MATERIALS SCIENCE MA(S)TERS

developing a new master's degree

IO1

THE MARKET AND SCIENCE ENVIRONMENT NEEDS ANALYSIS

Analysis on current needs in the labor market and expectations of employers regarding necessary competences of potential job candidates and current state of education in material engineering according to students and their needs

MATERIALS SCIENCE MASTERS

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UNIVERSITY OF SILESIA IN KATOWICE

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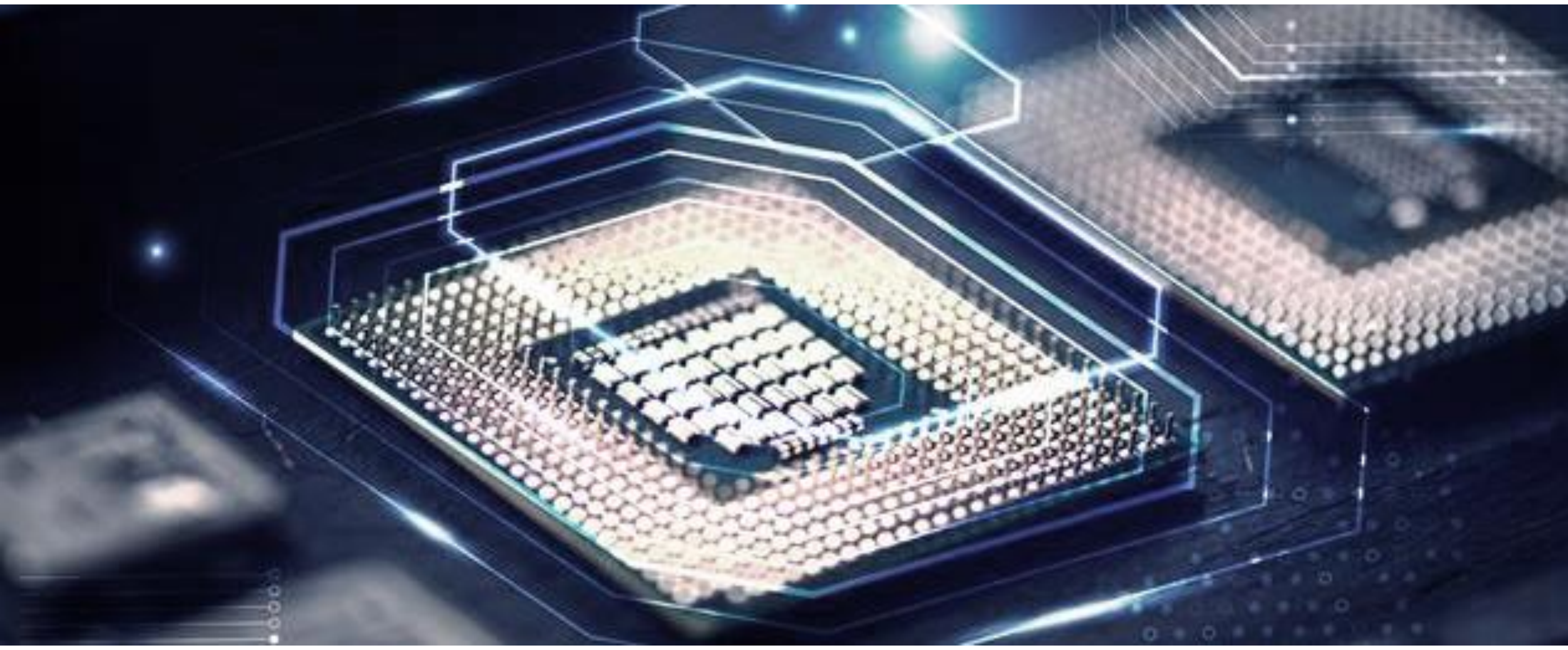

Introduction

The need for the development of Science and Engineering is a long-term struggle for the humanity in order to improve the life and conditions i.e. well-being for the better future for all living subjects. It is almost an obligatory duty for all to fulfill the desire and curiosity as to learn and apply for the matter of technology which is a collective title for the result of advancing science and its application put into the use of humanity.

Technology was and is the only means of advancement in carving through science and climbing up the ladders of perfection to a complete knowledge driven community. Applied sciences base themselves in the heart of student or scholars who have the affinity for knowledge; where there is no desire for such there will be no advancement in driving force in related scientific community. In the meantime, science evolves and adapts itself into the necessity from interacting subjects i.e. humans, particularly the ones applying science into practice, that is, industry.

One of the most technologically advanced subjects is the materials science and its applied branch, Materials Engineering in addition to Metallurgy being the oldest technological profession on earth, which changed the destitute of living beings. However, being a driving force and engulfing the variety of basics and applied sciences together, Materials Science and Engineering is in decline in preference to newly spiked professions which also utilize its products. This is not the indication of contempt in those branches of science and technology but it is the finding a new role in Materials Science and Engineering in newly reforming or reshuffling scientific medium. As stated earlier, where there is no desire, there will be no well paced advancement but rather ill paced and slow growth tends to be observed.

In order to maintain the interest and further research in Materials Science and Engineering field, and to reveal its potential in developing scientific world, a step forward is a must in this field, by either sustaining existing interesting features of materials science and engineering or speak of its broadness in the development of almost all technological branches.

"Materials Science Ma(s)ters - developing a new master's degree program" is a project co-funded by the European Union within the scope of Erasmus + program KA220 HED and is a collaboration between the University of Silesia in Katowice (Poland), the University of Zilina in Zilina (Slovakia), Afyon Kocatepe University in Afyonkarahisar (Turkey) and Ivan Franko National University of Lviv in Lviv (Ukraine). The goal of this initiative is to develop an industrial-oriented materials engineering master's program. As a requirement of this project, ideas and opinions are taken from businesses and institutions of different sizes about the lessons to be offered and the topics to be covered.

The aim

Awareness of the growing relationship between education and the labor market requires educational activities to shape students' competencies as closely correlated with the labor market requirements. In order to prepare students to compete in the labor market, it is necessary to know the expectations of employers in the scope of the relevant competencies of potential job candidates. Materials Science and Engineering graduates are able to work in many sectors when it comes to manufacturing in the broadest sense.

Thus, the aim of this project, "The market and science environment needs analysis" was aiming to identify knowledge and skills desired by employers and students' expectations as well as reveal the problems relating to the gap between the expectations and the actual state. In order to meet the project requirements, the ideas/opinions in the form of surveys were collected from students, companies, and institutions of different sizes about problems in the education of Materials Science and Engineering. The identified problems and sources of differences will find their complement in the form of prospective topics/modules that will be offered in the newly developed master's program. of the growing relationship between education and the labor market requires educational activities to shape students' competencies as closely correlated with the labor market requirements. In order to prepare students to function in the best way in the labor market, it is necessary to know the expectations of employers in the scope of the necessary competencies of potential job candidates. Materials Science and Engineering graduates are capable of working in many sectors as long as manufacturing is involved, in a broad sense.

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Materials and methods

Sampling and data collection

The study was conducted from April 2022 through June 2022 using self-administered questionnaires, which were distributed among students of Materials Science and Engineering and companies operating in branches related to this discipline in four countries: Poland, Slovakia, Turkey and Ukraine. Table 3.1 presents the universities whose students participated in the survey. Table 3.2 shows the branches represented in the students' survey by country.

The respondents were selected using non-probability sampling. The links to the questionnaires were sent to students mainly by email as well as via social media or messaging applications (Messenger, WhatsApp).

The student questionnaire was completed by a total of 160 students from 4 countries, 54 from Poland, 23 from Slovakia, 26 from Turkey and 57 from Ukraine. In the Table 3.3 is presented the demographics of students who participated in the survey. Figure 3.1 shows their current employment status. Figure 3.2 reveals the distribution of academic degrees of students participated in the survey whereas Figure 3.3 represents the ratio of students (1st and 2nd degree) who wish to continue their study at PhD level.

Table 3.1. Universities which took part in the students' survey

Country	Universities
Poland	University of Silesia, Lublin University of Technology, Technical University of Lodz, Warsaw University of Technology, Pedagogical University of KEN in Krakow, The Silesian Technical University,
Slovakia	UNIZA
Turkey	Istanbul Technical University, Afyon Kocatepe University, Eskisehir Technical University, Gazi University, Karabuk University, Eskisehir Osmangazi University, Ataturk University
Ukraine	Ivan Franko National University of Lviv,

Table 3.2. Branches are represented in the companies survey by country.

Country	Branches
Poland	Materials Engineering, Management and Production Engineering (Industrial Engineering), IT education
Slovakia	Materials Engineering, Environmental Engineering, Engineering Technologies, Machining and Manufacturing technology
Turkey	Mechanical Engineering, Metallurgical and Materials Engineering, Materials Science and Engineering, Metallurgy and Mechanical Engineering
Ukraine	Chemistry

Table 3.3. Students participants' demographics

Demographics	Frequency	%
Country		
Poland	54	33,7
Ukraine	57	35.6
Slovakia	23	14,4
Turkey	26	16,3
Education		
1 st. degree	51	31,88
2 st degree	106	66,25
3 st. degree/PhD	3	1,88

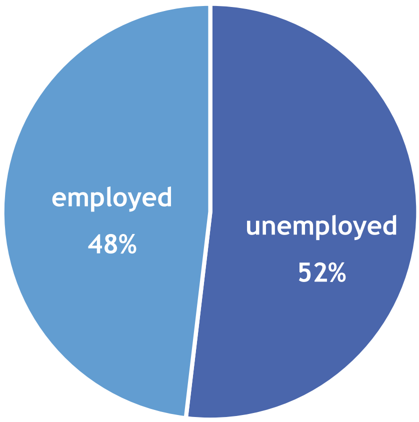


Figure 3.1. The employment status of students participated in the survey

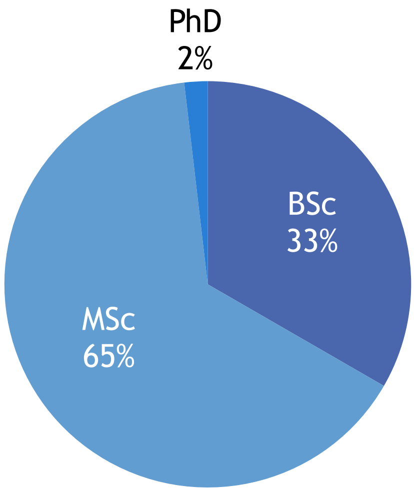


Figure 3.2. Distribution of academic degrees of students participated in the survey

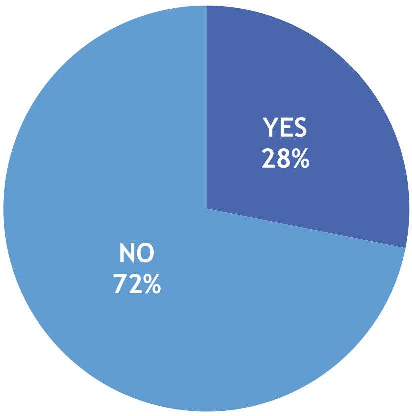
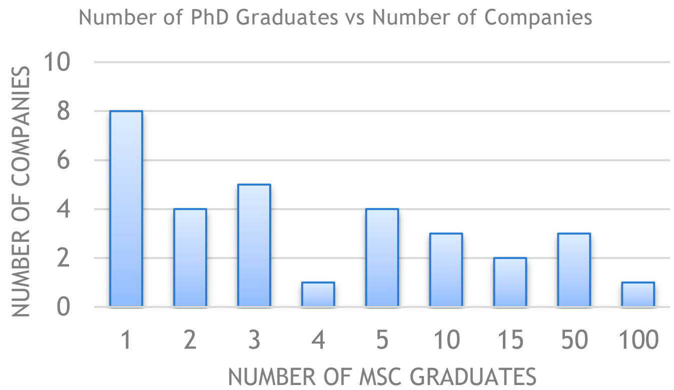


Figure 3.3. Distribution of 3rd degree students participated in the survey

The industry survey was completed by a total of 50 firms/companies with regard to their size - determined according to European classification rules (Table 3.4). In the survey, the numbers of companies were as follows: 17 from Poland, 16 from Turkey, 9 from Ukraine and 8 from Slovakia. In the first part of the survey, the contact person's details, i.e. name, company, unit and size of the company, were collected. In the remaining parts of the survey, participants from companies were requested to give express their pre-employment expectations and present opinions about the hard and soft skills of their employees who have degrees in Materials Science and related areas (fields). Finally, participants from companies were asked to suggest lectures that, in their opinion, would be beneficial for the Master(s) programme in Material science.

