



Bartłomiej Wróblewski* and Olesya Petrenko

Descriptive and inferential statistical analysis of expectations and needs of engineering students and graduates: a case study at the University of West Bohemia

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Abstract: A good command of English for Specific Purposes (ESP) among Czech engineers seems to be of crucial importance since the engineering field has been developing rapidly and the Czech labour market is becoming increasingly international (Eurostat 2020). The authors of this article, who supervise the ESP courses offered to the students of the Faculty of Mechanical Engineering (FST) at the University of West Bohemia (UWB) in Pilsen (Czech Republic), attempt to meet the changing needs of the engineering field by conducting needs analyses among students, university graduates and prospective employers, and keeping their ESP courses' syllabi up-to-date and relevant to their engineering students. This paper presents a comparative analysis of a questionnaire that was distributed in the year 2021 among UWB engineering students and graduates. Having analysed the responses that dealt with graduates' needs and students' expectations of using ESP in a workplace, the authors noticed several discrepancies between the answers they received from the students and those they received from the graduates. Based on the analysis, a hypothesis that current students sometimes have misconceptions about their future work life has been formulated. To confirm this hypothesis, in the next stage of the research, selected students and graduates are to be interviewed to gather additional information. The authors also wish to examine this hypothesis by having prospective engineering employers reply to the same survey questions.

Keywords: Academic English; English for mechanical engineering; English for specific purposes; graduates' needs; needs analysis; students' expectations

*Corresponding author: Bartłomiej Wróblewski, University of West Bohemia, Pilsen, Czech Republic, E-mail: bartlomiej.wroblewski@ruk.uni.cz

Olesya Petrenko, University of West Bohemia, Pilsen, Czech Republic,
E-mail: petrenko@ujp.zcu.cz

1 Introduction

Since mechanical engineering has been developing rapidly and the Czech labour market is becoming increasingly multinational (Eurostat 2020), a high level of proficiency in English for Specific Purposes (ESP) among engineers would appear to be of value in order to succeed in the engineering field. As a result, the authors, who teach ESP to students of the Faculty of Mechanical Engineering (FST) at the University of West Bohemia (UWB) in Pilsen (Czech Republic), face a major challenge to tailor their course syllabi to meet the needs of the continuously changing engineering industry.

There is a variety of ESP courses that FST offers to its students. Bachelor's degree students can choose from among four technical English courses: 'English for Mechanical Engineering 3 (AST3)', 'English for Mechanical Engineering 4 (AST4)', 'English for Mechanical Engineering 5 (AST5)', and 'English for Mechanical Engineering 6 (AST6)', which have been meticulously designed to be taught in four consecutive semesters. AST3, AST4 and AST5 are 'C' category courses (electives); AST6, on the other hand, is a 'B' category course (compulsory-elective). Even though AST6 is the only mandatory course for FST students, they tend to enroll in the elective courses as well, given that the compulsory-elective course, where the required level of proficiency is the highest, might be considered to be a challenge by some of the students. Having completed the AST6 course, an FST student should be equipped with language competence at B2 level as specified by the Common European Framework for Languages. Master's degree students take two 'B' category Academic English courses (AEP5 and AEP6) that are taught at the CEFR's C1 proficiency level.

After completing certain AST and AEP courses, a number of students expressed conflicting opinions about the content of the courses; various topics that seemed to be essential to some of the students were considered rather useless by others. To discover what might be causing this peculiar contradiction, the authors decided to review their ESP courses' content.

All of the above-mentioned English courses adopt carefully chosen ESP coursebooks. Having been designed by the employees of the Institute of Applied Language Studies (UJP) at the University of West Bohemia (UWB), the technical English coursebooks were specifically tailored to the students' needs. It should be emphasised, however, that they were written in the year 2013, which, according to the AST courses' supervisor, means that due to the rapid development of the engineering industry, many of the materials are outdated. The syllabi of the Academic English courses are based on the 'Oxford EAP' coursebook, which equips the students with a variety of practical academic skills. Even though the skills taught seem to be advantageous, the students have been expressing

increasing dissatisfaction with the course content due to the fact that the ‘Oxford EAP’ coursebook deals mainly with topics that are not closely related to mechanical engineering, e.g. economics, psychology, and natural sciences.

Hence, the authors have decided to investigate the needs of two specific groups: FST students and FST graduates, with the objective of updating the syllabi of the English for Mechanical Engineering and Academic English courses appropriately. The needs analysis also aims at elucidating the sources of the students’ contradicting opinions on the courses’ contents. To achieve the objectives, a questionnaire was created and then distributed among FST students and graduates in order to analyse their expectations and needs concerning the use of English in the workplace. It is worth mentioning that the questionnaire technique has been widely used for conducting ESP needs analyses (Čapková and Kroupová 2017; Chin-Ling 2016; Kim 2013).

The results of the analysis that dealt only with the needs and expectations of FST students can be found in Wróblewski and Petrenko (2021). They indicate that a high number of students regard improving their speaking skills as essential; thus, very strong correlations between responses that relate to various speaking skills were received (such tasks as speaking on the phone, speaking English during business meetings, debating and presenting in English returned coefficient values from 0.5 to 0.7). Therefore, we assumed that interactive lessons focusing on speaking activities, which would be designed by the university language institute or Language Centre, would meet the students’ needs. On the other hand, the expectation of the limited utility of academic writing and reading is particularly apparent in the results. Once the FST students’ expectations and needs were analysed, the authors decided to conduct a comparative analysis of the responses received from students with those received from graduates in order to confirm or disprove the assumption based only on the students’ responses that speaking skills, e.g. negotiating or making business phone calls, should be the focus of the English courses that are offered at the Faculty of Mechanical Engineering. Once the assumption has or has not been confirmed, the courses’ syllabi need to be analysed and, if necessary, redesigned accordingly.

