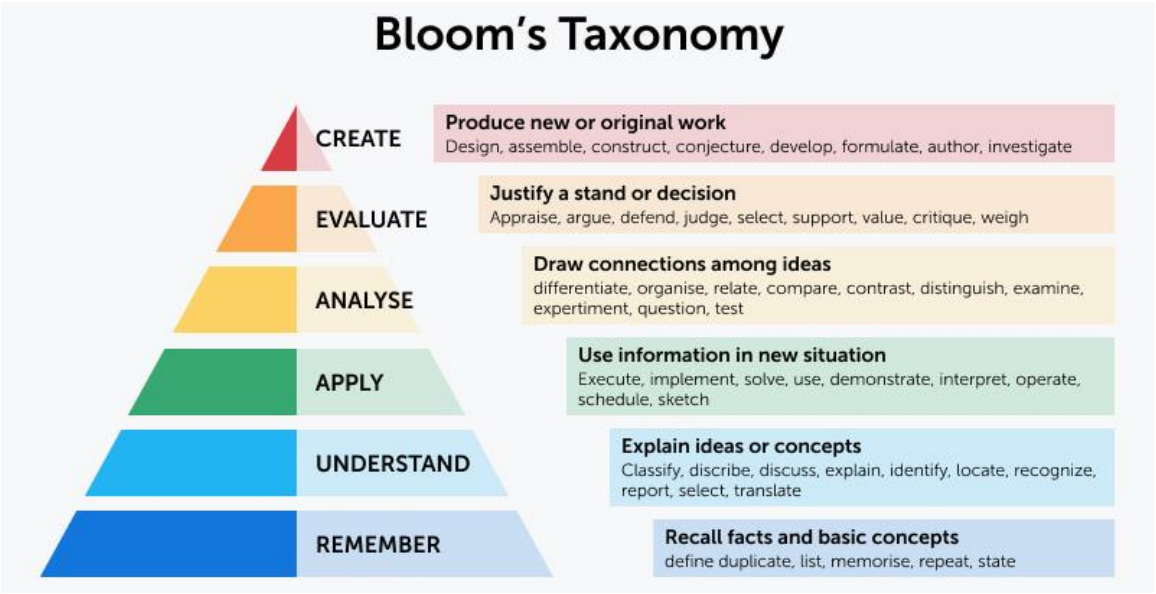


Fig. 1. Bloom's taxonomy [7].

Additionally, Krashen and Swain assert that language must be learned in context by reenacting the themes of the subject matter and the cognitive processes that go along with it, such as language intake and output [11]. Weizhen (Zane) Xie, Ph.D., a cognitive psychologist, believes that memories are ingrained in neural connections and are searched after by the human brain in a way similar to how search engines retrieve content online [12]. These calls for the development of a system of language instruction through the subjects that includes critical thinking and the context of "real-life" experience.

1. Methodology

1.1 Primary survey

A primary survey was conducted to collect information regarding the facts and approaches discussed above, such as integrated learning and the progressive development of students' skills. This information served as the foundation for further analysis. With it as a resource, it was feasible to identify the students' knowledge level and problem areas.

Exercises included three levels of skill, in accordance with Bloom's taxonomy and CLIL methodology in language learning. Firstly, students had to identify the correct translation for each word. They then had to fill all of the gaps with the missing terms in order to determine the word's context-specific use. Last questions requested learners to define the object by image without any help or possible answers.

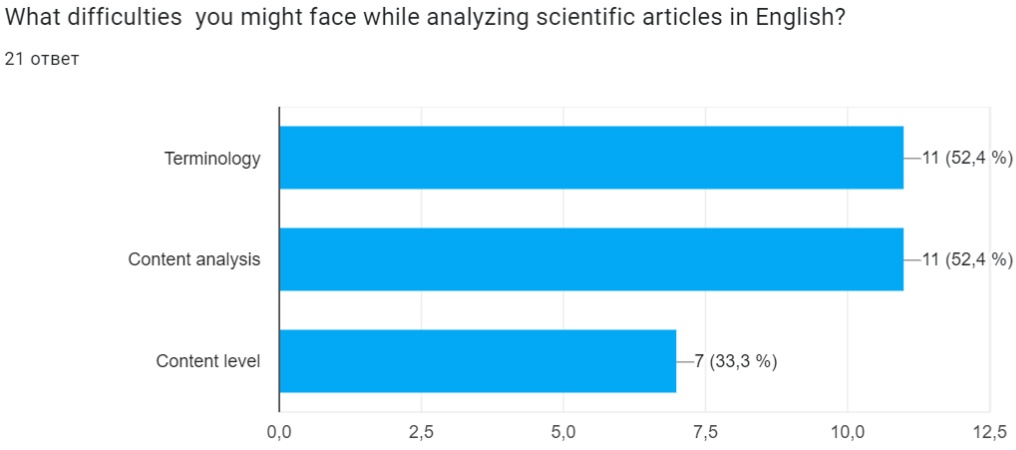


Fig. 2. Aspects of scientific articles analysis in which students might face problems.

Choose the missing word

Just as the stomach and intestines receive food and _____ it, so the brain receives impressions, analyzes it and has as its organic secretion, thought.