Table 3.4. Number of company respondents in the size classifications

Enterprises	Micro	Small	Medium	Large
Number of Employees	<10	<50	<250	>250
Number of Respondents	3	8	11	28



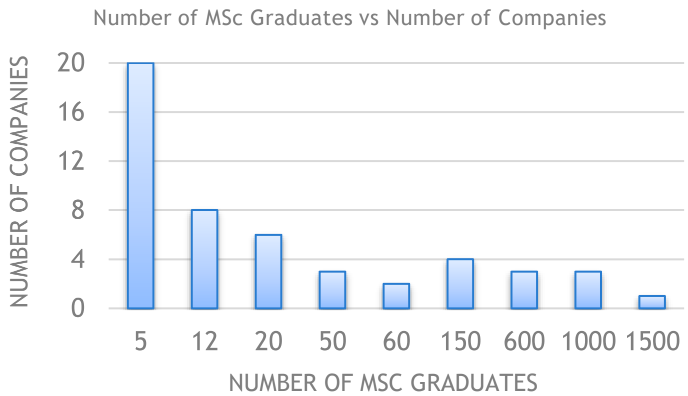


Figure 3.4. Distribution of MSc and PhD degree holders in participating companies

The companies employ not only MSc but also PhD students or PhD focused on materials engineering. Figure 3.4 shows the share of MSc and PhD depending on the number of employees. It shows the level of awareness of the staff concerning academic training and research. It also shows the company's attitude towards research and academic involvement.

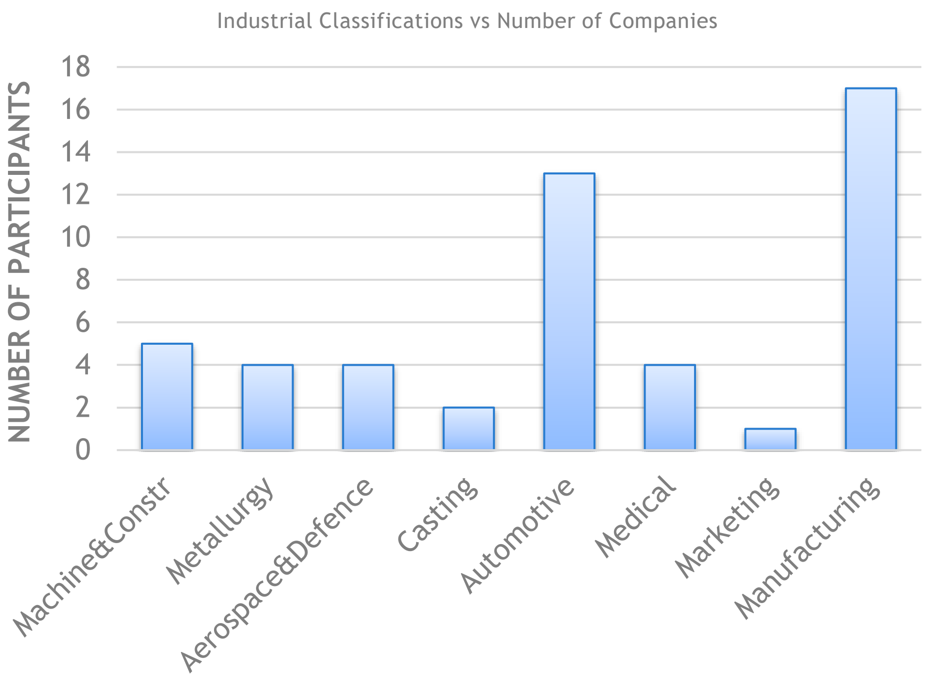


Figure 3.5 Industrial field classifications of the survey participants from Industry

Materials engineering covers many diverse industries. Hence, industrial respondents indicated their areas of activity subordinated to particular branches. The results of the answers are shown in Figure 3.5. The y axis is the number of companies that responded to the surveys and x axis is the sub-classification terms. Mainly, there were five dominating sectors: metallurgy, machine and construction, aerospace, defense, manufacturing and automotive industries. Casting, marketing, and medical sections have been added and included in the survey because their industrial class was either directly related to materials science or the respondent him/herself was somehow related to Materials science and engineering discipline.

Research tools

The literature review and other sources examination was the basis to design the questionnaire. The intention of the questionnaire construction was to give two perspectives, both students and companies, to compare the results of the study. The questionnaire included closed-ended and semi-open-ended questions in order to collect information in assumed sections related to:

student survey:

- general information,
- the quality of the study program,
- teaching quality,
- learning resources/student's support,

company/industry survey:

- general information,
- knowledge and engineering skills,
- employer's expectations,
- current state of master graduates in the company,
- competencies gap in organizational skills and others,

employer's expectations,

- current state of master graduates in the company,
- course (s) or subject(s) suggestions,
- comments regarding materials science education,
- collaborations with Industry and Universities.

The assessment was based on respondents' self-evaluation using a dedicated scale.

The questionnaires were approved by all project partners involved in the IO1 task.

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Data analysis

The survey data were descriptively analysed using two methods; value-dominated distribution of data entries, i.e. true or false (0/1), 0-4 value distribution and text data. The entries were converted to true or false (0/1) and 0-4 values between 0 to 4 (0: None, 1: Low, 2: Medium, 3: High and 4: Very High, or in some questions 0: Not at all, 1: Slightly, 2: Moderately, 3: Quite and 4: Definitely) and then analysed through standard statistical procedures (based on average, Median, standard deviation and Confidence levels). Averages of values (0-4) and their standard deviations were used to determine the trend of the question and the exact value in 5 score rating which were arranged in the order of smallest to largest and the results were presented graphically on the charts. Although, true/false data entries were high in numbers, the most important parts of the data were text based and 0-4 value dominated entries. Text based entries were classified into necessary number of subclasses for which a descriptive number was given to define them. Number of responds for each subclass was counted and a ratio of each subclass was created to determine their effect within the population. The inferential and prescriptive statistical analysis were naturally more important parts of the surveys which have focused on drawing meaningful conclusions on the basis of the data analyzed. The conclusions and results from the descriptive part of analysis and text based data entries were studied to propose several predictions about the number of lectures, various opinions of respondents and lectures suggestions for the whole population.

Limitations

The main limitations of the study include:

- the use of respondents' self-assessments, which were not verified against any objective measures (however, self-assessments are the basis of most a competencies research),

- the questionnaires were distributed via social media and e-mail, and respondents completed them on their own. This approach, despite some drawbacks, seemed to be the safest at a time when the pandemic showed no signs of receding and the number of SARS-CoV-2 infections was rising and the beginning of the war in Ukraine due to the russian attack. Such form of survey distribution provided a good reach to respondents.

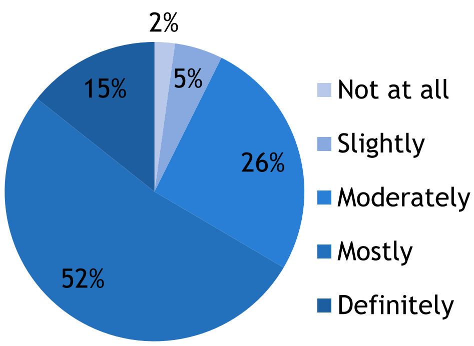
Results

Part I. Survey for students

Section 1: Quality of the study program

The quality of programme from which a student has graduated or already enrolled in is an indication of how well the institutional i.e., lecturer competency, course design or curriculum content is organized and gives an idea about the reliability of the responses that are assumed to be free from presumption, prejudice/bias or preconception based on their experience of particular cases. These have been directly investigated in Q 2.1, Q 2.2, Q 2.10, Q 2.15 and Q 2.18. The remaining Questions are mostly to investigate the result particularly important for the job-oriented qualification i.e. the benefit from a foreign language, subjects and modules helping to find a better job or advantageous in finding a job and also the sufficiency of courses in terms of professional activity/endurance in general, including the Q 2.6 where an idea of which courses are essential for the professional activity is investigated. Q 2.6 should be particularly helpful in deciding the courses suggested in Intellectual Output 2.

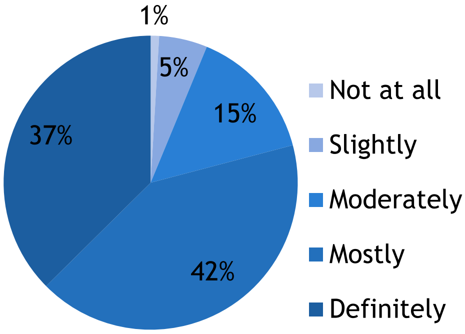
Q 2.1. Did the study process meet your expectations?



POL %	SLV %	TUR %	UKR %	Average %	
0,00	0,00	0,00	8,77	**2,19**	Not at all
11,11	4,35	0,00	5,26	**5,18**	Slightly
33,33	30,43	23,08	17,54	**26,10**	Moderately
46,30	52,17	57,69	52,63	**52,20**	Mostly
9,26	13,04	19,23	15,79	**14,33**	Definitely

Figure 4.1 Results from the question "the study process meet your expectations" and corresponding detailed table.

Q 2.2. Was your choice of study program that you are currently studying/graduated, the appropriate decision?

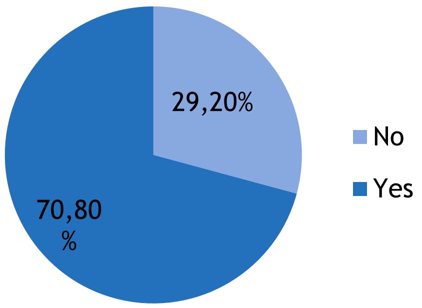


POL %	SLV %	TUR %	UKR %	Average %	
3,70	0,00	0,00	0,00	**0,93**	Not at all
1,85	4,35	11,54	3,51	**5,31**	Slightly
18,52	4,35	7,69	28,07	**14,66**	Moderately
37,04	56,52	34,62	38,60	**41,69**	Mostly
38,89	34,78	46,15	29,82	**37,41**	Definitely

Figure 4.2 Results from the question "Was your choice of study program that you are currently studying/graduated, the appropriate decision" and corresponding detailed table.

Q 2.1 and Q 2.2 target the students' level of experience in the programme that they are studying or studied find out the contentment in general. It is shown that half of the respondents are "mostly" happy with respect to their expectations and a quarter of the respondents are "moderately" pleased with the programme's outcome study in the programme they are enrolled in, whereas the choice of programme is mostly inclined towards "mostly" and "definitely yes" options. In both cases, the distribution of "mostly" and "definitely yes" options appears homogeneous with respect to the average percentage. Q 2.10 investigates the students' view on the theoretical course duration compared to the duration of practical classes, which most students are happily attend and believe that learning is easier with practical classes. As given in Q 2.10, the majority of students are in fact happy with the duration of theoretical classes. There is a balanced distribution of the durations of theoretical classes to practical classes in Poland and Turkey. It appears that students are less content in Turkey and Poland with duration of practical classes and consider them to be more constructive if longer durations are implemented. This may also be related to the lecturer's competency but in this part of the survey, a correlation between lectures/courses and durations was not investigated.

Q 2.10. The number of hours of lectures compared to laboratory/practical/exercises was insufficient or sufficient.

