Влияние факторов возраста и мотивации на академическую успеваемость магистрантов инженерных специальностей

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АННОТАЦИЯ

Введение. Принимая во внимание что с увеличением конкурса на поступление в магистратуру, зачастую вызванного мотивацией повысить профессиональные компетенции, наблюдается также увеличение среднего возраста обучающегося, возникает необходимость учета влияния данных факторов на эффективность процесса их обучения.

Цель исследования была в выявлении взаимодействия между успеваемостью магистрантов и такими факторами как их возраст и академическая мотивация, а также выявления эффективности модели корпусного подхода в подготовке инженеров.

Методология и методы исследования включали в себя определение параметров эксперимента; адаптацию вопросника об отношении и мотивации (AMTB) для контекста исследования; начальное и итоговое тестирование как в контрольной группе (CG), с использованием традиционных педагогических методов, так и в экспериментальной группе (EG), где обучение проводилось на основе корпусного подхода; обучение иностранному языку для специальных целей в течение года; обработка данных и их статистический анализ.

Результаты исследования показали, что на основе собранных данных не было обнаружено статистически значимого влияния возрастной группы учащихся на академическую успеваемость в CG или EG. Эффект от мотивации к обучению, измеренный с помощью вводного вопросника, был ограниченным и имел минимальное влияние на результаты начального тестирования для обеих групп. Однако, итоговое тестирование продемонстрировало, что две субмотивационные группы – «мотивационная интенсивность» и «желание изучать иностранный язык», были наиболее надежными предикаторами академической успеваемости как в CG, так и в EG. Была подтверждена эффективность обучения магистров инженерных специальностей с использованием корпусного подхода.

Научная новизна. Изучение влияния факторов мотивации и возраста на академическую успеваемость очень неоднородной категории обучающихся – магистров, в условиях перехода к личностно ориентированному процессу обучения, способствует разработке более эффективных подходов к обучению.

Практическая значимость исследования состоит в применение полученных данных в разработке новых рабочих программ, учебных и методических материалов для подготовки магистров инженерных специальностей, ориентированных как на совершенствование знаний в профессиональной области, так и на учет факторов, оказывающих влияние на успеваемость.

КЛЮЧЕВЫЕ СЛОВА

мотивация, возраст, академическая успеваемость, корпусный подход

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Influence of Age Factors and Motivation on the Academic Performance of Master's Degree Engineers

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ABSTRACT

Introduction. Considering that the increasing competition for admission to master's programs, often driven by the motivation to enhance professional competencies, is accompanied by a rise in the average age of students, there is a need to take into account the influence of these factors on the effectiveness of their learning process.

The aim of the study was to identify the interaction between the academic performance of master's students and factors such as their age and academic motivation, as well as to assess the effectiveness of the corpus-based approach in engineering education.

The methodology and research methods included defining the parameters of the experiment; adapting the Attitude and Motivation Test Battery for the context of the study; conducting initial (IT) and final testing (FT) in both the control group (CG), which utilized traditional teaching methods, and the experimental group (EG), where instruction was based on a corpus-based approach; teaching the ESP course over a year; data processing and statistical analysis.

The results of the study indicated that, based on the collected data, there was no statistically significant effect of age group on academic performance in either CG or EG. The effect of motivation for learning, measured through an introductory questionnaire, was limited and had minimal impact on IT results for both groups. However, FT demonstrated that two subscale groups – "motivational intensity" and "desire to learn a foreign language" – were the most reliable predictors of academic performance. The effectiveness of training master's students using a corpus-based approach was confirmed.

Scientific novelty. The investigation into the influence of motivational and age factors on the academic performance of a highly heterogeneous category of learners – master's students – within the context of transitioning to a learner-centered educational process contributes to developing more effective teaching approaches.

The practical significance of the research lies in applying the obtained data to develop new curricula, educational, and methodological materials for training master's students, aimed at both enhancing knowledge in their professional field and considering factors that influence academic performance.