2 Theoretical background

According to Anthony (2018: 10, 11), “English for Specific Purposes (ESP) is an approach to language teaching that targets the current and/or future academic or occupational needs of learners, focuses on the necessary language, genres, and skills to address these needs, and assists learners in meeting these needs through the use of general and/or discipline-specific teaching materials and methods.” It can be derived from this definition that ESP is divided into English for Academic

Purposes (EAP) and English for Occupational Purposes (EOP). The former is aimed at students who pursue education in English and the latter helps professionals to gain specific language skills necessary within their work settings. Both branches are divided further into disciplines that cover various academic and professional skill sets. A chart outlining these sub-branches is presented, for example, in Anthony (2018: 14).

Naturally, language requirements vary from discipline to discipline, addressing multiple concerns of students involved in tertiary education, professional researchers, publishers, teachers and potential employers. An illustration of the language needs on three levels can be found in Robinson (1991).

One of the main characteristics of ESP is that it attempts to acquaint learners with the reasons for learning. The central idea brought forward in multiple research studies (Basturkmen 2003; Johns and Salmani Nodoushan 2015; Master 2005) and textbooks (Cargill and Burgess 2008) is that the language needs generally relate to common situations and language settings that the learners will find themselves in. It is crucial, therefore, to share a global vision, a purpose and learning needs with the students and to set target requirements (e.g. language goals for the students every term), as university ESP courses are time-bound.

In cases of courses offered repeatedly, it is recommended that continuous needs analyses be conducted (Basturkmen 2010), as they can assess the changing needs of both the market and the language learners enrolled at the tertiary level and build on existing knowledge more quickly. Such sustainable adjustments may help stakeholders (students, teachers, course supervisors and potential employers) to stay in tune with rapidly changing language skill requirements. Not only is it necessary to assess the worth and quality of current courses, materials and course objectives (Anthony 2018), but also it is essential to ensure that the courses correspond to the language tasks graduates are faced with as they start working as young professionals. From a methodological perspective, this can be achieved by using quantitative and qualitative analysis methods together (Huhta et al. 2013). This group of researchers (2013: 183) also claimed that for creating a diverse and reliable CEF (Common European Framework) professional profile, to understand what our groups of students potentially become and which language skills they need the most, it is necessary to gather high-quality data which “takes into account different contextual factors”.

Important aspects of genre, discourse analysis, corpora and discipline-based methodologies were described by Woodrow (2018) in her book devoted to various approaches to ESP. Hyon (2018) introduced a detailed description of using a genre concept as a way to introduce students to their target work settings. It can be concluded that language and communication need to be assessed holistically by teachers so that English language learners have greater abilities to reflect on their

own performance and evaluate their progress. As a result, it may lead them to having a higher level of self-awareness as they become young professionals.

We think our priority as English course teachers and course supervisors is continuous course adjustment alongside uninterrupted needs analysis of both graduates and students within the framework of basic ESP principles. According to Coffey (1984: 4–5), key features of ESP courses include authenticity and methodology: “the main consideration in ESP exercise typology must be that of authenticity (= authentic texts + authentic tasks)”. Teachers should “make the materials both more relevant and more interesting to the student by varied and ingenious exploitation of the opportunities provided by ESP settings”.

3 Methods

In order to adjust the courses in the most teacher- and learner-resourceful way, it was decided to evaluate graduates’ needs and students’ expectations by implementing qualitative and quantitative analyses. Creswell (2014) argued that such mixed research methods depend on the research rationale and design. We believe that using quantitative and qualitative research methods together allows us to fulfill research objectives and receive a better image of the students’/graduates’ needs and the reasons they choose to concentrate on specific language skills. In the case of this research, studying the needs of graduates and comparing them to the language expectations for workplaces of current UWB students is performed through sequential design because the deadline to carry out a quality survey to gather the data consistently was tight. One of the predominant features of sequential mixed-method design is that a researcher does not have to opt for any type of data in particular (qualitative or quantitative). What is more, it is possible to apply methods one after the other accordingly throughout the process of course design. In this paper we analyse the results of the graduates’ answers received during the first phase of the project and compare them to the results we received from UWB students in the same year.

We also use the case study method, since the project is carried out in the University of West Bohemia and we survey the stakeholders in the Czech Republic. Two groups are included in our case study – current students of the Faculty of Mechanical Engineering (100 people) and 38 alumni of the same faculty who work in the Pilsen Region. We believe it is a case study, as our research covers specific groups of people at a single faculty and the total number of respondents is less than 150. To work through the answers of the questionnaire we use both descriptive and inferential statistical methods as we carry out frequency analysis and box-plot description, correlation and factor analyses and compare language needs of

graduates to the language expectations of students. It was decided to create and use a questionnaire which included some evaluative statements that covered graduates' current experience of using English in their daily lives at work. The graduates were asked to highlight language skills and particular technical topics they thought it would have been useful to study thoroughly in the framework of their English AST courses. More detailed information about the analysis of students' needs and expectations can be found in Wróblewski and Petrenko (2021).

