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Using translation in the course of English for specific purposes for chemical technology programs

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ABSTRACT

The purpose of foreign language teaching in the academic courses is shifting from learning general English to English for Specific Purposes (ESP). This allows to develop new methodologies for training. Here we present an option to integrate the study of ESP in the courses in chemical technologies and the development of skills for translation. There have been strategies that students apply in the course of their study and the dependencies between the language skills and the learning outcomes in the course.

Keywords: learning strategies, ESP, chemical engineering education, regression analysis.

INTRODUCTION

Effective language learning of students largely depends on the application of appropriate learning strategies, described generally as a set of procedures through which to achieve some sort of plan or purpose. In education, these strategies are described by experts as a series of procedures by which learners can be facilitated in their own learning. They are characteristic of the school activity that occurs with many variations depending on the student‘s individuality, specialty, etc. If a certain set of strategies is useful for application in one particular academic specialty, it is not for another, and focusing the attention of the students on strategies that may not be appropriate for their academic purpose, is a waste of resources [1]. Therefore, if certain strategies are useful for a specific student in a degree program, but not for another student in the same specialty, maybe we need to rethink how best to direct the students to use their strategies to achieve the best results in a variety of tasks, and also to expand their repertoire of strategies. Learning strategies are the product of the combination of learning styles, motivation and task, and as such may not be considered as a permanent characteristic of the students [2]. The contrast between the strategies as „thought“ and „action“ gives rise to the challenge in finding the connection between what

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students think and what they actually do with learning tasks [3].

One of the training activities, widely advocated in higher education, is the translation of a text from and into a foreign language and this builds an important component of the language skills. That's why it gets the focus of this study, tracking the development of learning strategies in translation in the terms of a new methodological system. The results obtained are evaluated as level of development of communicative competence and knowledge in the subject in which training in English for Specific Purposes (ESP) is formed and conducted.

CONCEPT

The development of specific methodological decisions is based on the nature of translation and its role in teaching English. Translation is a component of grammar-translation method (GTM) for learning a foreign language, which is first used in the middle ages, and later as the only method for learning a foreign language, especially in the 19th century. It was widely spread and in America was called "the Prussian Method" [4]. In Bulgaria it is at its peak from the 50's to the 80's of the 20th century, and even now, as it becomes clear, is applied in some schools in its original version, and in others in mixed form. Its main characteristic is the importance that is given to grammar and application of translation as a learning activity. In the original version of the GTM the idea is to translate separate sentences taken out of any context, from the foreign language into the mother tongue and vice versa. Such structuring of the educational material we observe traditionally in academic courses and textbooks. Modern teaching materials are being developed, taking into account the principles of communication, autonomy, authenticity, functionality, efficiency and economy and to assist the learner to develop total competence, declarative and procedural knowledge as well as linguistic, sociocultural and pragmatic competence [5].

There are conflicting opinions on the question of the use of the native language and accordingly translation in English learning. In Bulgaria, in higher education institutions the translation of specialized literature is used as part of learning English. In that case, when the school program requires it, then inevitably it is concluded that a translation should be used even at the initial stage of training, before using it for specialized literature.

The main idea of this study is to propose a methodology that ensures the acquisition of specific learning content and encompasses purpose, process, content, control and evaluation of educational achievements. The content is being developed as a result of content analysis and identification of the key components and the relations between them. This gives the frame terminology/lexical base of operation with the scientific information used to develop exercises designed to broaden the range of tasks both in the field of target language learning and in the academic subject of the engineering course. The objective is to prepare the students before they deal with the translation tasks and they could manage to find an effective system of learning strategies in the performance of this component of the course. This system is a dynamic combination of cognitive, metacognitive and social strategies [6].

Method

We have developed a set of exercises on the content of the disciplines of the curriculum of Chemical Technology – "Organic chemistry" and "Technology of organic synthesis". The content of scientific texts is jointly developed by the lecturers on the subjects and the English teacher to ensure authenticity. That is how the key concepts that make up the structure, providing an understanding of the system of knowledge on relevant educational modules, are formed. All the exercises are organized in worksheets (handouts). The texts for translation are authentic [7, 8].