KEYWORDS

motivation, age, academic performance, corpus-based approach

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INTRODUCTION

The global demand for engineering professionals in recent years has been largely driven by the widespread adoption of new technologies that promote sustainable development. UNESCO's report, "Engineering for Sustainable Development," emphasizes the key role of engineering education in improving quality of life, while also drawing attention to the existing shortage of engineers. These global trends are also reflected in Russia. The socio-economic fabric of Russia has undergone substantial evolution in recent decades. This evolution is most conspicuously reflected in the proliferation of novel information technologies and their integration into virtually every aspect of society, encompassing both industrial and educational domains [1]. Educational standards are being revised to emphasize the training of engineering graduates who can support advanced production automation, promote innovation, and enhance the efficiency of mineral resource extraction and processing [2; 3]. Central to these standards is the integration of information technologies, including online technologies and databases [4; 5], within new educational models designed to build these skillsets [6]. These technologies facilitate a transition from passive learning under constant instructor supervision to active, self-directed knowledge construction and personal growth [7]. This transition is exemplified by the use of technology-driven methodologies in teaching ESP [8; 9]. The use of corpus linguistics in teaching enables analysis of patterns through digital-based search and has created the conditions for individual students to study their language for the ability to both analyze grammar structures and to understand the correct usages of words [10; 11]. The ability to utilize information technology for the rapid analysis of language features within vast datasets [12; 13] significantly differs from the capabilities of traditional approaches in education [14]. This technology-driven approach is especially beneficial for Master's degree students, who aim to enhance their professional knowledge while developing greater autonomy in their learning process.

Despite these advancements, a critical challenge confronting the education of engineering Master's degree students in Russia is the pronounced heterogeneity of this cohort with respect to motivational factors and age. In the context of a recognized transition towards learner-centered instruction facilitated by information technologies, this issue remains an area requiring further investigation. The link between student motivation and the enhancement of educational efficiency and quality [15] is further underscored by the findings of international researchers [16; 17]. Furthermore, the highly competitive admissions process for Master's degree programs in Russia, attracting not only recent Bachelor's graduates but also experienced professionals seeking to enhance their skills, has resulted in an increase in the average age of students. Therefore, it is essential to consider the impact of age-related characteristics of engineering Master's degree students on their academic performance. In order to mitigate the challenges outlined above, this research investigates the impact of age and motivation on the learning outcomes of ESP among engineering Master's degree students. The educational intervention was structured using a corpus-based model, the details of which were previously presented by the authors [18].

THEORETICAL BACKGROUND

Both domestic [19] and international research communities [20; 21] have demonstrated an increasing focus on motivation and its influence on learning processes in recent years. This growing emphasis has, in turn, stimulated interest in the domain of foreign language acquisition. Among established learning theories and frameworks prevalent in research on motivation in foreign language learning, the socio-educational model holds a prominent position. According to Gardner's socio-educational model [22], motivation exerts a significant influence on the foreign language learning process, as evidenced by student achievement. Motivation acts both as an initial impetus at the start of language study and as a key factor in sustaining student interest throughout the learning process. A key characteristic of studying motivation in Master's degree students, according to several authors [23; 24], is that the relatively short duration of their studies and the rapid transition from academic to professional pursuits place a premium on maximizing learning efficiency. The potential for effective application of knowledge gained in ESP courses to their professional work can positively influence Master's degree students' engagement with the subject, fostering an interest in expanding their vocabulary and working with linguistic contexts. By the time they enter a Master's degree program, many students possess not only prior academic experience but also professional experience

in their field. As a result, they may be primarily focused on acquiring knowledge directly relevant to their professional domain, which is essential for enhancing their competencies. Consequently, unlike Bachelor's degree students entering higher education directly after secondary school, Master's degree students' initial perceptions of their future career paths can influence their level of motivation and, thus, impact the effectiveness of their learning process.

From the perspective of several scholars [25; 26], learner age is an equally critical determinant of foreign language learning outcomes, as it plays a role in mediating individual learning styles. A noteworthy feature of second language learning among Master's degree students, whose mean age is between 23 and 24 years, is their enhanced capacity to maintain concentration on the subject matter, display increased self-assurance in interpreting professional texts, and exhibit a greater tendency to pursue further insights into terminological units central to their vocational lexicon [27]. However, it is also important to acknowledge that age-related variations among students can substantially impact the efficacy of second language instruction due to the gradual decline in various physiological functions, including attention and memory [28; 29]. This decline can pose significant challenges to the learning experiences of older Master's degree students.

The possibility that age and motivation may affect learning outcomes in ESP programs for engineering Master's degree students underscores the need to examine these factors in order to characterize them within the previously developed corpus-based method.

This study investigated the following two research hypotheses:

1. The factors of age and motivation had no significant impact on the results of initial and final testing and questionnaire administered to Master's degree students in the CG, subject to traditional pedagogical methods, and the EG subject to the corpus-based method.

2. There was no significant difference between the total scores of the initial and final testing for Master's degree students in the CG, subject to traditional pedagogical methods, and the EG subject to the corpus-based method.

The primary objective of this study was to comparatively analyze the influence of age and motivation on the outcomes of initial and final testing and questionnaire administered to Master's degree students in a CG, instructed via a conventional model, and an EG, instructed via a corpus-based model. Furthermore, the efficacy of the corpus-based model was also evaluated.

