



I-BEE-VR

Immersive Business and Engineering English in Virtual Reality: A Tool for the Sustainable Mobility of the Skilled Workforce in the EU

WP 2: Analyses

O2: Analysis of authentic engineering professionals' needs

Final Evaluation Report

Istanbul Technical University

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1. Introduction

To realize the defined tasks of Output 2 “Analysis of authentic engineering professionals’ needs”, the needs analysis process was administered in two phases: Conducting the Survey and Observations. In the phase of the conducting the survey, the following activities have been performed:

- Conducting a comprehensive literature review
- Designing the survey instrument
- Performing validity and reliability analyses
- Collecting data via the online survey link from engineers working in the professional workplaces through academic partner institutions
- Analysing the collected data performing SPSS analyses

In the phase of observations, the following activities have been performed:

- Creating the field observation form based on the existing literature and the survey instrument
- Sharing the form with partner institutions
- Collecting data through observing engineers in their actual workplace environments
- Analysing collected observation data

2. Outcomes of the Survey

The analyses related to validity and reliability studies and the findings of the collected data have been indicated below.

2.1. Validity and Reliability of the Scales

In this study, it was aimed to perform the validity and reliability analyses of **Frequency of Use of English Scale** which measures the frequency of use of English in the professional settings and **Degree of Difficulty in Use of English Scale** measuring the level of difficulty in the use of English in professional settings. Reliability analyses are conducted to determine the consistency between a series of measurements, how accurately the surveyed property is measured, and whether the measurement results show consistency over time (Tavakol & Dennick, 2011). In this respect, the Cronbach Alpha values, which are internal consistency coefficients, were analyzed.

For validity analyses, Exploratory Factor Analysis (EFA) was performed to determine the groupings (factors) among the items. The aim of the exploratory factor analysis carried out during the scale development process is to determine whether the items actually measure the desired structure and to reveal the independent factors of this structure (Buyukozturk, 2002).

In this respect, a common item pool comprising of 40 items was created by the project team, who were experts in their field in the process of development of both Frequency of Use of English Scale and Degree of Difficulty in Use of English Scale. Then, the items formed together were evaluated with another group within the project team in terms of language and meaning; in the end, the draft form was finalized. For the scoring of the items in the draft form, it was decided to use a 5-point Likert-type scale for both scales. For Frequency of Use of English Scale, the participants were asked to mark one of the statements among “Very Frequently (1)”, “Frequently (2)”, “Occasionally (3)”, “Rarely (4)”, and “Never (5)”, which indicates their attitudes towards the frequency of use of

English in the professional settings. For Degree of Difficulty in Use of English Scale, the participants were asked to mark one of the statements among “Strongly Agree (1)”, “Agree (2)”, “Undecided (3)”, “Disagree (4)”, and “Strongly Disagree (5)” which reveals the level of difficulty in the use of English in professional settings.

The finalized versions of two scales were conducted to 275 participants working in different countries; then, validity and reliability analyses were performed. For the validity analysis, the factor analysis of the data was firstly carried out for the KMO (Kaiser - Meyer - Olkin) coefficient and Barlett’s test values; and then the principal component analyses were performed, and Varimax rotation operations were performed. The findings related to Frequency of Use of English Scale and Degree of Difficulty in Use of English Scale indicating the descriptive values of the participants were given in the tables below.

Table 1. Descriptive statistics related to the country variable

Country	<i>f</i>	%	% _{valid}	% _{cumulative}
France	78	28.4	28.4	28.4
Turkey	57	20.7	20.7	49.1
Spain	61	22.2	22.2	71.3
Austria	39	14.2	14.2	85.5
Poland	40	14.50	14.5	100
Total	275	100.00	100	

As seen in Table 1, among the participant group, 78 (28.4%) work in France, 57 (20.7%) work in Turkey, 61 (22.2%) work in Spain, 39 (14.2%) work in Austria, and 40 (14.2%) work in Poland.

Table 2. Descriptive statistics related to the field variable

Field	<i>f</i>	%	% _{valid}	% _{cumulative}
Aerospace engineering	13	4.7	4.7	4.7
Automotive engineering	21	7.6	7.6	12.4
Biomedical/technology engineering	16	5.8	5.8	18.2
Cross sector	5	1.8	1.8	20
Business	3	1.1	1.1	21.1
Chemistry engineering	3	1.1	1.1	22.2
Civil engineering	8	2.9	2.9	25.1
Computer-it engineering	77	28	28	53.1
Electric-electronics engineering	17	6.2	6,2	59.3
Energy engineering	14	5.1	5.1	78.5
Finance	17	6.2	6.2	84.7
Maritime engineering	10	3.6	3.6	88.4
Telecommunication engineering	22	8	8	96.4
Transportation engineering	10	3.6	3.6	100
Others	39	14.2	14,2	73.5
Total	275	100	100	

As displayed in Table 2, 13 (4.7%) of the participants work in the field of aerospace engineering, 21 (7.6%) of the participants work in the field of automotive engineering, 16 (5.8%) of the participants work in the field of biomedical/technology engineering, 77 (28%) of the participants work in the field of computer-it engineering, 17 (6.2%) of the participants work in the field of electric-electronics engineering, 14 (5.1%) of the participants work in the field of energy engineering, 10 (3.6%) of the participants work in the field of maritime engineering, 22 (8%) of the participants work in the field of telecommunication engineering, and 10 (3.6) of the participants work in the field of transportation engineering.

Table 3. Descriptive statistics related to the position variable

Position	<i>f</i>	%	% _{valid}	% _{cumulative}
Manager	97	35.3	35.3	35.3
Non-manager	178	64.7	64.7	100
Total	275	100	100	

As shown in Table 3, 97 (35.3%) of the participants in the sampling group are managers and 178 (64.7%) of the participants work as non-manager personnel.

Table 4. Descriptive statistics related to the variable of the tenure in the company

Experience	<i>f</i>	%	% _{valid}	% _{cumulative}
1-5 years	178	64.7	64.7	64.7
6-10 years	38	13.8	13.8	78.6
11-15 years	19	6.9	6.9	85.5
16-20 years	11	4.0	4.0	89.5
21-25 years	17	6.2	6.2	95.7
26 and over	12	4.4	4.4	100
Total	275	100	100	

As indicated in Table 4, 178 (64.7%) of the participants have been working for the same company for 1 to 5 years, 38 (13.8%) of them 6 to 10 years, 19 (6.9%) of them 11-15 years, 11 (4.0%) of them 16 to 20 years, 17 (6.2%) of them 21 to 25 years, and 12 (4.4%) of the participants have 26 years and over work experience in the same company.

