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Learning styles of the Armed Forces of Ukraine personnel undergoing English language courses

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Abstract. The preferred learning styles according to the Felder-Soloman method of military personnel of the Armed Forces of Ukraine with various military ranks studying English on four-month face-to-face foreign language courses based on the Foreign Languages Education and Research Center of the National Defense University of Ukraine were studied. Active, sensing and visual styles account for approximately 85% of students, while the remaining 15% have reflective, intuitive and verbal styles. The advantage of the sequential over global style is about 75%. No correlation was found between individual learning preferences, the results of the English language entrance test (four tests – listening, writing, reading and speaking), and officer ranks. The method of two-stage cluster analysis shows that respondents form two clusters (Silhouette cluster quality – 0.5-0.6) of approximately the same size according to the level of language proficiency. The most influential factor for cluster formation is the results of listening. Military personnel learning styles were compared with literature data on students' learning styles from 12 fields of study. Two fields (military and natural sciences) demonstrate the preferences toward four styles in all four dimensions; preferences in 2 directions (sensing and visual) and balance in the other two are characteristic of six fields of study. Four other studied fields have a propensity in only one dimension (visual perception of information).

Keywords: English courses for military personnel, learning styles, language proficiency level

1. Introduction

The concept of lifelong education occupies a leading place in modern education [24]. The reason is that things are changing so fast now that what was true 20 years ago is either outdated or inconsistent with today's point of view. More traditionally, we are talking about various professional development courses, where a person enriches, deepens, and modernises his knowledge in the field he studied earlier and works in. A newer and increasingly popular situation is when a person begins to acquire elements of education in new areas where he is either wholly uninvolved or only partially involved. That is, we are talking about expanding the field of human expertise. For example, in Ukraine, the study of the English language is becoming more and more relevant – from university students to adults. Knowledge of the language contributes to academic mobility in learning and increases the working population's competitiveness.

Everything that was said above fully applies to military personnel. It is about professional

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growth, acquiring new knowledge in the traditional field, and expanding expertise beyond the main professional field. Dramatic events surrounding Ukraine in recent years bring to the fore the problem of communication and establishment of permanent ties with partner countries to conclude military alliances and, above all, join NATO. Under these conditions, knowledge of the English language becomes critical for ensuring communication with partners. In addition, within NATO, as a single organisation, the level of knowledge of English is formalised [38], which automatically establishes requirements for the military of Ukraine, which should be involved in cooperation with this organisation.

The lifelong learning in question has two characteristics. First, the urgency of educational processes is measured not in years but in months or weeks. Therefore, the pedagogical process must be built as efficiently as possible. Otherwise, little can be achieved or learned. Secondly, we are talking about adult education. The education of adults, as evidenced by the foundations of andragogy [30], has its specificity in that adults have their own fixed ideas about many things. Adults are usually motivated to learn because they understand their needs and the potential benefits of learning. All this understanding is formed from life examples. Therefore, considering life situations instead of abstract subjects should be considered when organising adult education. The adult learning model should be based on experience, with its analysis as the central methodology. According to [30], the teacher's role is to engage in a process of mutual inquiry with students, not imparting knowledge to them and then assessing its relevance. Individual differences between people increase with age, so adult education should provide optimal conditions for differences in style, time, place and pace of learning [30].

Both of the above features bring to the fore the problem of finding an optimal, individual approach to a potential student who is motivated, has fixed ideas and has to learn something in a limited time. As can be seen from the analysis of the literature, for successful teaching and learning of a foreign language in adulthood, in addition to the actual pedagogical methods and approaches, it is essential to observe specific rules and ensure the following conditions, especially for military personnel:

- Gradual implementation of teaching military disciplines in English [35];
- To ensure the same level of teaching of academic and military disciplines [28];
- When developing the curriculum and selecting educational methods and technologies for teaching in English, it is necessary to take into account the inverse relationship between the level of knowledge and progress in education [22, 26];
- Contribute to developing students' vocabulary since there is a direct correlation between it and the motivation to study and the tendency to communicate [2, 3].

Particular importance is attached to the creation of the necessary learning environment. It includes the individual goals and previous experience of students, as well as the socio-cultural context [43], the implementation of information and communication technologies (ICT) in the educational process of teaching English to military personnel, as evidenced by the growing number of publications on the topic [33, 45, 48]. In this field, the questions of determining the methodology in the context of military training, which will ensure the optimal implementation of ICT [6, 32], as well as the adaptation of ICT tools for teaching martial disciplines [34, 47], remain relevant. At the same time, as shown in [7, 23], the effectiveness of ICT implementation

fundamentally depends on their perception and readiness to integrate into the educational process from both sides of the educational process, students and teachers.

The concepts of learning styles are often used to facilitate the satisfaction of students' individual needs [39, 42]. Learning style is an integrative concept that reflects individual personal characteristics and is of great importance for predicting the effective cognitive activity of a person for training specialists with versatile competence and variable cognitive abilities. The use of the concept of learning styles in pedagogical practice is aimed at forming an individual approach to students in the learning process, using their strengths, which are associated with educational preferences, and at the same time isolating weaknesses by minimising the use of educational technologies that such students poorly accept.

Only a few examples of the study and use of learning styles exist in military education. Thus, for more than 20 years, US Air Force pilots obtaining flight qualifications have been tested for the preferred learning styles according to Kolb's method, which has practically become a mandatory procedure [29]. Similar studies are not limited to applying Kolb's method and extend to other problems, namely the influence of age and gender of military respondents [41], organisation of training in groups formed based on existing learning preferences [5].

At the same time, the available information about the prevailing styles is still incomplete and not always related to the problems of the organisation of the educational process. This article aims to study the learning styles of military personnel undergoing a 4-month course in English at the Educational and Scientific Center of Foreign Languages of the National Defence University of Ukraine using the Felder-Soloman method. The identified educational preferences are compared with the learning profiles of students of civilian study fields. The data obtained, particularly similarities and differences in learning profiles, are discussed from the point of view of the possible impact on academic progress and optimising educational methods.

2. Experimental

2.1. Respondents' sample

72 military personnel who underwent full-time 4-month training in English at foreign language courses participated in the study. Most (except for two sergeants) had officer ranks – from lieutenant to colonel.

At the beginning of the course, all 72 respondents passed the entrance test for English proficiency according to the STANAG 6001 language standard. The level of knowledge was assessed according to a 5-point system (from 1 to 5 points maximum) in four dimensions – listening, writing, reading and speaking. If necessary, the total score of each student was calculated as the sum of the scores obtained in 4 tests.

The results obtained were analysed for the whole group of respondents and compared for individual subgroups, which were conditionally formed depending on military rank, proficiency in the English language and learning style.