The survey was conducted during 2008/2009 academic year (29 students) and 2015/2016 (22 students) at the University of Chemical Technology and Metallurgy (UCTM) with students from the third and fourth year, Bachelor's programme in "Fine Organic Synthesis", "Engineering ecology and Environmental Protection", "Biotechnology" and "Biomedical Engineering".

The assessment and analysis are made on the basis of the level of proficiency of English. It is determined by standard test [9]. The tested skills are: reading, grammar and vocabulary.

The test contains questions from the elementary level (Elementary) and progresses to more difficult questions to the highly advanced level (Very Advanced). The test results are determined according to the ALTE levels (0 - 5) and the corresponding Council of Europe levels (A1 - C2).

Statistical analysis and modeling

Under primary data processing techniques and methods we understand evaluating the fundamentals of the observed phenomenon (sample average, standard deviation, median, quartiles, etc.); establishment of relations in the current available data; cluster tasks; preview; graphic analysis, etc.

Primary data processing

The achieved results are analyzed (29 students from the old design and 22 from the new design) in the chemical technology subjects (CTS) "Organic Chemistry" 1 and 2, "Technology of Organic Synthesis" and English.

The average score in CTS (X, Xn) is formed by the average of the grades obtained from: entry-level colloquium in chemistry, course assignments, participation in workshops and homework assignments. The average score in ESP is formed by the average of the grades from: vocabulary=лексика? (L, Ln), grammar (G, Gn), syntax (S, Sn), translation (T, Tn) and appropriate use of a dictionary entry (TV, TVn). The letter n in the name of the variable means that it is a result of the new methodology.

Mean, median, standard deviation, etc. for the variables mentioned are shown in Table 1. The histograms for translation (T) and syntax (S) with their approximating densities of a normally distributed random variable are given in Fig. 3.

Comparative analysis of component achievements in English for specific purposes

The assumption is the following: the new design of doing exercises in ESP improves the quality of the training in ESP. Specifically: the expected results of the students are to cope better with the translation of specialized chemical-technological literature from English to Bulgarian and vice versa, and generally to increase their success in ESP.

With the old methodology, the variable T (translation), see Table 1 and Fig. 1, there is: median Me = 5, interquartile range $Q_{0.75} - Q_{0.25} = 6 - 4 = 2$, and for the new methodology, see the variable Tn, we have: Me=5, interquartile range $Q_{0.75} - Q_{0.25} = 5 - 4 = 1$.

Table 1. Descriptive statistics of the variables L, Ln, …, Y, Yn.

	L	*Ln*	*G*	*Gn*	*S*	*Sn*	*T*	*Tn*	*TV*	*TVn*	*Y*	*Yn*
Mean (M)	5.069	5.091	4.448	4.591	4.931	4.545	5.034	4.682	5.379	5.182	4.972	4.818
Median	5	5	5	5	5	5	5	5	6	5	5.4	4.9
StD (S)	0.799	0.610	0.948	0.666	1.100	0.800	1.085	0.839	0.820	0.664	0.883	0.632
Valid N	29	22	29	22	29	22	29	22	29	22	29	22
Min	4	4	3	3	3	3	3	3	3	4	3.2	3.4
Max	6	6	6	6	6	6	6	6	6	6	6	6
$Q_{0.25}$	4	5	4	4	4	4	4	4	5	5	4.4	4.4
$Q_{0.75}$	6	5	5	5	6	5	6	5	6	6	5.8	5.2

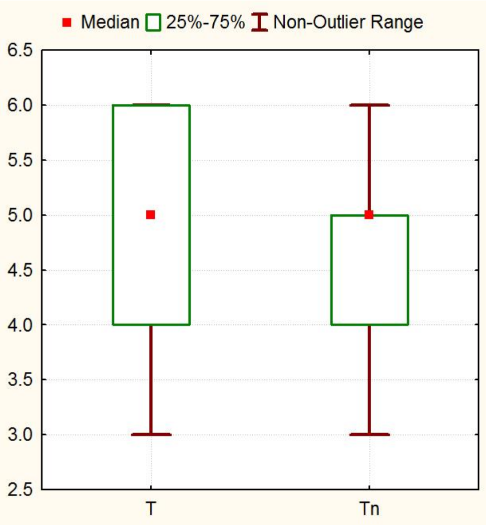

Fig. 1. Box Plot Diagram of translation.