Table 5. Descriptive statistics related to the age variable

	N	Minimum	Maximum	\bar{X}	Standard Deviation
Age	275	21	69	35.80	11.04

The age range of the participants is between 21 and 69 years old. ($\bar{X} = 35.80$, $SD=11.04$).

Table 6. Descriptive statistics related to the variable of exam status

Entering Exams	<i>f</i>	%	% _{valid}	% _{cumulative}
No	142	51.6	51.6	51.6
Yes	133	48.4	48.4	100
Total	275	100	100	

As shown in Table 6, 142 (51.6%) of the participants in the sampling group did not take any English proficiency exams while 133 (48.4%) of them took an English language exam.

Table 7. Descriptive statistics related to the variable of the exam type

Exam Type	<i>f</i>	%	% _{valid}	% _{cumulative}
Cambridge	5	1.8	3.7	29.9
IELTS	7	2.5	5.1	35
TOEFL	31	11.3	22.8	57.7
TOEIC	58	21.1	42.6	100
Others	35	12.7	25.7	26.3
Total	137	49.5	100	

As displayed in Table 7, 58 (42.6%) of the participants in the sampling group took the TOEIC exam, 31 (22.8%) took the TOEFL exam, 7 (5.1%) took the IELTS exam, 5 (3.7%) passed the Cambridge examination and 35 (25.7%) took other English language exams.

2.2. Findings of the Validity and Reliability Analyses of Frequency of Use of English Scale

Factorability of the Frequency of Use of English Scale was measured before the evaluation of data reduction and potential factor structure solutions. For the final factor solution, it was decided that the minimum value of the communality was accepted as .30 and the items measured below this value were decided to be excluded in the process of factor analysis. According to the results of the analyses performed, it was revealed that the common load values of the items varied between .54 and .88 value; therefore, it was decided that there was no need to eliminate any items (Tabachnick & Fidell, 2007).

In order to evaluate the suitability of the data for factor analysis, KMO and Bartlett's test sphericity values were analyzed in the factor analysis processes of Frequency of Use of English Scale. For factorisability, the KMO value must be greater than .60 and the Bartlett's test of sphericity must be significant ($p < .05$) (Worthington & Whittaker, 2007) (See Table 8).

Table 8. KMO and Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.954
	Chi-Square	12535.251
Bartlett's Test of Sphericity	df	780
	Sig.	.000

As indicated in Table 8, KMO value was marvelous (.95). According to this value, the suitability of the data structure for factor analysis is in the level of marvelous (0.90 to 1.00). The Barlett's test of sphericity also revealed significant results [$\chi^2=12535.25$, $p<.001$]. According to this value, it is assumed that the data come from the multivariate normal distribution. In order to identify the factor pattern of Frequency of Use of English Scale, the principal component analysis was carried out, and to evaluate the dimensionality of Frequency of Use of English Scale, Varimax rotation operations were performed. After the factor analysis, priorly eigenvalues were examined. Eigenvalues are used to calculate the variance explained by the factors and to decide the number of factors. In factor analysis, only the factors with the eigenvalues of 1 and above are considered as stable (Haynes et al., 2011). Using all of the 40 items in the item pool, factor analysis was carried out, and Varimax rotation operations were performed in order to detect the distribution of items to the factors.

After Varimax rotation analysis, the common load values of the items were below .30, and the procedure was pursued until the difference of load values between two different factors was below .100. As a result of the analyses made in this direction, respectively; 40, 27, 13, 4, 11, 36, 37, 23, 38, 34, and 9 were removed from the scale, and the analysis was continuously repeated after each item was extracted. After 11 repetitions, 29 items remained, and as a result of factor analysis performed with these 29 items, it was determined that 4 factors explained 72.50% of the total variance. The amounts of the variance explained for eigenvalues and dimensions are indicated in Table 9.

Table 9. Factor Eigenvalues of Frequency of Use of English Scale and the Amount of Variance Explained

Component	Total Variance Explained		
	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	15,663	54,01	54,01
2	2,537	8,75	62,76
3	1,527	5,26	68,02
4	1,298	4,48	72,50
...
29	0,047	0,16	100

As seen in Table 9, when the eigenvalue is considered to be 1, and according to the continuous analyses, a 4-factor structure appears. Regarding the amount of variance explained by each factor, the first factor was determined as 54.01%, the second factor was 8.75%, the third factor was 5.26%, and the fourth factor was 4.48%. The loads of the items according to the factors are displayed in Table 10.

Table 10. Rotated Component Matrix of Frequency of Use of English Scale

	Component			
	1	2	3	4
item 17	0.857			
item 15	0.843			
item 16	0.837			
item 18	0.828			
item 19	0.820			
item 14	0.737			
item 8	0.717			
item 7	0.705			
item 10	0.608			
item 5	0.607			
item 6	0.591			
item 12	0.553			
item 31		0.881		
item 33		0.833		
item 29		0.723		
item 28		0.721		
item 26		0.687		
item 30		0.671		
item 39		0.654		
item 35		0.624		
item 32		0.578		
item 24			0.761	
item 25			0.757	
item 21			0.712	
item 20			0.649	
item 22			0.621	
item 2				0.853
item 3				0.831
item 1				0.789

When the eigenvalue taken as 1 is processed, the final form of the scale is composed 29 items in total distributed into four factors. Accordingly, the first factor consists of 12 items (17, 15, 16, 18, 19, 14, 8, 7, 10, 5, 6, and 12), the second factor includes 9 items (31, 33, 29, 28, 26, 30, 39, 35, and 32), the third factor consists of 5 items (24, 25, 21, 20, and 22), and the fourth factor comprises of 3 items (1, 2, and 3).

After analysing all the items under each factor, sub-dimensions were named according to the literature. In this respect, the first factor was named as Business meetings the second factor as Documents, the third factor as Correspondence, and the fourth factor as Job application process. After the sub dimensions were identified, reliability analyses for each sub-dimension were carried out. Therefore, Cronbach Alpha values were calculated on the items entering each sub-dimension (See Table 11).

