Science, Engineering & Education, 2, (1), 2017, 83-95

Integration of English for specific purposes in the chemical technology training

Tsvetanka Dilkova*, Anton Georgiev, Kameliya Anichina

University of Chemical Technology and Metallurgy, 8 Kl. Ohridski, 1756 Sofia, Bulgaria

Received 24 April 2017, Accepted 20 September 2017

ABSTRACT

Learning English for Specific Purposes (ESP) is one option for optimizing foreign language teaching in a course for academic purposes. The article presents a study on the integration of ESP in the chemical technology subjects. Specialized content was designed to investigate the application of translation of scientific and professional literature on methodological context and in accordance with its specific functions in engineering disciplines (in particular specialties of vocational direction chemical technology) to build professional competencies. Arising problems are identified; an approach for optimizing and monitoring of training is developed, taking into account its specific nature in the engineering disciplines.

Keywords: foreign language, ESP, control charts.

INTRODUCTION

Successful realization of young specialists is the result of many factors, among which the main place is held by the learning outcomes in higher education and the way in which they can be applied easily in a professional environment. Here's why education strives continuously to serve the needs of the practice, in the face of the various sector and business organizations.

According to the European qualifications framework for lifelong learning, learning outcomes are defined as " statements of what a learner knows, understands and is able to do on completion of a learning process" in terms of knowledge, skills and competences [1]. In the field of engineering there is a growing demand for personnel and increased requirements to their training. Engineering technology develops and improves, and this requires the adaptation of educational programs in order to develop the expected knowledge and skills and to promote the acquisition of competences to facilitate rapid integration to different professional positions. And in the center of the learning outcomes stands the need for clearly defined and purposefully applied

**Correspondence to: Tsvetanka Dilkova, Department of Humanities, University of Chemical Technology and Metallurgy, 8 Kliment Ohridski, 1756 Sofia, Bulgaria, E-mail: dilkova_c@abv.bg*

transferable key skills as an integral part of the qualifications of each specialist and an element of trust of employers to the education system. Communication in a foreign language (English) has established itself as a key competence for the engineering professions and it should find its reflection in educational programs [2 - 4].

RESEARCH CONCEPT

Language learning is an important element of the strategy of the European Commission, which ensures the efficiency of European education systems and the competitiveness of the European economy, but the EQF and related frameworks define the competences and skills-building as an essential element of defined learning outcomes. Effective communication skills in English are an obvious necessity for future engineers in today‘s globalized environment [5].

It is a challenge for all countries in the educational process and therefore professional organizations at national and international levels are exploring the need for outgoing results from the training of engineers in different fields including technical knowledge, professional skills and attributes, interpersonal skills: teamwork and communication (English, the language of regional industrial nations, other languages); design, implementing and operating systems in enterprise and societal context [6].

English for special purposes (English for Specific Purposes – ESP) and especially for students in science and technology is designed for the teaching of languages according to the needs of students and their level of proficiency so that they can read and understand without help authentic scientific texts [7]. The engineers are expected to communicate with their colleagues, with society, with customers and authorities; to use the English language for emails, letters, reports, proposals, and phone calls. This requirement is placed before the engineers at the beginning of their career. Those who know how to communicate well in written and oral form will always have an advantage over the others [8]. The end result of the learning competence in engineering disciplines associated with the use and application of the English language are laid down in the following way: „future engineers must be able to present the engineering knowledge of different audiences, in written and oral form, in English“ [9].

Training related to the acquisition of communicative competence in a foreign language does not develop on universal concepts, but is looking for methodological approaches that are oriented towards specific groups, trained in specific terms. This implies a change in the role of teachers of foreign languages: they not only teach a specific training material, but also actively participate in the construction of a school complex, which is in accordance with the specific terms, conditions, needs, expectations, motives and abilities of students; take the self and independent responsibility for the effectiveness of their teaching, the main objective of which must be to teach learners how to learn using their previous language experience, and this leads us to the teaching goal to assist students to develop effective personalized learning strategies [10].

Language learning strategies are considered essential in the determination of significant academic achievements; they are perceived as a shift of focus from the teachers and teaching to learners and learning [11].

Learning strategies are everywhere, where we try to learn something, but unfortunately not all learners are aware of their essence and subsequently apply them. For this reason, it is important for learners to understand that good performance depends on appropriate strategies, not luck or any special ability for that. The role of the teacher, however, should not be restricted to the function of inducing awareness. On the contrary, the teacher should guide the students to the models of good thinking and to learning the qualities which are characteristic of successful students always in the context of their own strategies. Only when they consciously reflect on the cognitive activity can they protect themselves from failure. Students with a better level of proficiency using cognitive and compensatory strategies are more effective in learning the language than their colleagues with a lower level of proficiency in the targeted language [12].

