European Journal of Contemporary Education
E-ISSN 2305-6746
2023. 12(1): 28-39
DOI: 10.13187/ejced.2023.1.28
https://ejce.cherkasgu.press

European Journal of Contemporary Education

ELECTRONIC JOURNAL

Teaching English for Special Purposes to Bachelors of Engineering and Technology: Corpus Approach and Terminological Units

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Abstract

This article deals with application of the corpus approach in ESP teaching to Bachelors of Engineering and Technology in order to reach their research goals of finding and selecting authentic language contexts, analyzing and classifying grammar structure, making conclusions about grammar environment of the terminological units, selecting the best translation method and enriching their basic terminological vocabulary. Work with the text corpus as the source of comprehensive information about actual use of terminological units can be treated as the backbone in searching for empirical and supportive material about various grammatical environments of the terminological units and further use of such information to make foreign language learning more effective. Work with the authentic text corpus develops skills of correct use of terminological units and ensures management of the learning outcomes level thanks to a vast array of examples found in the natural context environment used by native speakers. The educational experiment included three stages (introductory, operational and final); introductory and final tests, analysis and processing of the statistical learning data. In the course of the educational experiment, the experimental group of bachelors was taught to work with the corpus data and analyze the grammar environment of the terminological units, in addition to other available classical educational methods and learning aids. The outcome of the experimental learning included great improvement in information coverage when translating professional texts, correct use of terminological units in grammar structures, and terminological vocabulary enriched with characteristics of grammar environment of a term in a professional context.

Keywords: corpus-based approach, grammatical environment, ESP course, translation.

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1. Introduction

Nowadays, educationalists engaged in theory and methods of teaching English are diligently looking for the ways to upgrade learning methods in order to match modern goals of higher education. Therefore, we need to pinpoint new approaches to learning content development and find a more effective way to overcome a large gap between the contents in the ESP textbooks and the real engineering discourse of the native speakers. For instance, Russian technical universities allocate lots of face-to-face hours to analysis of formal grammar rules and phenomena; however, most often, grammar exercises do not ensure any practical use of professional terms in grammar structures of the engineering discourse. In the recent decades, Russian and foreign researchers in the field of learning content and quality of specialized learning have been concentrating on information (Chitez et al., 2020; Valeeva et al., 2019; Murzo et al., 2019; Gerasimova et al., 2020) and corpus resources (Boulton, 2016; Boulton et al., 2017; Ma et al., 2022). A turn to those resources provides comprehensive reference data (Rogers et al., 2021; Durovic, 2021) about use of terminological lexical units (Skornyakova et al., 2021; Vinogradova et al., 2020) and grammar structures (Brooke, 2022) in the natural language environment, thus contributing to a higher quality of translation and deepening the insights into the norms of modern language.

Another important aspect of upgrade in the modern Russian higher technical education, which is embodied in the educational standards, is a focus on independent students' research. Its key goal is development of lexical and research competencies in students of engineering programs (Bakirova, 2021; Goman, 2019; Pushmina et al., 2022; Sveshnikova et al., 2022). So, corpus-based learning can be treated as student-centered, ensuring a shift from an inductive to a deductive approach. The teacher acts here as a research consultant, who guides and coordinates language corpus data learning; while students, as subjects of the learning process, are to deal with corpus data by themselves and develop independent learning skills. This paper studies application of the corpus approach in teaching ESP to Bachelors of Engineering and Technology in order to reach their research goals of finding and selecting authentic language contexts, analyzing and classifying grammar structure, making conclusions about grammar environment of the terminological units, selecting the best translation method and enriching their basic terminological vocabulary.

2. Theoretical background

The main way of using corpus approaches in teaching foreign language is Computer-Assisted Language Learning, which uses corpus linguistics techniques (Lacková, 2021; Ma et al., 2021) and applies a methodology based on collection and study of language data – Data-Driven Learning. Long-term benefits and importance of this methodology are widely discussed in papers of foreign and Russian authors (Lin et al., 2015; Crosthwaite, 2017; Rudneva, 2020). Topical nature of this approach, especially in terms of modern requirements to higher education in Russian colleges, can be proved by the fact that independent research encourages students to get continuous learning through the use of information technologies. For instance, the theory is apprehended through quantitative and qualitative analysis, when working directly with the original linguistic data in natural contexts derived from the text corpus (Sun, 2022). Investigating grammar environment of the term in a certain context, students guess its meaning and representation in the language, and reinforce this knowledge by doing relevant tasks. In this way students act as researchers, learning to understand grammar environment of the terminological units, make independent conclusions about grammar environment with reliance upon linguistic material, and use the terms in speech. This approach makes the learning process student-oriented (Jablonkai et al., 2020).