Table 11. Reliability Values for Sub-dimensions of Frequency of Use of English Scale

Factor	Cronbach Alfa
Business meetings	.968
Documents	.920
Correspondence	.888
Job application process	.901
Total	.978

As showed in Table 11, all of the reliability values were above .70, which indicates the reliability level was high. Regarding the reliability coefficients of the sub-dimensions, the Cronbach Alpha value of Business meetings is $\alpha = .968$, for Documents, it is $\alpha = .920$, the Cronbach Alpha value of Correspondence is $\alpha = .888$, and for Job application process, it is $\alpha = .978$. These results show that the scale has high values at the internal consistency.

2.3. Findings of the Validity and Reliability Analyses of Degree of Difficulty in Use of English Scale

In the validity and reliability studies of Degree of Difficulty in Use of English Scale, the process of validity and reliability of Frequency of Use of English Scale was followed. First of all, it was decided that the items with common load values below .30 would not be included in the factor analysis process. According to the results of the analyses, the common load values of the items were found out to vary between .58 and 83. Therefore, it was decided that there is no need to eliminate any items. (Tabachnick & Fidell, 2007). Then, the factorisability of Degree of Difficulty in Use of English Scale was measured and the results were presented in the table below.

Table 12. KMO and Bartlett's Test Results

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		.957
	Chi-Square	12981.922
Bartlett's Test of Sphericity	df	780
	Sig.	.000

As indicated in Table 12, the KMO value is .96 and the data structure is perfectly compatible for factor analysis. Also, the Bartlett's Test of Sphericity also showed significant results [$\chi^2=12981.92$, $p < .001$]. According to this value, it is assumed that the data come from the multivariate normal distribution.

The principal component analysis was used to determine the factor pattern of Degree of Difficulty in Use of English Scale, and Varimax rotation technique was used to evaluate the dimensionality. After the factor analysis, priorly eigenvalues were examined. Eigenvalues are used to calculate the variance explained by the factors and to decide the number of factors. In factor analysis, only the factors with the eigenvalues of 1 and above are considered as stable. (Haynes et al., 2011). Using all of the 40 items in the item pool, factor analysis was carried out, and Varimax rotation operations were performed in order to detect the distribution of items to the factors.

After Varimax rotation analysis, the common load values of the items were below .30, and the procedure was pursued until the difference of load values between two different factors was below .100. As a result of the analyses made in this direction; respectively, the 32, 36, 38, 8, 40, 13, 14, 9, 20, 10, 12, 34 and 6 items were removed from the scale, and the analysis was continuously repeated

after each item was extracted. After 13 repetitions, 27 items remained and the factor analysis revealed that 4 factors explained 75.27% of the total variance. The amounts of variance explained for eigenvalues and dimensions are presented in Table 13.

Table 13. Factor Eigenvalues of the Degree of Difficulty in Use of English Scale and the Amount of Variance Explained

Component	Total Variance Explained		
	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	15.53	57.52	57.52
2	2.37	8.76	66.28
3	1.29	4.76	71.04
4	1.14	4.23	75.27
...
27	.072	.265	100

As displayed in Table 13, when the eigenvalue is considered to be 1, and according to the continuous analyses, a 4-factor structure appears. Regarding the amount of variance explained by each factor, the first factor was determined as 57.52%, the second factor was 8.76%, the third factor was 4.76% and the fourth factor was 4.23%. The loads of the items according to the factors are displayed in Table 14.

Table 14. Rotated Component Matrix of Degree of Difficulty in Use of English Scale

	Component			
	1	2	3	4
item 31	0.808			
item 26	0.793			
item 30	0.786			
item 33	0.769			
item 28	0.766			
item 35	0.753			
item 29	0.738			
item 39	0.734			
item 37	0.676			
item 27	0.586			
item 18		0.822		
item 19		0.817		
item 16		0.811		
item 17		0.805		
item 15		0.740		
item 11		0.652		
item 7		0.596		
item			0.803	
item 25			0.763	

item 23	0.667	
item 5	0.600	
item 22	0.581	
item 4	0.540	
item 3		0.826
item 2		0.772
item 21		0.617
item 1		0.611

When the eigenvalue taken as 1 is processed, the final form of the scale is composed 27 items in total distributed into four factors. The first factor consists of 10 items (31, 26, 30, 33, 28, 35, 29, 39, 37, and 27), the second factor 7 items (18, 19, 16, 17, 15, 11, and 7), the third factor appears to be composed of 6 items (24, 25, 23, 5, 22, and 4), and finally the fourth factor consists of 4 items (3, 2, 21, and 1).

After analysing all the items under each factor, sub-dimensions were named according to the literature. In this respect, the first factor was named as Business related documents, the second factor as Business meetings, the third factor as Correspondence and listening comprehension skills, and the fourth factor as Job application and formal written communication skills. After the sub dimensions were identified, reliability analyses for each sub-dimension were carried out. Therefore, Cronbach Alpha values were calculated on the items entering each sub-dimension (See Table 15).

Table 15. Reliability values for sub-dimensions of Degree of Difficulty in Use of English Scale

Factor	Cronbach Alfa
Business related documents	.949
Business meetings	.957
Correspondence and listening comprehension skills	.918
Job application and formal written communication skills	.874
Total	.981

As displayed in Table 15, all of the reliability values were above .70, which indicates the reliability level was high. Regarding the reliability coefficients of the sub-dimensions, the Cronbach Alpha value of Business related documents is $\alpha = .949$, for Business meetings, it is $\alpha = .957$, the Cronbach Alpha value of Correspondence and listening comprehension skills is $\alpha = .918$, and for Job application and formal written communication skills, it is $\alpha = .874$. These results show that the scale has high values at the internal consistency.

2.4. Findings of Frequency of Use of English Scale

Descriptive statistics, t-test results, one-way analysis of variance (ANOVA) results, and Scheffe test results related to Frequency of Use of English Scale was presented in this section.