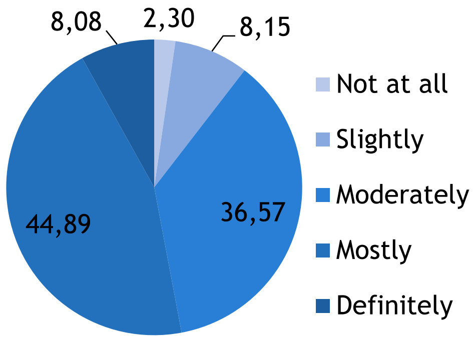


PL %	SLV %	TUR %	UKR %	Average %	
50,00	8,70	42,31	15,79	**29,20**	No
50,00	91,30	57,69	84,21	**70,80**	Yes

Figure 4.3 Results from the question "The number of hours of lectures compared to laboratory/practical/exercises was insufficient /sufficient." and corresponding detailed table.

Q 2.15 investigates the institutional capacity for specialist knowledge that is mostly related to the efficiency of courses to transfer the knowledge presented in the courses i.e. its content to the students. Specialist knowledge/directional knowledge may be affected by the Lecturer's competency and curriculum issues but in general, investigating how successful the course was is the underlying question. It appears that students are generally content with the definition of "high" at a moderate level but it is dominantly valid for all students from all countries that the level is between "mostly" and "moderately", which is similar to Q 2.1 entry. Another entry for measuring the content of the student with the institution is to ask whether the course could be suggested to another person/student seeking a course to study. Q 2.18 inquires about the level of content of students by scoring the satisfaction from the course in an indirect way. The results indicate that almost 70 % of students are happy with their course which is in accord with Q 2.1. Similarly, in Q 2.17, this scoring was directed to the field they are studying or enrolled in, and the majority of students are relatively happy with their choice of study as in Q 2.18

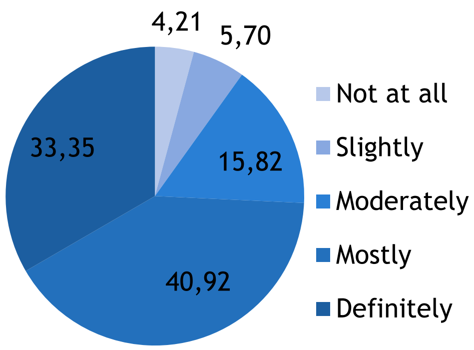
Q 2.15. Can you describe the level of specialist/directional knowledge acquired during your studies as "high"?



POL %	SLV %	TUR %	UKR %	Average %	
1,85	0,00	3,85	3,51	**2,30**	Not at all
14,81	8,70	3,85	5,26	**8,15**	Slightly
25,93	39,13	46,15	35,09	**36,57**	Moderately
48,15	43,48	42,31	45,61	**44,89**	Mostly
9,26	8,70	3,85	10,53	**8,08**	Definitely

Figure 4.4 **Results from the question "Can you describe the level of specialist/directional knowledge acquired during your studies as "high"?" and corresponding detailed table.**

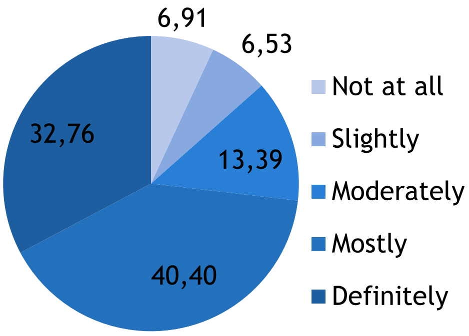
Q 2.18. Would you recommend your place of study/course to other candidates?



POL %	SLV %	TUR %	UKR %	Average %	
3,70	0,00	9,62	3,51	**4,21**	Not at all
11,11	4,35	3,85	3,51	**5,70**	Slightly
14,81	8,70	13,46	26,32	**15,82**	Moderately
46,30	43,48	42,31	31,58	**40,92**	Mostly
24,07	43,48	30,77	35,09	**33,35**	Definitely

Figure 4.5 **Results from the question "Would you recommend your place of study/course to other candidates" and corresponding detailed table.**

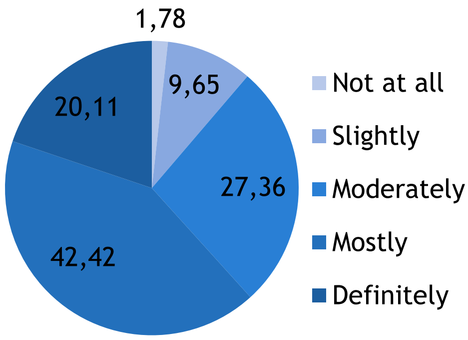
Q 2.17. If you could choose the field of study again, your choice would be the same.



POL %	SLV %	TUR %	UKR %	Average %	
9,26	0,00	9,62	8,77	**6,91**	Not at all
7,41	4,35	3,85	10,53	**6,53**	Slightly
12,96	4,35	13,46	22,81	**13,39**	Moderately
40,74	43,48	42,31	35,09	**40,40**	Mostly
29,63	47,83	30,77	22,81	**32,76**	Definitely

Figure 4.6 Results from the question "If you could choose the field of study again, your choice would be the same" and corresponding detailed table.

Q 2.3. Did the acquired knowledge/skills/competencies make it easier for you to find employment or continue your studies?

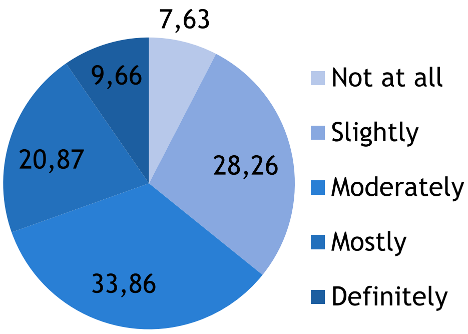


POL %	SLV %	TUR %	UKR %	Average %	
1,85	0,00	0,00	5,26	**1,78**	Not at all
18,52	8,70	7,69	3,51	**9,60**	Slightly
27,78	34,78	15,38	29,82	**26,94**	Moderately
31,48	43,48	57,69	35,09	**41,93**	Mostly
20,37	13,04	19,23	26,32	**19,74**	Definitely

Figure 2.7 Results from the question "Did the acquired knowledge/skills/competencies make it easier for you to find employment or continue your studies?" and corresponding detailed table.

Q 2.3 entry in this section of the survey is the level of acquired knowledge /skills /competencies, which represent mostly hands-on skills and laboratory skills and how much of the competencies are defined at an industrially oriented practical or knowledge level from the general and practical classes. Laboratory classes are classified as the application of knowledge as to facilitate the acquired knowledge into practice, whether it be obtained from the accompanying lecture or be it a standalone to teach certain skills, the prime target is usually to make this experience/skill viable for a job opportunity or academic development in the advantage of respondents. Q 2.3 reveals a trend levelled with the average percentages as in all countries, i.e. the answer "mostly" is a dominant response but the "definitely yes" option is rather low as opposed to the "moderately" one, which indicates that respondents are not fully content with acquired knowledge, however, the type of acquired knowledge appears to be mostly hands on experience from the results. Hands-on experience is hard to get through because some students are not ready to absorb the theoretical or such training requires multiplication of exercises in numbers.

Q 2.4. Was the study programme that you have been studying/graduated adequately prepared for your employment in another country?

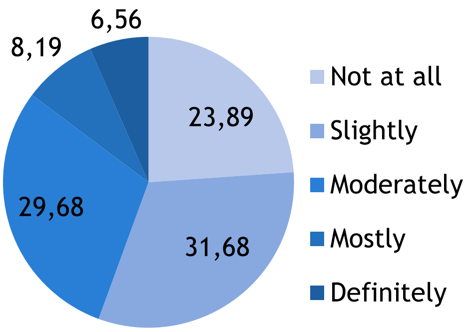


POL %	SLV %	TUR %	UKR %	Average %	
11,11	4,35	11,54	3,51	**7,63**	Not at all
35,19	30,43	30,77	15,79	**28,04**	Slightly
29,63	30,43	34,62	38,60	**33,32**	Moderately
20,37	8,70	19,23	33,33	**20,41**	Mostly
3,70	26,09	3,85	8,77	**10,60**	Definitely

Figure 4.8 Results from the question "Was the study programme that you have been studying/graduated adequately prepared for your employment in another country?" and corresponding detailed table.

The aim of the Q 2.4 is primarily for the employed respondents, however, almost half of the respondents are not currently employed. It is also not known if they were employed previously or would their internship provided them with some insight regarding this question. In any case, most of the respondents are mostly aware that, through their internship or hearsay information from presently/previously working for a third party, certain qualifications are required for employment in another country. It is also known that the requirements for employment are a mostly competitive struggle as many apply for the same job, hence, the answers are inclined towards mostly to the "moderately" option.

Q 2.5. The knowledge of a foreign language that you developed during your studies can be described as very good.



POL %	SLV %	TUR %	UKR %	Average %	
16,67	34,78	23,08	21,05	**16,67**	Not at all
37,04	30,43	15,38	43,86	**37,04**	Slightly
29,63	26,09	38,46	24,56	**29,63**	Moderately
7,41	4,35	19,23	1,75	**7,41**	Mostly
9,26	4,35	3,85	8,77	**9,26**	Definitely

Figure 4.9 Results from the question "The knowledge of a foreign language that you developed during your studies can be described as very good" and corresponding detailed table.

One of the requirements of employment is obviously the command of a foreign language to express your views or get your message across. As given in Q 2.5, the confidence level of a having an established level of foreign language is the lowest as it lies between "slightly" and the "moderately" option. "slightly" option is a dominant choice for the respondents from Poland, Slovakia and Ukraine. This outcome may be the result of the employment of respondents, that is, the majority of respondents from Turkey (92%) are in employment, and hence, the language experience is not to be inflated as a prime qualification for the employment, or, the companies have sufficient number of people who have a good command of foreign language. However, some of the respondents are known to work mostly in international companies; three of the respondents are employed by a research institute, two are unemployed and the remaining respondents are mostly employed by medium and large size exporting companies (Survey for companies; size of company section; 56% Large, 22 % Medium, 16% small and 6 % micro size company).

Q 2.6. Please list 3 subjects/modules whose content (knowledge, competencies, skills) was most useful in the further part of your studies / professional activity.

Table 4.1 Detailed table of results for the question "Please list 3 subjects/modules whose content (knowledge, competencies, skills) was most useful in the further part of your studies / professional activity"

		POL %	SLV %	TUR %	UKR %	Av %
Welding	1	1,37	3,17	5,41	0,00	2,49
Materials /Science/engineering	2	13,70	28,57	13,51	7,69	15,87
Heat Treatment	3	1,37	1,59	2,70	0,00	1,41
Nanomaterials	4	0,00	0,00	0,00	15,38	3,85
Materials Selection	5	1,37	0,00	0,00	0,00	0,34
Materials Characterization/Analysis	6	2,05	3,17	8,11	10,26	5,90
Composites	7	6,16	0,00	1,35	0,00	1,88
Strength of Materials	8	2,05	0,00	2,70	0,00	1,19
Mechanics of materials	9	2,74	1,59	0,00	0,00	1,08
polymers/Plastics related	10	5,48	0,00	4,05	1,28	2,70
Quality Control	11	5,48	1,59	4,05	1,28	3,10
Corrosion/Surface Science	12	1,37	9,52	0,00	1,28	3,04
Surface/Coating Engineering	13	2,74	0,00	0,00	1,28	1,01
Language	14	4,11	0,00	1,35	3,85	2,33
Crystal chemistry	15	0,00	0,00	0,00	0,00	0,00
Colloid Chemistry	16	0,00	0,00	0,00	0,00	0,00
Physical chemistry	17	0,00	0,00	0,00	0,00	0,00
Manufacturing related	18	9,59	0,00	9,46	0,00	4,76
CAD/Simulation/Eng Drawing	19	3,42	0,00	0,00	0,00	0,86
Ceramics/nonmetallic	20	1,37	4,76	4,05	0,00	2,55
Phase transformations/diagrams	21	0,00	1,59	6,76	1,28	2,41
Testing incl. Labs	22	0,68	0,00	9,46	6,41	4,14
Chemistry All	23	1,37	1,59	0,00	0,00	0,74
Structure of materials/Crystallography	24	1,37	6,35	4,05	12,82	6,15
Math/statistics	25	9,59	1,59	1,35	6,41	4,73
Functional materials	26	0,00	1,59	0,00	7,69	2,32
P Construction materials	27	0,00	19,05	0,00	0,00	4,76
Biomaterials	28	2,05	3,17	0,00	0,00	1,31
Materials research methods	29	4,11	0,00	0,00	0,00	1,03
30 Rest	30	13,01	6,35	9,46	20,51	12,33
Failure Analysis	31	0,68	0,00	4,05	0,00	1,18
Thesis related	32	2,05	0,00	5,41	0,00	1,87
Thermo/heat/fluid	33	0,00	4,76	2,70	0,00	1,87
None	0	0,68	0,00	0,00	2,56	0,81

Q 2.9. Please list 3 subject/modules whose content (knowledge, competencies, skills) did not contribute anything to the further part of your studies/professional activity.