The distribution by military ranks was not quite standard but forced due to the significantly different number of students with different ranks. Thus, a limited number of sergeants and junior officers led to uniting them into one group (with the conventional name of junior officers).

There were significantly more senior officers, so in most cases, subgroups consisting of majors, lieutenant-colonels and colonels were considered separately.

When dividing students according to the English language proficiency level, efforts were made to align the distribution by subgroups with the European Credit Transfer and Accumulation System (ECTS) rating scale requirements. Five subgroups were formed roughly corresponding to ECTS grades A, B, C, D, and E. The relative number of students in each quasi-ECTS subgroup was selected as close as possible to the expected distribution 10%-25%-30%-25%-10% but based on the obtained test scores (table 1).

Table 1
Division of students into quasi-ECTS subgroups based on knowledge of the English language.

ECTS grades	E	D	C	B	A
Share of successful students typically achieving the grade, %	10	25	30	25	10
Actual shares of the formed quasi-ECTS subgroups, %	26	22	29	14	8
The total number of points in 4 tests	4	5-7	8-11	12-13	15-16
The mean test scores for the formed subgroups	4	5.63	9.52	12.30	15.50
Standard error of mean	0	0.180	0.245	0.153	0.443

2.2. Index of Learning Styles by R. Felder – B. Soloman

To determine the preferred learning style of each respondent (a total of 67 students participated in the study of styles) and the learning profile of the whole group, a toolkit known as the Index of Learning Style and available for free online use [19] was applied. This tool was developed based on the so-called Felder-Soloman model of learning styles, which first appeared in the work of [18] and was later developed and improved by [20]. Among the advantages of this method, we note the relative simplicity of interpreting the results and the large number of publications, which confirms the popularity and effectiveness of the technique [9, 31].

The Felder-Soloman model defines the presence and strength of preferences in four dimensions. These dimensions are responsible for the channels of receiving information, its perception and understanding and how data is processed. For each dimension, a choice is made between two opposing ways of acting, often called style and antistyle. Each scale for each dimension contains 11 points, which the respondent distributes between style and antistyle depending on his preferences in his answer. Thus, if the respondent's score varies between 6 and 11 points, it indicates the existing advantage of a particular style (6 points – the preference is very moderate, and 11 points – the absolute domination), and when between 0 and 5 points – it is the advantage of the corresponding antistyle. The point of absolute balance of style and antistyle is 5.5 points.

The respondent is inclined to one or another course of action depending on the identified learning preferences. So, the two main channels of receiving information are visual (in short, `vis`) and verbal (`vrb`). Accordingly, we have a style and antistyle `vis-vrb`. The processing of incoming data takes place in an active (`act`) way, that is, through experimentation or reflective (`ref`) through reflection. Comprehension of information occurs through the use of sequential (`seq`), step-by-step mastery of it, or, on the contrary, in the process of a leap-like, global (`glo`) approach. The fourth dimension concerns the perception of information, which is evaluated

through the awareness of information and facts in a sensing way (`sen` for short) or intuitively (`int`), through forming an abstract concept.

Note that the superiority of one style over another can be proven in two ways. For the first option, the dominant style includes all answers with 6-11 points, as opposed to the dominance of the antistyle with 0-5 points. In this way, it is easy to calculate the relative number of respondents who prefer a particular style and antistyle in each dimension. Relative numbers in percentages were used to describe the preferred learning styles in different groups of students. The method of calculating the proportion of respondents with a given style has been used since the beginning of Felder-Soloman style research, so the literature has accumulated a large amount of data on the preferred styles. For this reason, this method was used to build learning profiles of groups of students, compare profiles in different groups, and analyse literature data on the preferred styles among students of various specialities and universities. It illustrates the overall preferences picture well.

However, typically, the proportion of students with a particular style does not reflect the strength of existing preferences in a pair of styles. The strength of preference is usually assessed by calculating each style's mean learning preference scores. For example, if the average advantage is 8-11 points (0-3 points remain for the antistyle out of the total 11 points), it is evident that this style has a strong advantage. However, if the advantage of the style is 6 or even 7 points, 5 and 4 points are left for the antistyle, respectively. In this case, the style and antistyle are balanced (the possible difference between them is 1 point minimum or 3 points). Most likely, the respondent, assigning 6 points to the style and leaving 5 points to the antistyle, respectively, perceives both competing styles almost equally. He does not reject any style and only gives one of them a slight advantage of 1 point. Thus, scores of 6-5 and sometimes 7-4 (as in the original works of R. Felder) are usually regarded as a manifestation of a relative balance of styles. The difference concerning style and antistyle is insignificant for such students, affecting their conclusions regarding constructing the optimal pedagogical process.

Each dimension can be assigned a line segment to illustrate the preferred learning styles in the group and for individual respondents. One end of the line segment lies in the centre of the coordinates. The opposite end represents the maximum possible style strength (11 points or 100% of respondents). The segments should be placed at an angle of 45° from each other as a petal. At the same time, for each pair, the style and antistyle should be located opposite each other, i.e. at an angle of 180°. Marking a point on each of the 8 segments with the percentage of students (from 0 to 100% at the end of the segment) or the strength of the advantage in points and connecting these points in series, we get an 8-petal diagram that reflects the available educational preferences.

2.3. Statistical processing of results

Statistical processing of the obtained results was carried out using the IBM SPSS version 21 statistical program package [37]. The nature of the available data determines the choice of statistical models and tests. As will be shown in more detail in the following sections, data distribution among respondents or their groups often did not obey the normal distribution law. In addition, in some cases, the data available are nominal or ordinal instead of quantitative. Both factors limit the use of correlation models and tests to compare samples.

Thus, τ-β Kendall's and ρ-Spearman's methods were used when studying correlations. These are rank correlations that examine the statistical relationship between ordinal features.

Nonparametric tests were used when comparing samples: the Mann-Whitney U-test (if two groups were compared) or the Kruskal-Wallis H-test (if three or more groups were compared). Two-stage cluster analysis methods were used for classification studies.

3. Results

3.1. Entrance tests in English

The main task of analysing the results of testing the English language proficiency level is understanding the nature of the data obtained. It is essential for their correct further use and interpretation. First, the presence or absence of distribution of the investigated values according to a normal law (Gauss' law) determines statistical analysis methods of the results that should be applied.

Secondly, using the sum of scores for four tests instead of the results of four separate tests in most cases dramatically simplifies data analysis and comparison. However, the transition from individual tests to an integral indicator requires an answer to whether all these data are correlated.