Table 16. Descriptive statistics regarding Frequency of Use of English Scale

	N	\bar{x}	Sh_x	SS	Skewness	Kurtosis
Business meetings	275	2.279	0.065	1.071	0.565	-0.489
Documents	275	1.688	0.045	0.749	0.995	0.854
Correspondence	275	1.871	0.054	0.898	0.934	0.156
Job application process	275	2.600	0.075	1.250	0.262	-0.99

As indicated in Table 16, the participants who make up the sample group use English in professional settings more in Documents sub-dimension ($\bar{x} = 1.69$), and the least in Job application process ($\bar{x} = 2.60$). In other words, the use of English is “frequently” compared to other sub-dimensions of Documents and Correspondence. Besides, it was revealed that the values are between 1 and -1 when Frequency of Use of English Scale sub-dimension scores are examined for skewness and kurtosis values; in this direction, it can be said that the scores of the sub-dimensions have a normal distribution.

Table 17. Independent groups t-test results to determine whether Frequency of Use of English Scale sub-dimension scores differ by the position variable

Sub-dimensions	Position	N	\bar{x}	Sh_x	SS	t-test		
						t	sd	p
Business meetings	manager	97	2.10	1.08	0.11	-2.01	273	0.045
	non-manager	178	2.37	1.05	0.08			
Documents	manager	97	1.72	0.77	0.08	0.51	273	0.611
	non-manager	178	1.67	0.74	0.06			
Correspondence	manager	97	1.71	0.85	0.09	-2.25	273	0.025
	non-manager	178	1.96	0.91	0.07			
Job application process	manager	97	2.63	1.30	0.13	0.32	273	0.752
	non-manager	178	2.58	1.23	0.09			

As displayed in Table 17, regarding the Independent Groups t-test results conducted to determine whether the sub-dimension scores Frequency of Use of English Scale differ according to the position variable, there is a statistically significant difference between the sub-dimension scores of Business meetings and Correspondence in favor of the non-manager group ($p < .05$). In other words, the participants who are in the managerial position in the sub-dimensions of Business meetings and Correspondence used English more frequently than the ones in non-managerial position.

Table 18. Independent groups t-test results to determine whether Frequency of Use of English Scale sub-dimension scores differ by the variable of the exam status

Scores	Entering Exam	N	\bar{x}	Sh _x	SS	t-test		
						t	sd	p
Business meetings	no	142	2.488	1.063	0.089			
	yes	133	2.056	1.037	0.090	3.407	273	0.001
Documents	no	142	1.744	0.726	0.061			
	yes	133	1.629	0.770	0.067	1.283	273	0.200
Correspondence	no	142	1.934	0.925	0.078			
	yes	133	1.805	0.867	0.075	1.194	273	0.234
Job application process	no	142	2.892	1.255	0.105			
	yes	133	2.288	1.172	0.102	4.116	273	0.001

As demonstrated in Table 18, it is statistically significant that the sub-dimension scores of Business meetings and Job application process are in favor of those who do not take the exam regarding the results of the Independent Groups t-test analyses conducted to determine whether the Frequency of Use of English Scale sub-dimension scores differ according to the test variable ($p < .01$). In other words, the participants who took the exam for the sub-dimensions of Business meetings and Job application process used English more frequently than those who did not take any language exams.

Table 19. One-way analysis of variance (ANOVA) results to determine whether the sub-dimension scores of Frequency of Use of English Scale differ according to the country variable

	Groups	N	Std.			ANOVA Results				
			Mean	Deviation		Sum of Squares	df	Mean Square	F	p
Business meetings	France	78	2.04	1.10						
	Turkey	57	2.06	1.02	Between G.	37.46	4	9.36	9.136	0.000
	Spain	61	2.22	1.01	Within G.	276.73	270	1.03		
	Austria	39	3.16	0.91	Total	314.18	274			
	Poland	40	2.29	0.92						
Documents	France	78	1.73	0.87	Between G.	5.43	4	1.36	2.472	0.045
	Turkey	57	1.59	0.69	Within G.	148.16	270	0.55		
	Spain	61	1.55	0.67	Total	153.58	274			
	Austria	39	1.99	0.80						
	Poland	40	1.66	0.56						
Correspondence	France	78	1.79	0.89	Between G.	27.96	4	6.99	9,778	0,000
	Turkey	57	1.58	0.83	Within G.	193.04	270	0.72		
	Spain	61	1.93	0.83	Total	221.00	274			
	Austria	39	2.59	0.90						
	Poland	40	1.66	0.76						
Job application	France	78	2.22	1.22	Between G.	71.85	4	17.96	13.601	0.000

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process	Turkey	57	2.56	1.18	Within G.	356.59	270	1.32
	Spain	61	2.53	1.11	Total	428.44	274	
	Austria	39	3.81	0.96				
	Poland	40	2.33	1.20				

As seen in Table 19, there is a statistically significant difference between the arithmetic means of the groups as a result of the one-way analysis of variance (ANOVA) conducted to determine whether the sub-dimension scores of Frequency of Use of English Scale show a significant difference according to the country variable ($p < .001$). After this process, complementary post-hoc analysis techniques were applied to determine which groups were determined by ANOVA. Then, Scheffe multiple comparison technique was used which is widely used in cases where homogeneity of variance is preferred. The results of the Scheffe multiple comparison analysis are presented below.

Table 20. Scheffe test results of Frequency of Use of English Scale after one-way analysis of variance (ANOVA) to determine which sub-dimension scores differ according to the country variable

Dimensions	(I) country	(J) country	Mean Difference (I-J)	Std. Error	p
Business meetings	France	Turkey	-0.017	0.176	1.000
		Spain	-0.176	0.173	0.905
		Austria	-1.115	0.199	0.000
		Poland	-0.243	0.197	0.823
	Turkey	France	0.017	0.176	1.000
		Spain	-0.159	0.187	0.948
		Austria	-1.098	0.210	0.000
		Poland	-0.225	0.209	0.883
	Spain	France	0.176	0.173	0.905
		Turkey	0.159	0.187	0.948
		Austria	-0.940	0.208	0.001
		Poland	-0.067	0.206	0.999
	Austria	France	1.115	0.199	0.000
		Turkey	1.098	0.210	0.000
		Spain	0.940	0.208	0.001
		Poland	0.873	0.228	0.006
France	Turkey	0.140	0.129	0.882	
	Spain	0.189	0.127	0.695	
	Austria	-0.253	0.145	0.555	
	Poland	0.077	0.144	0.991	
Documents	Turkey	France	-0.140	0.129	0.882
		Spain	0.049	0.136	0.998
		Austria	-0.392	0.154	0.168
		Poland	-0.063	0.153	0.997
	Spain	France	-0.189	0.127	0.695