MATERIALS AND METHODS

The experimental ESP course was conducted with first-year Master's degree students at Empress Catherine II Saint Petersburg Mining University during the 2023-2024 academic year over two semesters. This student cohort was selected because the curriculum required ESP instruction during their first year. Language proficiency testing, which is administered annually at Saint Petersburg Mining University to assess the English language skills of both Bachelor's and Master's degree students, was also conducted. Our testing mechanisms allowed us to identify 307 of the available students as possessing intermediate language capabilities (identified as level B2 under the common EU framework). These students were then chosen using random sampling method and, of this cohort, 161 students were enrolled in our new, experimental language training. Further details relating to the age profile of EG and CG can be found below (Table 1).

To conduct the experimental training, educational materials were utilized, developed from two online corpora: Hong Kong Engineering Corpus and Russian National Corpus. The educational materials used methods of corpus analysis of language data. Such methods include not only quantitative concordance analysis, but also qualitative. The CG included students who studied ESP on educational materials within the framework of the educational program. The EG included students who in addition to studying the standard materials, also learned to work with language corpus.

The experimental training is presented in three stages: preparatory, organizational and final.

Table 1 General information about the participants of CG and EG

N		161	
Group		Experimental	Control
N		88	73
%		54.66%	45.34%
Age	21	38	
		11 (6.8%)	27 (16.8%)
	22	30	
		24 (14.9%)	6 (3.7%)
	23	36	
		21 (13%)	15 (9.3%)
	24	30	
		13 (8.1%)	17 (10.6%)
	25	27	
		19 (11.8%)	8 (5%)

During the preparatory phase, a corpus-based model was implemented to define the conditions, algorithm, and assessment criteria for the experimental training [18]. To analyze the motivation levels of the experimental participants, an adapted international version of the Gardner's Attitude/ Motivation Test Battery (AMTB) [22] was used, modified to align with the objectives of this study. The questionnaire consisted of two sections: the first section collected information about the student (age and type of the group), while the second section presented 30 statements. The 30 questions presented three subscales: motivation intensity (MI), desire to learn the language (DLL) and attitude towards the language learning (ATLL), each with 10 statements for each subscale. Six-point Likert scale, in which 1 score - completely disagree, 2 score - partially disagree, 3 score - rather disagree, 4 score - rather agree, 5 scores - partly agree, 6 scores - fully agree, was used to determine the level of motivation of students to learn ESP. It is important to note that students in both the CG and EG were informed about the study's purpose and provided their consent for the use of their responses to fulfill its aims and objectives. To verify the reliability of the questionnaire, a Cronbach's alpha coefficient was calculated. The overall internal reliability of the questionnaire is estimated at 0.75 for 30 questions based on a sample of 161 participants in the experimental training. According to Taber [30], the Cronbach's alpha coefficient of 0.7 indicates an acceptable reliability of the study instrument. This confirms the reliability of the developed questionnaire in measuring the motivation levels of participants in the ESP experimental training.

During the organizational phase, the experimental participants in both the CG and EG underwent initial questionnaire (IQ) and testing (IT), followed by ESP training throughout the academic year, and culminating in final questionnaire (FQ) and testing (FT).

In the final stage, the data obtained from the IQ and FQ and testing in both the CG and EG were processed and statistically analyzed.

Since this study was structured as a quantitative comparative analysis, the results from the IQ and FQ and testing of both the CG and EG were examined using IBM SPSS (version 26). The descriptive statistical analysis encompassed not only the means of the questionnaires and tests but also the computation of their standard deviations. Given that this research analyzes data from both the CG and EG, we are working with independent samples. It should be highlighted that the analyzed data did not conform to a normal distribution; therefore, non-parametric tests were employed. The Kruskal–Wallis H test was employed to evaluate the first research hypothesis, revealing a statistically significant relationship between the age of Master's degree students and the results of the IT and FT in both the CG and EG. To assess the impact of the independent variables of motivation and subscale factors on the statistical significance of the differences between the IT and FT results in the CG and EG, the Mann–Whitney U test was utilized. For testing the second research hypothesis and identifying statistically significant differences between the IT and FT results in the CG and EG, a Paired T-test was conducted.

RESULTS

Table 2 presents descriptive statistics of the IT and FT of CG and EG. The mean values of the IT and FT for the CG are 3.53 and 4.05 respectively. In the EG, they were 3.53 for the IT and 4.37 for the FT. Considering that the average values of the IT were equal for both groups, it is not surprising to note that the results of the FT already differed markedly. The increase of the mean value for the CG was 0.52, while for the FT it was 0.84. It is also worth noting the higher values of the FT variance in the EG, which are equal to 0.648. Taking into account all the above, it can be concluded that the students of the CG and the students of the EG improved the mean values in the FT, but the students of the EG had higher values.