21 ответ

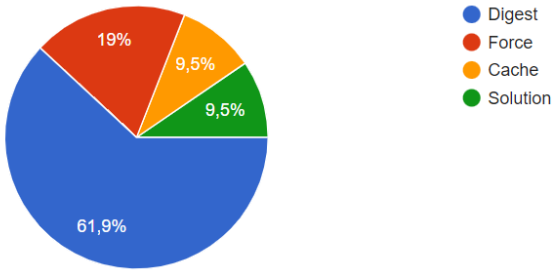


Fig. 3. First task with missing word from biology terminology.

Choose the missing word

During this time he specialized in computer programming and _____ software courses.

21 ответ

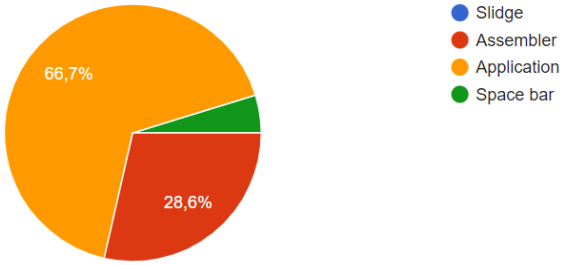


Fig. 4. Second task with missing word from informatics terminology.

Choose the missing word

A _____ is a push or a pull and a product of the interaction between two objects. It is a vector quantity, which means it has both magnitude and direction.

21 ответ

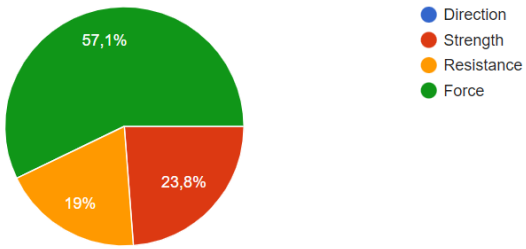


Fig. 5. Third task with missing word from physics terminology.

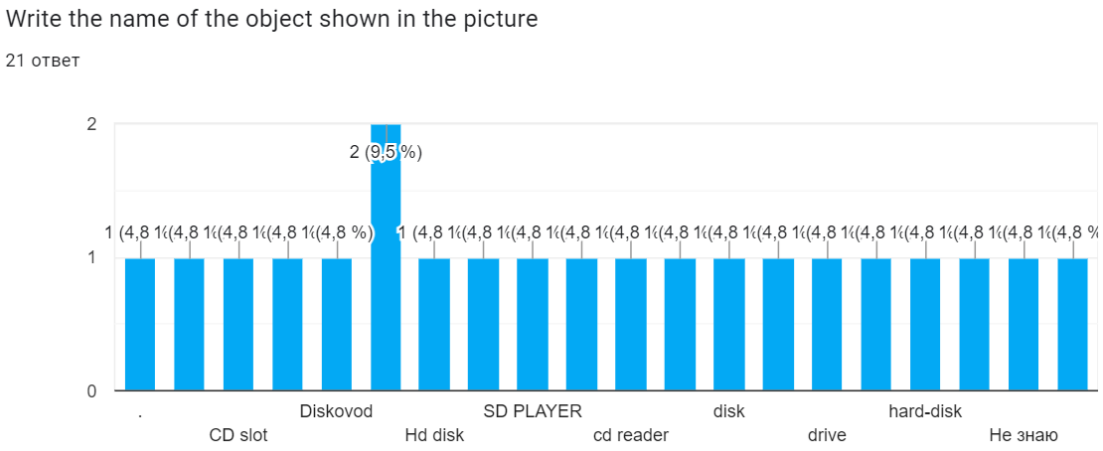


Fig. 6. First task of finding definition of the word by picture.

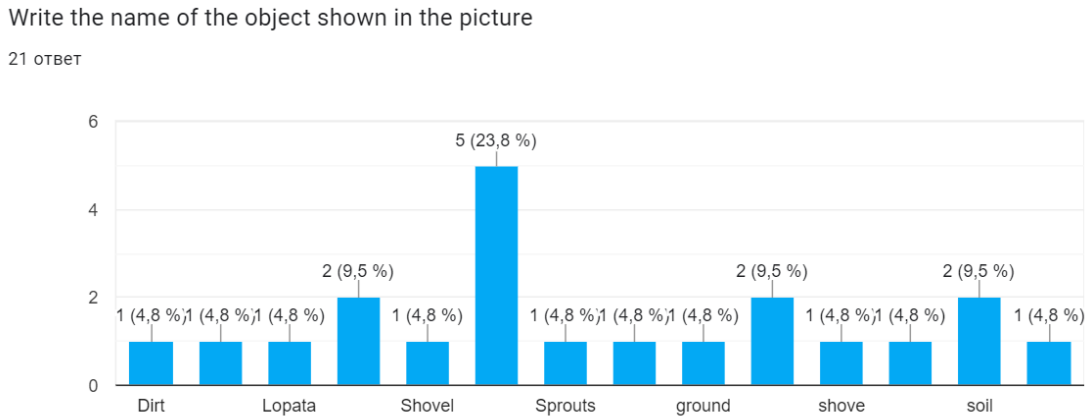


Fig. 7. Second task of finding definition of the word by picture.