		Turkey	-0.049	0.136	0.998
		Austria	-0.441	0.152	0.080
		Poland	-0.112	0.151	0.968
	Austria	France	0.253	0.145	0.555
		Turkey	0.392	0.154	0.168
		Spain	0.441	0.152	0.080
		Poland	0.330	0.167	0.420
	France	Turkey	0.212	0.147	0.724
		Spain	-0.144	0.145	0.911
		Austria	-0.808	0.166	0.000
		Poland	0.127	0.164	0.963
	Turkey	France	-0.212	0.147	0.724
		Spain	-0.356	0.156	0.269
		Austria	-1.019	0.176	0.000
		Poland	-0,085	0.174	0.994
Correspondence	Spain	France	0.144	0.145	0.911
		Turkey	0.356	0.156	0.269
		Austria	-0.664	0.173	0.006
		Poland	0.271	0.172	0.648
	Austria	France	0.808	0.166	0.000
		Turkey	1.019	0.176	0.000
		Spain	0.664	0.173	0.006
		Poland	0.935	0.190	0.000
	France	Turkey	-0.333	0.200	0.598
		Spain	-0.308	0.196	0.653
		Austria	-1.590	0.225	0.000
		Poland	-0.103	0.223	0.995
	Turkey	France	0.333	0.200	0.598
		Spain	0.026	0.212	1.000
		Austria	-1.256	0.239	0.000
Job application process		Poland	0.231	0.237	0.918
	Spain	France	0.308	0.196	0.653
		Turkey	-0.026	0.212	1.000
		Austria	-1.282	0.236	0.000
		Poland	0.205	0.234	0.942
	Austria	France	1.590	0.225	0.000
		Turkey	1.256	0.239	0.000
		Spain	1.282	0.236	0.000
		Poland	1.487	0.259	0.000

As indicated in Table 20, according to Scheffe test results in the sub-dimensions of Business meetings, Correspondence and Job application process of Frequency of Use of English Scale after one-way analysis of variance (ANOVA) to determine which sub-dimension scores differ among

country sub-groups; only one statistically significant difference was found out between Austria and other countries in favor of Austria. ($p < .05$). It was revealed that the level of English use was not significantly different among other countries except Austria. The sub-dimension of Documents showed no significant difference between groups ($p > .05$).

Tablo 21. Kruskal Wallis-H test results of Frequency of Use of English Scale to determine which sub-dimension scores differ according to the variable of the tenure in the company

	Tenure	N	Mean Rank		
Business meetings	1) 1-5 years	178	132.720	Chi-Square	5.698
	2) 6-10 years	38	150.960	df	5
	3) 11-15 years	19	172.920	Asymp. Sig.	0.337
	4) 16-20 years	11	134.090	Sig.df	---
	5) 21-25 years	17	132.560		
	6) 26 + years	12	131.290		
Documents	1) 1-5 years	178	132.080	Chi-Square	7.429
	2) 6-10 years	38	156.380	df	5
	3) 11-15 years	19	163.820	Asymp. Sig.	0.191
	4) 16-20 years	11	164.910	Sig.df	----
	5) 21-25 years	17	125.760		
	6) 26 + years	12	119.420		
Correspondence	1) 1-5 years	178	133.670	Chi-Square	5.437
	2) 6-10 years	38	151.640	df	5
	3) 11-15 years	19	168.820	Asymp. Sig.	0.365
	4) 16-20 years	11	128.550	Sig.df	----
	5) 21-25 years	17	123.410		
	6) 26 + years	12	139.630		
Job application process	1) 1-5 years	178	123.520	Chi-Square	18.536
	2) 6-10 years	38	166.580	df	5
	3) 11-15 years	19	157.370	Asymp. Sig.	0.002
	4) 16-20 years	11	146.450	Sig.df	
	5) 21-25 years	17	181.380		
	6) 26 + years	12	162.460		2>1; 5>1

As Kruskal Wallis-H test results revealed, there was no significant difference between the groups Business meetings, Documents and Correspondence according to work experience variable ($p > .05$). Only in the sub-dimension of Job application process, the statistically significant difference was observed between the groups. This significant difference was in favor of those with 6-10 years of work experience in the same company between 1-5 years and 6-10 years; and there was a significant difference between the average of 21-25 years between the 1-5 years, and 21-25 years in favor of those who had 21-25 years of work experience. ($p < .05$).

2.5. Findings of Degree of Difficulty in Use of English Scale

Descriptive statistics, t-test results, one-way analysis of variance (ANOVA) results, and Scheffe test results related to Degree of Difficulty in Use of English Scale was presented in this section.

Table 22. Descriptive statistics regarding Degree of Difficulty in Use of English Scale

	N	\bar{x}	Sh_x	ss	Skewness	Kurtosis
Business related documents	275	2.23	0.05	0.80	0.39	-0.01
Business meetings	275	2.74	0.06	0.99	0.02	-0.48
Correspondence and listening comprehension skills	275	2.12	0.05	0.78	0.42	-0.04
Job application and formal written communication skills	275	2.54	0.05	0.87	-0.07	-0.61

As demonstrated in Table 22, the difficulties of the use of English the participants have in professional settings are more in the sub-dimension of Correspondence and listening comprehension skills ($\bar{x} = 2.12$) and the least in Business meetings sub-dimension ($\bar{x} = 2.74$). In other words, more difficulty was revealed in using English in the sub-dimensions of Correspondence and listening comprehension skills and Business related documents than other sub-dimensions, and the level of this difficulty is often perceived as “frequently”. Besides, it was revealed that the values are between 1 and -1 when Degree of Difficulty in Use of English Scale sub-dimension scores are examined for skewness and kurtosis values; in this direction, it can be said that the scores of the sub-dimensions have a normal distribution.