Table 4.2 Detailed table of results for the question "Please list 3 subject/modules whose content (knowledge, competencies, skills) did not contribute anything to the further part of your studies/professional activity"

		POL %	SLV %	TUR %	UKR %	Av %
I am good/not at all	0	5,41	11,11	12,50	8,13	9,29
Management/economics	1	18,02	13,33	2,08	0,81	8,56
Physcology/Pedogogy	2	3,60	0,00	0,00	13,01	4,15
Philosophy/sociology	3	2,70	0,00	0,00	21,14	5,96
History/culture/Humanities	4	5,41	0,00	2,08	9,76	4,31
Politics	5	0,00	0,00	0,00	12,20	3,05
Math/statistics/Eng Math	6	4,50	8,89	22,92	0,00	9,08
Ethics/labor/Occup. Safety/Life Saving	7	5,41	0,00	2,08	5,69	3,29
Physics/mechanics	8	5,41	24,44	0,00	0,00	7,46
Sports/physical education/training	9	0,90	0,00	0,00	9,76	2,66
Thermo/fluid.mech./transport	10	0,90	2,22	8,33	0,00	2,86
Physical/Chemistry/teaching	11	1,80	0,00	8,33	2,44	3,14
Ecology	12	1,80	0,00	0,00	0,81	0,65
Programming /IT	13	8,11	0,00	6,25	0,00	3,59
Language/Foreign/technical	14	0,90	2,22	4,17	0,81	2,03
Welding	15	0,90	4,44	2,08	0,00	1,86
Polymer related	16	2,70	0,00	6,25	0,00	2,24
Plastic deformation/plasticity	17	2,70	8,89	0,00	0,00	2,90
Crystallography/Defects/crystal	18	4,50	0,00	2,08	0,81	1,85
Colloid/Organic/Quantum Chemistry	19	0,00	0,00	2,08	4,07	1,54
Organic synthesis	20	0,00	0,00	0,00	5,69	1,42
Operational/process/quality	21	8,11	0,00	0,00	0,00	2,03
Engineering/technology/Electrical	22	9,91	22,22	6,25	0,00	9,60
Metallic Materials/Failure/Casting	23	2,70	2,22	2,08	0,00	1,75
Materials testing/metallography	24	1,80	0,00	0,00	0,00	0,45
Composite/Powder metallurgy/ceramics	25	0,90	0,00	8,33	0,00	2,31
Materials related (other)	26	0,90	0,00	2,08	0,00	0,75
Chemistry related(other)	27	0,00	0,00	0,00	4,88	1,22

The sufficiency of a course or programme may be well defined by its number of modules and contents to prepare students for academic and industrially oriented positions. The lectures of which their content is found to be useful by students may be a guide to a curriculum for a master's course or its modulus. In this section of the survey, i.e. Q 2.6, 440 choices of lectures/subjects have been analyzed and 32 subjects/lectures have been isolated or grouped to determine the best possible outcome. The students who responded to this survey are mixed in terms of education level and employment status; this poses an advantage of having views from employed, unemployed, low level and high level educated parties. Although, the views are bound to be different at many levels, the difference in vocational background matters the most, that is, the respondents from Ukraine, for example, are basically chemists in nature, and the students from Slovakia are from Environmental Engineering, Engineering Technologies, Materials Engineering, on the other hand, students from Poland and Turkey are dominantly from Materials Engineering; the distribution and titles of lectures suggested are in accord with these backgrounds.

The grouped titles/courses are therefore in a broad range of subjects but the effect from students from Ukraine is only 34.9 %, however, some courses are related to manufacturing and characterization of materials, which reduces this ratio to approximately 18 %. This is relatively low level effect and the results are, even though left or right sided Gaussian is proclaimed, sufficiently homogeneous to draw a tangible conclusion.

As given in Table 4.1, Characterization oriented courses (Materials Characterization/Analysis, Quality Control, Testing including Labs, Structure of Materials/Crystallography, Failure Analysis) corresponds to 16.60 % (19.42%), Basic and advanced Materials Science courses (Materials/ Science/ Engineering/ Functional Materials/ Constructional Materials) corresponds to 21.01 % (22.95%), Manufacturing related courses corresponds to 4.76 %, in total, 42.37% (47.13 %); the values in bracket are valid when some Chemistry related courses are removed from the list. Hence the majority of the courses should be related to characterization or characterization related subjects; it would be ideal if the lectures are accompanied by practical one such as field training or factory exercises etc.. In addition, industry oriented or related courses may be advantageous, such as Failure Analysis may be advantageous.

It is therefore possible to suggest that one or two courses should be related to Materials Engineering Basics- for example, Advanced Materials/Technology), two courses could be related to Characterization of Materials and Characterization Techniques containing extensive practicals, one course related to Manufacturing, Surface Science (Corrosion and Tribology etc.), two courses for Polymers or Processing of Polymers (Manufacturing of Plastics, plastics technology or Mechanical and Physical Properties of Plastics), one course for language (Technical English for Graduates), Research Techniques and Thesis writing course(s), Mechanical properties of Materials (Fracture mechanics, Elasticity and Plasticity of Materials etc..), Composites, Ceramics, Course(s) related to Non ferrous Materials, Biomaterials, nanomaterials and finally joining related courses (Theoretical Welding Metallurgy, Advanced Welding Metallurgy, Welding and Adhesive Bonding for Materials etc..). In a contrary comparison, Q 2.9/Table 4.2 suggests that students are not fully contented with Social based courses; these courses include management/Economics, Philosophy, Pedagogy, History, Humanity and Basic Science courses such as Mathematics, Advanced Mathematics etc.., although there are technical courses (Engineering Technology, Metallic Materials, casting, Failure analysis, Plastic deformation, Polymers, welding etc.. also listed in Table 4.1, but the reasoning given by students is mostly related to lecturer competency or lecturer approach or less practicals involved during the course of study.

Q 2.7. Which IT tools/skills were the most useful for acquiring knowledge/undertaking professional activity? Office Software, Computer Modeling Background, Image Processing, Machine learning, Data analysis tools (Statistics etc..), Data visualization, Programming language, Automation (Arduino etc..)

Table 4.3 Detailed table of results for the question "Which IT tools/skills were the most useful for acquiring knowledge/undertaking professional activity"

		POL %	SLV %	TUR %	UKR %	Av %
None/I know everything	0	11,69	14,29	18,75	3,45	12,04
Apps	1	0,00	0,00	0,00	0,00	0,00
Office	2	19,48	35,71	9,38	12,07	19,16
CAD/Simulation	3	20,78	0,00	0,00	0,00	5,19
Engineering Drawing	4	15,58	21,43	9,38	0,00	11,60
Statistical analysis	5	3,90	0,00	0,00	0,00	0,97
Online Resources(Research)	6	3,90	0,00	40,63	4,31	12,21
Atom/Molecule modelling	7	1,30	0,00	0,00	25,86	6,79
Graphical Editors	8	0,00	0,00	0,00	12,07	3,02
Data Processing (non Office)	9	1,30	0,00	0,00	12,07	3,34
XRD Programs	10	0,00	0,00	0,00	12,07	3,02
Distant Learning Tools	11	1,30	0,00	9,38	3,45	3,53
Programming	12	7,79	0,00	3,13	2,59	3,38
IT literacy	13	5,19	7,14	0,00	2,59	3,73
Numerical Analysis/FEM	14	3,90	0,00	3,13	2,59	2,40
Image Analysis	15	2,60	7,14	0,00	0,00	2,44
3D Printing	16	0,00	3,57	0,00	0,00	0,89
Robot Control Software	17	0,00	3,57	0,00	0,00	0,89
Testing Equipment Software	18	0,00	7,14	6,25	0,86	3,56
PLC	19	1,30	0,00	0,00	0,00	0,32
Drawing/scientific	20	0,00	0,00	0,00	2,59	0,65
others	21	0,00	0,00	0,00	3,45	0,86

The IT Skills or computer-based materials analysis or numerical analysis and modeling are already the main part of our research activities in applied engineering. Basic IT skills such as MS Word, MS Excel etc.. are inseparable tools for academicians and engineering students and more specialized IT tools such as CAD/Simulation, Engineering Drawing, numerical analysis, data analysis (including Origin) tools, Atomistic or molecular modeling are demanded more than others. However, as seen in Table 4.3, most of the entries/titles are well distributed within themselves, which means that almost all of them are required by the students. PLC software may not be necessary for a Materials Technologist but online resources courses may be more useful and can be easily integrated into Research Tools (Research Techniques and Thesis writing) course(s).

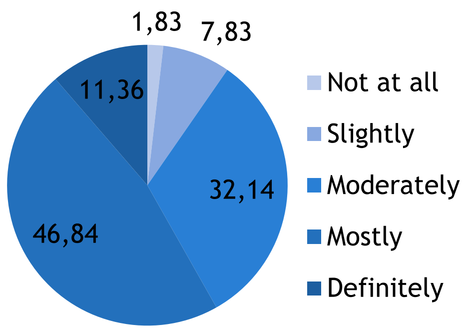
Q 2.8. What might be helpful in your professional work/continuing education that your studies have not taught you? Office Software, Computer Modeling Background, Image Processing, Machine learning, Data processing tools (for XRD, DSC etc...), Data analysis tools (Statistics etc...), Data visualization tools, Programming language, Automation (Arduino etc..), IT competency and computer-modelling experience, Research and report-writing skills, Time management, planning and organizational skills.

Table 4.4 Detailed table of results for the question "What might be helpful in your professional work/continuing education that your studies have not taught you"

		POL %	SLV %	TUR %	UKR %	Av %
None/I know everything	0	23,08	22,22	2,63	28,17	19,02
Foreign language	1	1,54	7,41	15,79	14,08	9,70
CAD/Simulation7Eng Drawing	2	13,85	3,70	7,89	0,00	6,36
Programming/machine learning	3	10,77	0,00	2,63	1,41	3,70
IT Skills/Tools	4	0,00	0,00	0,00	14,08	3,52
Practical problem solving/Lab/work experience	5	16,92	44,44	18,42	22,54	25,58
Economics/Management/Operational management	6	15,38	0,00	18,42	0,00	8,45
Quality Control	7	3,08	0,00	5,26	0,00	2,09
Communication skills	8	1,54	0,00	5,26	0,00	1,70
Research tools	9	6,15	7,41	2,63	11,27	6,87
Standards	10	1,54	0,00	2,63	0,00	1,04
Numerical methods/FEM	11	1,54	0,00	0,00	0,00	0,38
Statistics	12	3,08	0,00	0,00	0,00	0,77
Stress management/team management/leadership	13	0,00	3,70	15,79	0,00	4,87
Gain experience/Excursions	14	0,00	3,70	0,00	1,41	1,28
Learning through project/projects	15	0,00	3,70	0,00	2,82	1,63
Others	16	1,54	3,70	2,63	4,23	3,02

The courses offered in a curriculum differ at the BSc level or at higher levels of education. BSc courses are mostly defined, arranged, and usually distributed single handedly by Higher Education Councils or central educational organization which is directly connected to specialist authority. These contain experts from universities and other similar institutions involved in policy making in education. In European educational institutions, ECTS rules are imposed to generalize and level up the knowledge differences, hence the number of courses and sometimes, the title of the courses and contents are fixed but technical courses are derived from mostly experienced/previously established institutions with consideration of teaching staff or professorial personnel available to deliver courses. In Q 2.8/Table 4.4, considering the fact that not many courses are on the plate due to their specialization grouping or level, and most of the students are also selective on courses offered by curriculum due to many reasons such as lecturer competency, lecturer approach, practical content etc.., some subjects are not thought. In this section, the types of courses that are needed in professional work or continuing education are investigated. It appears that, and it is very logical choice, problem solving (at industrial level)/work/Hand on experience is the most required skill, which is followed by Foreign Language skills, CAD/ Simulation/ Engineering drawing tools, Management/ Operational Management and research tools, respectively. Management with Economics and team management skills are somewhat applied knowledge and conditions of work place may be sufficient to excel at it. Therefore, some of the course content are difficult to offer or may be possible with an expert from industry. Q 2.14/Figure 4.10 also relates the offer of subjects with professional activity. Students believe that the satisfaction level of courses offered in the programme is between "mostly" and "moderately", approximately 70% of respondents in average. Professional activity predominantly requires basic technical knowledge with some practical content that is the base for augmented or accumulated processing capacity to foresee the problem and act accordingly. In Q 2.16/Figure 4.11, how much curriculum helped the student to orient him/herself to use the knowledge acquired during study and/or how much curriculum was oriented towards industry related activities. The respondents indicate that the knowledge acquired, which is not based on the theoretical or basic sciences content, could be satisfactorily put into practical knowledge.