4 Results

We decided to organize the data we received from the graduates and students by implementing the techniques of descriptive statistics: frequency analysis, presented using boxplots and histograms, and correlation analysis, which helps to understand if there are any positive or negative relationships between various responses and the strength of these relationships. After that we further evaluated the nature of these findings and performed factor analysis to reveal hidden, unobserved factors that might have influenced the respondents in their answers. In fact, factor analysis helped to determine possible motivations of graduates to develop certain language skills.

The frequency analysis was carried out on the questions the graduates answered about current instances of using English at work and language skills they consider to be important to use. We asked them three basic questions: 1) How often do you use the following skills at work? 2) How important are the following skills for your current career? 3) Which topics from the following list should be addressed in English courses at the university? This frequency analysis is compared to the analysis we performed in spring 2021 with the students majoring in mechanical engineering at the University of West Bohemia (The results in full can be found in Wróblewski and Petrenko 2021). Subsequently, a correlation analysis was carried out for specific skills (writing, speaking and reading/listening). Our objective was to tap graduates' current experience in order to compare the actual language challenges they face at work with the English skills that students expected to be useful to them in the future. This comparative analysis may help to discover misconceptions students could have about their future. This information is expected to be valuable for updating current language courses so that they can fully meet the actual needs of prospective job seekers.

Despite the quantitative difference between the two samples (38 graduate responses as opposed to 100 responses from students over the previous research phase), Figure 1 depicts frequencies that help to bring out the fact that in their professional lives, graduates tend to exchange formal correspondence, attend

meetings, make presentations, negotiate and debate more often than is expected by the current students of the university. About three quarters of the students expect they will often write formal emails (75% of students as opposed to 81.6% of graduates) and technical reports (72% of students as opposed to 74% of graduates) in their future jobs. Moreover, speaking skills are slightly underrated for potential use in the future work environment by the majority of the students compared to graduates, e.g. 75% and 77% of students expect to make phone calls in English or participate in meetings in English, however, 87% and 89% of graduates participate in these activities “often” and “very often” in real life. The frequency analysis for our sample with working professionals in Figure 1 suggests that in their work life the UWB graduates do not tend to take a lot of international business trips, whereas quite a number of students expect to have international business trips (72% of students as opposed to 11% of graduates). Graduates also responded that they negotiate with clients and debate in English more often than is expected from the students’ perspective (70% of students as opposed to 76% of graduates). The graduates also responded that they make formal presentations in English and write technical documentation more often than is expected by the students (39% of students as opposed to 63% of graduates). Therefore, it is important for students and teachers to reconsider the practical use of writing skills that many students marked as slightly less important or unimportant.

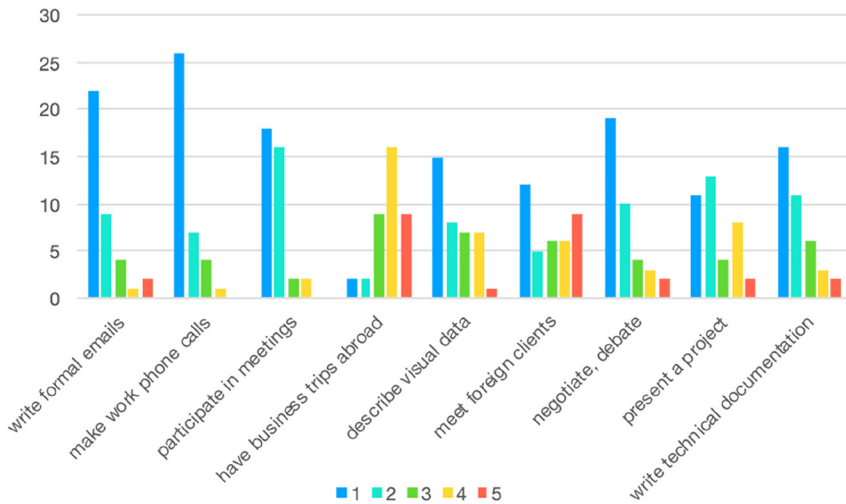


Figure 1: How often do you do the following at work? (graduates) – frequency (1 – very often, 5 – never).

Figures 2a and 2b demonstrate linear dependencies between specific language skills. Matrices for both students and graduates show that there is a strong positive correlation between writing formal emails and selected speaking skills such as negotiating, debating, making presentations and taking part in business meetings. For graduates, it appears to be more important to participate in debates and meetings in English and negotiate with clients. These answers strongly correlate with writing skills, which is different from the students’ data sample. A number of correlation coefficients tend to decrease for “having business trips abroad” (Figure 2a: “writing formal emails”, “making business phone calls, “participating in meetings” against “having business trips abroad”). We believe that this tendency is not purely caused by the current COVID-19 pandemic, but also by the frequencies. Coefficient values seem to be larger for activities that are performed at work more often. If people do not often undertake business trips, the relationships with other activities may not be strong either.

In order to obtain a good graphical image of the concentration of the data and to understand how extreme the minimum and maximum values are for samples of both graduates and students, we constructed box-and-whisker plots for the same