In the process of formation of communicative competences for engineers, the idea for the development of learning strategies sets specific tasks for teaching foreign languages and the disciplines of the curriculum as far as foreign language skills are required to perform academic tasks. The translation is a natural focus of study and application of foreign language for academic and specialized purposes, making it a key component of the design of the training. Its importance for the development of communicative competence in the field of specialised English oriented the current research to the application of translation in training.

The approaches for the educational environment development towards creating such conditions that support individual learning may become a central focus of a pedagogic system of methods, means and training tools. They follow the specific nature of the educational content and that is where teaching can make use of a creative selection of innovative approaches and technologies. Here we present the design of English language training using translation of scientific and professional literature that reflects its specific functions in engineering and technical disciplines (in particular chemical technology) to build professional competencies.

The aim of this study is to explore the use of native language (translation) when working with specialized scientific texts in groups and individually, in and out of the classroom learning activities; to create an integrated design of training that combines the English language learning and the disciplines «Organic chemistry» and «Technology of organic synthesis» for students at University of Chemical Technology and Metallurgy (UCTM). The study includes: developing a methodological toolkit (training materials), which integrates the technological knowledge of specialized native and foreign language and teaching materials designed for teachers and students; organizing integrated training; evaluation and analysis of the results with the aim of further development of the methodology for teaching English for specific purposes /ESP/, oriented to the acquisition of communication skills through the use of translation.

METHOD

The development of training materials is based on content analysis: „a class of psycholinguistic methods for systematic analysis of language texts“ [13]. It includes analysis of the content of educational material in the textbooks in English for engineering and technological disciplines. Activities and tasks are analysed with the help of which translation to and from English language can be done. On the basis of content analysis are defined: specific activities and tasks that could present difficulties for students and the possibilities of their second implementation with options for overcoming these difficulties; the sequence of the units in the courses that should be in parallel with the study of related units in engineering and technological training.

The disciplines studied are: „Organic Chemistry" and "Technology of Organic Synthesis". The texts for translation are authentic [14, 15].

As a result of the content analysis are derived key (scientific and technical) terms and expressions related to the understanding of the contents in Bulgarian and in English in order to build a specialized glossary of terms for individual work. The basic logical connections in the scientific texts are defined from which to determine the content of the exercises in the training materials for students and teachers. There are learning activities designed to involve working with scientific content in English and in Bulgarian language and which are to become the basis for supporting success in translation. A pattern of the sequence of activities for preparation and implementation of the training tasks is created to support the transfer of knowledge and experience between engineering technology and language learning.

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 which 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 (hand-outs) – Appendix 1. The design of the exercises is consistent with the objectives of the study and the expected learning results in English and in the disciplines of the curriculum.

As research tools, the exercises are graded in difficulty and structured in a way that does not create additional difficulties in the course of work, but to facilitate students in their implementation, taking account of such factors as duration of classes, different levels of English language proficiency of students and the individual abilities to work with a specialized text. The purpose of this set of exercises is to find what is the dynamics in the application of different learning strategies of students and to what extent their knowledge in a certain field has an impact on their results in ESP and vice versa.

The contents of each worksheet with exercises include:

Exercise for matching words and expressions in the targeted language with their equivalent in the native language. The terms are defined by the experts for two main reasons: they are part of the new terminology knowledge which is an essential prerequisite for the understanding of the content; the disclosure of the relation between the terms in their native language and the targeted language equivalents would boost the scientific text translation tasks.

The purposes of this type of exercise are:

- To update the discipline-related terminology learned so far;
- To provide assistance when there are gaps in the students’ knowledge of required terminology. For this purpose, there is an opportunity to work with a dictionary and/or in cooperation with colleagues and help from the teacher;
- To get ready to work on the following tasks 3 and 4 of the worksheet.

Exercise for matching expressions. Implementation requires the students to recall the grammatical constructions in English and link correctly with their Bulgarian expression. In this exercise are used models, which on the one hand are the most common in scientific texts, and on the other hand, most frequently mistaken by people learning English. In the English language, there are quite particular and specific grammatical forms, for which it is hard to find matches in the Bulgarian language, for example, verbs in the progressive tenses, the perfect tenses, verbs in the passive voice, sequence of tenses, the use of the gerund, infinitive and participle, impersonal subject, etc. Therefore, to support students in the tasks of translation they are provided with the opportunity for exercising such forms and thus avoid the mistakes due to grammatical incorrectness.

The purposes of this type of exercise are:

- To revise problematic grammatical forms;
- To get ready to work on tasks three and four of the worksheet.