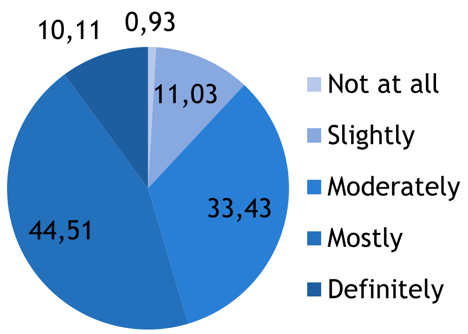
Q 2.14. The offer of subjects was useful in further education/undertaking professional activity. Not at all, Slightly, Moderately, Quite, Definitely yes



POL %	SLV %	TUR %	UKR %	Average %	
5,56	0,00	0,00	1,75	**1,83**	Not at all
22,22	0,00	3,85	5,26	**7,83**	Slightly
48,15	17,39	38,46	24,56	**32,14**	Moderately
18,52	73,91	42,31	52,63	**46,84**	Mostly
5,56	8,70	15,38	15,79	**11,36**	Definitely

Figure 4.10 Results from the question "The offer of subjects was useful in further education/undertaking professional activity." and corresponding detailed table.

Q 2.16. Can you apply the acquired knowledge in practice? Not at all, Slightly, Moderately, Quite, Definitely yes

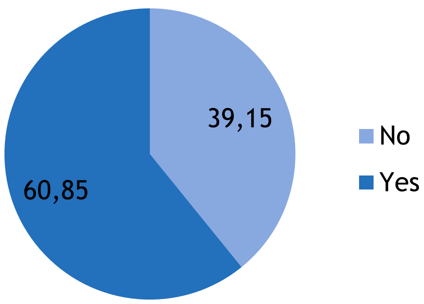


POL %	SLV %	TUR %	UKR %	Average %	
3,70	0,00	0,00	0,00	**0,93**	Not at all
20,37	8,70	11,54	3,51	**11,03**	Slightly
33,33	47,83	19,23	33,33	**33,43**	Moderately
35,19	30,43	61,54	50,88	**44,51**	Mostly
7,41	13,04	7,69	12,28	**10,11**	Definitely

Figure 4.11 Results from the question "Can you apply the acquired knowledge in practice." and corresponding detailed table.

The learning process of students is not a one-way ticket for all and offers challenges for many reasons i.e. cultural background, economic conditions, interest etc.. The most of the student respondents are employed and this presents a major difficulty in attaining classes or following the courses in a face-to-face manner. During the pandemic period, e-learning processes have been the main course of learning in many institutions including Universities and courses offered remotely. It is interesting to note that the remote learning process is not fully supported by the students due to mostly practicality reasons and lab courses are not carried out properly. Although, humanity is used to communicate and socialize through some commercial programs/software, teaching and learning are still seen as physically oriented activity by most students. Q 2.13 investigates the alternative way of in-course and after-course activities such as exams, lectures, seminars and other educational tasks. Table 4.4 shows that majority of students are more interested in seminar form of remote education and exams in general. A possible practical outcome may differ within the group or country but lectures and seminars are possibly tangible choices.

Q 2.12. Do you think that e-learning/remote form should be an integral part of education? YES/NO



POL %	SLV %	TUR %	UKR %	Average %	
16,67	69,57	42,31	28,07	**39,15**	No
83,33	30,43	57,69	71,93	**60,85**	Yes

Figure 4.12 Results from the question "that e-learning/remote form should be an integral part of education?" and corresponding detailed table.

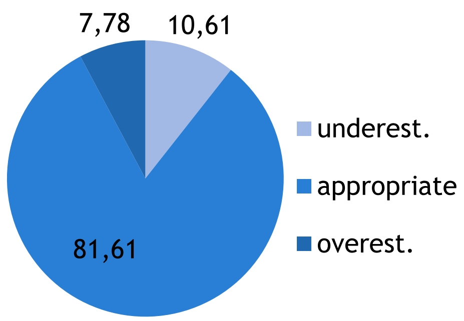
The ECTS course points were also enquired in this survey to relate the difficulty of courses and their corresponding ECTS points. Some courses may be given a higher ECTS point if they are non electives and believed to be learned by the students. Courses such as Materials Science and Labs and Advanced mathematics are more likely to be difficult subjects for the students. A correlation between the difficulty of the lecture and scoring by students should produce similar results. In Q 2.11/Figure 4.13, most students favor a balance between the ECTS points and the corresponding difficulty of the courses.

Q 2.13. Please choose the tools of the learning process that, in your opinion, should be implemented remotely: Lectures, laboratory exercises, seminars, exams, Passes, Other (please specify)

Table 2.4 Detailed table of results for the question "Please choose the tools of the learning process that, in your opinion, should be implemented remotely"

		POL %	SLV %	TUR %	UKR %	Av %
Lectures	1	3,81	27,59	3,51	1,75	**9,16**
Seminars	2	42,86	44,83	22,81	44,74	**38,81**
Exams	3	26,67	17,24	43,86	24,56	**28,08**
Final Exams	4	7,62	0,00	12,28	16,67	**9,14**
Laboratory	5	10,48	3,45	8,77	10,53	**8,31**
Excursions	6	8,57	3,45	3,51	1,75	**4,32**
Assignment	7	0,00	3,45	5,26	0,00	**2,18**

Q 2.11. The number of ECTS points assigned to individual subjects/modulus according to the student workload was: underestimated, appropriate, overestimated



POL %	SLV %	TUR %	UKR %	Average %	
20,37	0,00	11,54	10,53	**10,61**	underest.
66,67	91,30	80,77	87,72	**81,61**	appropriate
12,96	8,70	7,69	1,75	**7,78**	overest.

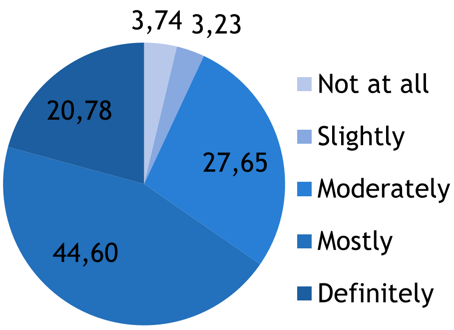
Figure 4.13 Results from the question "The number of ECTS points assigned to individual subjects/modulus according to the student workload?" and corresponding detailed table.

Section 2: Teaching quality

Definitions of teaching quality of a course across the world have different bases and changed over time due to many factors such as pupils' future interest, the structure of the classroom, value motivation (inspiration, ambition) behavior, and classroom-lecturer interaction that will expectedly provide a positive outcome on the students' learned behavior/knowledge. It is also related to the infrastructure of the institution, which plays an important role in the knowledge obtained during the study.

The teaching quality of the studied programme was investigated in this part of the survey with 9 different questions to establish a relationship between the teaching quality and students' expectancy from the programme and the performance and attentiveness of lecturers. Data were analyzed with respect to country and against 5 different levels of scoring.

Q 3.1. Was the quality of teaching in the studied/completed study programme high? Not at all, Slightly, Moderately, Quite, Definitely.



POL %	SLV %	TUR %	UKR %	Average %	
1,85	0,00	9,62	3,51	**1,85**	Not at all
5,56	0,00	3,85	3,51	**5,56**	Slightly
35,19	39,13	13,46	22,81	**35,19**	Moderately
42,59	39,13	42,31	54,39	**42,59**	Mostly
14,81	21,74	30,77	15,79	**14,81**	Definitely

Figure 4.14 Results from the question "Was the quality of teaching in the studied/completed study programme high?" and corresponding detailed table.

Q 3.1 examines the teaching quality of the study programme based on their experience. Students are "mostly" satisfied with the study program however the balance between "moderately" and "definitely" is not established. Polish, Ukrainian and Slovak students are between "moderately" and "mostly" scoring levels while students from Turkey are slightly more content with the teaching quality. Since it is a collective analogy, the teaching quality levels are more ambiguous when teaching methods are not entirely the same or similar and teaching culture is also a dominant factor. The majority of the students demand more practical classes and industrially-oriented courses that will provide an advantage in the job searching process, as the expectations are not met through the curriculum, the satisfaction level is usually lower. The students are reluctant to define the programme level as "high" because of various reasons that are given in detail in Section 2.

Q 3.2. What was the best-conducted subject/modulus and why?

A total of 57 courses have been named by the students and 6 different scoring for the question "why" have been determined. The number of classes or courses is numerous and the closest classification is not sufficient to group them, however, the important outcome of this part of the survey is the reasoning given by the students. These considerations have been grouped into 8 scores under "No Idea", "Lecturer competency", "Practical Application", "Teaching Materials", "Lecturer Approach", "Teaching Method", "Interest in subject" and other reasons. Lecturer competency is related to how knowledgeable or competent the lecturer is. Teaching materials are given as a suggestion because the lecturer or professor distributes up-to-date information leaflet or lecture notes are plenty in amount or digital materials are given out to students by the trainer/lecturer. The lecturer approach compromises the approach of the lecturer towards a student, his goodwill, concern and care during and after the classes. The teaching method is another important factor, that is, explaining the subject and showing videos related to lectures or case study presentations are found to be useful by the students. Practical application represents the hands-on practice obtained from lab classes, factory visits, etc. In Table 4.5 lecturer competency is a major factor in the results, which shows that students are affected by the information and knowledge transferred by the lecturer and her/his efforts during the lecture to teach the subject.

Table 4.5 Detailed table of results for the question "What was the best-conducted subject/modulus and why??"

0	All courses/None/No Idea	19	No Idea	0	45
1	Composite Engineering	8	Lecturer Competency	A	65
2	Materials/ Science	11	Practical application	B	34
3	Characterization	6	Teaching materials	C	13
4	Math/Advanced Math	11	Lecturer approach	D	7
5	Polymers/Plastics/engineering	4	Teaching method	E	25
6	Colloidal chemistry	3	Interesting Subject	F	4
7	Inorganic Chemistry	9	other	X	3
8	Applied crystal chemistry	5			
9	Labs/All labs Classes	11			
10	Materials Labs	2			
11	Applied courses	3			
12	Crystal chemistry	5			
13	Surface Eng/Coating	7			
14	Strength of Materials	3			
15	Materials Testing	1			
16	Heat treatment				
17	Welding/Joining/Adhesive Technology	4			
18	Manufacturing/processing technology	2			
19	Metallic materials				
20	Theory of phase transformations	1			
21	Failure analysis	1			
22	Materials selection	1			
23	Analytical chemistry related	5			
24	Physical chemistry				
25	Chemical current/power courses				
26	Nanomaterials related	1			
27	Casting/technology	1			

Contrary to Q 3.2/Table 4.5, Q 3.3/Table 4.6 examines the worst performing subjects or modules and the reason behind the choice made by students. Over 60 different lectures or courses are suggested in the results and due to the difficulty in classifying them, Technical and non technical classifications are generated. Half of the respondents are not satisfied with the practice of lecturers during the course based on their experience in the lecture. The teaching practice experience observed by students/respondents is given in Table 4.6 and lecturer incompetency/ low performance and attentiveness are one of the main reasons. The low level of the enthusiastic approach of Lecturer to students, not willing to reply/answer the questions or care to elaborate on the subject poses another high factor reasons given by the respondents. Teaching methods (confusing information, skipping information, slide reading and not providing extra materials) are believed to be interrelated to lecturer competency but students are less concerned about the lecturer or rather believe that s/he is competent but not making enough effort to clearly elevate the interest in the classroom. The other reasons such, as difficulty passing the lecture and time management issues, are also mentioned by respondents which could be emanating from the lecturer practice of teaching or in class activities, hence not significant for the survey.