It should be noted that even a complete and detailed list of terminological units does not dismantle the issue of correct translation and use of a term in a foreign-language sentence. In this regard, it is especially difficult to deal with specialized engineering and scientific discourses presented by the texts that engineering students study throughout the whole training period at a higher educational institution (Borisova et al., 2020; Pushmina et al., 2021; Rogova et al., 2020). When translating such texts into a foreign language, students face many obstacles, like no analogues of some grammar structures, or different grammar environments of the terminological units, misuse of which distorts the content.

Application of corpus techniques aimed at understanding characteristics of grammar environment of terminological units provides ample opportunities for ESP teachers. Regrettably, nowadays this approach is not widely popular in higher technical educational institutions of

Russia, which still focus on classical methods of ESP learning that omit use of modern information technologies. Apart from terminological units and complex nominal constructions profession-oriented engineering and scientific texts have complex grammar structures.

The corpus approach allows students to make a lexical and grammatical profile of terminological units, taking into account their possible contexts, i.e. grammar environment; while concordance line ensures understanding of grammatically correct use of terms in speech. Students have a chance to study grammar environment of terminological units independently, see how a specialized term functions in its real contexts, develop lexical and grammatical language skills, as well as skills of information analysis and further conclusion drawing, thus bringing their language proficiency in line with the required standards. In teaching ESP to engineers-to-be, authenticity and reliability of information plays an important role, since classical textbooks often contain artificial clichés, fabricated by a resourceful teacher or textbook author, however, such phrases are far from accurate and real native-speaking structures.

The hypothesis of the study is formulated as follows: use of corpus techniques aimed at studying characteristics of grammar environments of the terminological units in ESP teaching ensures greater efficiency of foreign language learning for Bachelors of Engineering and develops their professional skills. The learning goal is to develop skills in analyzing text material and identifying key information, including terminological units, skills in searching for and analyzing grammar environment of terminological units in the language corpus, skills in translating specialized texts, taking into account grammar environment of terminological units. The learning objectives included learning to identify terminological units, search for and analyze characteristics of their grammar environment, translate them in accordance with such characteristics and enrich the basic terminological vocabulary with data about grammar environment of the terms.

3. Materials and methods

Experimental ESP learning was performed at Saint Petersburg Mining University under the curriculum of the second-year bachelors, and was initiated in order to validate effective use of corpus techniques aimed at studying characteristics of grammar environment of the terminological units. The study included 160 students who studied the course of General English for two academic semesters (2021–2022 academic year) with proven English proficiency of "upper – intermediate" (there was no special selection into experimental and control groups apart from English proficiency level). The students were divided into control and experimental groups by using the stratified sampling technique; so that each group includes students of 6 academic majors. Then we used simple random sampling to sample from each academic major. It should be pointed out that in this study we did not take into account the gender of students either when dividing them into the control and experimental groups, or when making calculations; the gender is mentioned below for reference only. The control group contained 80 participants, with 49 male and 31 female students, the experimental group included 80 participants, with 43 male and 37 female students. Linguistic learning materials were derived from the corpus of engineering texts -Hong Kong Engineering Corpus (HKEC) and Russian National Corpus (RNC) using quantitative and qualitative methods for studying concordance lines. Experimental ESP learning was applied to majors as "Electronics and Nanoelectronics", "Metallurgy", "Civil Engineering", "Oil and Gas Engineering", "Ecology and Nature Management", "Chemical Technology". Experimental learning included three stages (introductory, operational and final), introductory and final tests, analysis and processing of the statistical learning data.

During the educational experiment, bachelor students of the control group were taught under a traditional approach, through classical learning and teaching aids; while, bachelor students of the experimental group were taught to work with corpus data, analyze grammar environment of the terminological units, in addition to other available classical educational methods and learning aids. Students did assignments aimed at translating a specialized text; they were asked to identify terminological units in the corpus, search for characteristics of their grammar environment, select the best option and translate the terms, and enrich the basic terminological vocabulary with the data about grammar environment of terminological units. At the final stage of training, the students were asked to refine this algorithm by giving a research task for their peers and acting as an expert for peers.

The algorithm of experimental learning can be described by three stages in the model of corpus analysis of grammar environment of a term and is presented in Figure 1.