Table 2 Descriptive statistics of the IT and FT

Group	N	Testing	∑ of scores	x̄	SD	O'2	Points gain	x̄ gain
Control	73	Initial	258	3.53	0.647	0.418	38	0.52
		Final	296	4,05	0.643	0.413		
Experimental	88	Initial	311	3.53	0.642	0.412	74	0,84
		Final	385	4,37	0.648	0.420		

The descriptive statistics of the IQ and FQ of the CG and EG, presented in Table 3, shows that the average values of the subscales MI, DLL, ATLL are equal to 3.88, 3.93, 4.07 for the IQ and 4.10, 4.12, 4.27 for the FQ of the CG respectively. In the EG they were 3.88, 4.00, 4.06 for the IQ and 4.32, 4.52, 4.65 for the FQ respectively. The average values for the FQ have increased in both groups. This increase is more pronounced in the EG. The highest values of mean arithmetic are observed in the subscale ATLL in the CG and EG, both in the IQ and FQ. The highest value frequency in the subscales MI, DLL, ATLL for the CG at both the IQ and FQ stage was 4, while for the EG it was 5, 4, 5 at the IT stage and 6, 5, 6 in the FT phase. Given that the minimum and maximum values for questionnaires were 1 and 6 respectively, it can be noted that average values of subscales, as well as the frequencies of the highest mean arithmetic values are presented in the FQ of the EG. Therefore, the level of motivation of students in the EG increased more than that of students in the CG as a result of the experimental training.

Table 3 Descriptive statistics of the IQ and FQ

Group	Number of observations	Type of questionnaire	Motivation	Number of questions	∑	Mean	SD	O'2	Mode
Control	730	Initial	MI	10	2,837	3.8863	1.3515	1.8266	4
			DLL	10	2,875	3.9384	1.423	2.025	4
			ATLL	10	2,978	4.0795	1.3736	1.8867	4
		Final	MI	10	2,995	4.1027	1.2708	1.6149	4
			DLL	10	3,009	4.1219	1.3498	1.8219	4
			ATLL	10	3,119	4.2726	1.2813	1.6416	4
Experimental	880	Initial	MI	10	3,421	3.8875	1.4174	2.0089	5
			DLL	10	3,527	4.008	1.373	1.885	4
			ATLL	10	3,575	4.0625	1.349	1.8198	5
		Final	MI	10	3,803	4.3216	1.35	1.8225	6
			DLL	10	3,981	4.5239	1.2546	1.5739	5
			ATLL	10	4,094	4.6523	1.2215	1.4921	6

The influence of age on the results of IT and FT of the CG and EG was measured by Kruskal–Wallis test and summarized in Table 4. The test showed that there is small difference in the results of IT for CG and age groups of students, χ (4) = 2.45, p = .653, with a mean rank score of 38.46 for 21 years, 31.67 for 22 years, 38.33 for 23 years, 39.21 for 24 years and 28.88 for 25 years, as well as for the results of the FT and age groups of students χ (4) = 2.0, p = .2, with a mean rank score of 37.59 for 21 years, 30.67 for 22 years, 37.27 for 23 years, 40.65 for 24 years, 31.5 for 25 years. The observed effect size for IT is very small (-0.023), and it is similarly small (-0.029) for the FT. This suggests that the difference in averages is minimal for both types of testing. The p-value for the IT is 0.6532, while for the FT, it is 0.7256. Also there is small difference in the results of IT for EG and age groups of students, χ (4) = 1.73, p = .785, with a mean rank score of 44.73 for 21 years, 43.29 for 22 years, 48.57 for 23 years, 45.61 for 24 years and 39.42 for 25 years, as well as for the results of the FT and age groups of students χ (4) = 1.73, p = .785, with a mean rank score of 41.91 for 21 years, 37.75 for 22 years, 54.33 for 23 years, 43.35 for 24 years, 41.5 for 25 years. The observed effect size for IT is very small (-0.027), while it is small (0.019) for the FT. This suggests that the difference in averages is very small for the IT and small for the FT. The p-value for IT is 0.7846, and for the FT, it is 0.2345. The null hypothesis, which should be tested, is – the difference between the mean ranks of certain age groups during the IT and FT cannot be considered as large enough to be significant. The data collected showed that for all four tests, the probability of a Type I error—is too high. It is well established that a larger p-value lends more support to the null hypothesis. Since the p-value exceeds α, we are unable to reject the null hypothesis.