Q 3.3. What was the worst-conducted subject/modulus and why?

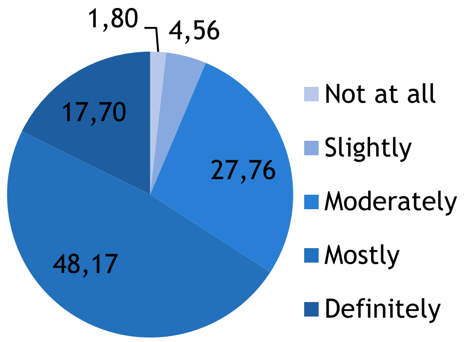
Table 4.6 Detailed table of results for the question "What was the worst-conducted subject/modulus and why?"

Lecturer incompetency
Slide teaching/ Teaching method
Lecturer approach
Course content is different/insufficent
Course content is outdated
Time management by lecturer
Difficult to pass the lecture

None	Technical	Non Technical
12	28	14
22.5	51.85	25.93

The lecturer competency, approach toward the students and stimulating the students for in class training or teaching to elevate the level of teaching have been examined in Q 3.4-3.9. As given in Section 2 and Q 3.1 and 3.2 the lecturer's approach in the sense of support when teaching the subject and/or making sure that students learn and absorb the knowledge presented in the classroom was targeted in this subsection, Q 3.4/Figure 4.15. Results yielded a score between "mostly" and "moderately" for this question. There is a great deal of contentment as a result of lecturer behavior in the class/labs but it signals that the improvement should be made in due course. Similarly, Q 3.7/Figure 4.16 also probes the level of stimulation of students by the lecturer either to make the student make an effort to learn in an efficient way or create an interest in the subject of the relevant lecture(s). The stimulation of student in the learning process may also be a help for the preparation of students for the next stage of learning in theoretical or practical classes. In any case of stimulation, students are thought to be advantageous by pre-learning the subjects or post-learning the subject by self-study with broader content from various sources. However, the lecturer should guide the students and make ensure that unnecessary or excessive information is filtered out. The feedbacks on the performance of students or outcome of a lecture/course are also justifiable learning tools of the improvement for either exam marks or achieving accurate knowledge of related course content. In Q 3.8/Figure 4.17, the results suggest that students or respondents are mostly happy with the feedback from the lecturers and a sufficient improvement appears to be attained by the students. This is also an indication of how well the lecturer deals with the students and contrary to the reasoning given in Q 3.1. and 3.2, students are in general pleased with the support of the lecturers.

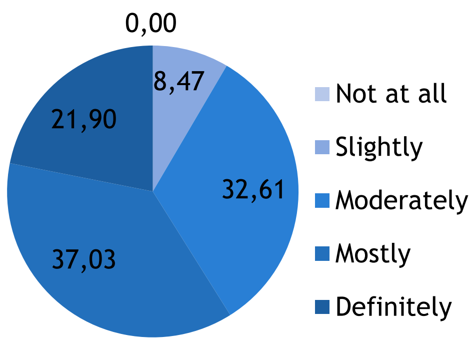
Q 3.4. Was the overall approach to the student as expected? Not at all, Slightly, Moderately, Quite, Definitely.



POL %	SLV %	TUR %	UKR %	Average %	
3,70	0,00	0,00	3,51	**1,80**	Not at all
1,85	8,70	7,69	0,00	**4,56**	Slightly
29,63	26,09	30,77	24,56	**27,76**	Moderately
50,00	56,52	42,31	43,86	**48,17**	Mostly
14,81	8,70	19,23	28,07	**17,70**	Definitely

Figure 4.15 Results from the question "Was the overall approach to the student as expected?" and corresponding detailed table.

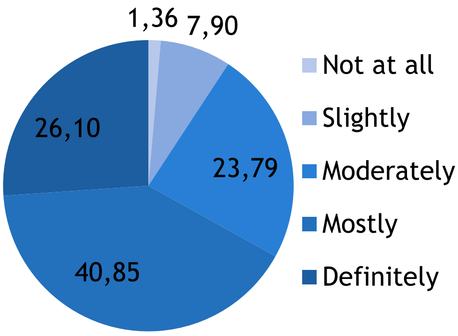
Q 3.7. Have teachers stimulated you to self-study? Not at all, Slightly, Moderately, Quite, Definitely.



POL %	SLV %	TUR %	UKR %	Average %	
0,00	0,00	0,00	0,00	**0,00**	Not at all
12,96	17,39	0,00	3,51	**8,47**	Slightly
44,44	26,09	23,08	36,84	**32,61**	Moderately
33,33	39,13	42,31	33,33	**37,03**	Mostly
9,26	17,39	34,62	26,32	**21,90**	Definitely

Figure 4.16 Results from the question "Have teachers stimulated you to self-study?" and corresponding detailed table.

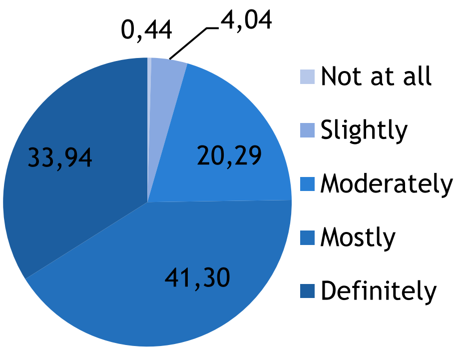
Q 3.8. Has your teacher's feedback helped you learn and improve? Not at all, Slightly, Moderately, Quite, Definitely.



POL %	SLV %	TUR %	UKR %	Average %	
3,70	0,00	0,00	1,75	**1,36**	Not at all
12,96	13,04	3,85	1,75	**7,90**	Slightly
38,89	17,39	23,08	15,79	**23,79**	Moderately
33,33	56,52	38,46	35,09	**40,85**	Mostly
11,11	13,04	34,62	45,61	**26,10**	Definitely

Figure 4.17 Results from the question "your teacher's feedback helped you learn and improve?" and corresponding detailed table.

Q 3.5. Were teachers available to the student? Not at all, Slightly, Moderately, Quite, Definitely.

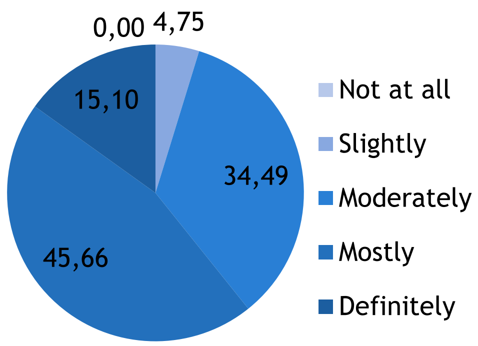


POL %	SLV %	TUR %	UKR %	Average %	
0,00	0,00	0,00	1,75	0,44	Not at all
1,85	8,70	3,85	1,75	4,04	Slightly
22,22	13,04	23,08	22,81	20,29	Moderately
50,00	60,87	19,23	35,09	41,30	Mostly
0,00	0,00	0,00	1,75	33,94	Definitely

Figure 4.18 Results from the question "Were teachers available to the student?" and corresponding detailed table.

The lecturer attentiveness in the class environment and afterwards to further stimulate or motivate the students for effective learning have been scored in this Question (Figure 4.18). Non class environments are supportive when in class activities are less or the subject is difficult to absorb by the students. Hence students make extra effort to clear off the ambiguous representation given or implemented by lecturer. Results show that in most of institutions, lectures are eager to answer questions and dedicated for the transfer of knowledge by an extra effort.

Q 3.9. Did the teachers choose the right didactic tools for the form of classes? Not at all, Slightly, Moderately, Quite, Definitely.

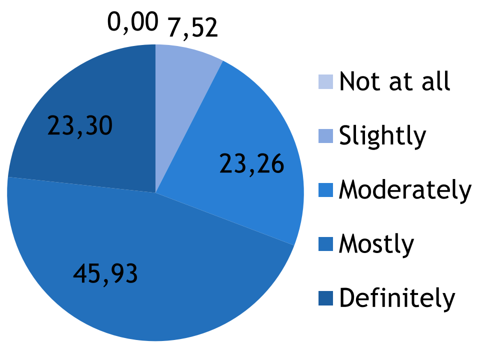


POL %	SLV %	TUR %	UKR %	Average %	
0,00	0,00	0,00	0,00	**0,00**	Not at all
5,56	4,35	3,85	5,26	**4,75**	Slightly
42,59	34,78	30,77	29,82	**34,49**	Moderately
44,44	47,83	50,00	40,35	**45,66**	Mostly
7,41	13,04	15,38	24,56	**15,10**	Definitely

Figure 4.19 Results from the question "the teachers choose the right didactic tools for the form of classes?" and corresponding detailed table.

Didactic materials usually refer to any means that is designed to aid a student in their learning experience. These tools can help a student improve their knowledge and understanding of the world through manipulation and experience in the class activities or in labs. Didactic tools in some cases may be a computer program to simulate the atomic arrangement and also simulation software to ease the learning of how a machine works etc.. In this Question/subsection (Figure 4.20), respondents believe that there is more to do with didactic tools employed during in class activities based on their scores of "mostly" and "moderately".

Q 3.6. Did the teachers communicate their requirements clearly? Not at all, Slightly, Moderately, Quite, Definitely.



POL %	SLV %	TUR %	UKR %	Average %	
0,00	0,00	0,00	0,00	**0,00**	Not at all
7,41	17,39	0,00	5,26	**7,52**	Slightly
35,19	13,04	30,77	14,04	**23,26**	Moderately
35,19	52,17	38,46	57,89	**45,93**	Mostly
22,22	17,39	30,77	22,81	**23,30**	Definitely

Figure 4.20 Results from the question "Did the teachers communicate their requirements clearly?" and corresponding detailed table.

Lecturers or professors are usually concerned with the content of the courses and have a desire to arrange the flow of course by stating some facts such as, the importance of certain knowledge for practical applications. As it may help the students, the numerous requirements by lecturer, conditional homework/assignment, inclusion of some subjects within the class/labs and request students perform certain calculation/ educational duties prior to lecture or labs class or after the labs/lectures should be stated clearly and openly with an obvious and understandable reasoning for it. Students who responded this question (Figure 3.7) believe that teaches are more or less clear of what they are asking from students. The requirements from the class and students have been communicated adequately between the students and lecturers.

Section 3: Learning resources/student's support

Learning resources as well as support was determined basing on the 5 most important factors that prevent graduation marked by respondents from the list as that entire respondent took into account. Details are shown in Table 4.7.