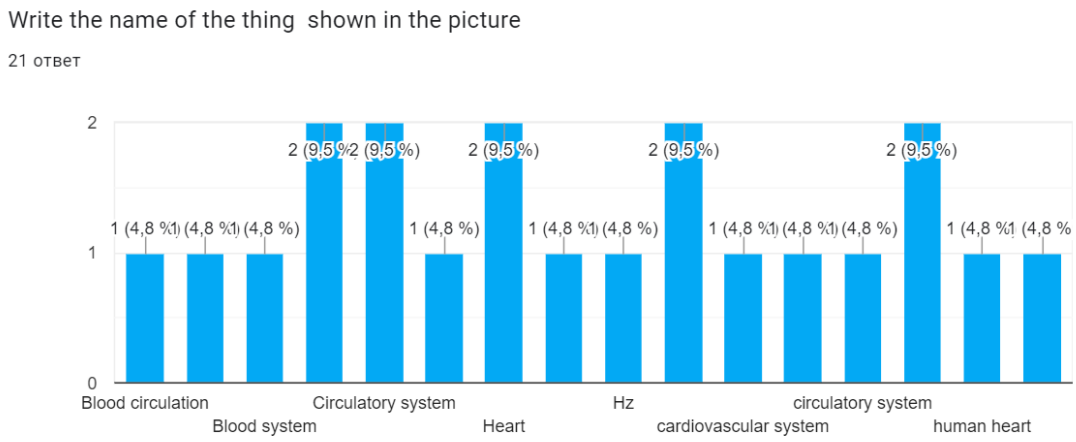


Fig. 8. Third task of finding definition of the word by picture.

Based on the primary survey results, we concluded that students have some foundational knowledge of certain terms, but they have difficulty with using them in later stages, that require high order thinking. The average score for the assignment in which students had to find the missing word was 61.9%. (Fig 3, 4, 5) The average score of a task that required students to identify a term based on picture was only 28.5%. (Fig. 6, 7, 8), including average score on the first task, average percent on all assignments was 58,6%. Students encounter difficulties with determining objects on their own without assistance and find it complicated to apply the phrases in context. This shows that their abilities are only at

the fundamental level of Bloom's taxonomy, or "Remember." However, most of the time, assignments and circumstances in educational and professional institutions require a person to employ their critical thinking and memorization skills. The project's objective is to strengthen both the ability to produce original content and the ability to use scientific terminology in context.

1.2 Experiment

2.2.1 Scientific thinking methodology

In order to get better results and teach students how to use their knowledge in practice, it was determined to improve their skills in accordance with Bloom's technique and CLIL approach. Bloom's taxonomy will allow students to effectively achieve the result in the form of "4C" skills according to the methodology of CLIL. We named the chosen combined method a "Scientific thinking methodology".

Fig. 9. Scientific thinking methodology.

This strategy enables students to achieve the requirements they'll need in their future lives and careers. Students will be educated with the necessary 4C skills through the gradual development of high-order abilities, which will allow them to think critically and globally. Students initially recall facts and vocabulary from the chosen subjects. Then, in order to remember the words better, they practice applying terms practically and in context. Students subsequently develop their abilities until they can finally use language and produce content independently.

2.2.2 Website creation

This website (https://projectnis.vercel.app/) is a project created using a variety of technologies and programming languages. It utilizes Angular [13], JavaScript (JS) [14], TypeScript (TS), HTML, CSS, Spring Boot, and various other frameworks. It's designed to be multilingual and incorporates OPENAI's chatbot [15], [16].

To integrate the GPT-3.5 chatbot into the website, we used OPENAI's API and metadata. This allows the website to interact with artificial intelligence and provide answers to user questions. Users can take tests, and the architecture ensures scalability and reliability.

The testing section comprises three main routes: Physics, IT, and Chemistry/Biology, where questions progressively become more challenging from one question to the next. The development phase spanned four weeks, and the research and preparation for study materials took three months. Overall, it represents a versatile web project for both educational and entertainment purposes.

Students were first instructed to memorize the topic terms as part of the first phase, "Term's memorization and comprehension". Then, multiple-level activities were made for each subject, applying the methodology.

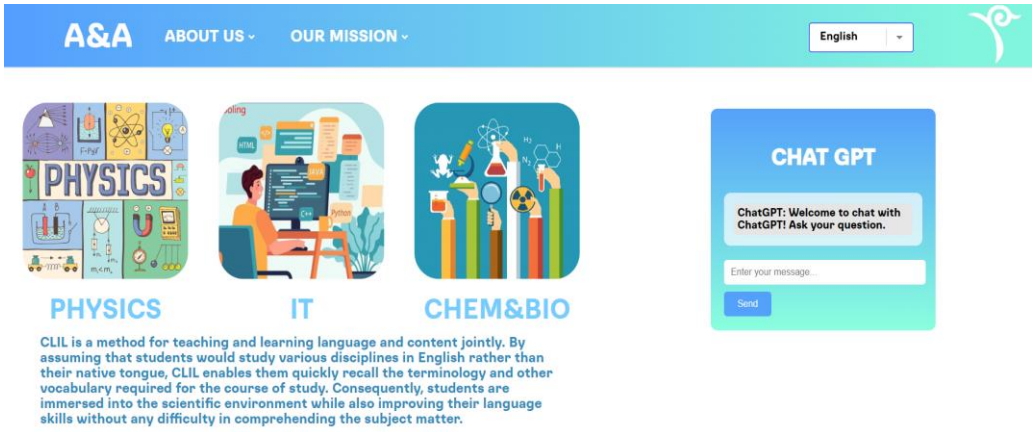


Fig 10. Website's main page.