Exercises 3 and 4 are related, as the sentences for translation in exercise 3 are taken out of the context of the specialized text in exercise 4. The idea is to give students one more chance to work with a text related to the subject taking into account that this will update their knowledge of the topic and will be implemented immediately in the style and complexity of the text to be translated.

At this stage of the work with the experimental training Toolkit students should feel a lot more confident in their ability to make the correct translation. After completion of the first exercise, students are expected to have overcome the pressure of not being aware of the contents of the subject in English and the difficulty in understanding. With the success of the implementation of the tasks their motivation should be different from that in traditional translation tasks of an unknown text in English in class and for self-study. Practically, students are encouraged to apply a combination of learning strategies to achieve a satisfying result.

The survey was conducted during 2008/2009 academic year (29 students) and 2015/2016 (22 students) at 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".

ANALYSIS

The assessment and analysis are made on the basis of the level of proficiency of English. It is determined by standard test [16]. Skills that are tested 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).

In Table 1 are given scores from: entry level colloquium in chemistry – variable X1; coursework task in a chemical technology subject – X2; participation in seminars and homework activities – X3; the other variables refer to the English language skills: vocabulary – X4; grammar – X5; syntax – X6; translation – X7 and appropriate use of a dictionary entry – X8. The same table contains the average scores in a chemical technology subject (CTS) – X and in English (EL) – Y. They have been achieved as the average of the components in CTS and EL. The average value for individual components is represented by Mean. Students with numbers from 1 to 11 have A2 level of English; students with numbers from 12 to 20 have B1 level of proficiency in English and the rest have B2 level.

Table 2 shows the descriptive statistics (mean, standard deviation, minimum and maximum values) for the observed components of CTS and ESP.

The histogram of the average scores in CTS is shown in Fig. 1. Bimodal distribution with right asymmetry (the modes are drawn to the left). Fig. 2 shows the histogram of the average scores in ESP – bimodal distribution with left asymmetry (the modes are drawn to the right). It is possible that the data represent a mixture of two normal distributions.

For the academic year 2015/2016, the dis-

Table 2. Descriptive statistics for the variables X1, …, Y.

Statistics	X1	X2	X3	X	X4	X5	X6	X7	X8	Y
Mean	3.621	4.034	3.414	3.67	5.067	4.448	4.931	5.034	5.379	4.972
StDev	0.862	0.944	1.296	0.776	0.799	0.948	1.100	1.085	0.820	0.882
Min	3	3	2	2.67	4	3	3	3	3	3.2
Max	4	5	5	5.67	6	6	6	6	6	6

Table 1. Scores in CTS and ESP (Organic chemistry) for 2008/2009 academic year.

Level	Student	X1	X2	X3	X	X4	X5	X6	X7	X8	Y
	1	3	4	2	3	4	3	3	3	3	3.2
	2	3	3	3	3	4	3	3	4	4	3.6
	3	3	4	2	3	5	4	4	4	5	4.4
	4	3	3	2	2.67	4	3	3	3	4	3.4
	5	3	4	2	3	4	3	4	4	5	4
A2	6	3	4	2	3	5	4	4	4	5	4.4
	7	4	5	3	4	5	5	5	6	6	5.4
	8	3	5	3	3.67	6	5	6	6	6	5.8
	9	3	4	2	3	4	4	4	4	4	4
	10	3	4	2	3	4	3	3	3	5	3.6
	11	3	3	4	3.33	4	3	4	4	5	4
	12	4	6	5	5	6	5	6	6	6	5.8
	13	5	5	4	4.67	5	5	6	5	6	5.4
	14	3	6	3	4	6	5	5	5	6	5.4
	15	4	5	4	4.33	6	5	6	6	6	5.8
B1	16	4	4	5	4.33	6	4	6	6	6	5.6
	17	3	5	5	4.33	5	5	5	6	6	5.4
	18	3	5	2	3.33	5	4	5	5	5	4.8
	19	5	4	5	4.67	5	4	5	5	5	4.8
	20	3	4	3	3.33	5	4	4	4	5	4.4
	21	3	3	2	2.67	6	5	6	6	6	5.8
B2	22	4	3	3	3.33	6	6	6	6	6	6
	23	5	3	5	4.33	6	6	6	6	6	6

tribution of 22 students according to their level in ESP is the following: the first 4 are students are level A2, the next 12 (with numbers from 5-16) are level B1 and the last 6 are level B2. Their average scores in CTS and ESP are given in Tables 3 and 4.