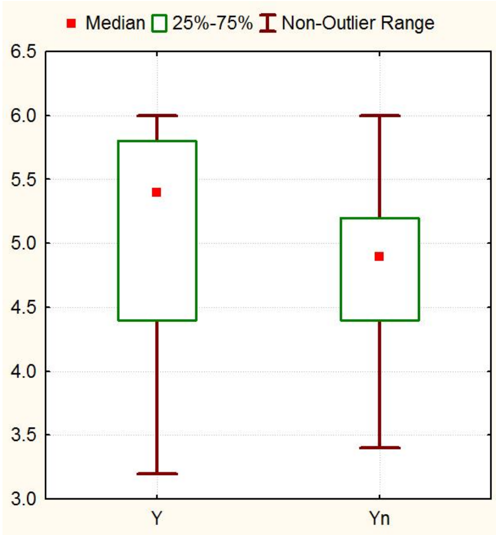

Fig. 2. Box Plot Diagram of average score in ESP.

Medians are equal, the average values do not differ significantly, deviations from average values on the new methodology are smaller than those of the old. In Fig. 1 are shown diagrams of the Box Plot type of these variables. No significant improvement/deterioration is observed. This is shown by the preview analysis.

To analyze the success in ESP we shall compare the box plots of average scores. Fig. 1 shows the diagrams of the variables Y and the new one Yn, respectively for students working with the old and the new methodology.

For Y, see Table 1 and Fig. 2, we have: median Me = 5.4, interquartile range $Q_{0.75} - Q_{0.25} = 5.8 - 4.4 = 1.4$. For the average scores in ESP with the new methodology Yn we have: Me = 4.9, interquartile range $Q_{0.75} - Q_{0.25} = 5.2 - 4.4 = 0.8$. Medians differ with 0.5; the average values do not differ significantly, see Table 1.

There is no distinct difference before and after the introduction of the new design of ESP, i.e. no significant improvement of the results can be observed. This is a realistic outcome in terms of the volume of content in the materials in the English language and the availability of opportunities for the exercise of certain components of the knowledge in this type of texts. As well known, scientific texts do not provide many opportunities for exercise of verb tenses in translation - for an explanation of the processes, effects or facts are mostly used Simple Present Tense and the Present Perfect Simple Tense; for this genre is characteristic the use of Passive Voice, but in the tenses mentioned, so from that point of view, the students are much facilitated. The only possible difficulty, as can be seen from the analyses may arise on the basis of poor command of syntax in the English language: terminology, if it is not learned until now can be verified in a specialized dictionary, for example; the limited number of grammatical tenses and rules (for the needs of the scientific text) is already taught, and in most cases learned; the construction of the sentence, so that it sounds natural in Bulgarian or the target language, is achieved through the translation exercises which require the composition of a text on the part of the learners by applying grammatical and vocabulary knowledge into one whole. After all, development depends not only on purely linguistic competence of students, but also on their communicative competence.

Therefore, we cannot expect a sharp jump in the overall level of foreign language competences for the period of the experiment, but it appears that are developed those components that are set in the expected learning outcomes for engineering specialties which allow graduates to handle scientific and professional information and achieve an understanding at the level necessary to implement this information effectively in their activities. As for the purposes of communication with colleagues in the target language, it is obvious that full development of the skills will require exercising in "general English", too.

Methods for secondary data processing are used to establish the relationships between the monitored variables, verification of hypotheses, prediction, etc. The most commonly used techniques are regression, correlation and factor analysis, and compare average and/or the variances of two or more samples.

Correlation and regression analysis

In real life most often are explored dependencies and relationships between a resultant variable (response) y and one or more independent variables (factors/predictors) $x_1, x_2, ..., x_n$. The variables are quantified and are measured on an interval or relative scale. The relationship between y and predictors represents a somewhat disturbed functional (correlation) dependency. Correlation dependencies are modelled by the methods of regression analysis.