The question of the normal distribution has two dimensions. The more global question is whether the individual test results of all 72 respondents obey the normal law. Less challenging is whether there is a normal distribution between quasi-ECTS subgroups. Within the framework of the Bologna system, the student's knowledge level and the difficulty of test tasks are adequate for each other if the result of the assessment is a normal distribution of the level of knowledge between ECTS subgroups.

The Kolmogorov-Smirnov and Shapiro-Wilk normality tests are used to test the hypothesis regarding the presence of a normal distribution. The latter is considered the most effective for small samples. The null hypothesis of both tests is that the random variable whose sample is known is normally distributed. An alternative hypothesis is that the law of distribution is not normal. The null hypothesis is accepted if the experimental significance exceeds a given value (for example, $p = 0.05$).

The results of tests for the normality of the total score from 4 types of speech activity are given are given in table 2 separately for distribution of individual results and distribution among five selected quasi-ECTS subgroups.

As seen from table 2, the individual exam results do not show a normal distribution with a high probability ($p < 0.001$) according to the results of both tests. Accordingly, when conducting statistical analysis, it is advisable to rely on nonparametric tests that do not require the presence of a normal distribution.

Conversely, the distribution of the total English language score between the five subgroups according to ECTS ranks has a normal character according to the data of both tests. It means that the difficulty of the tasks in the tests corresponds to the student's level of knowledge; that is, the obtained results by subgroups adequately describe the actual situation.

As mentioned before, the survey results on four independent tests (listening, writing, reading, speaking) are supplemented with a general assessment of proficiency level in the English

Table 2
Normality tests for entrance English exams by Kolmogorov-Smirnov and Shapiro-Wilk.

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Testing by individual scores	0.169	72	0.000	0.890	72	0.000
Testing by five quasi-ECTS subgroups	0.201	5	0.200*	0.938	5	0.651

[a] Lilliefors Significance Correction
* This is the lower bound for true significance

language. The total score is calculated as the sum of four separate tests, each based on a 4-point system. This approach greatly simplifies the analysis of available data. However, this kind of replacement looks adequate only if there is a strong positive correlation between the overall score and the results of individual tests. Otherwise, conclusions based on the overall assessment may differ significantly from similar conclusions based on the results of individual tests.

Correlation analysis measures the strength of the relationship between two variables. The null hypothesis in correlation analysis is that there is no relationship between the studied variables. Two commonly accepted nonparametric rank correlation models calculate τ-β-Kendall's and ρ-Spearman's rank correlation coefficients. Typically, τ-β-Kendall exhibits lower coefficient values than ρ-Spearman. Spearman's rank correlation coefficient is more widely used. The interpretations of τ-Kendall's and Spearman's rank correlation coefficients are very similar and invariably lead to the same conclusions.

The results of correlation coefficient calculations for both models are given in table 3. Any tables with calculated correlation coefficients contain a diagonal from the upper left to the lower right corner. All diagonal cells have coefficients equal to one since these are correlations between the same values. For this reason, the array of indicators in the upper right corner is identical to the array in the lower left corner. To avoid duplication of indicators, in table 3, Kendall's τ correlation coefficients are given in the upper right corner above the diagonal, and Spearmen's ρ coefficients are below the diagonal in the lower left corner.

Results of calculations from table 3, according to both correlation models, indicate that:

1. There are strong correlations between all five considered parameters at the significance level $p < 0.001$;
2. The correlation coefficients between the overall assessment and each test are always higher than the correlations between individual tests;
3. The values of Spearman's coefficients are expected to be slightly higher than those of Kendall's.

However, both correlational models proved the existence of a strong positive correlation between the overall score in English and the scores on individual tests. This fact is the basis for using data on the general assessment of English in cases where it is appropriate.

Table 3
Correlations and their significance are shown between the results of four separate tests and the English total test for 72 students. τ-Kendall's correlation coefficients are given in the upper right corner above the diagonal 1.000-1.000 (shown in red), and ρ-Spearman's coefficients are below the diagonal in the lower left corner.

		Listening	Speaking	Reading	Writing	English total
Listening	Correlation coeff.	1.000	0.678**	0.717**	0.717**	0.836**
	Sig. (2-tailed)	–	0.000	0.000	0.000	0.000
Speaking	Correlation coeff.	0.743**	1.000	0.645**	0.704**	0.810**
	Sig. (2-tailed)	0.000	–	0.000	0.000	0.000
Reading	Correlation coeff.	0.797**	0.715**	1.000	0.668**	0.786**
	Sig. (2-tailed)	0.000	0.000	–	0.000	0.000
Writing	Correlation coeff.	0.788**	0.759**	0.732**	1.000	0.796**
	Sig. (2-tailed)	0.000	0.000	0.000	–	0.000
English total	Correlation coeff.	0.922**	0.896**	0.882**	0.885**	1.000
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	–

** The correlation is significant at the $p < 0.01$ level (2-tailed)

3.2. Learning styles

The majority of respondents, 67 out of 72 participants, took the Felder-Soloman test to determine their dominant learning style.

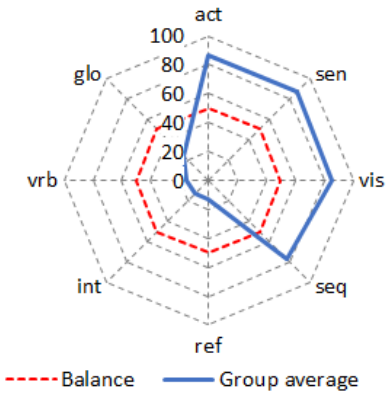

Figure 1: The group's learning preferences are shown as student shares.

The results for the studied whole group are shown in figure 1, where the share of students is shown for each of the eight styles.

A clear preference for active, sensing, visual, and sequential styles attracts attention. For the first three listed, the share of respondents is close to 85%. In the sequential-global dimension, the sequential style's advantage is only slightly less, about 75%.

Figure 2 provides more detail as it includes preferences calculated for four subgroups of military rank. The justification for this rank distribution was provided earlier in the methodical section.

A comparison of the four profiles at first glance gives reason to draw some additional conclusions:

1. There are no significant differences between the groups regarding `act-ref`;
2. The `sen` style preference increases from junior officers to the subgroup of lieutenant-colonels but then declines among colonels;

3. The `vis` style is constantly strengthened with the growth of the rank level – from junior officers to colonels;
4. The style of the `seq`, on the contrary, mostly remains sedentary, except for failure in the subgroup of lieutenant-colonels.

Therefore, the above observations are only preliminary data or conclusions at a qualitative level. It is necessary to apply statistical analysis methods to make sure the difference in the indicators of the subgroups is significant or it is just a certain scatter in the data.