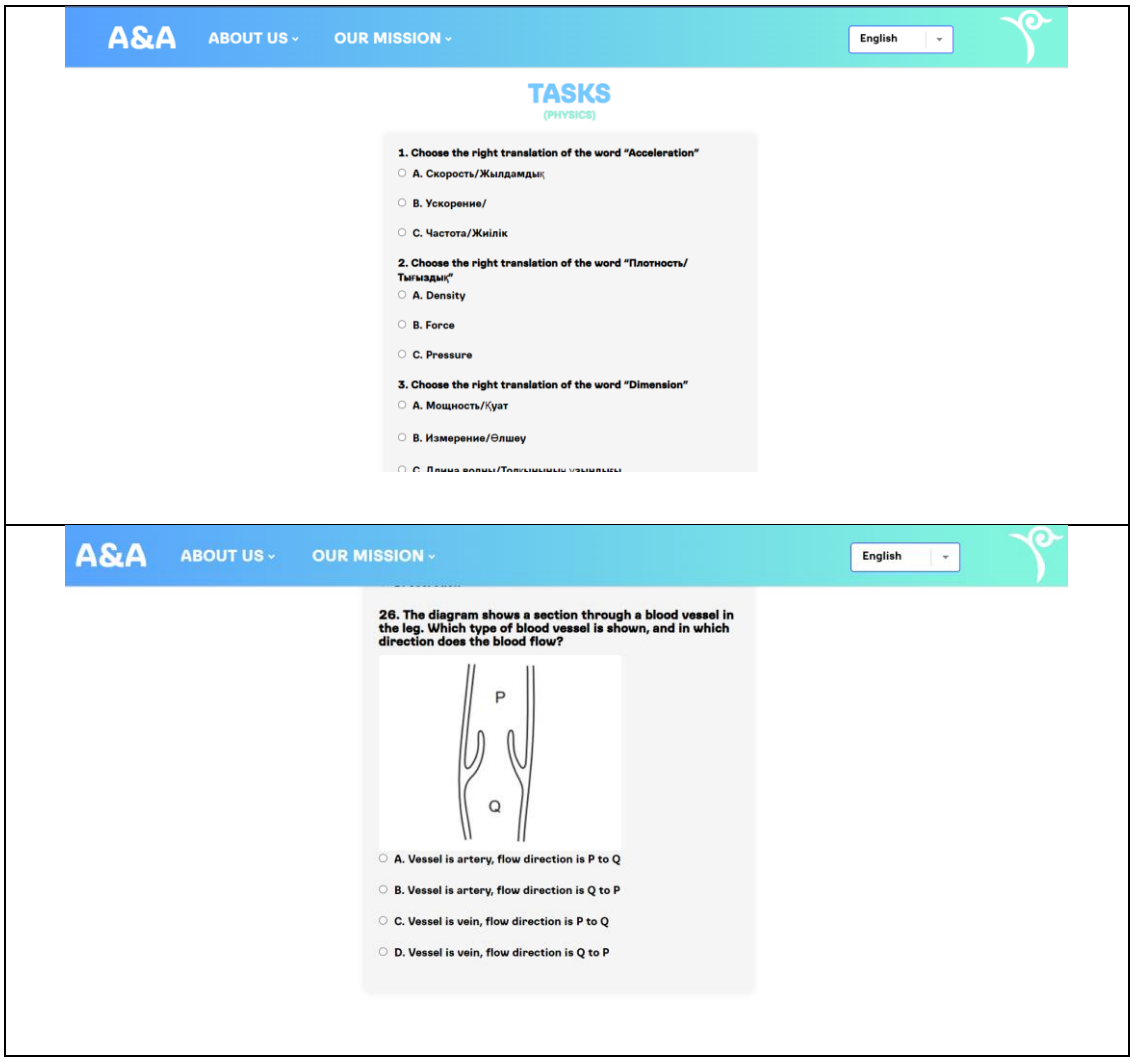


Fig 11. Examples of tasks on the website.

Five test questions pertaining to the "Use of terms in assignments" stage were included in the first level. Next five questions required students to identify missing words in sentences about the topic, thus, developing their second skill- "Analysis and synthesis of ideas". Many people firmly believe in the method known as "sentence mining"—learning collections of complete sentences. People assert that since they memorize the grammar and typical applications from the beginning, it helps them employ new words more quickly [17], [18]. Last five are questions on subject itself. They refer

to “Ability to draw conclusions, criticize” step. These assignments, which were based on the academic school assignments [19] allow students to practice their knowledge in integration with the subject matter.

The Chat GPT bot is the final component of the structure. Due to the last step of the scientific thinking method, it enables students to practice their knowledge at a high level, engage in critical thinking, as well as create new content.

In addition, the website’s layout satisfies the requirements for using colors most effectively in learning process. Ball State University students claim that blue is a color that can make people more likely to engage in imaginative activities and strive for success [20]. Wilson suggested employing passive colors (cool colors like blue and green) to relax students [21].

2.2.3 Experiment process

We assembled students from various classes, schools, and cities to conduct the experiment in the most honest and efficient way possible. Their level stayed the same, despite the age gap, making it feasible to observe them learn scientific terms throughout the study.