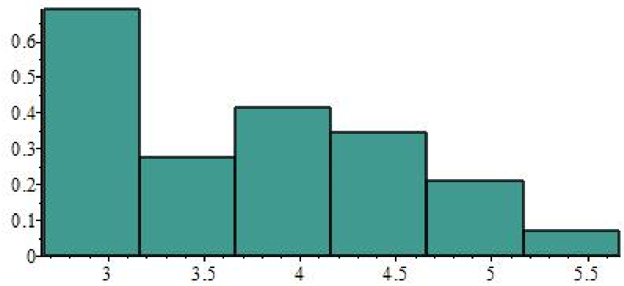

Fig. 1. Histogram of the average scores in Organic chemistry of 29 students.

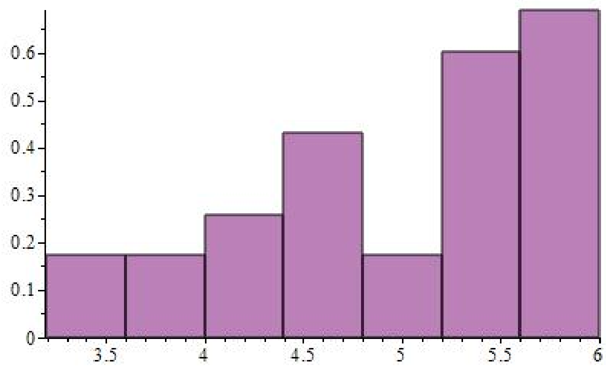

Fig. 2. Histogram of the average scores in ESP of 29 students.

CONTROL CHARTS

Control charts (CC) are designed to control a certain process for the occurrence of non-random perturbations in time. CC are a graphical method for monitoring and maintenance (control) of a certain process in a steady state by testing samples for non-standard behavior. If variations in the process are not random, it is called unstable. To control the learning process are used Shewhart CC [17, 18]: X-chart and I-chart controlling the mean of the process;R-chart for the average magnitude; S-chart for the standard deviation, etc. All CC are designed assuming that the data is independent and normally distributed (with mean μ and standard deviation σ).

From the properties of the normal distribution, it is known that: in the interval (confidence interval – CI) [μ-3σ, μ+3σ] are 99.7 % observations of the mean and [μ-2σ, μ+2σ] is 95.5 % CI for the mean.

Normally, a 3-sigma control chart is used $\pm 2\sigma$ and $\pm 3\sigma$ control lines for the mean μ.

The central line (CL) controls the mean of the process. Control limits: μ -3σ lower limit (LCL) and μ +3σ upper limit (UCL) mean that if data is in the interval [μ-3σ, μ+3σ], then the process is under control.

The warning limits $\mu \pm 2\sigma$ (WLCL, WUCL) serve as a warning against dangerous situations when the process can become unstable and beyond statistics control.

To build a 3-sigma control chart we shall use data from previous monitoring, namely from Table 2.

Table 3. Average scores in CTS and ESP for 2015/2016 for levels A2 and B1.

Level	A2				B1											
Student	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
	Score															
CTS	4.5	5	4.5	5	5	4.5	5	5	6	5.5	5.5	6	5	5	6	5
ESP	4.2	4	3.4	4.4	5.2	4.4	4.6	5	5.6	5.4	4.4	4.8	4.4	5	4.4	4.4

Table 4. Average scores in CTS and ESP for level B2.

Student	17	18	19	20	21	22
	Score					
CTS	6	6	5.5	6	6	5.5
ESP	5.6	5	6	5.8	5	5

We shall calculate the mean M of the means, M_{Xi}, and standard deviation S:

$$M=\frac{1}{m}\sum_{i=1}^{m} M_X = 4.491,$$

where m=8 is a number of samples with size n=29, and

$$S=\sqrt{\frac{1}{m-1}\sum_{i=1}^{m}(M_X - M)^2} = 0.731.$$

Then the equations of the control lines of chart-X shall be:

LCL= M-3S; WLCL=M-2S; CL=M; WUCL= M+2S; UCL= M+3S.

Obviously, the control limits in a 6-grade system of assessment are outside the limits μ ± σ 3 at high dispersion in average grade scores, i.e. . LCL<3<6<UCL. We must therefore monitor the intervals [2, WLCL] and [WUCL, 6] or to use CC X, I-chart with "tighter" limits [17]:

$$LCL = M - \frac{3\overline{R}}{d_2\sqrt{n}}; \ CL=M; \ UCL= M + \frac{3\overline{R}}{d_2\sqrt{n}},$$

where: $\overline{R}$ =2.5 is the average magnitude from the previous research, see Table 2 – R=Max-Min, d_2 =4.057 [19], which are very tight for the particular data and therefore we shall use control limits as in [20] and the warning limits shall be made by analogy with the X-chart:

$$LCL = M - \frac{3\overline{R}}{d_2}; \ WLCL= M - \frac{2\overline{R}}{d_2}; \quad CL=M;$$

$$WUCL= M + \frac{2\overline{R}}{d_2}; \quad UCL= M + \frac{3\overline{R}}{d_2}.$$

For the interpretation of the CC are used the following rules [18]:

If most points are near one of the 3 sigma control lines, the process should be regulated by administrative means.