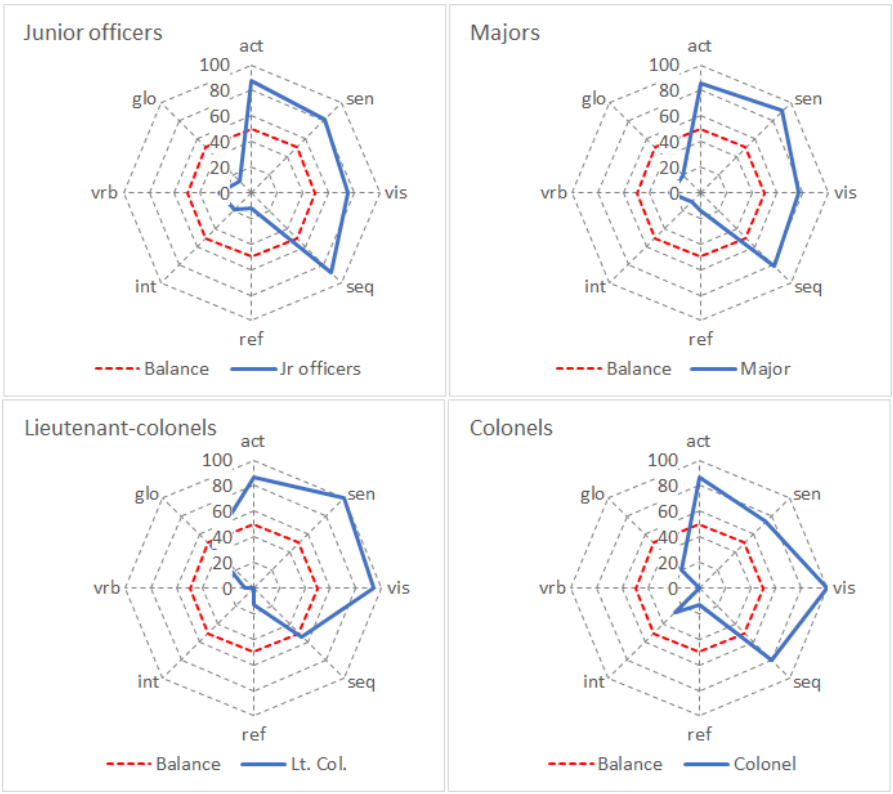

Figure 2: Profiles of academic preferences of students grouped by military rank.

4. Discussion

In the previous section, the primary available experimental data related to the English language proficiency level according to the results of 4 tests, the available educational preferences and the military ranks of each student of the courses are presented. However, no less important questions remain unsolved regarding the presence or absence of correlation between these data series and comparing the obtained results with the known data of other authors. The last remark primarily concerns the defined learning styles of military personnel. It is known [10] that preferences in learning styles are usually pretty stable characteristics typical for a

particular field of knowledge. In this context, comparing the preferences of military speciality students to others is interesting.

4.1. Classification by English proficiency

The students' knowledge was assessed through four independent entrance tests that tested different aspects of English language proficiency. The obtained results indeed characterise the initial level of expertise of each student. However, at least two questions need to be clarified. First, it is advisable to find out which of the conducted tests plays the role of the main predictor, the prognostic factor responsible for the level of language knowledge more than other tests. In addition, it is also difficult to say from the given data whether there is any connection between the proficiency level and military rank.

Additional information on both questions can be provided by classification methods when the aggregate sample is divided into separate clusters according to certain variables. We will use the technique of two-stage cluster analysis [44]. As input variables, we consider three options: 1) only the results of the four tests, 2) the results of the four tests and, in addition, the overall score in English, and 3) the five mentioned variables and the military rank. The chosen method will answer the following questions:

1. How many clusters do the sample optimally split into?
2. Which predictors (input variables) are the most influential for forming clusters?
3. How well does the object coincide with its cluster, and how poorly does it coincide with neighbouring clusters? That is, what is the quality of the classification into clusters?

The quality assessment of the created clusters will be carried out using the silhouette method, which checks the consistency of cluster data [44]. Silhouette magnitude measures how similar an object is to its cluster (cohesion) compared to other clusters (separation). The silhouette ranges from −1 to +1, where a high value indicates that the object matches well with its cluster and poorly matches neighbouring clusters. The silhouette quality threshold is usually set to 0.5. A score greater than 0.5 (from 0.5 to 1) indicates a high-quality cluster, while a score less than 0.5 indicates a low-quality cluster.

The main parameters of the two-stage cluster analysis are given in table 4. Calculations were performed with noise filtering (except for 25% of cases). The division into two clusters with relatively low and high language knowledge for all three models is optimal. The statistical package allows you to determine the expected number of clusters manually. The statistical package allows you to determine the expected number of clusters manually. However, when they increase to 3 or 4-5, the silhouette magnitude decreases, directly indicating a decrease in the distribution quality into clusters.

The silhouette size level is 0.5-0.6, corresponding to the high quality of the formed clusters. The sizes of the clusters are approximately equal, varying between 45-55%. It should be noted that with six input variables, the cluster corresponding to the best knowledge level is larger. In other cases, the situation is reversed.

Figure 3 illustrates a two-stage cluster analysis for the case with six input variables. The conducted analysis allows us to determine which variables have the most significant influence

Table 4
Summary of two-step cluster analysis.

Number of inputs	4	5	6
Variables	Scores of 4 tests	Scores of 4 tests and total English	Scores in 4 tests, total English and ranks
Clusters	2	2	2
Smallest cluster size, Largest cluster size, %	54.9% for worse proficiency	54.9% for worse proficiency	54.5% for better proficiency
Largest-to-smallest cluster ratio	1.22	1.22	1.2
Average Silhouette magnitude	0.6	0.6	0.5
The most valuable predictor	Listening (100%)	Listening (100%)	Listening (100%)
The less valuable predictor	Speaking (78%)	Speaking (78%)	Rank (10%)

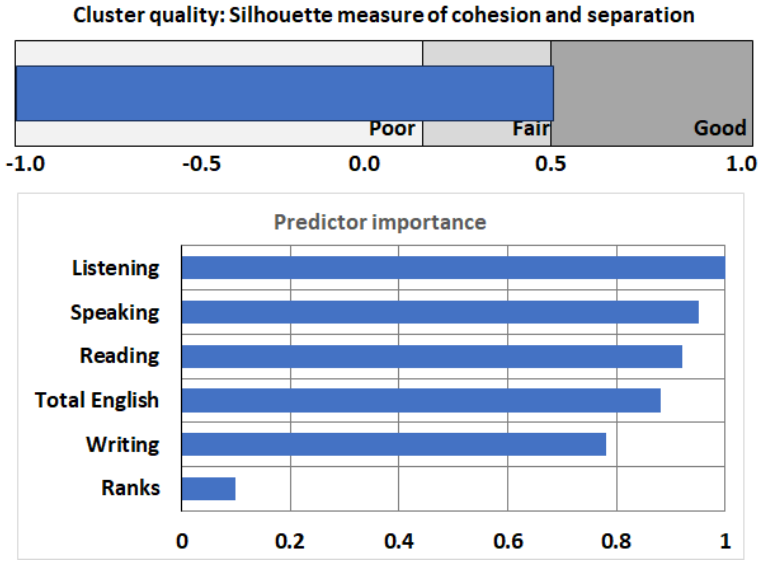

Figure 3: Results of the two-stage cluster analysis for the 6-variable case.

on the formation of clusters. Such a variable is listening for all studied cases, as shown in figure 3.