General mathematical model of one correlation dependency looks like this: $y = f(x_1,..., x_n, a_1,..., a_n) + \varepsilon$, where supposedly the residuals ε are normally distributed random variables with average 0 [10]. If the function f is linear regarding the coefficients $a_1,..., a_n$, but not regarding the factors, we talk about a linear regression. Regression is called simple if we have one factor and multiple if the predictors are at least two. Most commonly the models are of the type $y \approx \hat{y} = b_0 + b_1 x_1 + b_2 x_2 + ... + b_m x_m$, $m \leq n$.

The coefficients of the regression equation are determined in most cases by the method of least squares.

The correlation is an indicator, which explores the power of relation between two random variables. Correlation of Pearson r_{xy}, between quantitative variables x and y show if there exists a linear dependency between them. We have $-1 \leq r_{xy} \leq 1$; when it is positive, increasing the values of one of the variables leads to increase in the other and vice versa; if $r_{xy} < 0$, increase in the values of one of the variables leads to decrease in the other.

Conventionally it is assumed that when the coefficient is in the range of $|r_{xy}| \leq 0.3$ the relation is weak, if $0.3 \leq |r_{xy}| \leq 0.7$, then there is an average dependency, and if $|r_{xy}| \geq 0.7$ the dependency is strong (there are also other measurement scales). A coefficient of determination/definiteness $R^2 100\%$ can be used, that shows what percentage of the variance of the resulting variable is explained by the action of the factor variables.

The significance of the coefficients in the regression equation is done by testing of hypotheses: $H_0 : b_i = 0$ - the coefficient b_i is insignificant againts to the alternative $H_1 : b_i \neq 0$, i.e. b_i is significant with a significance level α=0.05. If for the test statistics t_{test} we have $|t_{test}| < t_{cr}$ (1-α/2 – quantile of the Student's distribution with N-m-1 degrees of freedom, N – number of observations, m – number of variables in the model), it is accepted H_0. In order not to use statistical tables for defining t_{cr} quantiles, the estimated value of p-value is compared to α. The p-values show to what extent there is a discrepancy between the data in the model. There has been some research recently about the incorrectness in the use of p-values [11]. The Fisher's distribution F is used to determine the significance of the regression equation: if the test statistics $F_{test} < F_{cr}$ (α – quantile of Fisher distribution of with N -m-1degrees of freedom, where m+1 is the number of coefficients in the regression equation and N – number of observations), then the regression equation is insignificant, otherwise the equation is significant. As a complex evaluation of the qualities of the regression equation is used the coefficient of determination R^2 and the correcting/adjusted coefficient of multiple determinationи - Adjusted $R^2 = \hat{R}^2$ [12]. These coefficient values are determined by the modelling objectives: if gross (incorrect) estimates are eligible, then it could be considered $R^2 \sim 0.8$, for more accurate assessments - $R^2 > 0.9$. The coefficient $\hat{R}^2$ is more informative – it takes into account the number of dependent variables. The model with higher $\hat{R}^2$ is preferable to use.

Often in regression analysis is observed multicollinearity between factors, namely the presence of a functional relation between some of the predictor variables (full collinearity) and partial, if there is a strong correlation between some of the variables, which must be independent. Full collinearity does not allow to define the parameters in the model. More often there is a strong correlation between the factor variables, leading to inaccurate estimates of the parameters of the model, small t-statistics, i.e. the coefficients are considered insignificant, although the model is considered to be statistically significant (large values of F-statistics). The presence of multicollinearity arises from the large values in module of correlations in pairs (> 0.7, 0.8). In this case is used Stepwise, Ridge-regression or other methods.

Most commonly used is the Stepwise regression [13], [14]. In this model, the results are displayed in several steps. The first step (including model) introduces one of the independent variables that influence the dependent, and then they are increased (Forward Stepwise Regression). The other step regression is backwards (Backward Stepwise Regression): it begins with all the factors; the next step is to exclude an independent variable, etc.

Regression and correlation analysis of data obtained with the old methodology

The results of regression and correlation analysis for the variables T (translation: with the old methodology) are presented in Tables 3, 4 and 5.