If most of the points are in the bands [LCL, WLCL] or [WUCL, UCL], above the average line, but from the bottom or top of the CL, the process is unstable and we must be looking for a reason for this instability from aside, too.

If most of the points are in the band [WLCL, CL] or [CL, WUCL], the process is slightly shifted, but under control – we just monitor it during the subsequent behavioral observations.

If all points are evenly spaced in the band [WLCL, WUCL] the process is stable.

Figures 3-10 show X, I-charts of average scores in CTS and ESP for 2008/2009 and 2015/2016.

The control charts of 29 students in CTS show lower scores – most are under the central line CL.

The control charts of 29 students in ESP are shown in Figures 5 and 6.

For level A2 in ESP (the first 11 students) the scores are lower, for the other two levels the scores are higher as all the scores are in the band above the upper warning limit.

Figs. 7 and 8 show the control charts of the average scores of 22 students in CTS.

The scores in CTS are higher – they are all above the central line.

Figs. 9 and 10 show the control charts of 22 students in ESP.

Assessment of the results of ESP training in the group of 4-year students (studying Technology of Organic Synthesis) compared to the results in the group of 3-year students (studying "Organic Chemistry") shows decrease in the scores

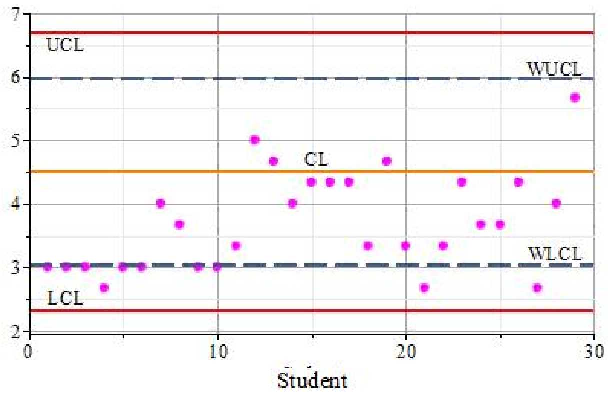

Fig. 3. X-CC with 2 and 3- σ limits in CTS.

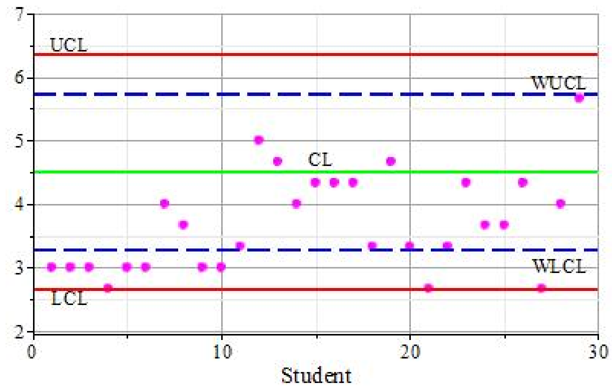

Fig. 4. I-CC with 2 and 3- R limits in CTS.

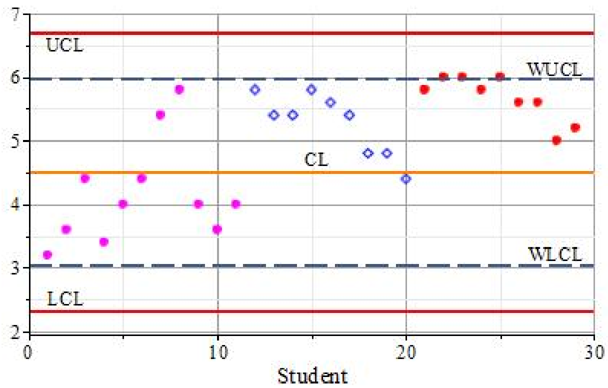

Fig. 5. X-CC with 2 and 3- σ limits in ESP.