Table 23. Independent groups t-test results to determine whether Degree of Difficulty in Use of English Scale sub-dimension scores differ by the position variable

Sub-dimensions	Position	N	\bar{x}	Sh_x	ss	t-test		
						t	sd	p
Business related documents	manager	97	2.14	0.78	0.08			
	non-manager	178	2.29	0.82	0.06	-1.486	273	0.138
Business meetings	manager	97	2.50	1.02	0.10			
	non-manager	178	2.87	0.96	0.07	-2.982	273	0.003
Correspondence and listening comprehension skills	manager	97	1.99	0.82	0.08			
	non-manager	178	2.19	0.75	0.06	-2.068	273	0.035
Job application and formal written communication skills	manager	97	2.34	0.92	0.09			
	non-manager	178	2.64	0.82	0.06	-2.816	273	0.005

As displayed in Table 23, regarding the Independent Groups t-test results conducted to determine whether the sub-dimension scores Degree of Difficulty in Use of English Scale differ according to the position variable, there is a statistically significant difference between the sub-dimension scores of Correspondence and listening comprehension skills, Business meetings and Job application and

formal written communication skills in favor of the non-managerial group ($p < .05$). In other words, the participants who are in the non-managerial position in these sub-dimensions experienced less difficulty in using English than in managerial group.

Table 24. Independent groups t-test results to determine whether Degree of Difficulty in Use of English Scale sub-dimension scores differ by the variable of the exam status

Sub-dimensions	Entering Exam	N	\bar{x}	Sh_x	SS	t Testi		
						t	sd	p
Business related documents	no	142	2.34	0.81	0.07	2.301	273	0.022
	yes	133	2.12	0.79	0.07			
Business meetings	no	142	2.91	1.02	0.09	3.124	273	0.002
	yes	133	2.54	0.93	0.08			
Correspondence and listening comprehension skills	no	142	2.23	0.82	0.07	2.499	273	0.013
	yes	133	2.00	0.72	0.06			
Job application and formal written communication skills	no	142	2.67	0.87	0.07	2.558	273	0.011
	yes	133	2.40	0.85	0.07			

As demonstrated in Table 24, it is statistically significant that the sub-dimension scores of Degree of Difficulty in Use of English Scale were in favor of those who did not take the exam regarding the results of the Independent Groups t-test analyses conducted to determine whether the Degree of Difficulty in Use of English Scale sub-dimension scores differ according to the test variable ($p < .01$). In other words, the participants who took the exam in all of the sub-dimensions had more difficulties in using English than those who did not take any language test.

Table 25. One-way analysis of variance (ANOVA) results to determine whether the sub-dimension scores of Degree of Difficulty in Use of English Scale differ according to the country variable

	Groups	N	Mean	Std. Deviation	ANOVA Results					
					Sum of Squares	df	Mean Square	F	Sig.	
Business related documents	France	78	2.06	0.73	Between G.	13.92	4	3.48	5.77	0.000
	Turkey	57	2.04	0.71						
	Spain	61	2.20	0.77	Within G.	162.95	270	0.60		
	Austria	39	2.49	0.84	Total	176.86	274			
	Poland	40	2.64	0.90						
Business meetings	France	78	2.45	0.86	Between G.	34.08	4	8.52	9.72	0.000
	Turkey	57	2.38	1.02						
	Spain	61	2.77	1.00	Within G.	236.74	270	0.88		
	Austria	39	3.15	0.70	Total	270.82	274			
	Poland	40	3.33	1.04						

Correspondence and listening comprehension skills	France	78	1.90	0.64	Between G.	9.66	4	2.41	4.13	0.003
	Turkey	57	2.04	0.87	Within G.	157.87	270	0.59		
	Spain	61	2.17	0.81	Total	167.53	274			
	Austria	39	2.47	0.77						
	Poland	40	2.24	0.75						
Job application and formal written communication skills	France	78	2.36	0.79	Between G.	15.06	4	3.76	5.32	0.000
	Turkey	57	2.27	0.88	Within G.	191.12	270	0.71		
	Spain	61	2.66	0.91	Total	206.18	274			
	Austria	39	2.96	0.64						
	Poland	40	2.66	0.94						

As seen in Table 25, there is a statistically significant difference between the arithmetic means of the groups as a result of the one-way analysis of variance (ANOVA) conducted to determine whether the sub-dimension scores of Degree of Difficulty in Use of English Scale show a significant difference according to the country variable ($p < .001$). After this process, complementary post-hoc analysis techniques were applied to determine which groups were determined by ANOVA. Then, Scheffe multiple comparison technique was used which is widely used in cases where homogeneity of variance is preferred. The results of the Scheffe multiple comparison analysis are presented below.

Table 26. Scheffe test results of Degree of Difficulty in Use of English Scale after one-way analysis of variance (ANOVA) to determine which sub-dimension scores differ according to the country variable

Sub-dimensions	(I) country	(J) country	Mean Difference (I-J)	Std. Error	p
Business related documents	France	Turkey	0.023	0.135	1.000
		Spain	-0.140	0.133	0.893
		Austria	-0.432	0.152	0.093
		Poland	-0.582	0.151	0.006
	Turkey	France	-0.023	0.135	1.000
		Spain	-0.163	0.143	0.861
		Austria	-0.455	0.161	0.096
		Poland	-0.606	0.160	0.007
	Spain	France	0.140	0.133	0.893
		Turkey	0.163	0.143	0.861
		Austria	-0.292	0.159	0.500
		Poland	-0.443	0.158	0.101
	Austria	France	0.432	0.152	0.093
		Turkey	0.455	0.161	0.096
		Spain	0.292	0.159	0.500
Poland		-0.150	0.175	0.946	
Business meetings	France	Turkey	0.073	0.163	0.995
		Spain	-0.319	0.160	0.413
		Austria	-0.692	0.184	0.008