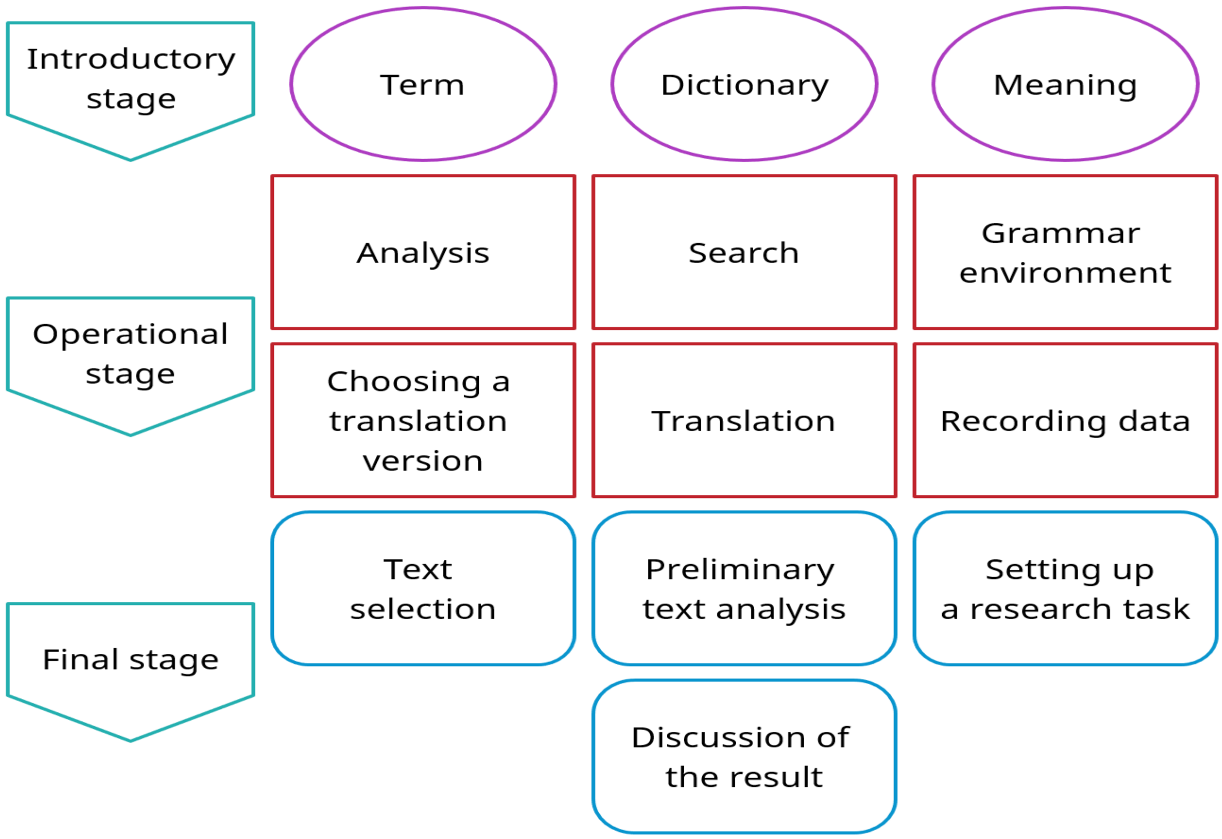

Fig. 1. The model of corpus analysis of grammar environment of a term
Compiled by Stepan Boyko.

Below we will consider each stage of the proposed model:

Introductory stage:

Identify professional terms in the original text.

Read available basic terminological vocabulary and specialized dictionaries.

In accordance with the list of meanings therein, select the most appropriate one in the given context.

Operational stage:

Analyze grammar environment of the term in the context of the original sentence.

Search for a term in the corpus.

In accordance with frequency of use, identify typical grammar environment of the term in the concordance lines.

In accordance with corpus data about grammar environment and meaning of the professional term selected at the introductory stage choose the most accurate translation version.

Translate the sentence containing the term, taking into account the data above.

Record data about characteristics of grammar environment of a term into the existing basic terminological vocabulary.

Final stage

Provide students with an opportunity to select original texts with various professional terms independently.

Provide students with a preliminary opportunity to analyze and translate such texts, following the proposed algorithm in the introductory and operational stages, and record characteristics of grammar environment of the terms in such texts.

Provide students with an opportunity to set a research task for translation in accordance with the introductory and operational stages, acting as experts for peers.

Discuss translation results and characteristics of grammar environment of a term.

The resulting translation must meet requirements of complete information coverage, correct use of grammar structures, use of relevant style in the professional context, including terminological units.

Translations were assessed by the following parameters:

The task was considered as "failed" if only 20 % of the text was translated. Number of correctly used grammar structures of the text was equal to 20 %. Number of correctly translated professional terms in the text was equal to 20 %. Cases added to the basic terminological vocabulary from all data about characteristics of grammar environment of terms in the text were equal to 20 %.

The task was considered to have been completed "satisfactory" if only 50 % of the text was translated. Number of correctly used grammar structures of the text was equal to 50 %. Number of correctly translated professional terms in the text was equal to 50 %. Cases added to the basic terminological vocabulary from all data about characteristics of grammar environment of terms in the text were equal to 50 %.