However, as a rule, other test results also have high indicators (at least 0.75). The rank is an absolute outsider; the contribution of this indicator does not exceed 0.1. In other words, the rank has no practical significance when forming clusters with different levels of knowledge of the English language.

4.2. Learning preferences for different study fields

The concept of learning styles has many facets. Among those that are directly related to the subject of this work, three should be singled out:

1. Sensitivity of styles to the field of study;

2. Relative stability of educational preferences;
3. The problem of consistency of learning and teaching styles.

The sensitivity of learning styles to the field of study was noticed in the first works devoted to the definition of styles. This feature, in one way or another, is inherent in all models of learning styles. Although the reasons for this phenomenon are not the subject of this article, different preferred styles in other specialities must require different approaches in the organisation of the educational process. In the scientific literature, many examples of applying the Felder-Soloman model to determine the learning styles of students of various civilian specialities. At the same time, very few known works are dedicated to military universities or military training courses. Moreover, some of these works are based on other learning style models, making it difficult to directly compare the results with the conclusions of the Felder-Soloman model [16]. There are practically no works that purposefully compare the preferred styles of military and civilian students of different fields.

Figure 4 fills this gap by presenting the average proportions of undergraduate students with specific academic preferences majoring in various civilian fields of study compared to preferences for graduates of military educational institutions. The diagrams were firstly based on data collected by one of the authors in the book [10]. Later literature [1, 4, 8, 17, 25, 36, 46] and own data [11–15] supplement these results. In addition, unpublished own and literature data [6, 32, 40] on the preferred learning styles of the military have been added.

The survey results of more than 11.5 thousand respondents, grouped into 125 separate records, were considered. When calculating, the specific weight of each record was taken into account; that is, the number of respondents who formed each record was taken into account. Despite such a large sample, accurate statistical analysis was complicated. In some cases, it was not easy to accurately classify the field of study; the years of study are not always known. In addition, the error of each record is unknown. Under such conditions, treating the obtained data as semi-quantitative is advisable.

As shown in figure 4, 12 branches of learning are defined, forming an array of 48 preferred styles. In 43 out of 48 cases, there is a predominance (share more than 50%) of the four styles mentioned above: `act`, `sen`, `vis` and `seq`. Only for five cases do the corresponding antistyles dominate: for design students – `int` and `glo` styles dominate over `sen` and `seq`; for medical students, the `ref` style prevails over `act`, and `glo` prevails over `seq`. Philological students are also characterised by a preference for the `ref` style over the `act`. Concerning graduates of military educational institutions, the fact that on all four dimensions, military personnel demonstrate the highest levels of dominating styles (from first to fourth place in the ratings in figure 4) compared to students of civilian specialities seems to be the most characteristic.

It should be noted that most of the literature data on learning preferences are expressed in the proportions of respondents with certain predominant styles. This approach has a significant drawback, as it does not consider the existing preference's strength and degree of expression. It contrasts with the alternative approach, which is based on calculating the average points of educational preferences. The alternative approach introduces threshold difference scores that separate cases of moderate preference, strong preference, or balance of styles. As a rule, cases where the difference between style and antistyle is 1 or sometimes 3 points are considered balanced. Cases with a difference of 5, 7, and sometimes 3 points are considered a moderate

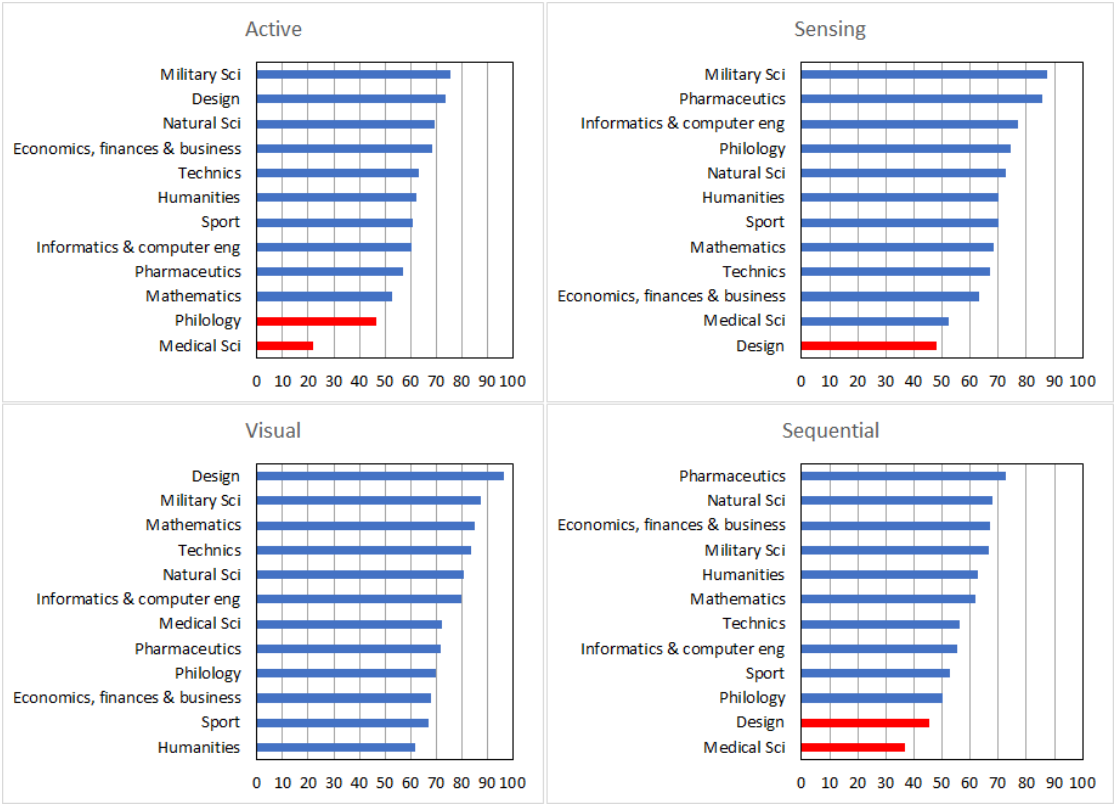

Figure 4: Average shares (in percentages) are shown as ranks for undergraduate students from various civilian fields of study who have the learning preferences of `act`, `sen`, `vis` and `seq`. For the military field, the results of graduates of military universities undergoing full-time course training in various disciplines are given. Shares less than 50%, corresponding to cases of dominance of antistyles, are marked with a different (red) colour.