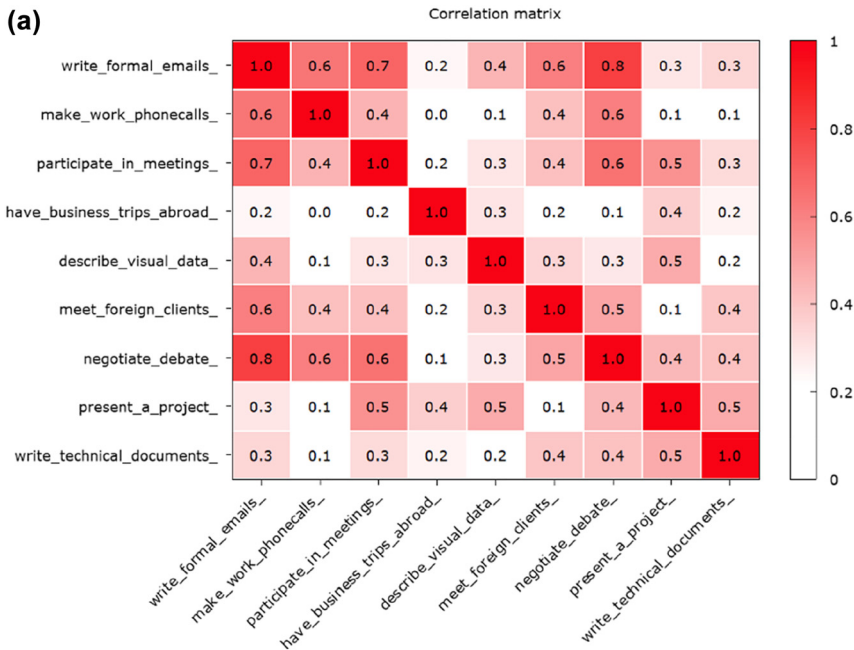


Figure 2a: How often do you do the following at work? (graduates) – correlation (1 – very often, 5 – never).

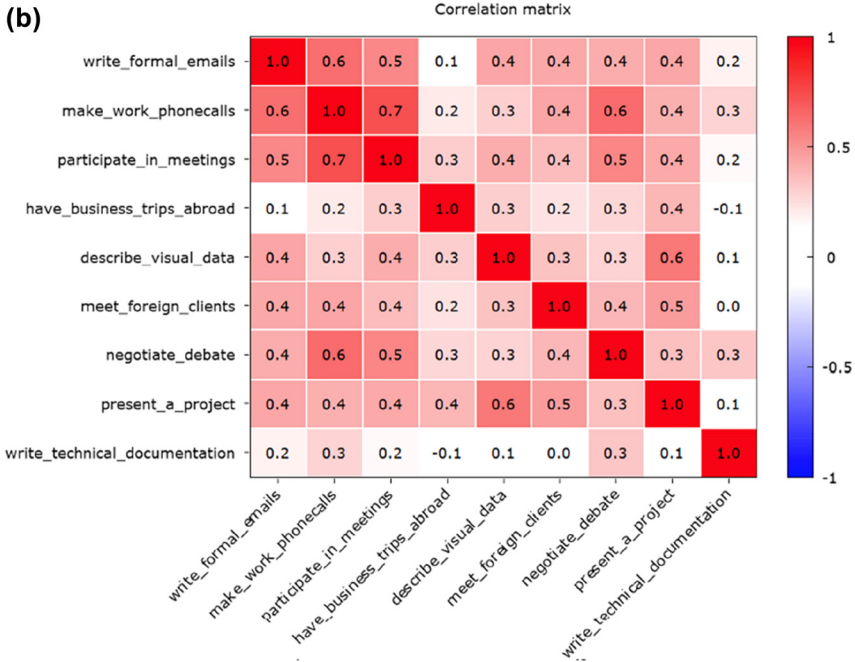


Figure 2b: How often do you think you will do the following at work? (students) – correlation (1 – very often, 5 – never).

questions (Figures 3a and 3b). These plots show maximum and minimum values that are represented by the top and bottom ends of the rectangles correspondingly. The mean is marked with a plus sign and the median is a line inside the rectangle that typically represents 50% of the data. It is important to note that the “whiskers” that extend from each end of the box represent a range equal to 1.5 times the interquartile range represented by the third and the first quartiles (Q3–Q1). The “whiskers” reach out to the largest and the smallest values. In some cases (Figure 3b, “participate in business meetings”), there are no rectangles to present the data. These dots picture the observations that tend to fall outside of that range, which means that some students expect to perform this activity much more often than normal or a lot less often than normal. Writing business emails, making calls and participating in meetings are thought to be more important for graduates (the values of mean and median are also shifted to the bottom of the rectangles; the “whiskers” are visibly shorter). Skill at describing visual data is evidently needed regularly at work. The majority of the graduate respondents answered that they meet foreign clients and partners more often than is expected by the students who