The task was considered to have been completed "good" if only 80 % of the text was translated. Number of correctly used grammar structures of the text was equal to 80 %. Number of correctly translated professional terms in the text was equal to 80 %. Cases added to the basic terminological vocabulary from all data about characteristics of grammar environment of terms in the text were equal to 80 %.

The task was considered as "excellent" if all 100 % of the text was translated. Number of correctly used grammar structures of the text was equal to 100 %. Number of correctly translated professional terms in the text was equal to 100 %. Cases added to the basic terminological vocabulary from all data about characteristics of grammar environment of terms in the text were equal to 100 %.

The original grades received by students of the control and experimental groups were summed up based on results of the introductory and final tests, and the sum was used to calculate the arithmetic mean. In order to check equality of mean values, of the introductory and final tests, we used a paired T-test, which included all grades received both in the control and experimental groups of bachelors. We calculated p-value in order to test correctness of the null hypothesis, and checked significance of the results. The null hypothesis was formulated as follows: the mean value of the expected difference between the two groups is zero for the introductory and final tests: $H_0: \mu_d = \mu_0$; $H_1: \mu_d \neq \mu_0$

T-value was calculated according to the formula:

$$t = \frac{\bar{X}_d - \mu_0}{S_d/\sqrt{n}} \quad (1)$$

Where:

$\bar{X}_d$ – average of differences;

μ_0 – expected difference between the two groups.

n - sample size;

S_d – standard deviation.

The effect size was calculated according to Cohen's d:

$$d = \frac{|\bar{X}_d - \mu_0|}{S_d} \quad (2)$$

4. Results

ESP Teaching was performed at Saint Petersburg Mining University under the curriculum of the second-year bachelors, which included 160 students who learnt for two academic semesters (2021–2022 academic year). The introductory test was made at the beginning of the academic year, in September 2021, while the final test was conducted at the end of the academic year, in June 2022. Students were trained in specialties of "Electronics and Nanoelectronics", "Metallurgy", "Civil Engineering", "Oil and Gas Engineering", "Ecology and Nature Management", "Chemical Technology" (Table 1)

Table 1. Distribution of students in the control and experimental groups

Speciality	Control group			Experimental group		
	Total number	Male	Female	Total number	Male	Female
Electronics and Nanoelectronics	15	9	6	15	12	3
Metallurgy	12	10	2	13	7	6
Civil Engineering	13	5	8	14	12	2
Oil and Gas Engineering	15	11	4	12	5	7
Ecology and Nature Management	14	6	8	12	3	9
Chemical Technology	11	8	3	14	4	10
Total	80	49	31	80	43	37

The control group included 80 students, of which 49 were male and 31 female, with proven English proficiency of "upper – intermediate". The control group used only traditional teaching methods in the classroom. Below we consider the test results (Figure 2).