advantage; a difference of 9 or 11 points is considered a strong advantage. If we compare the educational profiles built according to the two models, the profiles in the form of percentages of respondents will always give more clearly expressed educational preferences. Profiles based on the point model provide more information about the strength of existing preferences. Still, the body of literature based on the point model is significantly smaller, which limits the ability to compare existing preferences across cases.

Replotting data from figure 4 for individual educational areas into 8-petal diagrams allows one to conclude that such diagrams form several subgroups with similar learning profiles conditionally (figure 5). As a threshold, separating the areas with an existing advantage from the relative balance of style and antistyle, a value of 67% can be taken for further analysis. This choice allows for the strength of current preferences to be considered in addition to a simple majority of 50+%.

Under this condition, the 12 identified learning areas are divided into three subgroups. The first unites two areas of learning, which are characterised by preferences in 4 dimensions, then six areas with pronounced preferences in two dimensions and four areas with favours in one

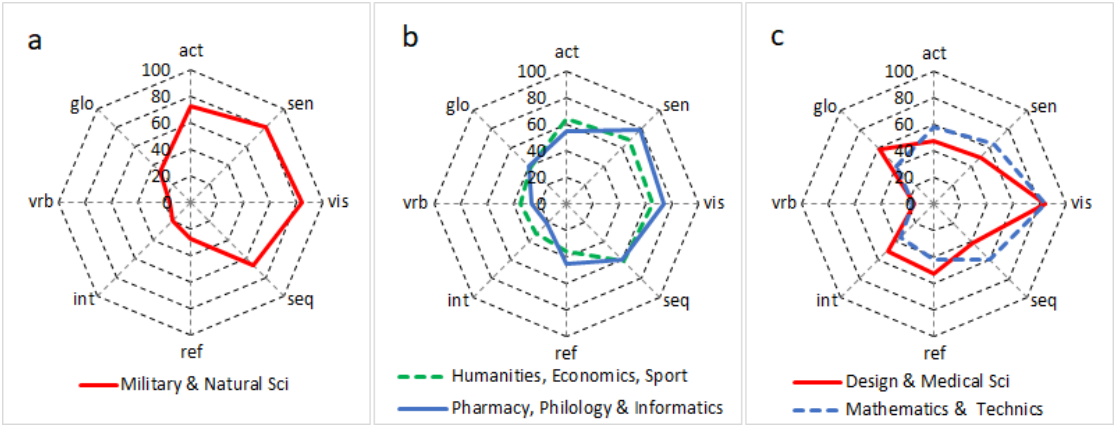

Figure 5: Petal diagrams to illustrate the learning preferences of students of different fields of study, grouped by their appearance into three subgroups: a – approximately equilateral diagram shifted to the right-up, b – approximately equilateral diagrams located closer to the centre, c – diagrams unequal in different dimensions.

dimension.

As seen from figure 5a, science and military students have clear preferences in all four dimensions. For each dimension, the share of students varies between 67-84%, and the profile itself looks like it is composed of two almost symmetrical tetrahedrons (left – smaller, right – larger), shifted up and to the right relative to the origin of the coordinates.

The most numerous subgroup (figure 5b) unites six fields of study simultaneously; each field is characterised by two pronounced preferences (with a share of students of more than 67%). In all 6 cases, these preferred styles are `vis` and `sen`. Externally, the profile of this subgroup looks even more rounded than in the previous case. Also, the profile is closer to the coordinates' origin; individual preferences vary within 55-79%.

The four fields of study that form the third subgroup have only one preference – `vis` style (figure 5c). The share of students in this dimension is 84-85%, while for the other three dimensions, it does not exceed 41-59%. Accordingly, the profiles of this subgroup look more asymmetric compared to the profiles of the other two subgroups.

As mentioned before, the characteristic relative stability significantly increases the importance of learning preferences for the organisation of the educational process, as it raises the issue of optimising the relationship between students' learning preferences and the methods and technologies used by teachers. There is some evidence that existing preferences cannot be rapidly reversed [21, 27]. They remain relatively unchanged for at least several years. For example, it has been experimentally shown that the dominant educational preferences, according to Felder-Soloman, show minimal changes during the four years of study in the undergraduate pharmacy school [11].

At the same time, students of the master's program of the same university demonstrate markedly different educational preferences. Master's students are generally more inclined to research work, which, in turn, forms a tendency to reflection and synthesis, activates various channels of information perception, strengthening the role of reflective, intuitive and verbal

styles. However, the difference in learning preferences between bachelor's and master's students is not related to changes in personality preferences. Most likely, this is caused by different profiles of student groups that arise at the stage of additional selection of students during the formation of master's groups [8, 11, 12].

The following practical issue is the problem of consistency of learning and teaching styles. Teachers' teaching styles are closely related to their learning styles. This question can be considered in continuing the bachelor – master – postgraduate – teacher chain, given that only a part of the respondents moves from one stage to the next. At the same time, it can be expected that with each transition, optimal learning preferences for a given field of science crystallise, and, on the contrary, those preferences that make learning more difficult are gradually eroded.

To test such an assumption, one should compare the learning preferences investigated by a single method at each chain stage. There are not many experimental facts about the educational preferences of master's and PhD students. Much more attention has been paid to the correlation between the preferences of bachelors and teachers. Figure 6 contains the learning preferences of students and teachers specialising in six fields of knowledge.

The red horizontal dash in the middle of each chart divides the region into two parts: the dominant styles marked on the chart (region 51-100%) and the corresponding antistyles (0-49%). First, it should be noted that, in all cases, students demonstrate a higher preference for the dominant styles `act`, `sen`, `vis`, `seq`. On the contrary, teachers' styles are shifted to one degree or another towards the corresponding antistyles.