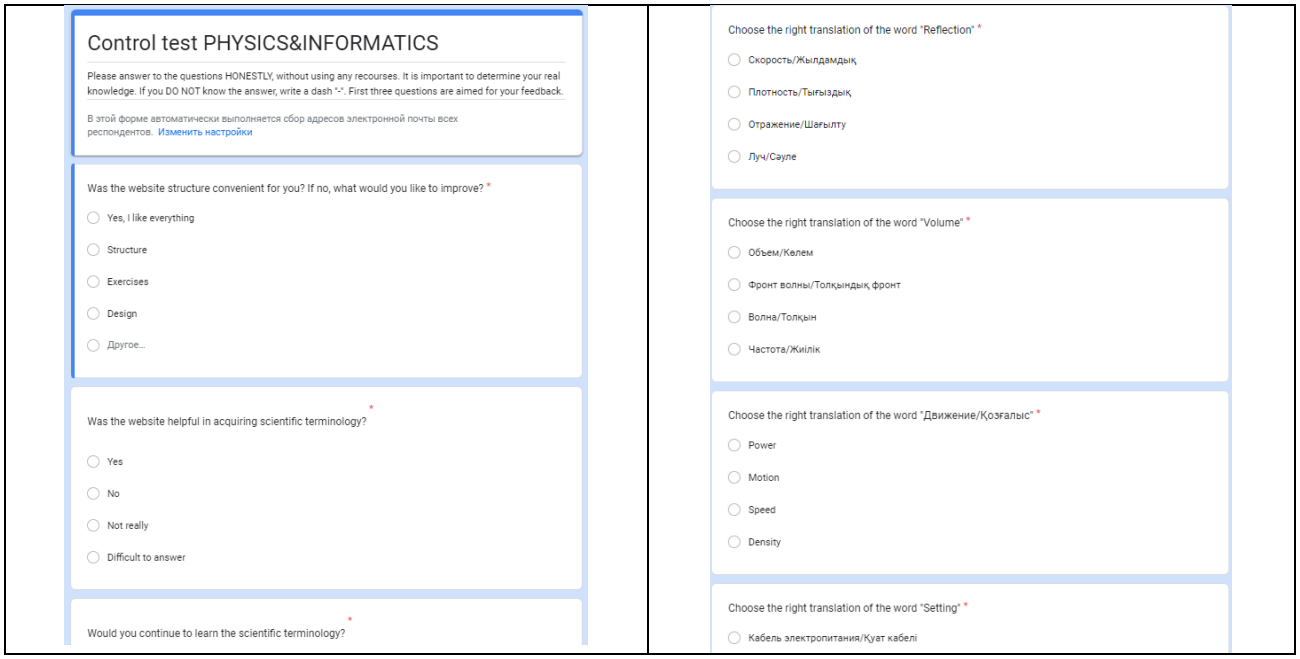
Students were given a week to study and memorize terminology. This amount of time was sufficient for them to retain these concepts in their short-term memory because it takes the average individual up to a minute to memorize a word. The exercises that students performed helped them to remember the terminology for a long time, by executing the precise repetitions and context usage of the word that are necessary for its retaining [22].

In order to compare the final results with the initial research, students were also given a comprehension test after the assignment's completion.

2. Findings

2.1 Control tests

The exercises in the control test were identical to those in the initial test, with the exception that there were now five exercises per level and level 3's objectives required students to employ critical thinking skills rather than only their comprehension of the "Use of terms in assignments" level. This test, which students took after finishing tasks on the website, allowed us to assess whether students had advanced or, conversely, regressed in their skills and knowledge.