The equation of the suggested regression model for the variable T (translation) is:

$T \approx \hat{T} = -0.267 + 0.167\,X + 0.043\,L + 0.207\,G + 0.625\,S + 0.087\,TV,$

The translation is influenced positively by (ranked by the values of the B coefficients) syntax, there is a weaker influence by grammar and knowledge in CTS and slightly by the translation with the use of a dictionary and by vocabulary. This is another confirmation of the positive result of transcoding conceptual knowledge, which builds the scientific texts, from Bulgarian to English and vice versa. It supports the construction of lexical competence, which gives sufficient confidence to students when working with scientific texts, and the knowledge of syntax and, to a lesser extent, grammar, is becoming indicative of success in the tasks of translation. These exact components of the foreign language skills remain beyond the range of the academic course of two semesters, 30 classes each, to be improved to a higher degree. Nevertheless, in the experimental design the purpose is to exercise the specialized vocabulary and help develop skills in other components of language competence on specific scientific content. This in practice leads to the real integration of new knowledge in the specialty and language skills in the same sphere

Table 3. Regression Summary for Dependent Variable T.

R= .943, R^2= .889, Adjusted R^2= .865, F(5,23)=36.916 p				
	B	Std.Err. of B	t(23)	p-level
Intercept	-0.267	0.668	-0.400	0.693
X	0.167	0.113	1.477	0.153
L	0.043	0.168	0.253	0.802
G	0.207	0.159	1.301	0.206
S	0.625	0.183	3.405	0.002
TV	0.087	0.184	0.473	0.641

Table 4. Correlation coefficients of the variables X, L, G, S, T, TV.

	X	*L*	*G*	*S*	*TV*	*T*
X	1	0.381	0.471	0.504	0.434	0.564
L		1	0.759	0.819	0.722	0.780
G			1	0.853	0.784	0.852
S				1	0.862	0.930
TV					1	0.828
T						1

with the development of a more effective system of learning strategies in translation.

The only significant coefficient is before S – syntax with a value p ≈ 0.002<0.05. The other coefficients in this model are insignificant as their values are p > 0.05, see Table 3, although the model explains R^2 100 % ≈ 89 % of the changes in the dependent variable T. The correlation coefficients of these variables are shown in Table 4.

All correlation coefficients in Table 4 are with values > 0.7 (excluding the variable X), which shows that variables are strongly dependent (correlated), i.e. there is multicolinearity between factors and therefore stepwise regression is used. In table 5 it can be seen that the stepwise regression models the data with the following equations (2) and (3):

$T \approx \hat{T} = 0.005 + 0.164\, X + 0.229\, G + 0.691\, S,$

In equation (2) there is only one significant coefficient before the variable S with p = 0.00002 < 0.05. The model explains ≈ 89 % of the changes in the dependent variable T. translation depends significantly on syntax and less on grammar and CTS results.

The other model is achieved by means of Backward Stepwise Regression, see Table 5. There we have:

$T \approx \hat{T} = 0.510 + 0.917\, S,$

where the coefficient before S in (3) is significant and the coefficient of determination is ≈ 86%, which explains a great part of the changes in T, i.e. translation depends mainly on syntax.

The regression line for T from (3), the scatterplot (the points with coordinates (S,T)) and the histograms of the variables S and T are presented in Fig. 3.

All the models (1) - (3) could be considered

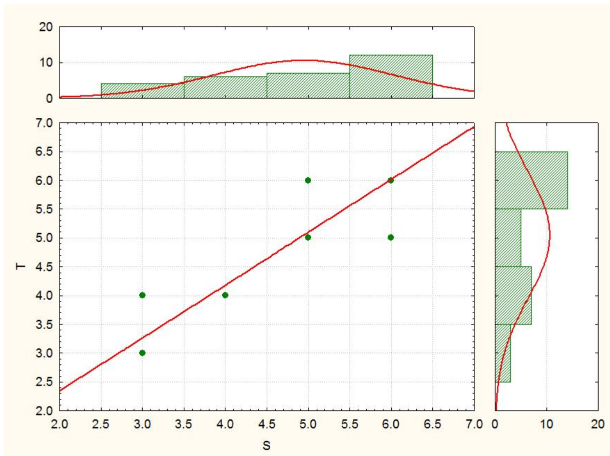

Fig. 3. Scatterplot with Histograms of *T* against *S*.