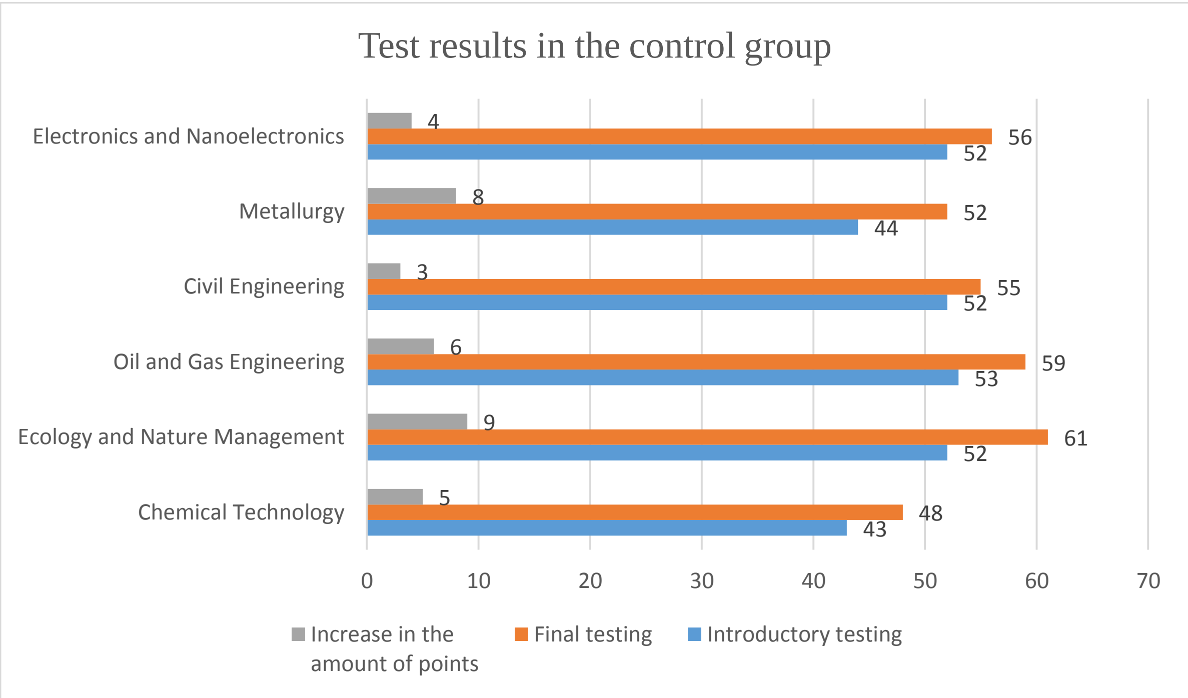

Fig. 2. Test results in the control group

Summarizing results of the introductory test in the control group, we get the total grade for all specialties as 296 points, in the final test it totals to 331 points, thus, we can see that the total figure for all Bachelors of Engineering increased by 35 points. We also witness a special increase among students of "Ecology and Nature Management" specialty.

The experimental group included 80 students, of which 43 were male and 37 female, with proven English proficiency of "upper – intermediate". In the experimental group, apart from traditional methods of ESP learning, we applied search for characteristics of grammar environment of a term in linguistic corpus. Below we consider the test results (Figure 3).

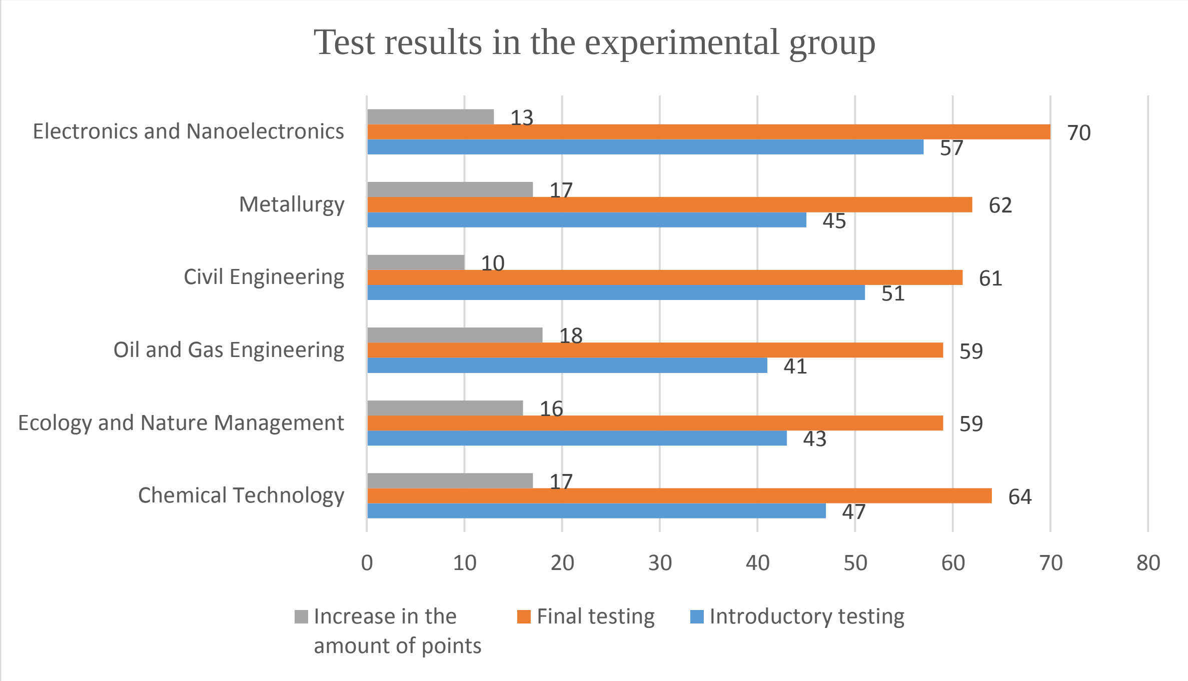

Fig. 3. Test results in the experimental group

Summarizing results of the introductory test in the experimental group, we get the total grade for all specialties as 284 points, in the final test it totals to 375 points, thus, we can see that the total figure for all Bachelors of Engineering increased by 91 points. We also witness a special increase among students of "Oil and Gas Engineering" specialty. Let's consider generalized grades of the introductory and final tests and their arithmetic mean (Table 2).