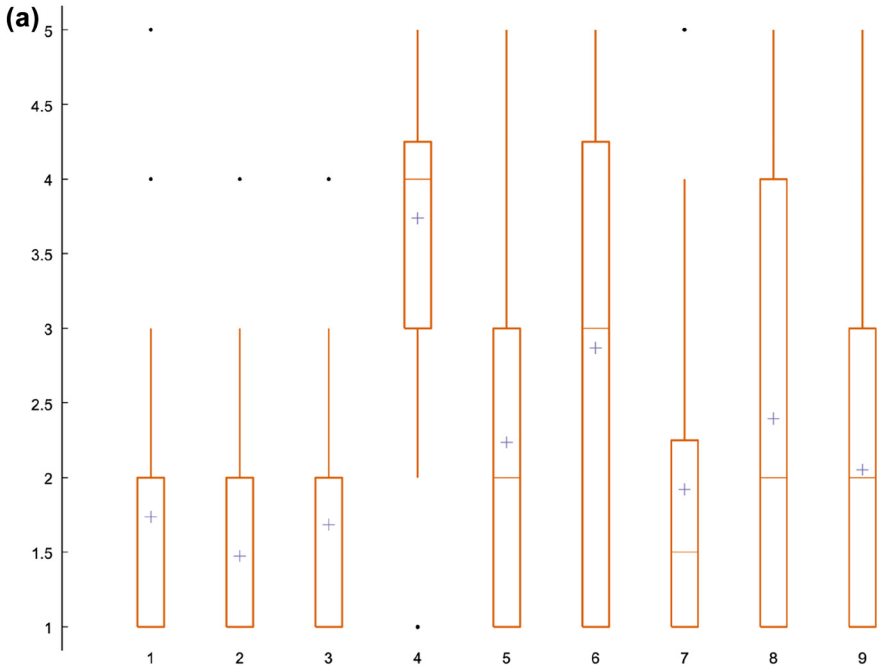


Figure 3a: How often do you do the following at work? (graduates) – Box-plot (1 – very often, 5 – never). **Horizontal axis:** 1) write formal emails, 2) make work phone calls, 3) participate in meetings, 4) have business trip abroad, 5) describe visual data, 6) meet foreign clients, 7) negotiate, debate, 8) present a project, 9) write technical documentation.

took part in the survey earlier in 2021. Debating skills are applied regularly by the young professionals. More than half of the respondents also stated they “often” present their projects in English. The frequency at which professionals need to write technical documentation remained almost unchanged for both samples, which may mean that this task might not be frequent in the job.

An English language needs analysis for UWB students performed in spring 2021 presented us with some interesting results. According to the data we received, hardly any students expected to write academic papers or articles in the future. This contradicts the current course requirements and curricula because all masters students of the faculty are obliged to take English for Academic Purposes courses. One of the key requirements to pass the courses is to write a full-scale academic paper. Figure 4 depicts the graduates’ responses to the same question. It is evident that the respondents do not write academic articles at work, as only two graduates chose academic writing as an essential skill. Therefore, we think that future steps

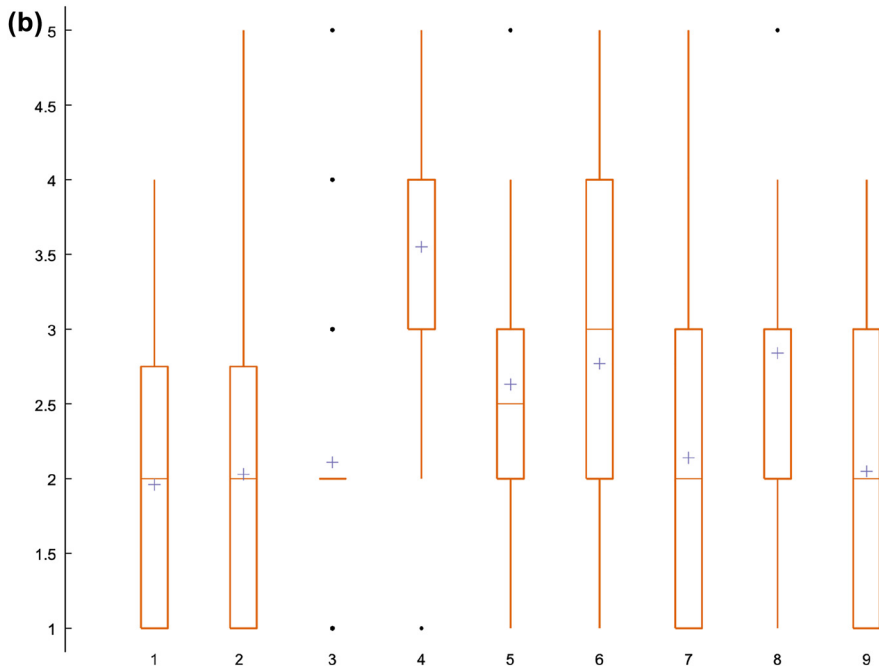


Figure 3b: How often do you think you will do the following at work? (students) – Box-plot (1 – very often, 5 – never). **Horizontal axis:** 1) write formal emails, 2) make work phone calls, 3) participate in meetings, 4) have business trip abroad, 5) describe visual data, 6) meet foreign clients, 7) negotiate, debate, 8) present a project, 9) write technical documentation.

would be to interview graduates and some international employers in the Pilsen region so that any new courses meet the needs of the market.

We would like to point out that analytical reading/writing skills like creating cohesive and coherent texts, scanning and skimming reading materials and evaluating the quality of written materials are considered to be immensely valuable by young professionals, but are currently considered to be less important by the students.

Figure 5b depicts the correlation coefficients between specific language skills according to the students' opinions. For example, those who marked "express ideas effectively" as important also tended to mark "create coherent texts". Citing sources correctly has a moderate connection with writing academic papers. In Figure 5a it is apparent that the graduates' responses reveal the importance of reading and writing skills applied at work. There are considerably stronger relationships between summarising information, using the internet for translation effectively, evaluating the quality of texts and citing sources. Moderate