		Poland	-0.874	0.182	0.000
	Turkey	France	-0.073	0.163	0.995
		Spain	-0.392	0.173	0.274
		Austria	-0.766	0.195	0.004
		Poland	-0.948	0.193	0.000
	Spain	France	0.319	0.160	0.413
		Turkey	0.392	0.173	0.274
		Austria	-0.374	0.192	0.437
		Poland	-0.556	0.191	0.078
	Austria	France	0.692	0.184	0.008
		Turkey	0.766	0.195	0.004
		Spain	0.374	0.192	0.437
		Poland	-0.182	0.211	0.945
	France	Turkey	-0.136	0.133	0.902
		Spain	-0.273	0.131	0.361
		Austria	-0.568	0.150	0.007
		Poland	-0.340	0.149	0.268
	Turkey	France	0.136	0.133	0.902
		Spain	-0.137	0.141	0.918
		Austria	-0.432	0.159	0.120
Correspondence and listening comprehension skills		Poland	-0.204	0.158	0.796
	Spain	France	0.273	0.131	0.361
		Turkey	0.137	0.141	0.918
		Austria	-0.295	0.157	0.472
		Poland	-0.067	0.156	0.996
	Austria	France	0.568	0.150	0.007
		Turkey	0.432	0.159	0.120
		Spain	0.295	0.157	0.472
		Poland	0.228	0.172	0.779
	France	Turkey	0.087	0.147	0.986
		Spain	-0.301	0.144	0.360
		Austria	-0.603	0.165	0.011
		Poland	-0.304	0.164	0.488
	Turkey	France	-0.087	0.147	0.986
		Spain	-0.388	0.155	0.184
Job application and formal written communication skills		Austria	-0.690	0.175	0.004
		Poland	-0.391	0.174	0.284
	Spain	France	0.301	0.144	0.360
		Turkey	0.388	0.155	0.184
		Austria	-0.302	0.173	0.549
		Poland	-0.003	0.171	1.000
	Austria	France	0.603	0.165	0.011
		Turkey	0.690	0.175	0.004

Spain	0.302	0.173	0.549
Poland	0.299	0.189	0.646

As indicated in Table 26, according to Scheffe test results in the sub-dimensions of Business related documents after one-way analysis of variance (ANOVA) to determine which sub-dimension scores differ among country sub-groups; there was a statistically significant difference in favor of Poland between Poland and Turkey ($p < .05$). In the dimension of Business meetings between France and Austria, there is a statistically significant difference in favor of Austria; and a statistically significant difference in favor of Poland between France and Poland; a statistically significant difference between Turkey and Austria in favor of Austria; and a statistically significant difference was found between Turkey and Poland in favor of Poland ($p < .05$). A statistically significant difference was found in favor of Austria between Austria and France in the sub-dimension of Correspondence and listening comprehension skills ($p < .05$). In the sub-dimension Job application and formal written communication skills, there is a difference between France and Austria in favor of Austria, and a statistically significant difference between Turkey and Austria were revealed in favor of Austria ($p < .05$).

Tablo 27. Kruskal Wallis-H test results of Degree of Difficulty in Use of English Scale to determine which sub-dimension scores differ according to the variable of the tenure in the company

	Tenure	N	Mean Rank		
Business related documents	1) 1-5 years	178	139.69	Chi-Square	4.897
	2) 6-10 years	38	133.95	df	5
	3) 11-15 years	19	129.79	Asymp. Sig.	0.429
	4) 16-20 years	11	133.64	Sig.df	---
	5) 21-25 years	17	113.79		
	6) 26 + years	12	177.00		
Business meetings	1) 1-5 years	178	133.79	Chi-Square	6.105
	2) 6-10 years	38	152.70	df	5
	3) 11-15 years	19	142.53	Asymp. Sig.	0.296
	4) 16-20 years	11	159.68	Sig.df	----
	5) 21-25 years	17	110.79		
	6) 26 + years	12	165.33		
Correspondence and listening comprehension skills	1) 1-5 years	178	137.27	Chi-Square	9.676
	2) 6-10 years	38	130.09	df	5
	3) 11-15 years	19	143.03	Asymp. Sig.	0.085
	4) 16-20 years	11	158.27	Sig.df	----
	5) 21-25 years	17	106.00		
	6) 26 + years	12	192.63		
Job application and formal written communication skills	1) 1-5 years	178	129.58	Chi-Square	7.682
	2) 6-10 years	38	154.51	df	5
	3) 11-15 years	19	148.87	Asymp. Sig.	0.175
	4) 16-20 years	11	159.55	Sig.df	
	5) 21-25 years	17	135.94		
	6) 26 + years	12	176.50		----

As Kruskal Wallis-H test results to determine which sub-dimension scores differ according to the variable of the tenure in the company revealed, there was no significant difference between the sub-dimensions of Degree of Difficulty in Use of English Scale according to work experience variable ($p > .05$).

Table 28. Results of Pearson correlation analysis to determine the relationship between the sub-dimensions of Frequency of Use of English Scale and Degree of Difficulty in Use of English Scale

	Business meetings	Documents	Correspondence	Job application process	Business related documents	Business meetings	Correspondence and listening comprehension skills	Job application and formal written communication skills
Business meetings	1							
Documents	.681**	1,000						
Correspondence	.736**	.635**	1,000					
Job application process	.629**	.446**	.496**	1,000				
Business related documents	.362**	.312**	.232**	.204**	1			
Business meetings	.460**	.257**	.314**	.286**	.688**	1		
Correspondence and listening comprehension skills	.443**	.272**	.363**	.235**	.730**	.765**	1	
Job application and formal written communication skills	.406**	.235**	.311**	.283**	.599**	.732**	.702**	1

$p < .001$ **

As indicated in Table 28, according to the results of Pearson correlation analysis to determine the relationship between the total scores and the sub-dimensions of Frequency of Use of English Scale and Degree of Difficulty in Use of English Scale, it was revealed that there is a statistically significant positive relationship at the medium level between the sub-dimensions of Frequency of Use of English Scale and Degree of Difficulty in Use of English Scale ($p < .001$). In other words, as the level of English use increases in occupational processes, the level of difficulty experienced in language use increase.

3. Outcomes of the Observations

Company observations were conducted in 10 different companies between the dates January 14-March 29, 2019. Within the scope of the observations, 4 of them were realized by Ecole Centrale de Lille, 3 of them by Pedagogical University of Krakow and the remaining 3 by Istanbul Technical University. Polytechnical University of Catalonia collected observation data through getting feedback from engineering professionals over the survey instrument. The validation to be realized by observations was conducted through taking expert opinions from the field regarding the survey instrument; thus, not included in this report but integrated into the final version of the survey instrument.