Table 4.7 Detailed table of results for the question "Learning resources/student's support"

	POL	SLV	TUR	UKR	%
Boredom/disinterest	16,88	19,23	12,68	14,29	15,77
No career prospects	9,09	7,69	14,08	9,74	10,15
Change of plans	6,49	11,54	8,45	11,69	9,54
Lack of support from teachers	7,14	7,69	8,45	7,14	7,61
Need to work	3,25	7,69	8,45	5,19	6,15
Health problems and stress	9,74	3,85	1,41	7,14	5,53
No support from the administration	8,44	1,92	7,04	4,55	5,49
Unfulfilled expectations	3,25	7,69	4,23	5,19	5,09
Financial problems	3,25	1,92	9,86	1,95	4,24
Family Responsibilities	3,90	7,69	2,82	1,95	4,09
Problem with commuting	4,55	1,92	4,23	5,19	3,97
Work overload problems	3,90	0,00	5,63	5,19	3,68
No academic exchange	1,95	5,77	1,41	5,19	3,58
The need to maintain a balance in life	1,95	3,85	1,41	1,95	2,29
Change of residence	2,60	0,00	0,00	5,84	2,11
Too high standard/expectations	1,95	1,92	2,82	1,30	2,00
Other development opportunities	1,95	3,85	0,00	1,30	1,77
Social reasons	1,95	0,00	1,41	1,95	1,33
A break in studies	1,30	0,00	1,41	1,95	1,16
Graduation problems	1,30	1,92	1,41	0,00	1,16
Need to take a break/rest	1,95	1,92	0,00	0,00	0,97
University reputation	0,00	1,92	1,41	0,00	0,83
Tuition fees	0,00	0,00	1,41	1,30	0,68
Professional duties	2,60	0,00	0,00	0,00	0,65
Laziness	0,65	0,00	0,00	0,00	0,16

Graduation can lead to more and career opportunities, higher earnings, and more financial stability. Completing the degree is sometimes challenging due to many factors such as changes in the economic or social status or family matters, health problems that appear suddenly or in chronic conditions i.e. long-term existence. In this question, the most significant barriers to graduation have been examined. Table 4.1 clearly shows that boredom/disinterest is the most significant obstacle graduation, followed by health problems and stress. No prospect of a career is also a predominant factor in all examined countries. The change of plans for future job interest / change of positions in management is followed by the "no career prospects" option with 9.54% and 10.15%. Lack of support from lecturers and administration scores 7.61% and 5.49%, respectively, indicating that few students require help with regulations imposed by the institution. Going to school is expensive, and it may temporarily mean a loss of income and an increase in expenses. 6.16% of students rated the option "need to work" as important.

Part II. Survey for industry

Section 1: Knowledge and engineering skills

Employer's expectations

What are your expectations from Materials Science Graduates regarding the competencies necessary to perform the following tasks listed below? (None, Low, Medium, High, Very High)

The graduates of the materials engineering should be able to know how to:

		Priority
1.	select the best combination of materials for specific application	HIGH
2.	test materials to assess how resistant they are to heat, corrosion or chemical attack	HIGH
3.	test materials structure and mechanical properties	HIGH
4.	analyse data using computer modelling software	HIGH
5.	assess materials for specific properties (such as electrical conductivity, durability, renewability)	HIGH
6.	develop/design prototypes	MEDIUM
7.	consider the implications for waste and other environmental pollution issues of any product or process	HIGH
8.	advise on the company's' adaptability to new processes and materials	HIGH
9.	collaborate with others to solve issues arising during the manufacturing process or with the finished product, such as those caused by wear and tear or a change of environment	HIGH
10.	supervise quality control throughout the construction and production process	HIGH
11.	monitor plant conditions and material reactions during use	HIGH
12.	help to ensure that products comply with national and international legal and quality standards	HIGH
13.	advise on inspection, maintenance and repair procedures	MEDIUM

14.	communicate with colleagues in manufacturing, technical and scientific support, purchasing and marketing units	HIGH
15.	supervise the work of materials engineering technicians and other staff	HIGH
16.	consider the costs implications of materials used and alternatives, in terms of both time and money	HIGH
17.	take into account of energy usage in manufacturing and in-service energy savings, e.g. in transport and construction applications.	HIGH
18.	carry out work taking into account the aspects of ecology and environmental protection	HIGH
19.	consciously conduct sustainable development of technological solutions	HIGH
20.	If others, which ones?	

In the point "others", respondents most often mentioned ability to solve problems in their area of work, technology of cold forming of solids in progressive cycles, proper interpretation of the profit and loss balance, knowledge of medical standards in the fields of material engineering, fault analysis and description of damage mechanisms, contamination analysis, surface phenomenal; engineer working with team consciousness to produce the best high quality product in a short time for competition; study of materials science in combination with IT. Also it was pointed that, due to the size of the company, the requirements were averaged based on the best available knowledge and experience. Each of the departments (production, laboratories, R&D) has different requirements and a different level of task specialization.

4.2.1.2. Current state of master graduates in the company

Please assess the extent to which the university competently prepares current materials engineering graduates to undertake the tasks listed below. Don't need competencies/knowledge (None, Low, Medium, High, Very High)

The graduates of the materials engineering should be able to know how to:

		Priority
1.	select the best combination of materials for specific application	MEDIUM
2.	test materials to assess how resistant they are to heat, corrosion or chemical attack	MEDIUM
3.	test materials structure and mechanical properties	MEDIUM
4.	analyse data using computer modelling software	MEDIUM
5.	assess materials for specific qualities (such as electrical conductivity, durability, renewability)	MEDIUM
6.	develop/design prototypes	MEDIUM
7.	consider the implications for waste and other environmental pollution issues of any product or process	LOW
8.	advise on the company's' adaptability to new processes and materials	MEDIUM
9.	work to solve problems arising during the manufacturing process or with the finished product, such as those caused by daily wear and tear or a change of environment	MEDIUM
10.	supervise quality control throughout the construction and production process	MEDIUM
11.	monitor plant conditions and material reactions during use	MEDIUM
12.	help to ensure that products comply with national and international legal and quality standards	MEDIUM
13.	advise on inspection, maintenance and repair procedures	LOW
14.	liaise with colleagues in manufacturing, technical and scientific support, purchasing and marketing	MEDIUM

15.	supervise the work of materials engineering technicians and other staff	MEDIUM
16.	consider the costs implications of materials used and alternatives, in terms of both time and money	LOW
17.	take account of energy usage in manufacturing and in-service energy saving, e.g. in transport and construction applications.	LOW
18.	carry out work taking into account the aspects of ecology and environmental protection	MEDIUM
19.	consciously conduct sustainable development of technological solutions	MEDIUM
20.	If others, which ones?	

In the point "others", respondents mentioned that the question did not concern them, no data were available or the company didn't employ any material engineer or data were not available. Also it was pointed that, due to the size of the company, the requirements were averaged based on the best available knowledge and experience. Each of the departments (production, laboratories, R&D) has different requirements and a different level of task specialization.

Section 2: Competences gap in organizational skills and others

Advances in technological revolution (Industry 4.0 etc...), global competition in manufacturing and innovative skills for the workplace are forcing higher levels of skills from engineering graduates. It is not only a foreign language anymore, advanced IT skills (computer literacy) and numerical modelling/simulation and CAD/Technical drawing s are almost becoming standard skills. However, the 4.2.2.1 section of this survey indicates that employers' expectation of IT skills is medium and commercial awareness is not primarily required. The level of expectations is "high", which is a modest expectation. The current state of materials engineers, the section 4.2.2.2, shows that the "Medium" level is an overall score. Commercial awareness and excellent knowledge of Math/Science and IT Skills are met, but problem solving, foreign language, communication skills, working as a team/decision making ability are well developed in favour of employer. In favor of this argument, some studies (e.g. Carnevale et al, 1991: Carnevale, A.P., Gainer, L. & Meltzer, A. (1991) Workplace Basics, the Essential Skills Employers Want. Jossey-Bass Inc., San Francisco, CA.) claim that most employers would primarily list technical skills, such as those required for computer literacy but a completely different perspective of employer/technical level manager require from the engineer. The primary need of employers was workers with a solid education coupled with relationship skills, and skills in self- motivation and self-management in addition to learning to learn; competence (reading, writing and computation); communication; personal management; adaptability; group effectiveness; and influence on workers/team.

In the section 4.2.2.3. (Q: Indicate the three significant problems/gaps in materials science education at universities?) is also related to this observation. One of our findings is that new graduates do not possess sufficient personal and interpersonal skills but graduates with at least five years of experience do. Effective communication skills were identified particularly lacking in Q1, Q2 Q5 and Q8. If students of engineering are to succeed within the profession of engineering, personal and interpersonal skill development will need to become a more important element of the educational experience.

Employer's expectations

What are the expectations of your company for the soft skills of materials engineering graduates? (None, Low, Medium, High, Very High)

The graduates of the materials engineering should have the following skills and knowledge:

		Priority
1.	good communication skills for presenting technical data, both in spoken and written form to colleagues from your discipline and other professionals	HIGH
2.	the ability to work as part of a team -as well as work independently - and decisions making	HIGH
3.	commercial awareness	MEDIUM
4.	an interest in scientific and technical issues and, for some positions, a real interest in a specific type of product	HIGH
5.	the ability to apply scientific reasoning to industrial situations	HIGH
6.	strong analytical skills and problem-solving ability	HIGH
7.	excellent knowledge of maths, science and IT skills	MEDIUM
8.	the ability to prioritise and plan efficiently to meet deadlines and targets	HIGH
9.	fluency in a foreign language (English/German/French	HIGH
10.	If others, please specify……………………	

In the point "others", respondents most often mentioned that the question did not concern them, fluent knowledge of, above all, English (other foreign languages are not so important). Due to the size of the company, the requirements were averaged based on the best available knowledge and experience. Each of the departments (production, laboratories, R&D) has different requirements and a different level of task specialization.

Current competence level of master graduates in the company

Please assess the level of competence to which university prepare a materials engineering graduate in the field of soft skills from list given below? (None, Low, Medium, High, Very High)

The graduates of the programme of the materials engineering should have the following skills and knowledge:

		Priority
1.	good communication skills for presenting technical data, both in writing and orally, to colleagues from your discipline and other professionals	MEDIUM
2.	the ability to work as part of a team as well as to take individual responsibility and decisions making	MEDIUM
3.	commercial awareness	MEDIUM
4.	an interest in scientific and technical issues and, for some positions, a real interest in a specific type of product	MEDIUM
5.	the ability to apply scientific reasoning to industrial situations	MEDIUM
6.	strong analytical skills and problem-solving ability	MEDIUM
7.	excellent knowledge of maths and science and IT skills	MEDIUM
8.	the ability to prioritise and plan effectively to meet deadlines and targets	MEDIUM
9.	fluency in a foreign language (English)	MEDIUM
10.	If others, please specify……………………	

In the point "others", some of respondents answered that they didn't employ any material engineer or data were not available.

Section 3: Lectures suggestions

Following sections 4.2.1.1. (Employer's expectations) and 4.2.1.2. (Current state of master graduates in the company), this one was constructed. Opinions from employers, managers or unit/company representatives were gathered, responds grouped and analyzed. The objective of this part of the survey is to suggest a list of subjects of interest for the Materials Science course. However, this data will be combined with students' responses and a universal list of courses will be advised.

Table 4.8 and Table 4.9 below present the analysis results from section 3. One of the major outcomes of this survey is that most of company representatives or employers are concerned with the characterization process of products/samples, which may cause a great deal of capital if a fault is experienced at later stage in manufacturing. Testing and standards are also imperative for manufacturing as part of the quality control procedures. Materials selection is followed by Failure analysis, and heat treatment in decreasing order. A possible list of lectures should therefore contain derivatives of these highly industrialized subjects in either at a high-level form i.e., more theoretical (Theory of heat treatment) or in applied form, such as "Applied Heat Treatment" or "Numerical Modelling in Heat Treatment". Characterization courses of "Microstructural Characterization and Analysis", "Image processing in Material science and engineering", and "Microstructure and property interactions" may be suggested. "Testing standards in Quality control procedures" or "Industrial testing standards" or derivatives may be useful for the industrially oriented courses. Numerical methods in Materials Science are other suggestions in addition to Surface science/Tribology/Mechanism in tribology and Welding and Joining related courses.

In this section, employers are requested to write the titles and contents of the courses they want their personnel who are expected to receive MSc title to attend, considering their account your institutional needs. Depending on your institution's field of study, you may be able to help by referencing a very specific course and/or subject or a previous course taken.