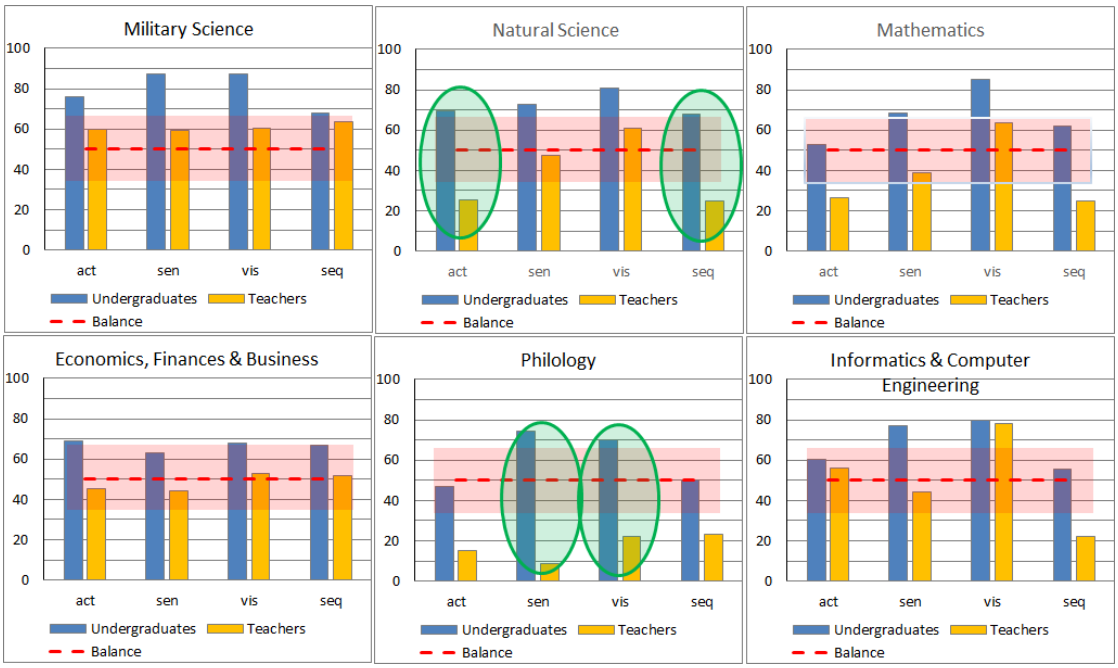

Figure 6: Comparison of learning preferences of undergraduate students and teachers by field of study. The red dotted line equals the share of respondents in 50%, and the horizontal coloured area illustrates the possible interval of existence of relative balance in the perception of the style and the corresponding antistyle. Charts constructed using relevant data from [1, 4, 10–15, 17, 32, 36, 40, 45, 46].

However, a thin border of the distribution is unlikely since the strength of preferences is not considered when calculating the share of respondents with specific preferences. In some cases, the difference in strength is minimal. The respondent practically has no preference for style or antistyle, which means he perceives both directions almost equally. A more realistic way is to mark the transition region, the region of relative preference balance between style and antistyle, not with a line but with a wide horizontal band (the shaded area in the diagrams). The width of the region of the relative balance between style and antistyle depends on many factors, first of all, on the strength of available preferences. Previously, it was already accepted as the most likely assumption that the balance band can occupy the interval 33-67%.

Suppose the educational preference of at least one of the two groups of respondents is in the area of balance. In that case, such respondents are fine with perceiving learning that best corresponds to style and antistyle. Thus, the most severe difficulties can arise when the learning preferences of students and teachers are one above and the other below (or vice versa) the neutral band. In this case, an intense conflict of learning styles can be expected. Figure 6 contains available data from the literature on six areas of learning for each of the four dimensions, i.e., a total of 24 cases comparing the learning preferences of students and teachers. The diagrams show that intense conflicts between learning styles are possible only in 4 cases.

For natural sciences, students prefer `act` and `seq` styles. Conversely, teachers of natural sciences in these dimensions have opposite preferences – `ref` and `glo`. In the philological sciences, a similar conflict is possible for the `sen-int` and `vis-vrb` dimensions. In the other 20 cases, at least one of the groups of respondents has a preference level located in the area of balance. As already mentioned, this significantly reduces the likelihood of potential conflict. For economic sciences, for example, virtually all indicators in all dimensions belong to the balanced area. In this case, the probability of style conflicts is practically absent.

The conducted research revealed a result that, at first glance, does not coincide with the above-formulated regularities during the transition from a lower to a higher level of education. Tests of the styles of military students indicate the presence of exceptionally strongly expressed preferences towards `act`, `sen`, `vis` and `seq`. It is evidenced by both own and literary data [6, 32]. At the same time, the academic preferences of military teachers, according to the literature, decreased in the mentioned four dimensions. However, they remained at a higher level (about 60%) than teachers of other specialities.

Unlike other fields of study, military studies were attended by adults who, based on their existing military ranks, have a higher education in the vast majority. Accordingly, their daily service is characterised by elements of the duties of teachers-educators for work with soldiers. For them, we should expect more balanced profiles due to the weakening of solid style preferences against antistyles, as in other specialities when moving from bachelor to master, postgraduates or teachers. The reason for this fact is unclear; one can only guess.

The considered training of military personnel (both in our experiments and the researched literary sources) included adults who underwent short-term (several months) training (courses) in a particular discipline and took part in the surveys. It is a significant difference from undergraduate students who received a full-fledged higher education, which includes the study of many subjects that are different in content, teaching methods and expected learning outcomes. As mentioned above, adult students are highly motivated to learn and make the necessary progress in their studies because they understand their needs and potential benefits.

It can be assumed that when answering the questions about their predominant learning styles, they were subconsciously describing the styles that, in their opinion, would help them complete coursework in one discipline. University students studying many different disciplines are unlikely to view the problem in this way because it is difficult for them to "optimise" learning styles for many disciplines simultaneously. In any case, additional research, first of all with the involvement of a larger mass of respondents, is necessary to understand this feature.

4.3. Possible correlations between language proficiency and learning style

As mentioned, individual English test results look like poorly ordered data arrays. The grouping of individual results into five quasi-ECTS subgroups somewhat organises the obtained results (table 2). Therefore, investigating the possible correlations between learning styles and the results of language tests should begin with analysing the change of preferred styles when moving between language subgroups.

To take into account the strength of the learning preferences in each of the four dimensions, we will divide the individual responses of respondents from each ECTS subgroup into three parts, corresponding to the pronounced advantage of this style (marked as subgroups 2), the advantage of the corresponding antistyle (1) and balanced respondents (0). Of the two options, only those for whom the difference in style and antistyle scores is 1 (−1) point are forcibly included in the group of balanced respondents. Due to the strong preference towards the `act`, `sen`, `vis` and `seq` styles, enrollment in the balanced subgroup of respondents with a difference of 3 points leads to the degeneration of subgroups of less popular antistyles (subgroup 1) due to the growth of subgroup 0.