Table 2. Sum of grades and their arithmetic mean in the control and experimental groups of students in the introductory and final tests

Students	Introductory testing – sum of points	Final testing – sum of points	Increase in the amount of points	Introductory testing – average	Final testing – average	Increase in the arithmetic mean
Control group	296	331	35	3.7	4.1	0.4
Experimental group	284	375	91	3.5	4.6	1.1

As Table 2 shows, combining traditional methods of ESP learning with search for characteristics of grammar environment of a term in linguistic corpus contributed to a dramatic increase of the total figures and arithmetic mean in the experimental group compared to the control group. Let's consider results of T-test for the introductory and final tests (Table 3).

Table 3. Results of T-test for the introductory and final tests

Parameter	Control group	Experimental group
	Value	
P-value	2.29e-7	0
T-value	5.665	13.123

Sample size (n)	80	80
Average of differences ($\bar{X}_d$)	0.438	1.137
SD of differences (S_d)	0.691	0.775
Normality p-value	5.06e-9	1.32e-7
Effect size (d)	medium, 0.63	large, 1.47

The data in the table was represented in Figure 4 for the control group, and in Figure 5 for the experimental group.

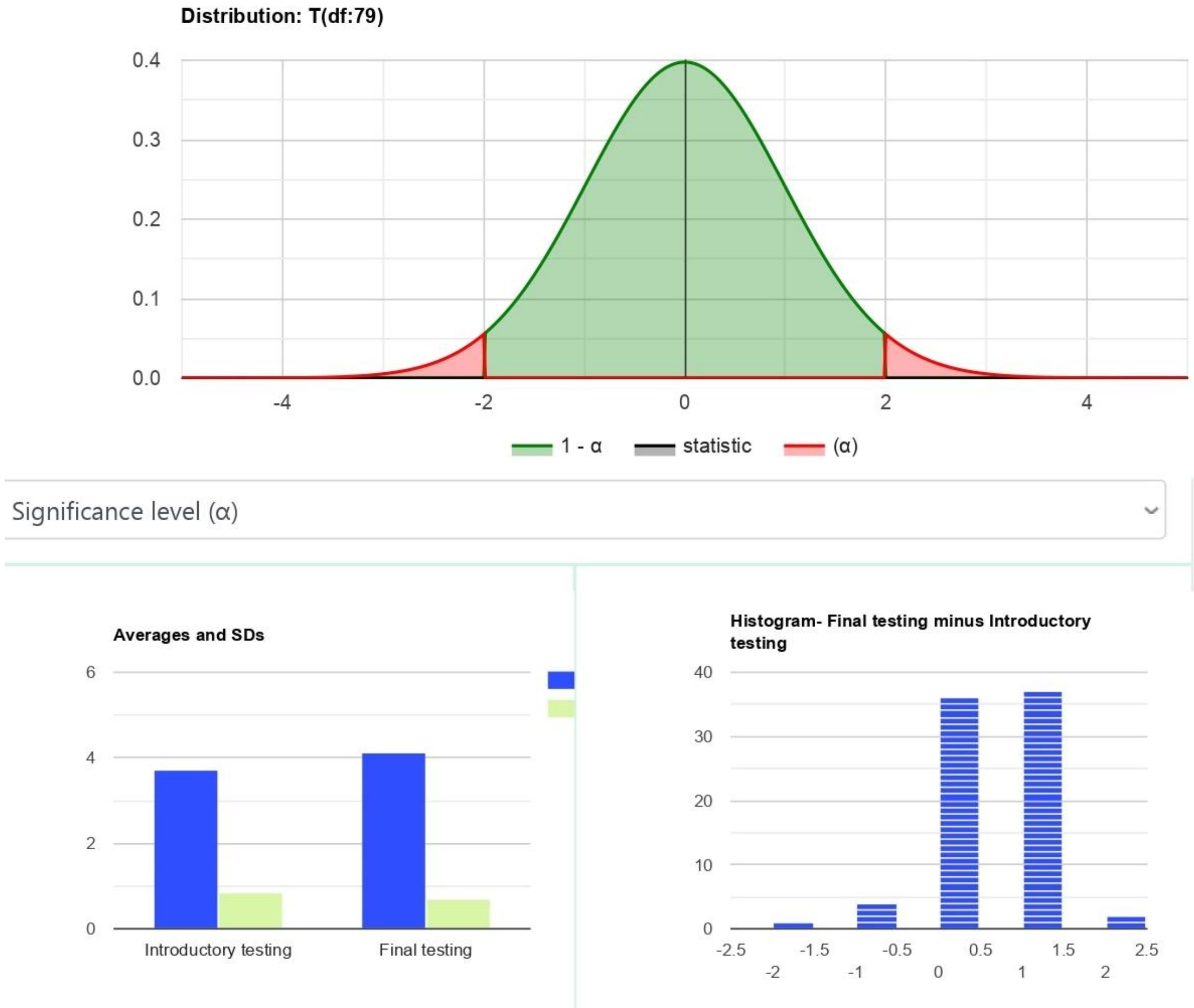

Fig. 4. Results of the paired T-test of the control group for the introductory and final tests.