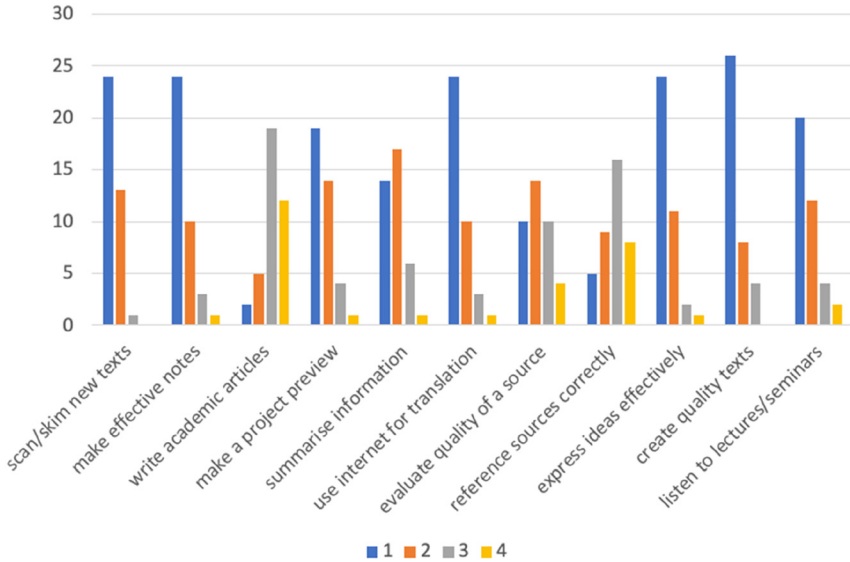


Figure 4: How important are the following skills for your current career? (graduates) – frequency (1 – very important, 4 – unimportant).

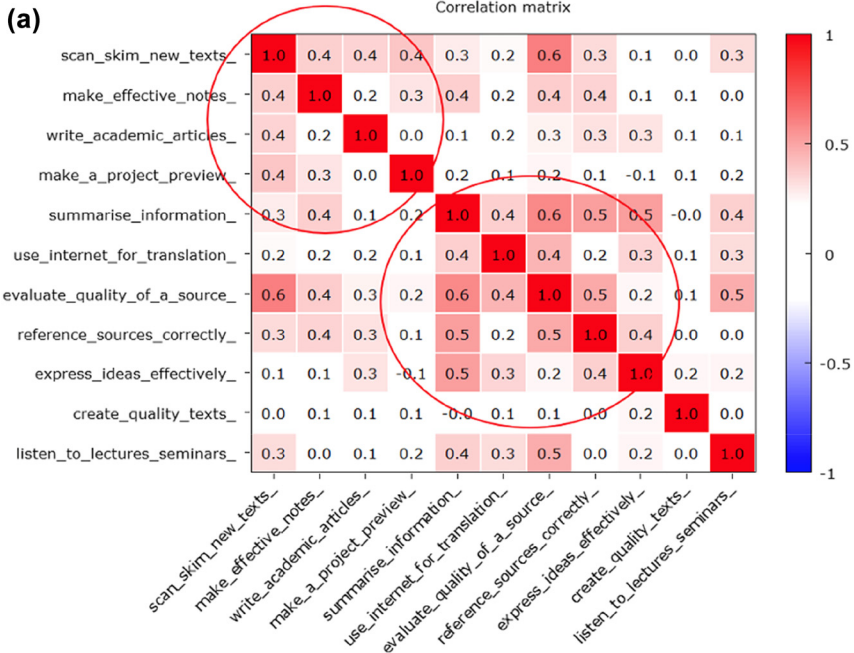


Figure 5a: How important are the following skills for your current career? (graduates) – correlation (1 – very important, 4 – unimportant).

dependencies feature reading and writing skills, such as skimming/scanning, taking notes effectively and creating outlines for presentations. Moreover, graduates who marked skimming/scanning and note-taking skills as important most probably marked evaluating the quality of sources and referencing sources correctly. These findings strongly suggest that it is important to develop and highlight crucial reading and analytical skills for mechanical engineering students.

We also constructed box-and-whisker plots for the same question (Figures 6a and 6b) in order to get an overview of the relationships of minimal and maximal values within our data samples. More graduates marked reading and note-taking skills as important. The median for writing a presentation outline shifted towards “more important” values for graduates. However, the range of “evaluating quality resources” became significantly larger, which may mean that a lot of people consider this skill much more (or less) important than the median value.

During the next stage of data analysis, we decided to take a closer look at the differences between the answers to Q2 received from the students and the graduates in order to see for which specific skills the answers of the graduates vary the most from those of the students. The correlation coefficients presented in

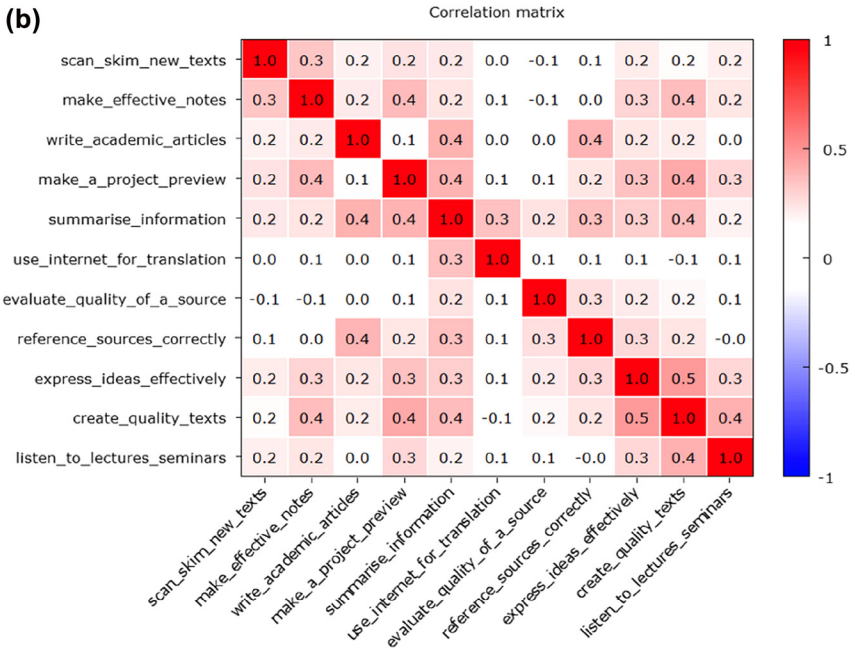


Figure 5b: How important are the following skills for your future career? (students) – correlation (1 – very important, 4 – unimportant).