For the same reason (optimising the size of the ECTS subgroups), subgroups 4 and 5 (the smallest) were merged into subgroups 4+5. Looking ahead, the obtained dependences on five and modified four subgroups were qualitatively similar in terms of observed trends. Combining the two smallest subgroups into one significantly improved the coefficients of determination in linear approximation.

For subgroups 0-2 and each ECTS subgroup 1 – 4+5, the share of students from the total sample was calculated. Thus, 12 experimental dependence curves of the proportion of students in groups 0, 1 and 2 as a function of four language subgroups were constructed for the four style-antistyle dimensions. In most cases, the constructed curves do not show a stable trend. For this reason, linear approximation equations with the corresponding coefficients of determination R^2 were calculated for each curve. In general, the R^2 value determines the proportion of explained variance. It is expressed as the difference between unity (representing a total sample) and the proportion of unexplained variance (variance of model errors). Accordingly, the closer R^2 is to 1, the more variance explains the linear model. Following a significant part of the experimental data in a linear straight line (increasing or decreasing) should be considered a sign of a stable trend in the increase or decrease in the share of students with certain styles when moving between ECTS subgroups—cases where $R^2 << 1$ indicate the absence of a stable trend. We will take $R^2 > 0.6$ as the threshold value and analyse such cases in figure 7.

Among the 12 style subgroups in 4 dimensions, only four subgroups in three dimensions show stable trends. There is no stable trend for antistyles among them. It is primarily due to the small size of these subgroups that increases the influence of statistical scatter on the data.

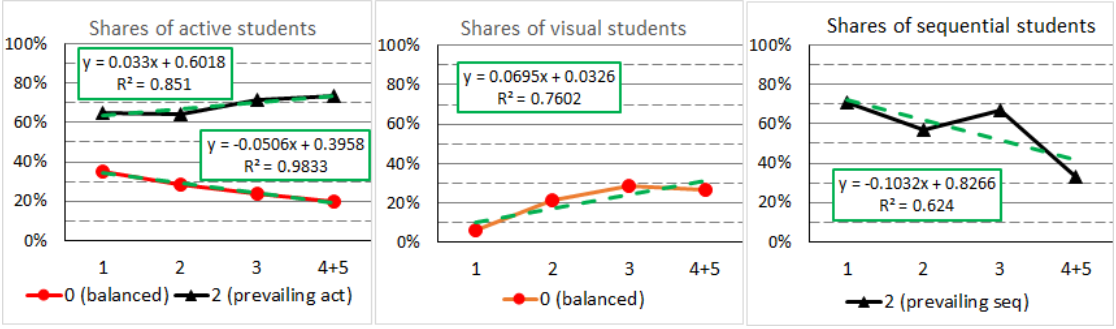

Figure 7: Proportion of students (%) with a pronounced style preference (2) and a balance between style and antistyle (0) for quasi-ECTS subgroups with different English proficiency levels. The equations of linear approximation and coefficients of determination R^2 are presented. Only experimental dependences for $R^2 > 0.6$ are shown.

Otherwise, the direction of changes in the curves in subgroup 1 would be generally opposite to the direction of changes in subgroup 2, which is visually observed. However, the value of R^2 in these cases remains below the threshold value (0.25-0.45).

For students with balanced learning styles (subgroup 0), the transition from group 1 to group 4+5 is accompanied by a decrease in the share of active students. Simultaneously, an increase in the proportion of balanced students with a predominantly visual style is observed in the `vis-vrb` dimension. For subgroup 2, the share of students with a pronounced preference for an active style is slightly increasing, and, on the contrary, the subgroup with a preference for a sequential style is falling quite noticeably in going from ECTS subgroup 1 to 4+5.

The possibility of linear approximation with relatively high values of R^2 allows us to suppose the presence of a stable trend in each of the described 4 cases (figure 7). At the same time, the magnitude of the effect varies quite significantly. Thus, the share of active students in the group with the highest proficiency in the language is only 8% more than the share in the group with the lowest knowledge. The decrease in the percentage of balanced students in the same dimension is almost twice as much (-15%). Even more significant changes occur in the measurements of `vis-vrb` and `seq-glo`. The increase in the share of balanced students and the decrease in sequential students are equal to 21% (increase by more than four times) and 38% (fall in half), respectively. The results in figure 7 contain certain signs of a correlation between some learning styles and the levels of English language proficiency. However, it is too early to discuss the reasons for these observations. For more thorough conclusions, further research involving a larger sample of respondents and additional data on progress in learning English is needed.

5. Conclusions and recommendations/Future directions

1. The entry-level English proficiency of respondents before the start of the 4-month full-time courses was investigated by four tests for listening, writing, reading and speaking. No correlation was found between the individual results of the English language entrance test, officer ranks, and learning preferences.

2. At the same time, ρ-Spearman's and τ-Kendall's correlation analyses prove a strong correlation between the results of individual language tests. According to the level of knowledge, the results of individual respondents can be grouped into five subgroups. The ratio between subgroup sizes is close to the requirements of the ECTS rating scale and follows a normal distribution law.
3. As follows from the method of two-stage cluster analysis, students form two clusters of approximately the same size (the quality of the clusters, expressed through the Silhouette measure of cohesion and separation, varies between 0.5-0.6) according to the entrance tests in language proficiency. The listening test results are the most influential factor (the main predictor) for forming clusters.
4. Preferences in learning styles for individuals and the whole group were tested by the Felder-Soloman method. The group of respondents showed a clear preference for active, sensing, visual, and sequential learning styles. For the first three of the listed styles, the share of students is close to 85%. In the measurement of sequential-global, the advantage of `seq` style is about 75%.
5. The identified learning preferences of military students were compared with those of students of 11 study fields. It allowed us to distinguish three subgroups based on the number of available educational preferences in four dimensions. Military and natural sciences students demonstrate solid preferences for each dimension of `act`, `sen`, `vis` and `seq` styles. Six study fields show two preferences, namely in the `vis-vrb` dimension in favour of the visual channel of information perception and the benefit of sensing information perception in the `sen-int` dimension. Four study fields demonstrate only one dominating style (visual), while there is a relative balance between style and antistyle in the other three dimensions.
6. The prospect of further research consists of expanding the base of respondents and collecting more detailed data on the training results, including progress in study at various stages. Extending the database will improve the accuracy of statistical treatment. It will open opportunities to more accurately determine existing correlations between learning styles and learning progress. As a result, practical recommendations for optimal organisation of the learning process in short courses for military students can be formulated.

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