Table 5. Summary of Stepwise Regression for Dependent Variable T.

Forward Stepwise Regression R= .942, R^2= .888, Adjusted R^2= .874, F(3,25)=65.933 p				
	B	Std.Err. of B	t(25)	p-level
Intercept	0.005	0.407	0.012	0.990
S	0.691	0.130	5.324	0.000
G	0.229	0.147	1.551	0.133
X	0.164	0.109	1.505	0.145
Backward Stepwise Regression R= .930 R^2= .865, Adjusted R^2= .860, F(1,27)=172.60 p				
	B	Std.Err. of B	t(27)	p-level
Intercept	0.510	0.352	1.447	0.159
S	0.917	0.070	13.138	0.000

Table 6. Regression Summary for Dependent Variable Tn.

R= .952, R^2= .907, Adjusted R^2= .878, F(5,16)=31.203 p				
	B	Std. Err. - of B	t(16)	p-level
Intercept	-1.817	0.804	-2.259	0.038
Xn	0.170	0.164	1.034	0.316
Ln	0.335	0.176	1.897	0.076
Gn	0.226	0.216	1.045	0.312
Sn	0.486	0.196	2.487	0.024
TVn	0.124	0.133	0.929	0.367

Table 7. Correlation coefficients of variables Xn, Ln, Gn, Sn, Tn, TVn.

	Xn	*Ln*	*Gn*	*Sn*	*TVn*	*Tn*
Xn	1	0.549	0.535	0.647	0.282	0.668
Ln		1	0.682	0.674	0.662	0.804
Gn			1	0.885	0.499	0.864
Sn				1	0.521	0.909
TVn					1	0.621
Tn						1

adequate, as $\hat{R}^2 > 0.85$. From them, the one with the highest additive coefficient of determination, 87 %, is model (2).

Regression and correlation analysis of data obtained with the new methodology

The results of regression and correlation analysis for the variable Tn (translation: with the new methodology) are presented in Tables 6 and 7.

The regression model of the dependent variable Tn (translation) is:

$Tn \approx \hat{T}n = -1.817 + 0.170\,Xn + 0.335\,Ln + 0.226\,Gn + 0.486\,Sn + 0.124\,TVn,$

The translation with the new methodology is influenced positively in equation (4) (ranked by the values of the B coefficients) syntax, there is a weaker influence by vocabulary, grammar and knowledge in CTS and insignificantly by translation with the use of a dictionary.

The significant coefficients are before Sn – syntax with a value $p \approx 0.02 < 0.05$ and the free article. The rest of the coefficients are insignificant because of the values $p > 0.05$, see Table 6, although the model explains R^2 100 % ≈ 90 % of the changes in the dependent variable Tn. The models could be considered adequate, as Adjusted $R^2 \approx 0.878$. The correlation coefficients of the variables are shown in Table 7.

All the correlation coefficients of the factor variables are with values < 0.7 with the exception of $r_{GnSn} = 0.885$, which indicates that the variables grammar and syntax are strongly dependent (correlated).

Forward Stepwise Regression, see Table 8, models data with the following equation:

$$Tn \approx \hat{T}n = -0.975 + 0.481\,Ln + 0.706\,Sn,$$

In equation (5), the coefficients before the variable Ln – vocabulary and Sn – syntax are significant with p = 0.0003 << 0.05. The model

Table 8. Summary of Stepwise Regression for Dependent Variable Tn.

R= .945, R^2= .893, Adjusted R^2= .882, F(2,19)=79.731 p						
	Beta	Std.Err. - of Beta	B	Std.Err. - of B	t(19)	p-level
Intercept			-0.975	0.527	-1.848	0.080
Sn	0.673	0.101	0.706	0.106	6.649	0.000
Ln	0.350	0.101	0.481	0.139	3.455	0.003