Table 4 Influence of age on the results of IT and FT

Group	Type of testing	Age	Median	$\bar{x}$	Sample size	Rank sum	Mean Rank	$x^2(4)$	P-value	Effect size
Control	Initial	21	3	3.59	27	1038.5	38.46	2.45	0.6532	very small, -0.023
		22	3	3.33	6	190	31.67			
		23	3	3.6	15	575	38.33			
		24	4	3.58	17	666.5	39.21			
		25	3	3.25	8	231	28.88			
	Final	21	4	4.07	27	1015	37.59	2.0	0.7256	very small, -0.029
		22	4	3.83	6	184	30.67			
		23	4	4.06	15	559	37.27			
		24	4	4.17	17	691	40.65			
		25	4	3.87	8	252	31.5			
Experimental	Initial	21	3	3.54	11	492	44.73	1.73	0.7846	very small, -0.027
		22	3	3.5	14	606	43.29			
		23	4	3.66	21	1020	48.57			
		24	3	3.56	23	1049	45.61			
		25	3	3.36	19	749	39.42			
	Final	21	4	4.27	11	461	41.91	5.56	0.2345	small, 0.019
		22	4	4.21	14	528.5	37.75			
		23	5	4.61	21	1141	54.33			
		24	4	4.34	23	997	43.35			
		25	4	4.31	19	788.5	41.5			

The Mann-Witney test, the results of which are presented in Table 5, was carried out to evaluate the influence of the motivation of the master's students studying in the CG and EG on the results of their IT and FT. Based on the mean value of the IT results and the IQ for the CG, we can see that the average values for the IQ are higher than the average values of the IT by 0.30. While the difference between the average values for the FT and the FQ is already 0.8. The reduction of the average difference by 0.22 tells us that with the increase in the average motivation value at the FQ,

there is also an increase in the average achievement value, relative to the IQ and the IT in the CG. It should also be noted that for the EG, the average value of the IQ results is higher than the average value of the IT by 0.426 while the difference between the average values for the FT and the FQ is already 0.10. The reduction of the difference in average values by 0.32 tells us that in the EG with an increase in the mean value of motivation on the FQ, there is also an increase in the mean value of achievement, relative to the IQ and the IT. The reduction of the difference in the mean values in the EG is more pronounced and is 0.10 compared to the CG values.

Table 5 Influence of motivation on the results of IT and FT

Type of group	Sample size	Type of testing	Sample average	Sample std. dev.	Median	W Wilcoxon	U	P- value	Effect size
Control	73	IT	3.53	0.647	3	4292	3738	0.00001816	medium (0.35)
		IQ	3.93	0.455	4	6439	1591		
		FT	4.05	0.643	4	5099	2931	0.2892	small (0.088)
		FQ	4.13	0.508	4.2	5632	2398		
Experimental	88	IT	3.53	0.642	3	6363.5	5296.5	0.00001662	medium (0.32)
		IQ	3.95	0.228	3.9	9212.5	2447.5		
		FT	4.37	0.648	4	7271	4389	0.12	small (0.12)
		FQ	4.47	0.321	4.4	8305	3355		

The Mann–Whitney U test conducted on the results of the IT and the IQ revealed a "medium" effect size of 0.35 for the CG and 0.32 for the EG. According to that, the difference in scores of the IT and the IQ is medium for both groups. Furthermore, it suggests that there is a discernible difference in their values, with the effect size for the CG being higher (0.3) than that of the EG. In contrast, the results of the FT and the FQ indicated a "small" effect size of 0.088 for the CG and 0.12 for the EG. According to that the difference in scores of the FT and the FQ is small for both groups, with the CG again showing a higher effect size (0.032) compared to the EG. Overall, the data suggests that the improvement in the FT results aligns with the increase in the FQ scores when compared to the IT and IQ. Notably, this increase is more pronounced in the EG than in the CG.

The null hypothesis, which should be tested, is – the difference between the random points of the IT and the IQ cannot be considered as large enough to be significant. The p-values obtained from the IT were 0.000011 for the CG and 0.000012 for the EG. The data collected showed that the probability of a Type I error is very low (0.00001816 for the CG and 0.00001662 for the EG). Since smaller p-values provide stronger support for the alternative hypothesis, we can conclude that the difference is indeed statistically significant. The another null hypothesis, which should be tested is – the difference between the random points of the FT and the FQ cannot be considered as large enough to be significant. In contrast, with the IT and IQ the p-values for the FT were 0.22 for the CG and 0.12 for the EG. The data collected showed that the probability of a Type I error is quite high (0.2892 for the CG and 0.12 for the EG). Since larger p-values lend more support to the null hypothesis, we can conclude that the difference is not statistically significant.

To evaluate the influence of subscales on the results of IT and FT of CG and EG, a Mann–Whitney test was carried out, the results of which are presented in Table 6. The ATLL subscale received the highest average value of the results of the IQ among others (MI and DLL) equal to 4.08 with respect to the mean value of the IT and 4.27 with regard to the FT of the CG. The difference between the average value of the IQ and the FQ was 0.19 for the subscale ATLL. It should be noted that this subscale ATLL received the highest average value of the results of the IQ equal to 4.06 with respect to the mean value of the IT and 4.65 with regard to the FT of the EG. The difference of the mean value of the subscale ATLL between the results of the IQ and FQ was 0.59. This tells us that in the EG with a strong increase of the mean value of the subscale ATLL in the FQ, there is an increase of the mean value of the academic achievement, relative to the IQ and the IT.