Results of the paired-t test indicated that there is a significant medium difference between introductory testing with M (means) = 3.7, SD (standard deviation) = 0.9, and final testing with M = 4.1, SD = 0.7. T - value (79) = 5.7, p < 0.001. The test statistic t-value = 5.665, which is not in the 95 % region of acceptance: [-1.99, 1.99]. The 95 % confidence interval of final testing minus introductory testing is: [0.284, 0.591]. The observed effect size d is medium, 0.63. This indicates that the magnitude of the difference between the average of the differences and the expected average of the differences is medium. The p-value = 2.29e-7, (P(x ≤ 5.665) = 1). It means that the chance of type I error (rejecting a correct H_0) is small: 2.29e-7 (0.000023 %). The smaller the p-value the more it supports H_1. Since the p-value < α, H_0 is rejected (the difference between the averages of introductory testing and final testing is big enough to be statistically significant).

Based on the results obtained, traditional methods of ESP learning used for bachelors in the control group gave small, but statistically significant differences in test results.

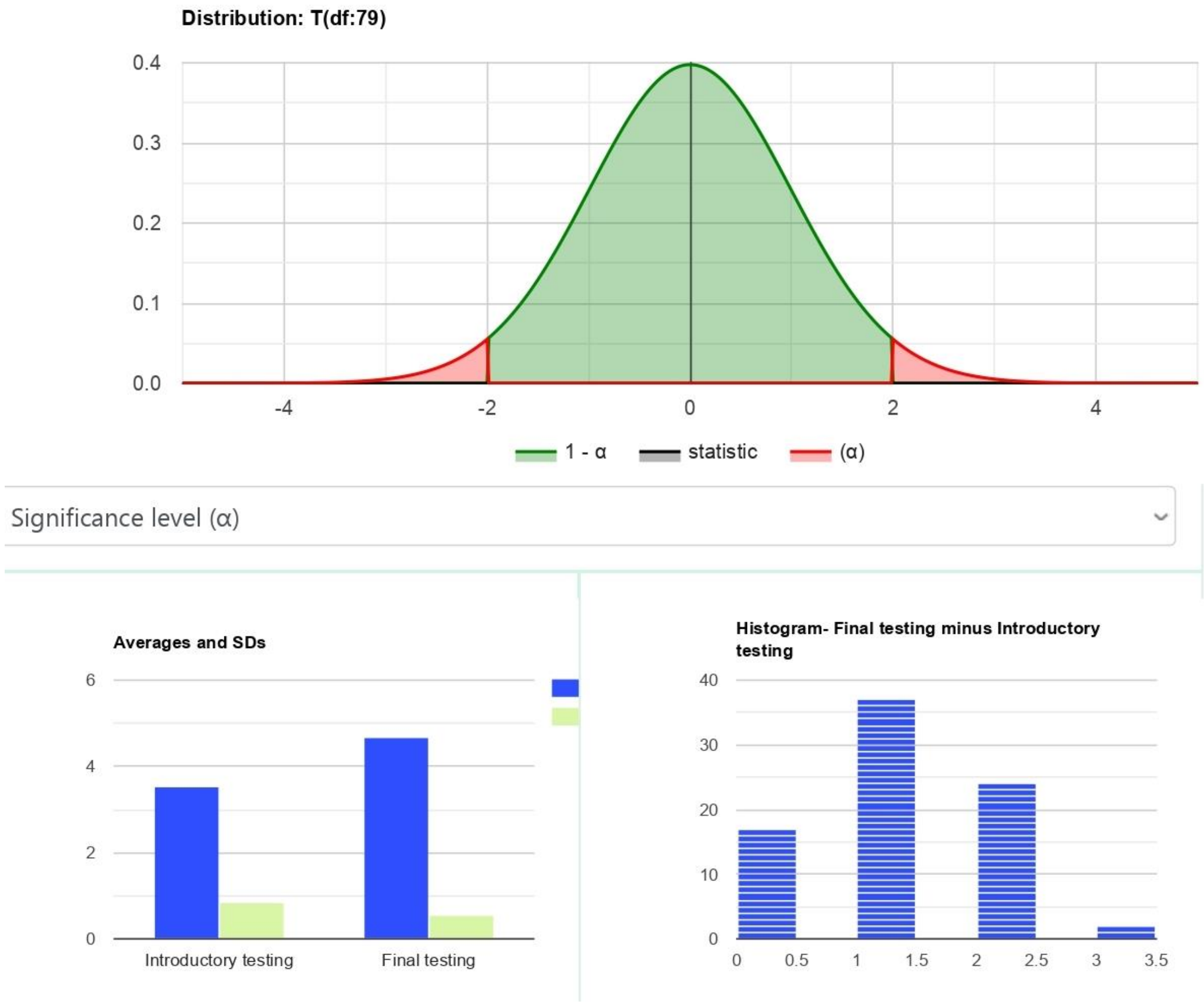

Fig. 5. Results of the paired T-test of the experimental group for the introductory and final tests