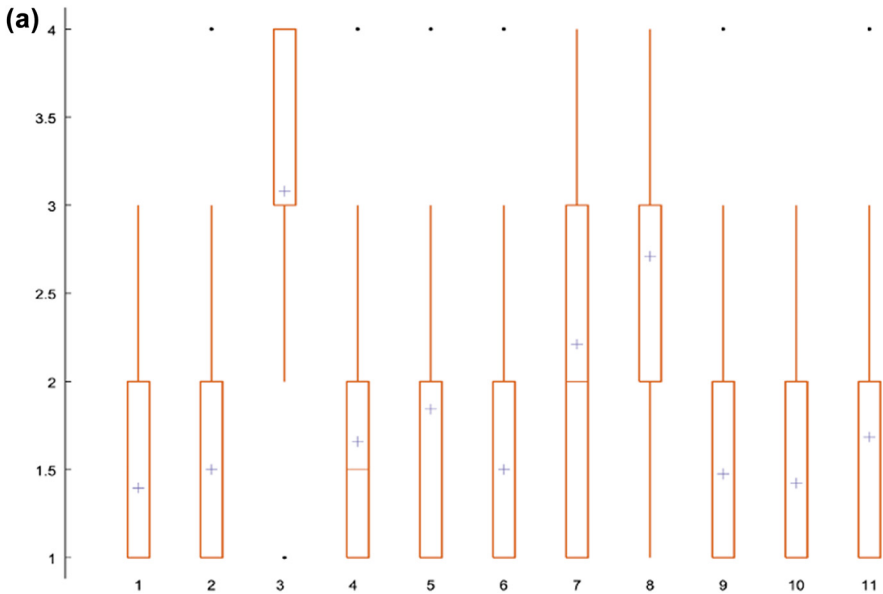


Figure 6a: How important are the following skills for your current career? (graduates) – box-plot (1 – very important, 4 – unimportant). **Horizontal axis:** 1) scan/skim new texts, 2) make effective notes, 3) write academic articles, 4) make a project preview, 5) summarise information, 6) use internet for translation, 7) evaluate quality of a source, 8) reference sources correctly, 9) express ideas effectively, 10) create quality texts, 11) listen to lectures/seminars.

Figure 7 demonstrate that skimming/scanning texts for students is negatively correlated with selected reading and writing skills (blue cells). This moderate negative relationship may mean that the expectations of the students are different from what happens in the real world. At work they would have to use their analytical reading skills and academic writing skills more often than they expect. Current UWB students seem to have misconceptions about their future activities on the job.

During the next stage of the research, we carried out a factor analysis to identify hidden factors that could possibly influence graduates' responses. It is particularly advantageous to reveal similar patterns in graduates to discover whether their responses depend on some unobserved factors. The factors were loaded via the principal factors method (principal axis factoring), which gives them a common variance. This means that the respondents may not have differentiated their answers between "often" and "very often" in the same way. It is known that these attributes may be quite subjective. Total variance was explained by two factors, as we received two representative Eigenvalues that determine the

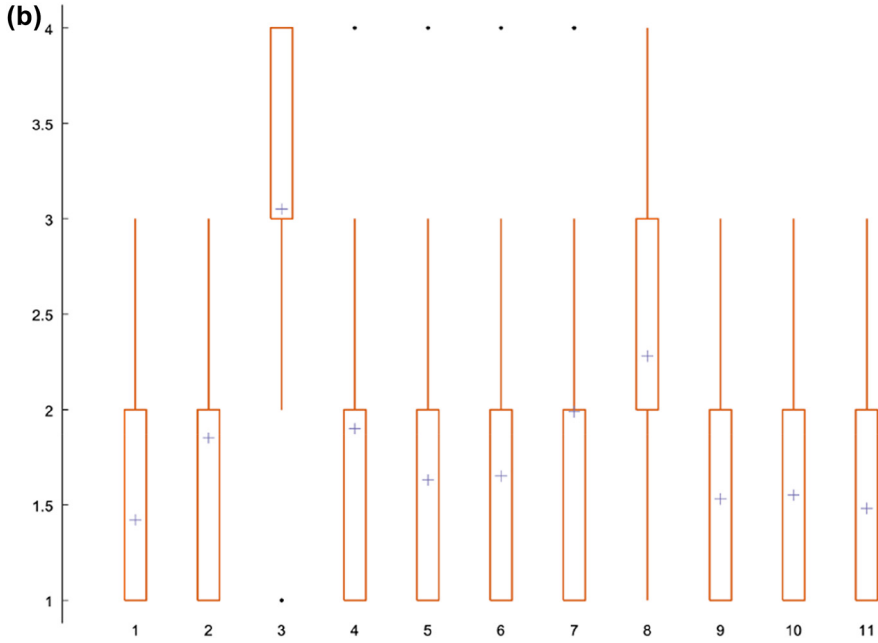


Figure 6b: How important are the following skills for your future career? (students) – box-plot (1 – very important, 4 – unimportant). **Horizontal axis:** 1) scan/skim new texts, 2) make effective notes, 3) write academic articles, 4) make a project preview, 5) summarise information, 6) use internet for translation, 7) evaluate quality of a source, 8) reference sources correctly, 9) express ideas effectively, 10) create quality texts, 11) listen to lectures/seminars.