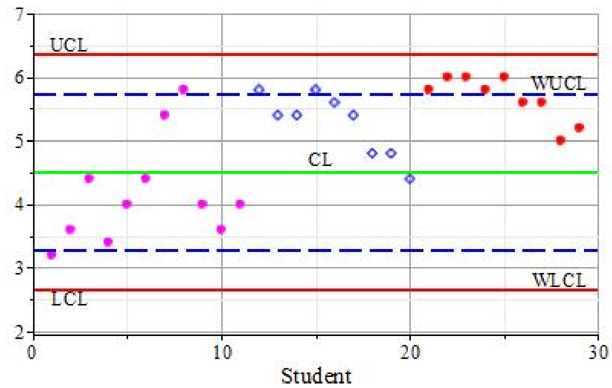

Fig. 6. I-CC with 2 and 3- R limits in ESP.

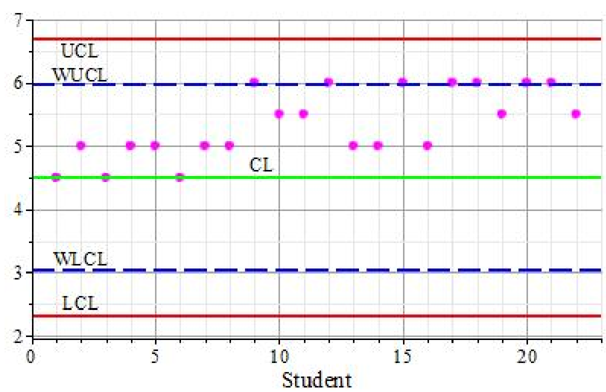

Fig. 7. X-CC with 2 and 3- σ limits in CTS.

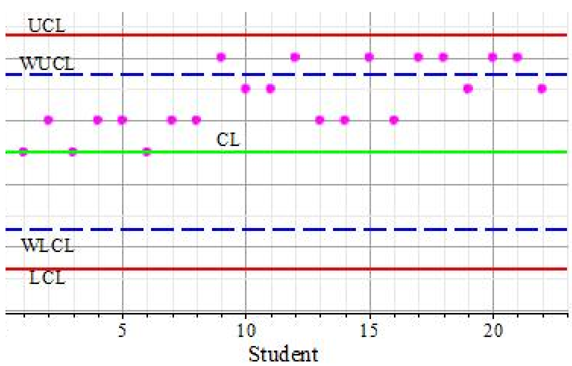

Fig. 8. I-CC with 2 and 3- R limits in CTS.

of English level A2, slight increase for level B1 and strong increase for B2.

This discrepancy shows that the academic experience is reflected on the applied learning strategies and the individual control of learning, as well as the development of skills by the learners. This should also be reflected on the approaches to record learning outcomes and assessment of progress. Apparently it is essential to have greater variability of learning tasks and

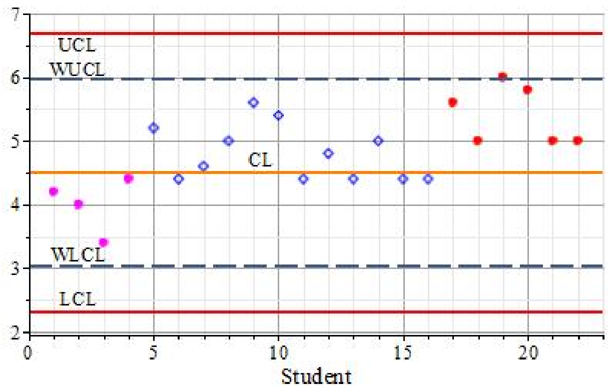

Fig. 9. X-CC with 2 and 3- σ limits in ESP.

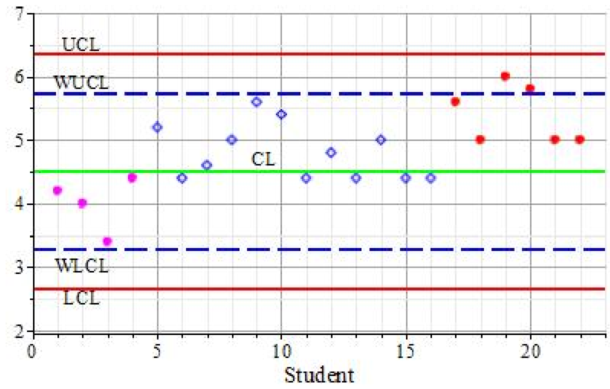

Fig. 10. I-CC with 2 and 3- R limits in ESP.

higher requirements in the evaluation procedures for more advanced language students.

Learning outcomes focus on clear and detailed statements about what students learn – the knowledge, skills and competences which are acquired. Survey data show the independence between the achievements in CTS and ESP.