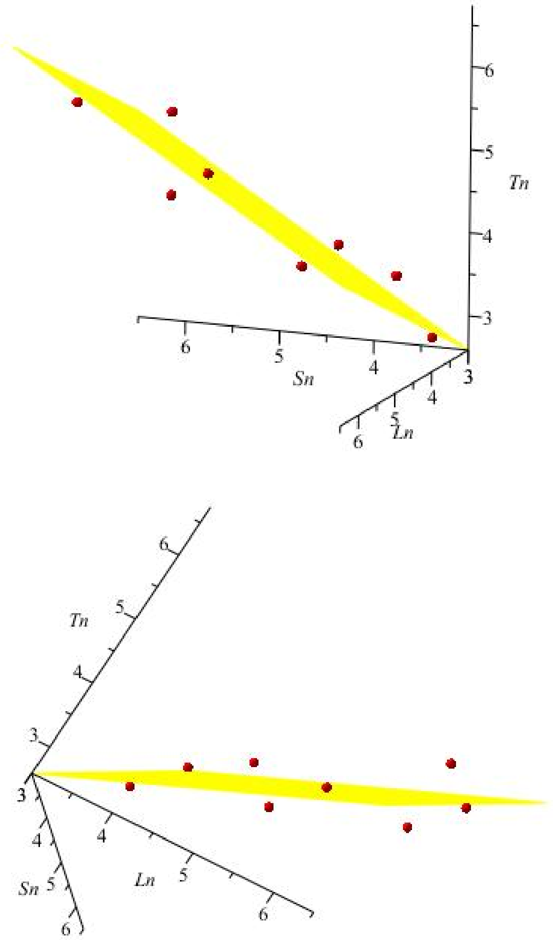

Fig. 4. Regression plane and points on which the equation (5) is obtained.

explains ≈ 89 % of the changes in the dependent variable Tn and could be considered adequate (the additive coefficient of determination ≈ 88 %). Successful translation depends significantly on syntax and less on vocabulary. The same model equation is obtained by means of Backward Stepwise Regression.

The graph of the equation (5) – plane in the space and the points with coordinates (Ln,Sn,Tn), see Table 1, are shown in Fig. 4 at different angles.

In the experimental design the strongest correlation that could be observed is between syntax and vocabulary. And syntax is in a very strong relation with the grammar skills in the target language, which is a logical consequence of the level of the foreign language skills of the students.

CONCLUSIONS

The statistical processing of the results support the expectations for developments in the learning strategies of students of engineering training in the process of developing communicative competence in English for specific purposes. The research data show changes occurring in modified learning environment compared to traditional methods of foreign language learning in academic courses and more specifically in the component of translation. The design of the training can stimulate the development of a system of learning strategies that effectively combines cognitive and metacognitive strategies to provide: individual control over the information processing; selective focused attention on the process of awareness and understanding of students what they are doing when studying; consideration of their own performance and progress.

Discussion on the data from the frequency, regression and correlation analysis shows the dependencies of the results of learning in their components as a basis for evaluating the effectiveness of learning strategies, i.e. specific actions that are planned for the acquisition of knowledge, skills and/or ways of thinking about their progress in learning.

The recorded changes in the strategies show differentiation depending on the basic foreign language competence. For the improvement of students' own learning, one should take into account the sources of errors and direct efforts towards improving learning, having selected the appropriate methods and techniques.

The choice of methods of learning, combining metacognitive and cognitive strategies is associated with the aspirations of students towards better and more detailed understanding of specific vocabulary and grammatical material, which they do on the basis of the application of knowledge in the chemical technology training. The acquisition of higher-level knowledge and skills further motivates students to progress to more difficult language tasks.

It can be assumed that the integrated design for training in English for specific purposes (ESP) and chemical technology disciplines meet the teachers' attitudes of supporting learning strategies, and the results of its experimental implementation provide a scientific argumentation for designing an effective environment in accordance with the current objectives of the engineering education.

Contrary to expectations, there were not found significant relations between learning outcomes in English for specific purposes and chemical technology disciplines, which outlines two key guidelines for further methodological work. On the one hand, there is the possibility for introducing the component of development of foreign language competence in training without disturbing the course of academic work in the disciplines of the curriculum of engineering specialty; and, on the other hand, the experimental design creates opportunities for redefining the purpose of teaching English in academic environment and linking them with the professional requirements to the specialists from the relevant disciplines. Thus defined specific purposes presuppose development of methodological approaches for their implementation as integrated courses, linking key competences (according to EQF), taxonomy of engineering competence [15] and the network of chemistry and chemical engineering.

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