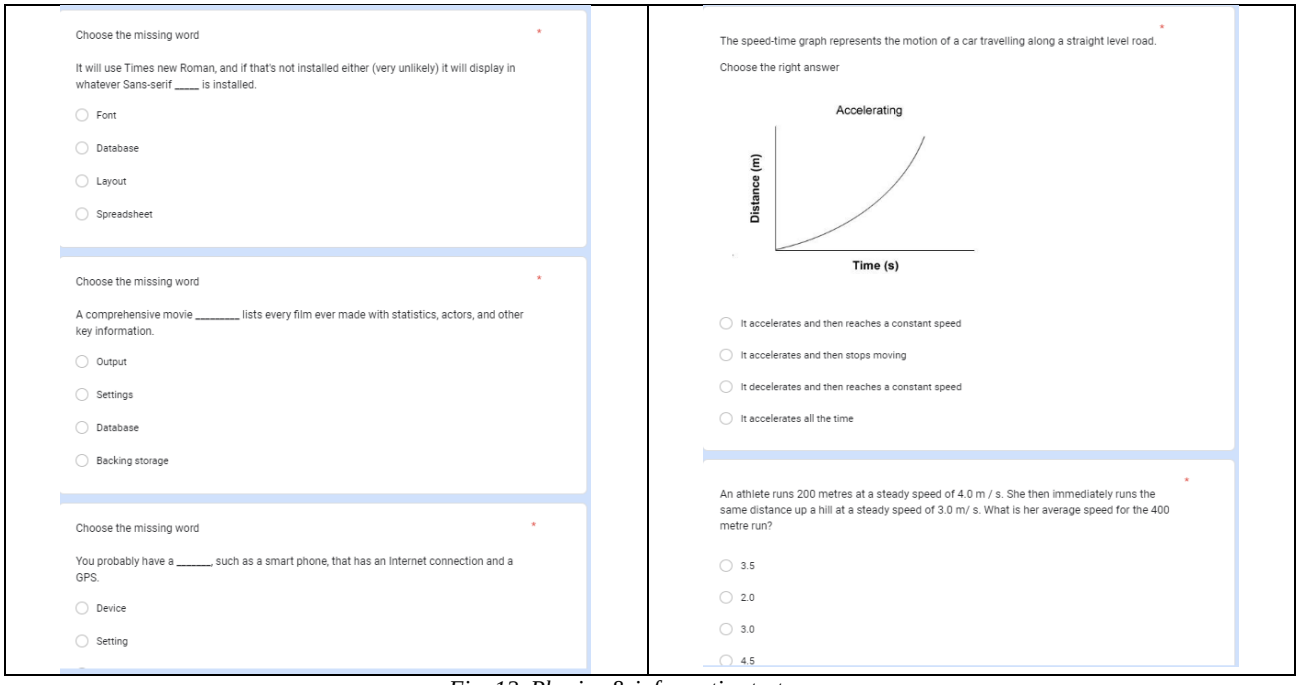
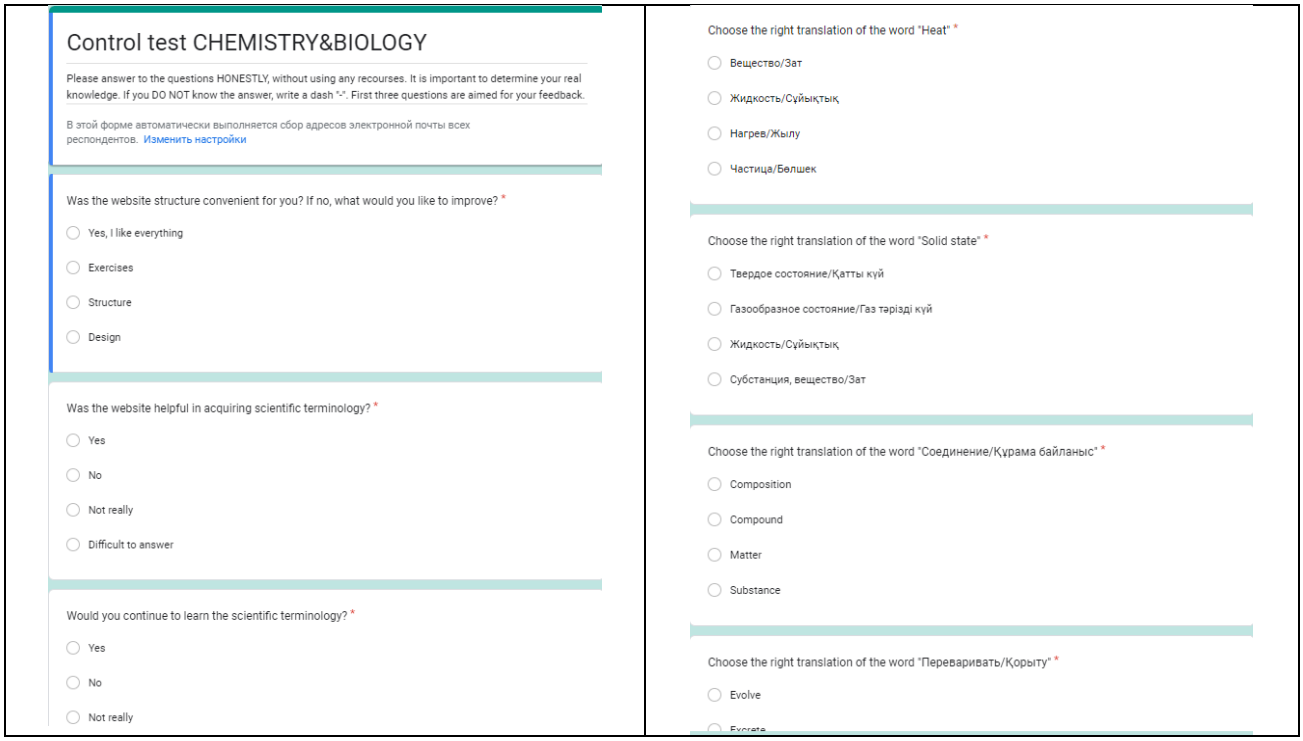


Fig. 12. Physics & informatics test pages.