Results of the paired-t test indicated that there is a significant large difference between introductory testing with M (means) = 3.5, SD (standard deviation) = 0.8, and final testing with M = 4.7, SD = 0.5. T-value (79) = 13.1, p <0 .001. The test statistic t-value = 13.123, which is not in the 95 % region of acceptance: [-1.99, 1.99]. The 95 % confidence interval of final testing minus introductory testing is: [0.965, 1.31]. The observed effect size d is large, 1.47. This indicates that the magnitude of the difference between the average of the differences and the expected average of the differences is large. The p-value = 0, (P(x ≤ 13.123) = 1). It means that the chance of type I error is small: 0 (0 %). Since the p-value < α, H_0 is rejected (the difference between the averages of introductory testing and final testing is big enough to be statistically significant).

Based on the foregoing, we can see that despite the fact that the control group got larger total figures and arithmetic mean in the introductory test compared to the experimental group, their total sum and arithmetic mean in the final test is much less than that of the experimental group. We should also consider that with statistically significant differences cancelling the null hypothesis in both tests, T-value and effect size of the experimental group is higher compared to the control group. The aggregate data suggests that ESP learning combined with search for characteristics of grammar environment of a term in linguistic corpus leads to better results.

5. Discussion

This study evolved the hypothesis of applying corpora in foreign languages learning as a source with most complete information about practical use of language units, and an important tool for development of students' vocabulary skills (Aşık et al., 2015; Mukhamadiarova et al., 2020; Safriyani, 2020); this idea was considered in our paper as a background in search for empirical and illustrative evidence of various grammatical environments of the terminological units to be learnt.

The paper presents a didactic method of applying the study results for improved efficiency of foreign language learning and control over the competence level of the learning content by involving ample examples used by native speakers in their natural contextual environment; the method matches the idea that class work with corpus data can help to generate most exact language lists of the terminological units to be learnt (Liu et al., 2015; Dang, 2020).

The study requires that the students of the experimental group make a concordance analysis of the corpus. An important role of corpus concordance lines, which ensures using corpus data in grammar learning (Park et al., 2019; Girgin, 2019), is highlighted herein by a possibility to use the lines in order to create a lexical-grammatical profile of the terminological units, taking into account their possible contexts expressed by grammatical environment.

The study results confirm the data presented in (Lanxin, 2021; Fauzan et al., 2022) about application of the corpus for grammar learning and prove an effective use of corpus technologies for learning of English language units, their grammatically correct use in speech, and development of students' professional skills.

It should be remarked that the study had a number of limitations. For instance, it was conducted in an engineering university of mineral sector and included 160 bachelors of the 2nd year of 6 majors with proven English proficiency of "upper – intermediate". The study did not take into account the gender and age of the subjects. In this paper, students were divided into control and experimental groups by using the stratified sampling technique, so that each group included students of 6 academic majors, which is relatively small numbers of strata that may have contributed to a decrease in the reliability of the results. In future studies we plan to have a larger sample to represent more engineering specialties and language proficiency levels, and take into account the gender and age of students.

6. Conclusion

This experimental ESP learning was performed at Saint Petersburg Mining University under the curriculum of the second-year bachelors, in the 2021-2022 academic year; it applied learning materials based on the data from language corpus, and was aimed at testing effectiveness of corpus techniques for understanding characteristics of grammar environment of terminological units.

In accordance with the learning goal, it ensured development of skills in analyzing text material and identifying key information, including terminological units, skills in searching and analyzing grammar environment of terminological units in the language corpus, skills in translating specialized texts, taking into account characteristics of grammar environment of terminological units.

Calculated results of the control group compared to the experimental group lead us to the conclusion that practical application of corpus technologies in the experimental learning confirms their effectiveness for teaching ESP to Bachelors of Engineering. The approach proposed in the study promoted analysis of specialized linguistic materials, identification of characteristics of grammar environment of terminological units, ensured fewer mistakes in using the terms in grammar structures, better information coverage in translation of professional texts, and enrichment of basic terminological vocabulary with data about characteristics of grammar environment of a term in a professional context.

The results prove that application of the corpus approach in identifying characteristics of grammar environment of the terminological units in the ESP course at technical universities deserves closer attention.

6. Acknowledgements

This research was carried out within the state assignment of the Ministry of Science and Higher Education of the Russian Federation for 2021. No. FSRW-2020–0014.

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