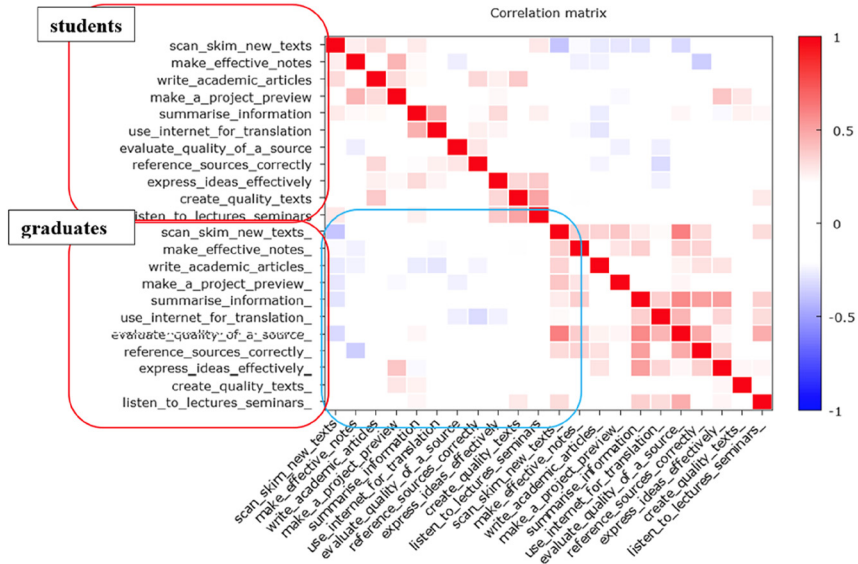


Figure 7: Correlation heat-map for students versus graduates.

total variance explained. The factors had to be labelled based on the factor values in the loadings table. Varimax rotation was used to interpret factor loadings, which represent to what extent a factor, as yet unlabelled, is related to the observations collected.

Labelling the factors “Communicating effectively” and “Professional and financial growth” may seem reasonable, as this corresponds to the idea that these two factors are positively related when the factor scores were generated with the help of the regression method. In fact, the line graph has an upward slope and a positive correlation coefficient 0.697.¹

This question type was represented by two hidden (unobserved) dimensions that were revealed and labelled thanks to the factor analysis we had carried out. Indeed, if graduates can communicate effectively and can be perfectly understood by their foreign colleagues, they are more likely to have better negotiation outcomes that may further lead to better opportunities, which might ensure better financial and professional results for such successful employees.

5 Conclusion

In accordance with UNESCO’s Sustainable Development Goal 4 (SDG 4) for education (UNESCO 2022), sustainability in tertiary language education plays an important role in preparing students to determine the most effective solutions to the challenging tasks that the world is facing. Future professionals need to be educated and trained to think about global development so that fewer adverse consequences of any type need to be dealt with by future generations. Needless to say, modern language education not only has to be transformational, but it must also help to motivate today’s students of mechanical engineering to think globally from various perspectives so that they are able to make informed decisions relying on various reputable sources of information. Moreover, due to the fact that English is spoken on a global scale, it is vital to attempt to transform and adjust tertiary ESP courses according to the latest needs of industry.

Due to the fact that the analysis indicates that there are several discrepancies between the answers given by the students and those by the graduates, it has been decided that subsequently the research requires more detailed stages that would allow the authors to confirm their assumption that the students might not always be aware of what is actually needed (in terms of using the English language) in a workplace. This conclusion is reached mainly based on the

¹ The graph can be shared by email upon request.

analysis of the correlation matrix (Figure 7), which demonstrates a negative relationship concerning selected reading and writing skills. This clearly suggests that the students' expectations vary from what the graduates actually experience on a daily basis. Based on the analysis, it can be concluded that analytical reading skills and academic writing skills seem to be of crucial importance to engineers. However, the assumption first needs to be confirmed by conducting further and more thorough research, which will adopt a qualitative interview technique. The plan is to interview selected graduates and students in early 2022 in order to gather additional information about their needs, expectations and motivation. The motivational aspect will be taken into consideration because it is expected to be a crucial factor that might have affected the answers of the respondents (factor analysis).

Once the interview phase is complete, it will be essential to contact prospective engineering employers from the Pilsen region in order to conduct an analysis of their expectations and compare the results with the responses received from the students and the graduates. Should the assumption be confirmed, the ESP course syllabi might require redesigning. We hope that once the statistical analysis has been presented to the FST students, they will be able to assess whether they have certain misconceptions about their future. They could determine whether their dissatisfaction is caused by inadequately designed syllabi or their wrong perception of the engineering field. The students might therefore feel more motivated to improve their English skills, which could also improve student-teacher cooperation. Due to the fact that all the graduate respondents in our study now work in well-known international companies, it can be concluded that language education often provided in Language Centres and institutions within a Higher Education Institution appears to be important as it can be provided at a scale, level and scope required by the current market needs.

We believe that not only will this study help us to convince prospective mechanical engineers of the importance of studying critical reading skills, academic writing skills, etc., but also to ensure that what is taught at their university is relevant to the needs of the market and the economy of the region. In our opinion, sustainable ESP language courses at the University of West Bohemia should educate global citizens for sustainable development. We want our students to be successful in their careers, armed with the language skills that have been demonstrated to be necessary on the job by current research. They should offer relevant insights on urgent challenges and changes in mechanical engineering, helping future professionals reduce negative environmental and socio-economic effects on future generations.

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