CONCLUSIONS

The new educational paradigm defines the learners not only as receivers, but as ones who intensively process and interpret incoming information; develop cognitive skills and require individual control and self-regulation of learning. The presented study proves the possibility of students to progress in learning by integrating the academic work in the field of foreign language skills and chemical technology disciplines. Specific data for the advancement in both disciplines are a landmark for the possibilities of experimental learning and how it should be applied and developed. The first step is organizing the academic training as integrated ESP courses: acquiring communicative competence in English language along with learning specialized engineering disciplines with an emphasis on open and flexible design, autonomy of teachers and learners.

REFERENCES

1.European Qualifications Framework for lifelong learning (EQF), https://ec.europa.eu/ploteus/sites/eac-eqf/files/EQF_note4_en.pdf

2. J. Bankel, K. Berggren, K. Blom, E.F. Crawley, S. Ostlun, The CDIO Syllabus: A comparative study of expected student proficiency", Eur. J. Eng. Educ., 28, (3), 2003, 297-315.

3. L. Woollacott, The goals of engineering education: a rationale for a universal document based on the CDIO syllabus and the taxonomy of engineering competences, University of the Witwatersrand, Johannesburg, South Africa, Proceedings of the 3rd International CDIO Conference, 11-14 June, 2007, MIT, Cambridge, Massachusetts.

4. K. Edström, Aims of engineering education research – the role of the CDIO initiative, School of Education and Communication in Engineering Science, KTH Royal Institute of Technology, Proceedings of the 12th International CDIO Conference, Turku University of Applied Sciences, 12-16 June, 2016, Turku, Finland, http://www.cdio.org/files/document/cdio2016/25/25_Paper_PDF.pdf.

5. M.J. Riemer, English and Communication Skills for the Global Engineer, Global J. of Engng. Educ., published in Australia, 6, (1), 2002, 91-100.

6. P. Spence, Gi-Zen Liu, Engineering English and the High-Tech Industry: A Case Study of an English Needs Analysis of Process Integration Engineers at a Semiconductor Manufacturing Company in Taiwan, English for Specific Pur-

poses, 32, (2), 2013, 97-109.
7. S. Kartali, Foreign Language Policy in the Technological Educational Institute of Thessaloniki, Greece, Smaller Languages in the Big World: Sociolinguistics and FLT; Papers of the International Conference held in Sofia, October 2001, Lettera, 2002, 226-231
8. R. Uma, Communicative Competency – an Essential Skill for Engineering Students, Saranathan College of Engineering Venkateswara Nagar, India, International Journal of Scientific Research, 3, (10), 2014, ISSN No2277-8179.
9. M.J. Mette, A Competence Based Framework for Engineering Education, at 40th annual conference, 23-26 September, 2012, p. 5, SEFI, Thessaloniki, Greece.
10. B. Wiesen, Content-based Unit Learning in English for Academic Purposes Courses in Teachers' Colleges:1, Journal of Adolescent & Adult Literacy, 44, 4, 2000, 372-381 www.questia.com/reader [Accessed on 28.03.2008].
11. K. Hakan, B. Aydin, A. Bulent, An Investigation of Undergraduates' Language Learning Strategies, 7th World Conference on Educational Sciences, (WCES-2015), 05-07 February, 2015, Novotel Athens Convention Center, Athens, Greece, Procedia – Social and Behavioral Sciences 197, 2015, 1348-1354, https://doi.org/10.1016/j.sbspro.2015.07.388.
12. J. Šafranj, Strategies of learning English as a foreign language at Faculty of Technical Sciences, 3rd World Conference on Learning, Teaching and Educational Leadership (WCLTA-2012), Procedia – Social and Behavioral Sciences, 93, 2013, 775-782, https://doi.org/10.1016/j.sbspro.2013.09.277.
13. Dictionary of Psychology, Science and Art, Sofia, 1989 (in Bulgarian).
14. F.G. Mann, B.C. Saunders, Practical Organic Chemistry, Longman, London & New York, 1974.
15. J. Leonard, B. Lygo, G. Procter, Advanced Practical Organic Chemistry, Third Edition, CRC Press Taylor & Francis, 2013.
16. Quick Placement Test, University of Cambridge Local Examinations Syndicate, 2001, www.cambridge-EFL.org.
17. C. Berardinelli, A Guide to Control Charts, iSixSigma, https://www.isixsigma.com/tools-templates/control-charts/a-guide-to-control-charts/
18. A.A. Ribanov, V.P. Shevchuk, E.A. Prikhodko, Intellectual system for assessing the quality of the learning process, Network electronic scientific journal "Systemotechnics", 2, 2004 (in Russian), http://systech.miem.edu.ru/2004/n2/Ribanov.htm
19. Minitab Express Support, Unbiasing constants d2(), d3(), and d4(), http://support.minitab.com/en-us/minitab-express/1/help-and-how-to/control-charts/how-to/variables-data-in-subgroups/xbar-r-chart/methods-and-formulas/unbiasing-constants-d2-d3-and-d4/
20. Engineering statistic handbook, Shewhart X-bar and R and S control charts, http://itl.nist.gov/div898/handbook/pmc/section3/pmc321.htm

Appendix I

ESP exercises on the content of "Organic chemistry"

Ex.1. Match the words/phrases on the left (1-7) with their Bulgarian equivalents on the right (a-g).