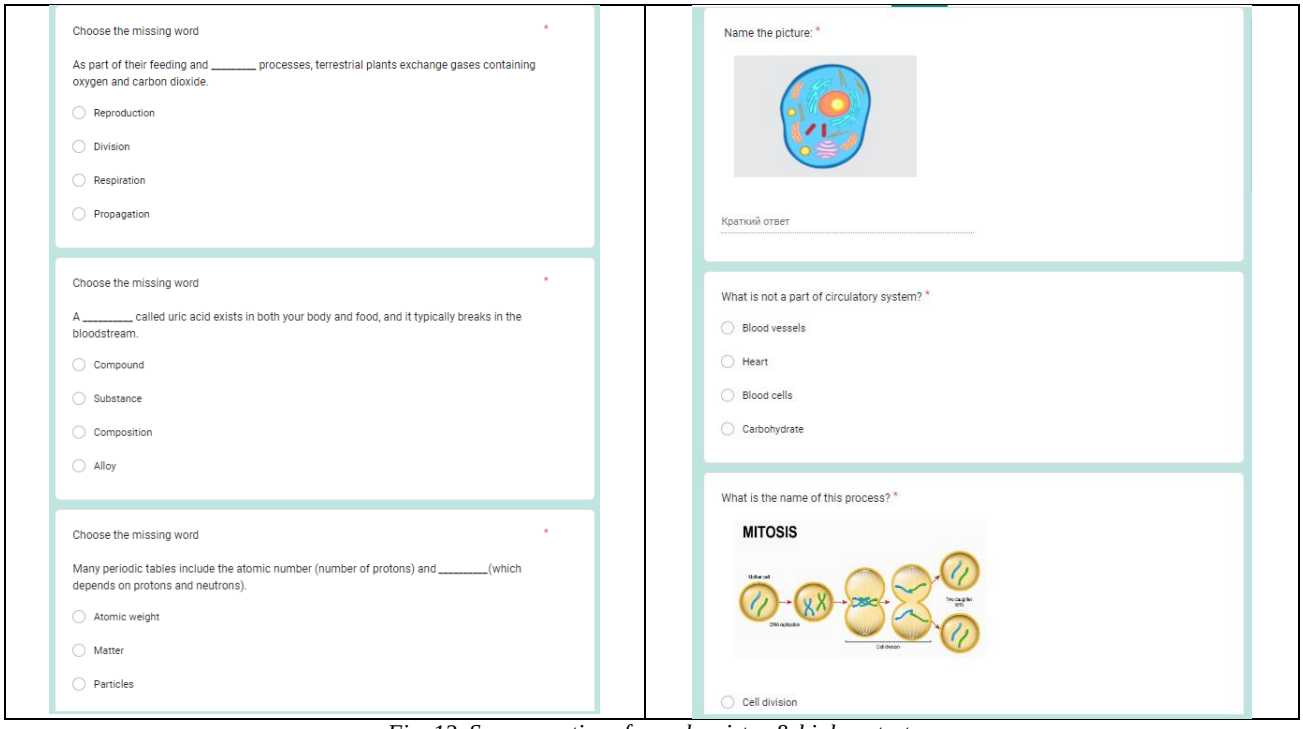


Fig. 13. Some questions from chemistry & biology test.

3.2 Results&Statistics

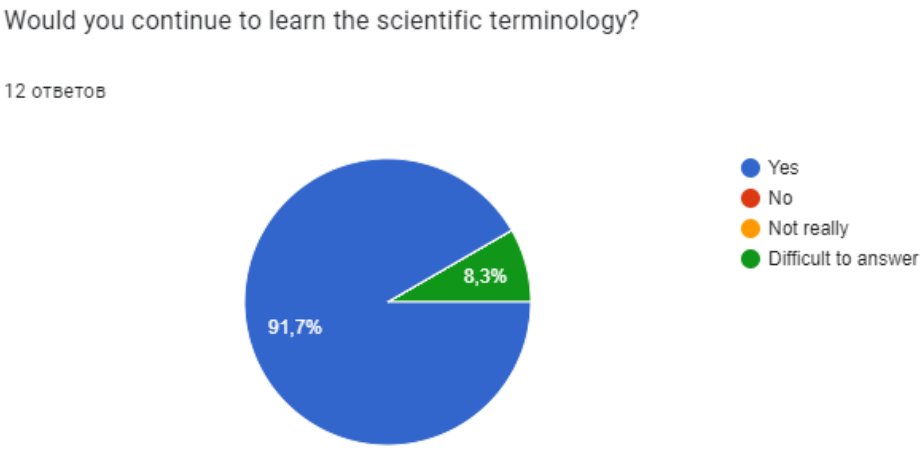


Fig. 14. Answer to the question "Would you continue to learn the scientific technology?"