Table 6 Influence of subscales on the results of IT and FT

Type of group	Sample size	Type of testing	Subscale	Sample average	Sample std. dev.	Median	W Wilcoxon	U	P- value	Effect size
Control	73	Initial	Performance	3.53	0.647	3	4568.5	3461.5	0.001423	small (0.26)
			MI	3.88	0.462	3.9	6162.5	1867.5		
			Performance	3.53	0.647	3	4408.5	3621.5	0.0001405	medium (0.32)
			DLL	3.93	0.622	4	6322.5	1707.5		
			Performance	3.53	0.647	3	4142	3888	0.000001161	medium (0.4)
			ATLL	4.08	0.565	4.1	6589	1441		
		Final	Performance	4.05	0.643	4	5099.5	2930.5	0.289	small (0.088)
			MI	4.20	0.518	4.2	5631.5	2398.5		
			Performance	4.05	0.643	4	5170.5	2859.5	0.4379	small (0.064)
			DLL	4.12	0.616	4.2	5560.5	2469.5		
			Performance	4.05	0.643	4	4743.5	3286.5	0.01305	small (0.21)
			ATLL	4.27	0.591	4.3	5987.5	2042.5		
Experimental	88	Initial	Performance	3.53	0.642	3	6396.5	5263.5	0.00002744	medium (0.32)
			MI	3.88	0.317	3.9	9179.5	2480.5		
			Performance	3.53	0.642	3	6033.5	5626.5	1.239e-7	medium (0.4)
			DLL	4.00	0.380	4	9542.5	2117.5		
			Performance	3.53	0.642	3	5793.5	5866.5	1.855e-9	medium (0.45)
			ATLL	4.06	0.348	4.1	9782.5	1877.5		
		Final	Performance	4.37	0.648	4	8039.5	3620.5	0.4493	small (0.057)
			MI	4.32	0.385	4.3	7536.5	4123.5		
			Performance	4.37	0.648	4	7468	4192	0.3365	small (0.072)
			DLL	4.52	0.390	4.5	8108	3552		
			Performance	4.37	0.648	4	6817	4843	0.003579	small (0.22)
			ATLL	4.65	0.428	4.6	8759	2901		

The Mann-Whitney U test performed on the results of the IT and IQ for subscales revealed a "small" standardized effect size of 0.26 for the CG (MI) and "medium" effect sizes of 0.32 (DLL) and 0.4 (ATLL) for the same group. In contrast, the EG exhibited "medium" effect sizes of 0.32 (MI), 0.4 (DLL), and 0.45 (ATLL). This indicates that the difference between the scores of the IT and the IQ for subscales was negligible only for MI in the CG, while it was moderate for the other measures. Additionally, it is noteworthy that the effect size for the EG was greater than that of the CG. Regarding the results of the FT and FQ for subscales, the standardized effect sizes were "small," measuring 0.088 (MI), 0.064 (DLL), and 0.21 (ATLL) for the CG, and 0.057 (MI), 0.072 (DLL), and 0.22 (ATLL) for the EG. This suggests that the difference between the FT scores and the FQ scores for subscales is negligible for both groups. The Mann-Whitney U test also indicates that the effect size for the CG is greater than that of the EG. Overall, the data suggest that the increase in FT results aligns with the increase in FQ results when compared to the IT and IQ.

The null hypothesis, which should be tested, is – the difference between the random points of the IT and the IQ for subscales is not substantial enough to be statistically significant. The p-values obtained from the IT were 0.001423 (MI), 0.0001405 (DLL), and 0.000001161 (ATLL) for the CG, and 1.239e-7 (MI), 1.855e-9 (DLL), and 0.4493 (ATLL) for the EG. The data collected showed that the probability of a Type I error is low. Since smaller p-values provide stronger support for the alternative hypothesis, we can conclude that the differences in MI, DLL, and ATLL between the IT and IQ for subscales are statistically significant. In contrast, the p-values for the FT were 0.289 (MI), 0.4379 (DLL), and 0.01305 (ATLL) for the CG, and 0.4493 (MI), 0.3365 (DLL), and 0.003579 (ATLL) for the EG. The other null hypothesis, which should be tested, is – the difference between the random points of the FT and the FQ for subscales is not large enough to be significant. The data collected showed that the probability of a Type I error in rejecting the true null hypothesis is quite high for

the MI and DLL subscales, as larger p-values lend more support to the null hypothesis. However, the p-value for the ATLL subscale p is low, indicating that the difference is statistically significant. Therefore, while the differences in MI and DLL between the FT and FQ are not statistically significant, the difference for the ATLL subscale is indeed significant.