1. organic compound	a) среща се, появява се
2. bonds	b) въглероден скелет
3. readily broken	c) обикновен, прост; популярен
4. common	d) органично съединение
5. occur	e) връзки
6. carbon backbone	f) част
7. portion	g) лесно разрушими

Ex. 2. Match the words/phrases on the left (1-5) with their Bulgarian equivalents on the right (a-e).

1. distinguish one from another	a) свързан
2. is called	b) са свързани
3. are bonded	c) е наречен
4. are easily broken	d) разграничават едно от друго
5. bonded	e) са лесно разрушими

Ex. 3 Translate the following sentences.

1. They determine a molecule's geometry, physical properties, and reactivity, and comprise what is called a functional group.
2. Heteroatoms have lone pairs and create electron-deficient sites on carbon.
3. Don't think, though, that the C-C and C-H σ bonds are unimportant.

Ex. 4. Translate the text below.

What are the characteristic features of an organic compound? Most organic molecules have C-C and C-H σ bonds. These bonds are strong, nonpolar, and not readily broken. Organic molecules may have the following structural features as well:

• Heteroatoms – atoms other than carbon or hydrogen. Common heteroatoms are nitrogen, oxygen, sulfur, phosphorus, and the halogens.

• π Bonds. The most common π bonds occur in C-C and C-O double bonds.

These structural features distinguish one organic molecule from another. They determine a molecule's geometry, physical properties, and reactivity, and comprise what is called a functional group.

• A functional group is an atom or a group of atoms with characteristic chemical and physical properties. It is the reactive part of the molecule.

Why do heteroatoms and π bonds confer reactivity on a particular molecule?

• Heteroatoms have lone pairs and create electron-deficient sites on carbon.

• π Bonds are easily broken in chemical reactions. A π bond makes a molecule a base and a nucleophile.

Do not think, though, that the C-C and C-H σ bonds are unimportant. They form the carbon backbone or skeleton to which the functional groups are bonded. A functional group usually behaves the same whether it is bonded to a carbon skeleton having as few as two or as many as 20 carbons. For this reason, we often abbreviate the carbon and hydrogen portion of the molecule by a capital letter R, and draw the R bonded to a particular functional group.

ESP exercises on the content of "Technology of Organic Synthesis"

Ex.1. Match the words/phrases on the left (1-5) with their Bulgarian equivalents on the right (a-e).

1. primary amines	a) следователно
2. the latter	b) редукция, намаляване
3. therefore	c) първични амини
4. reduction	d) киселина
5. acid	e) последният

Ex.2. Match the words/phrases on the left (1-5) with their Bulgarian equivalents on the right (a-e).

1. by the interaction	a) реакциите, които настъпват
2. which is formed	b) чрез взаимодействието
3. is carried out	c) който се образува
4. is based on	d) се извършва
5. the reactions involved	e) се основава на

Ex.3. Translate the following sentences.

1. The preparation of pure primary amines is carried out therefore by special methods, such as the reduction of oximes and of nitro-compounds.
2. The reactions involved probably proceed as follows.
3. A third method due to Hofimann is based on the action of bromine on acid amides, with subsequent alkaline hydrolysis.

Ex. 4. Translate the text below.

The preparation of pure primary amines by the interaction of alkyl halides and ammonia is very difficult, because the primary amine that is formed reacts with unchanged alkyl halide to give the secondary amine: the latter similarly gives the tertiary amine, which unites with unchanged alkyl halide to give the quaternary ammonium halide. The preparation of pure primary amines is carried out therefore by special methods, such as the reduction of oximes and of nitro-compounds. A third method due to Hofimann is based on the action of bromine on acid amides, with subsequent alkaline hydrolysis. The reactions involved probably proceed as follows. Acetamide when treated with bromine forms acetbromoamide, $CH_3CONHBr$, which in NaOH solution gives the ionised sodium acetbromoamide, CH_3CONBr^+ Na. The anion loses Br with simultaneous migration of the CH_3 group to the nitrogen, giving methyl isocyanate, which undergoes hydrolysis to methylamine.