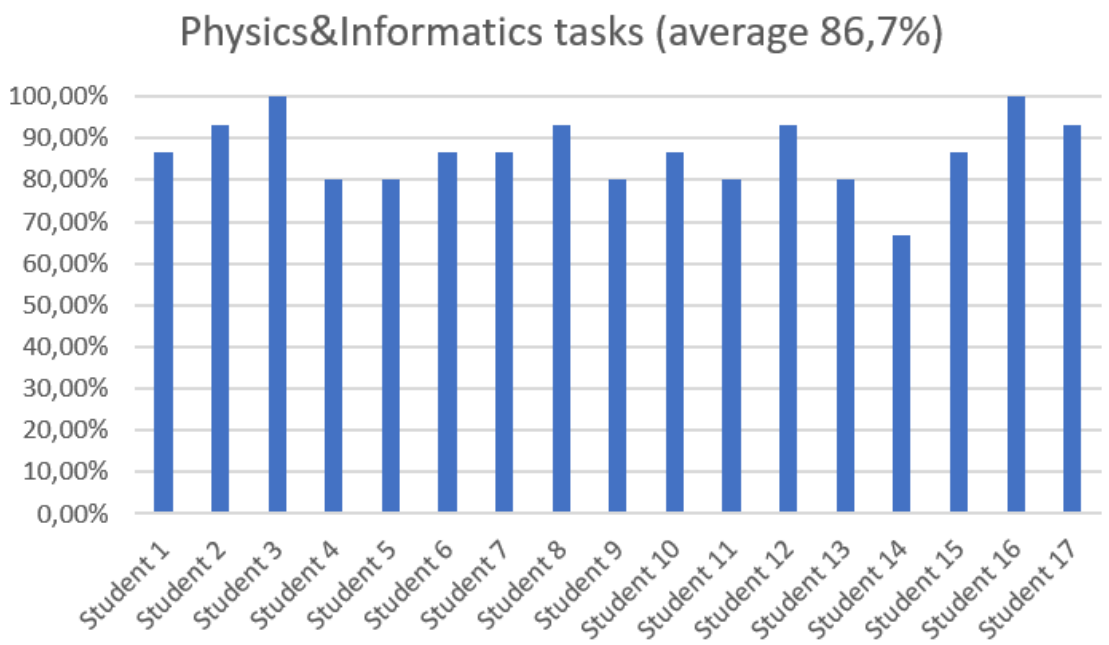


Fig. 15. Results of a group of students who chose physics and computer science.

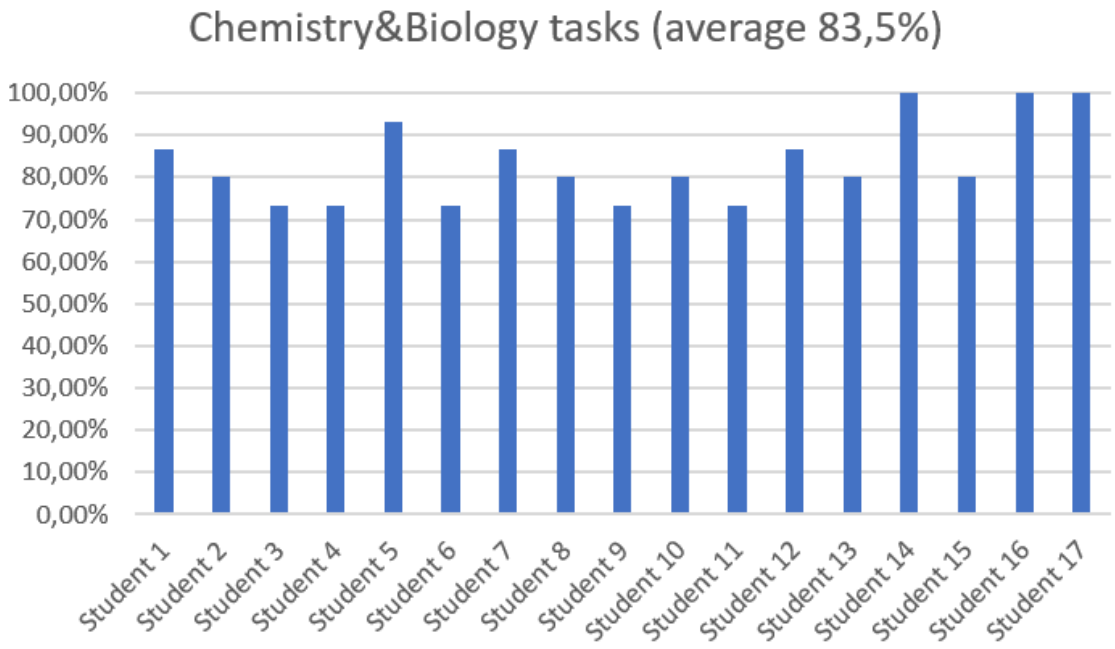


Fig. 16. Results of a group of students who chose chemistry and biology.

3. Evaluation

Having compared primary study and experiment outcomes made by students showed major improvements. Considering that the primary assignments were less difficult than on the website and that there were solely three questions per level, the results of solving assignments including scientific terminology for students with no prior training came to a total of 58.6% of correct solutions. After completing the practice exercises, students' test scores after finishing the practice tasks averaged 86.7% and 83.5%. These results demonstrated that the website had a great impact on students' knowledge and higher order thinking abilities, indicating that it can be utilized for educating people in the usage of scientific language.

The mean score for the task in which students were required to find the word that was missing rose from 61.9% to 76.46%. The average grade for a task in which students had identified a term from a picture and solve subject-matter

tasks rose from 28.5% to 85.89%. This demonstrates how more sophisticated abilities like "Ability to draw conclusions, criticize" can be significantly enhanced with the right education in specialized vocabulary.

The sole aspect that might require improvements is more particular terminology, which will be added to the website with its future development.

4. Conclusion

The major aim of this project was to use a particular website to help people develop their ability to work efficiently in the scientific field and to prepare them for lifelong learning.

The project's goals were all accomplished, data for the website's design was acquired and reviewed, and a website with an understandable layout and useful practice tasks was created. The outcomes of the students and their advancements in specialized vocabulary knowledge have demonstrated the effectiveness of the website integration into the learning processes. The results of the study showed that with the help of the website and the selected vocabulary approach, the established problem—a lack of resources required to study specialized terminology and the need to develop scientific thinking skills could be solved partially. As a result, we can claim that the project hypothesis was confirmed based on all the research that was conducted.

There will always be a need for new ideas and techniques to improve scientific thinking, the development of research platforms, and the extension of specialized vocabulary. The process of learning a language requires constant improvement and engaging activities. The study of scientific vocabulary and the scientific thinking technique are highly helpful in the processes of learning language and subject matter. This research is awaiting additional development since the findings of this investigation and the techniques employed are encouraging.

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