In this study, a paired T-test was performed to investigate statistically significant differences in the mean scores achieved by students in both the CG and EG between the IT and FT phases. The resulting statistical data, along with the corresponding histograms, can be found in Table 7 and Figure 1-2.

Table 7 Paired T-tests statistics

Group	Type of testing	N	Mean	SDs	P	T	s (x̄d)	s (Sd)	Cohen's D
Control	Initial	73	3,5342	0,647	4.714e-8	6.1045	0.5205	0.7286	medium, 0.7145
	Final	73	4,054	0,643					
Experimental	Initial	88	3,5340	0,642	0	10.4293	0.8409	0.7564	large, 1.1118
	Final	88	4,375	0,648					

Table 7 illustrates that the CG exhibits a significant medium difference between the IT and the FT. The mean score is 3.5 and SD is 0.6 for the IT while for the FT they are 4.1 and 0.6 respectively. The criterion value is 6.1 for the CG. In contrast, the EG shows a significant large difference between the IT and the FT. The mean score is 3.5 and SD is 0.6 for the IT while for the FT they are 4.4 and 0.6 respectively. The criterion value is 10.4 for the EG. The obtained mean scores from the IT are not equal to the mean scores from the FT for either group. It is worth noting that this discrepancy is substantial enough to be considered statistically significant.

Figure 1 Paired T-test distribution, averages and histogram for IT and FT of CG

Figure 2 Paired T-test distribution, averages and histogram for IT and FT of EG

The T-test statistic for the CG is 6.1045, while for the EG it is 10.49. Consequently, both groups fall outside the 95% region of acceptance, with confidence intervals of [-1.9935, 1.9935] for the CG and [-1.9876, 1.9876] for the EG. The 95% confidence interval for the difference between the FT and the IT is [0.3506, 0.6905] for the CG and [0.6806, 1.0012] for the EG. The null hypothesis, which should be tested, is – the discrepancy between the mean scores of the FT and IT is not substantial enough to be considered statistically significant. The p-value for the CG is 4.714e-8, while for the EG it is 0. The data collected showed that the probability of a Type I error is very low (4.714e-8 for the CG and 0 for the EG). A smaller p-value provides stronger support for the alternative hypothesis. Since the obtained p-value is less than α, we reject the null hypothesis. According to the calculated Cohen's d, the effect size is «medium» (0.71) for the CG and «large» (1.11) for the EG. The obtained mean scores from the IT are not equal to the mean scores from the FT for either group. It is worth noting that this discrepancy is substantial enough to be considered statistically significant. This confirms the effectiveness of the proposed experimental training.

DISCUSSION

There is a very small difference in the mean values between the CG and EG, as obtained from both types of testing through data analysis using the Kruskal-Wallis test. The disparity in mean ranks among age groups is not substantial enough to be considered statistically significant. The findings suggest that there is no significant impact of age groups (21-25 years) on the results of the IT and FT, particularly in the CG at both stages. While there is a slight increase in effect size and a decrease in the p-value observed during the FT of the EG, these changes remain modest. These results align with the observations of several authors [26; 29], who noted that the influence of age on the performance of foreign language learners is more pronounced in younger individuals and diminishes as they age [31].

The reduction in the difference of mean values which can be observed in the EG and CG indicates that as the mean motivation score increases in the FQ, the mean performance score also increases relative to the IQ and IT. This decrease in the difference of mean values is more evident in the EG. The results of the IT and IQ, analyzed using the Mann-Whitney test, indicated a medium standardized effect size, whereas for the FT and FQ, the effect size was very small. These data suggest that an increase in learning outcomes corresponds with an increase in motivation relative to the IT and IQ. The p-values for the CG and EG, obtained from the IT and IQ, indicated a small probability of a type I error, rejecting a true null hypothesis, while the p-values for these groups obtained from the FT and FQ indicated that the probability was too high. This suggests that the impact of motivation on learning outcomes is less evident during the IQ and IT phases, but becomes more pronounced by the FT stage in both the CG and EG. This effect is particularly noticeable in the EG compared to the CG. The relationship between motivation and academic achievement [15] has also been highlighted in various studies [32; 33].