Demographic information regarding the observed engineering fields can be summarized as follows:

TURKEY: Electronics and Communication, Communication and Software/Computer Engineering

POLAND: IT, Spatial Engineering

Funded by the Erasmus+ Program of the European Union. However, European Commission and Turkish National Agency cannot be held responsible for any use which may be made of the information contained therein

FRANCE: Computer, Energy, Management and Logistics Engineering

Findings related to the tasks observed are indicated below:

Themes	The employee/s can perform following tasks effectively	Yes %	No %
Job interview	participate in a job interview	90%	10%
Meeting	chair a meeting give oral briefings/reports at meetings	60%	40%
Presentation	organize effective presentation materials give formal oral presentations handle questions and misunderstandings in a presentation	60%	40%
Conference/Seminar	ask and answer questions in conferences ask and answer questions in video conferences	90%	10%
Negotiation	present a standpoint develop/justify ideas respond to objections compromise disagree with others in a formal environment	70%	30%
Correspondence-Communication	make phone calls to international colleagues/clients	90%	10%

The outcomes of the observations are summarized below under each heading provided in the observation form and categorized as strengths and weaknesses.

JOB INTERVIEW

STRENGTHS:

- **Turkish Case:** High level of fluency, excellent command of terminology
- **Polish Case:** Managing interviews effectively
- **French Case:** Effective communicative skills

WEAKNESSES:

- **Turkish Case:** lack grammatical accuracy, repetitions, hesitancy in daily interaction, code-switching, pronunciation mistakes
- **Polish Case:** Passive participation
- **French Case:** Challenges due to cultural differences

MEETING

STRENGTHS:

- **Turkish Case:** Effectiveness in oral briefing, average level of pronunciation and tone of voice, competency in interaction in meetings, ability to understand different accents, accurate conveyance of message despite grammatical mistakes, high level of fluency
- **Polish Case:** The situation was not available to collect sufficient data
- **French Case:** Competency in using ESP, effective skills of chairing a meeting, positive contribution of native speakers of English, effective use of short and clear sentences, substitution of technical vocabulary by effective communication skills, effective use of body language, ability to react quickly to the persons' emotions, reactions, effective use of connectors and building a logical discourse

WEAKNESSES:

- **Turkish Case:** Low level of communicative competence, insufficiency of grammatical accuracy, use of single vocabulary rather than complete sentences
- **Polish Case:** The situation was not available to collect sufficient data.
- **French Case:** Difficulty in understanding different accents

PRESENTATION

STRENGTHS:

- **Turkish Case:** Competency in giving presentations, effective handling of misunderstandings, good organization of presentation materials, impressive interaction between the speaker and the audience
- **Polish Case:** Competency in delivering a presentation
- **French Case:** The situation was not available to collect sufficient data.

WEAKNESSES:

- **Turkish Case:** incompetency in using daily language, difficulty in understanding and handling questions
- **Polish Case:** Achieving to deliver an effective presentation after long hours of preparation, stage fright during the presentation, anxiety about language accuracy and use of ESP.
- **French Case:** Achieving to deliver an effective presentation only when well-prepared, difficulty in handling questions, cultural barriers determining the formality of the presentation, accent-related problems.

CONFERENCE/SEMINAR

STRENGTHS:

- **Turkish Case:** Competency in use and interpretation of technical vocabulary, numeric values, figures and graphs, competency in asking-answering question
- **Polish Case:** The situation was not available to collect sufficient data.
- **French Case:** Competency in technical vocabulary

WEAKNESSES:

- **Turkish Case:** Lack of clarity in questions, grammatical errors, fluency issues
- **Polish Case:** The situation was not available to collect sufficient data.
- **French Case:** Difficulty in keeping the audience interested

NEGOTIATION**STRENGTHS:**

- **Turkish Case:** High fluency, clear and understandable standpoint, effective development of ideas, efficiency of handling disagreements, comfortable in communicating ideas
- **Polish Case:** The situation was not available to collect sufficient data.
- **French Case:** The situation was not available to collect sufficient data.

WEAKNESSES:

- **Turkish Case:** accuracy issues, communication related problems, repetitions and accuracy issues in case of problem-solving
- **Polish Case:** The situation was not available to collect sufficient data.
- **French Case:** anxiety issues, difficulty caused by cultural differences, difficulty in justifying choices especially in case of an audit.

CORRESPONDENCE-COMMUNICATION**STRENGTHS:**

- **Turkish Case:** effective and functional language use, positive influence of command of professional domain during interaction, effective skills of agreeing and disagreeing, responding to objections, giving supports, confirming the speaker; satisfying responses, developing and justifying ideas, comfortable in communicating ideas on the phone
- **Polish Case:** effective management of telephone calls, language proficiency
- **French Case:** The situation was not available to collect sufficient data.

WEAKNESSES:

- **Turkish Case:** dominance of native accent, resistance in answering personal questions
- **Polish Case:** informal use of language during phone calls, lack of technical vocabulary, poor language use, lack of grammatical accuracy
- **French Case:** difficulty in communicating on the phone or by Skype, understanding accents, influence of cultural differences, difficulty in adapting intercultural/personal differences, difficulty in catching people's attention, issues with public-speaking, handling unexpected questions

4. Implications

The needs analysis process has been completed and the following implications have been drawn based on the outcomes of the surveys and observations:

- To eliminate the degree of the difficulty faced by learners with different learning styles, a variety of activities should be incorporated.
- Snapshots from a variety of countries should be integrated into to-be-designed curriculum.
- Rather than focusing on exam preparation components, the curriculum should cater to the needs of different engineering groups.
- The information gap- especially during personal questions- should be focused on.
- Scenarios where the interviewee participates should be integrated into the curriculum.
- Pronunciation problems should be focused on in the curriculum design.
- Question-answer sessions during meetings should be focused on. Especially the questions requiring participants to give prompt responses should be emphasized in the syllabus design.
- How to handle misunderstandings in terms of accent should also be focused on.
- Question-Answer part especially questions requiring participants to give prompt responses should be focused on in presentation.
- Sufficient amount of fluency practice should be integrated into the syllabus design.
- The communicative skills during the conferences (especially in challenging situations) should be emphasized in the syllabus design.
- Problem-solving scenarios should be integrated into the syllabus design.
- Scenarios including justification of one's ideas should be used in the syllabus design.
- Cultural differences should be taken into consideration when preparing the scenarios.
- Formal vocabulary used during the phone calls should be integrated into the materials.
- Intercultural and personal differences should be taken into consideration.
- Attention-grabbing language/vocabulary should be integrated into the syllabus.

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