When assessing the influence of subscales on test results, it is notable that ATLL obtained the highest mean score at the IQ relative to the mean scores at the IT and FT for students in both the CG and EG. The observed difference in the mean scores indicates that, alongside a significant increase in the mean score at the FQ phase, there is also an increase in the mean performance score at the EG compared to the IQ and IT. The results of the IT and IQ for the subscales, analyzed using the Mann-Whitney test, revealed a standardized effect size ranging from small (MI) to medium (DLL, ATLL) for the CG, while it was medium for all subscales (MI, DLL, ATLL) in the EG. This indicates that there was negligible difference between the scores of the IT and the IQ for subscales but only for MI in the CG. It was moderate for the other groups (DLL, ATLL). In terms of the results from the FT and FQ for subscales (MI, DLL, ATLL), the standardized effect size was small for both the CG and EG, suggesting that the difference between the IT score and the IQ score for subscales is small in both groups. According to these data, an increase in learning outcomes corresponds with an increase in questionnaire results for subscales compared to the IT and IQ, especially in the EG. With regard to the subscales, MI and DLL were more pronounced than ATLL. The p-values for the EG, obtained from the IT and IQ for subscales (MI, DLL, ATLL), indicated a low probability of a type I error, rejecting a true null hypothesis, whereas the p-values for these groups obtained from the FT and FQ were too high (but only for the MI and DLL subscales). Regarding the ATLL subscale, the probability of a type I error, rejecting a true null hypothesis, is low. This indicates that there is a varying degree of influence of subscales on learning outcomes. During the IQ and IT phase, this influence is less pronounced. However, it can be observed during the FT phase (in subscales such as MI and DLL) in both the CG and EG (but not in the ATLL subscale). These data are consistent with findings from other studies [34; 35], whose authors also noted the influence of motivation on student academic performance in general [36] and on subscales in particular.

According to the results of the paired T-test, the effect size for the CG is classified as "medium," while for the EG, it is considered "large." Consequently, for the IT and FT of the CG, the magnitude of the differences between the expected mean differences score and the mean differences score is "medium." For the EG, this magnitude is "large." The obtained mean scores from the IT are not equal to the mean scores from the FT for either group. It is worth noting that this discrepancy is substantial enough to be considered statistically significant. This confirms the effectiveness of the proposed experimental training. Additionally, several studies [37; 38] have also validated the effectiveness of the corpus-based approach model in foreign language instruction [39].

This study has several limitations. First, the experiment was conducted with a relatively small group of Master's degree students, whereas Bachelor’s degree students are more widely represented in the academic environment of engineering education. The second aspect was conducting this experiment with a limited sample of universities, while a larger number of institutions, including international ones, could have enhanced the validity of the results. Third, there was insufficient representation of foreign language proficiency levels beyond B2. Future research should aim to conduct the experiment across a greater number of universities and with a larger cohort of students, preferably at the Bachelor’s level, who possess diverse levels of language proficiency.

CONCLUSION

The experimental training was conducted at Empress Catherine II Saint Petersburg Mining University. First-year Master's degree students studied an ESP course over two academic semesters (during the 2023-2024 academic year). Two groups were formed: one group received instruction using traditional materials (the CG), while the other group utilized additional materials based on corpus data (the EG). The aim of the experimental training was to identify the interaction between factors affecting the academic performance of Master's degree students, their age, and academic motivation. Equally important was the goal of determining the effectiveness of the previously proposed corpus-based approach model.

The research hypotheses were developed in accordance with the objectives of the experimental training. They considered that age and academic motivation would not significantly influence the results of the IT and FT for both groups (control and experimental) of Master's degree students, who were trained using a corpus-based approach. Additionally, it was hypothesized that the results of the IT and FT in both groups would not show significant differences.

Therefore, it was crucial to investigate the effects of age and motivation on the results of the IT and FT for both groups of Master's degree students in engineering disciplines, as well as to evaluate the effectiveness of their training based on the corpus-based approach model.

There is no pronounced influence of student age groups (21-25 years) on the outcomes of the IT and FT. Due to the results of the Kruskal-Wallis test, this lack of influence is evident in the CG at both the IT and FT stages, while it is only minimally present in the EG during the FT stage. Additionally, data from the Mann-Whitney U test revealed that the impact of motivation on test results is less pronounced during the IQ and IT phases, but becomes more noticeable at the FT stage for both the CG and EG. This effect of motivation is particularly noticeable in the EG compared to the CG. The influence of subscales on test results is also less significant during the IQ and IT phases, but can be observed at the FT stage for MI and DLL in both groups, although it is not evident for ATLL. Furthermore, the paired T-test results demonstrate that the mean scores from the IT differ significantly from those of the FT in both the CG and EG, with this difference being substantial enough to be statistically significant. The effectiveness of the proposed experimental training for Master's degree students in engineering disciplines, which was based on a corpus-based approach, may be considered to be proved.

The data obtained as a result of this research can be used in the development of new educational and methodological materials for the training of Master's degree students in engineering specialties within the discipline "English for Special Purposes".

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