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Please name or choose (from the list below) the Course (s) or subject(s) that you think will be beneficial your company (please choose as many as apply):

Table 4.8. Suggestions about the subjects and courses

Special Topics	Score	%
Additive Manufacturing	26	**4.97**
Advanced Ceramics	8	1.53
Aviatic and Defence Alloys and Science of Armours	9	1.72
Casting and Casting Technology	19	3.63
Characterization Techniques of Materials and Alloys	31	**5.93**
Composites	21	4.02
Computational Materials Science (Data Analysis and modelling Techniques)	23	**4.40**
Degradation processes and lifetime prediction	18	3.44
Designing devices	1	0.19
Electrical and magnetic properties of materials	18	3.44
Electroplating and chemical metallization of the dielectric	1	0.19
Energy Storage	10	1.91
Failure Analysis	29	**5.54**
Heat Treatment	29	**5.54**
High-Temperature Materials	21	4.02
Intermetallics and Superalloys	9	1.72
Materials Properties and Materials Selection	31	**5.93**
Materials for Biomedical Engineering	8	1.53
Mechanics of Materials	20	3.82
Metals and Alloys Production	19	3.63
Metal Forming and Processes	26	**4.97**
Nanomaterials	12	2.29
Polymers and Plastics in Engineering	20	3.82
Quality and Assurance in Materials Science	13	2.49
Surface Engineering	20	3.82
Testing and Standards in Materials Science and Metallurgical Studies	23	**4.40**
Traditional Ceramics and Glass	6	1.15
Waste recycling issues	11	2.10
Wear Prevention and Improvement	20	3.82
Welding and Joining	20	3.82
"Something that will support analytical thinking, such as a course where long-term practitioners will introduce the issue to beginners and ways to approach solutions"	1	0.19
If other, please write down here:...		

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TAB 4.9. Detailed table for suggestions and opinions on the subjects and courses

		POL	SLV	TUR	UKR	
		%	%	%	%	Avr %
1	Additive Manufacturing	5,91	3,30	4,74	5,36	4,97
2	Advanced Ceramics	1,08	0,00	2,63	1,79	1,53
3	Aviatic and Defence Alloys and Science of Armours	1,61	0,00	2,63	1,79	1,72
4	Casting and Casting Technology	3,76	3,30	4,21	1,79	3,63
5	Characterization Techniques of Materials and Alloys	4,30	5,49	6,84	8,93	5,93
6	Composites	3,23	3,30	5,26	3,57	4,02
7	Computational Materials Science (Data Analysis and modelling Techniques)	6,45	2,20	3,68	3,57	4,40
8	Degradation processes and lifetime prediction	3,23	5,49	3,16	1,79	3,44
9	Designing devices	0,00	1,10	0,00	0,00	0,19
10	Electrical and magnetic properties of materials	3,76	3,30	2,63	5,36	3,44
11	Electroplating and chemical metallization of the dielectric	0,00	0,00	0,00	1,79	0,19
12	Energy Storage	2,15	2,20	1,58	1,79	1,91
13	Failure Analysis	5,91	6,59	5,26	3,57	5,54
14	Heat Treatment	5,38	6,59	5,79	3,57	5,54
15	High-Temperature Materials	2,69	5,49	4,21	5,36	4,02
16	Intermetallics and Superalloys	1,61	1,10	1,05	5,36	1,72
17	Materials Properties and Materials Selection	7,53	4,40	5,26	5,36	5,93
18	Materials for Biomedical Engineering	2,15	0,00	1,05	3,57	1,53
19	Mechanics of Materials	4,30	4,40	4,21	0,00	3,82
20	Metals and Alloys Production	5,38	4,40	2,63	0,00	3,63
21	Metal Forming and Processes	5,38	5,49	5,79	0,00	4,97
22	Nanomaterials	2,69	0,00	2,63	3,57	2,29
23	Polymers and Plastics in Engineering	2,69	4,40	2,63	10,71	3,82
24	Quality and Assurance in Materials Science	1,08	3,30	3,68	1,79	2,49
25	Surface Engineering	2,69	6,59	3,16	5,36	3,82
26	Testing and Standards in Materials Science and Metallurgical Studies	4,84	7,69	3,68	0,00	4,40
27	Traditional Ceramics and Glass	0,54	0,00	1,58	3,57	1,15
28	Waste recycling issues	2,69	2,20	1,05	3,57	2,10
29	Wear Prevention and Improvement	3,23	3,30	4,74	3,57	3,82
30	Welding and Joining	3,76	3,30	4,21	3,57	3,82
31	"Something that will support analytical thinking, such as a course where long-term practitioners will introduce the issue to beginners and ways to approach solutions"	0,00	1,10	0,00	0,00	0,19

Section 4: Comments regarding materials science education

The advantages of having a degree in Materials Science and Engineering and related subjects are found to be related to mostly knowledge based outcome such as knowledge on materials (Materials Science knowledge in general), Materials selection, theoretical knowledge apart from Materials science (heat treatment, tribology, processing etc..) are demanded from the industry. One of the findings out of this section is that employers or company representatives believe that Materials science involves a wide range of subjects or can be associated with wide range of industrial branches. Personal development or communication skill and confidence forming activities are welcome by employers. For this, educational institutions should provide public speaking opportunities to students, either in the classroom/seminar/conferences. One of the application could include students explain specific subject in front of the class and/or a group of people. These presentations should be critiqued for technical content and for effectiveness of communication. Gaining these initial experiences while still a student will significantly enhance an engineer's ability to speak persuasively. Focusing on the gaps and barriers or problems in Education in Materials science is answered by the next question (Table 4.10 - Indicate the three significant problems/gaps in materials science education at universities?). Global competition, employers demand that engineers must have abilities such as work flow management, team management and communication, and economics of the manufacturing. Employer needs practical knowledge about the performing the job from engineer to make sure that process is actively pursued / problem is solved. Although this ability is time consuming and mostly gained in work place, lack of practical knowledge through/using theoretical knowledge, quality control, materials selection are basically the most technically challenging compared to the foreign language, which is not used as part of fixing machine or quality control of gears but rather an auxiliary benefit to the beholder in communication or reading standards/emails etc.. Another problem in Materials science education is that management/team work ability (Personal development) and engineers are not aware of how things work or do not want to involve in administrative procedures.

Table 4.10. Responses from "significant advantages of education in materials science in universities question

	POL	SLV	TUR	UKR	
	%	%	%	%	Avr %
None	8,57	12,50	0,00	4,35	6,35
Industrially Oriented	11,43	0,00	3,33	0,00	3,69
Materials selection	5,71	0,00	10,00	8,70	6,10
Knowledge: Materials	5,71	25,00	33,33	17,39	20,36
Knowledge: Theoretical	11,43	0,00	3,33	13,04	6,95
Knowledge: Practical	0,00	12,50	0,00	8,70	5,30
Knowledge: Manufacturing	0,00	6,25	16,67	4,35	6,82
Knowledge: Basic Sciences	2,86	0,00	0,00	4,35	1,80
Knowledge: Basic Vocational/Technical	5,71	0,00	0,00	0,00	1,43
Language	0,00	12,50	0,00	4,35	4,21
Quality Control	5,71	0,00	13,33	0,00	4,76
Analytical thinking	5,71	0,00	0,00	4,35	2,52
Problem solving	5,71	0,00	0,00	8,70	3,60
Wide range of Industry Branches/R&D	0,00	6,25	10,00	4,35	5,15
Wide sectoral job opp/Internship	2,86	0,00	3,33	4,35	2,63
IT skills/Design/Modelling	17,14	0,00	0,00	4,35	5,37
International cooperation	0,00	6,25	0,00	0,00	1,56
Personal development	8,57	12,50	0,00	8,70	7,44
Interdsicplinary	0,00	0,00	3,33	0,00	0,83

Demands from the engineers are easily and clearly stated by the employers and it is assumed by the most employers that educational institutions are unabridged and colossal in modification of curriculum in response to a demand from industry. Consequently, several higher institutes have begun to introduce curriculum reforms to ensure the development of highly qualified engineers [9]. The Waikato University has made major alterations pertaining to redesigning and reviewing the curriculum making it mandatory for all undergraduate students to complete one work-integrated learning course in order to enhance employability and develop workplace skills. Similarly, Technology faculties in Turkey were established in 2010 and 7th semester i.e. the first semester in 4th year is a compulsory industrial training term for all students. This made a great difference in student's approach to industry and working conditions. It is also interesting that the majority of students (more then 80 %) were employed by the company that student was trained as an engineer. The employer is content with the performance of student as s(he can teach what the work is about and processing or quality management. Modification of curriculum may be a step forward if there is substantial industrial activity nearby the educational institution. In this context (Table 4.11), employer was asked if they were the head of department and has the capacity of changing the curriculum, what changes would they think be useful to engineers? It is not surprising that the most of the employers/company representatives who are also engineers think that curriculum with less practical is to be blamed. More industry oriented courses such as surface engineering, any course that would establish structure-property relations are welcome and most interesting one is that internship would be main part of the curriculum. A similar result was observed in section 4.2.3. (Section 3: Lectures suggestions), Table 4.12 (*Indicate the three most significant advantages of education in materials engineering in universities?).*

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If you were the head of the materials engineering major, what three issues would you change to better prepare graduates for work?

Table 4.11. Responses from the question of "If you were the head of the materials engineering major, what three issues would you change to better prepare graduates for work?"

Course Content
Course content: functional electronic materials
Course content: Surface eng
Course content: Structure-property relationships
Foreign language medium,
Course content:fast and applied,
Industrials applications,
Industrial thesis,
Homework oriented,
Emphasize on materials selection
Course content: idea sharing
emphasize on Quality control
Course duration:practical and labs
Emphasize on Casting/Materials Science/Ceramics
Work experience/Internship
Internship (Industrial+abroad)
Internship (Industrial+abroad)
Internship
Professional practice

Indicate the three significant problems/gaps in materials science education at universities.

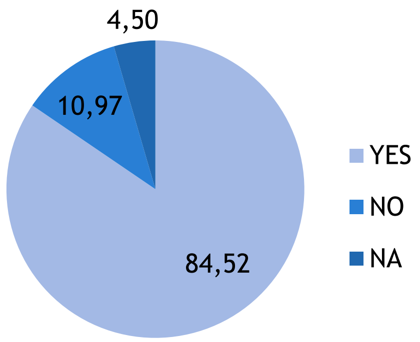
Table 4.12. Responses from "three significant problems/gaps in materials science education in universities

	POL	SLV	TUR	UKR	
	%	%	%	%	Avr %
Lack of practical knowledge	18,5	14,3	12,9	20	16,43
Foreign language	3,7	35,7	3,23	5	11,91
Lack of practical knowledge vs Theoretical Knowledge	3,7	21,4	16,1	5	11,57
Management (function):works/factory/company	22,2	0	3,23	5	7,61
Lack of quality control knowledge	3,7	14,3	9,68	0	6,92
Lack of Materials Knowledge	3,7	0	3,23	15	5,48
Practicals and labs	3,7	0	12,9	5	5,4
Lack of work experience/Internship	7,41	0	3,23	10	5,16
Contemporary knowledge about technology	0	0	0	20	5
Lack of knowledge on CAD/Simulation/Numerical Analysis	7,41	0	9,68	0	4,27
Lack of technical knowledge	7,41	0	0	5	3,1
Industry University Cooperation/Excursions	0	0	9,68	0	2,42
Communication skills	0	7,14	0	0	1,79
Course Content	3,7	0	3,23	0	1,73
Lack of vision/interest	0	0	6,45	0	1,61
No Idea/None/I don't know	14,8	7,14	3,23	0	6,3
Rest	0	0	3,23	10	3,31

Section 5: Collaborations with Industry and University

As can be seen in responses to Q1/Figure 4.21. and Q2/Figure 4.22 that the most of the companies are willing to cooperate with the Universities and, also willing to propose a project together to solve certain problems in practice. Cooperation between company and industry as suggested by some company representatives/employers are to be problem solving in nature. This is how industry and university communicate and advance in practice and should be encouraged at every level, within the ethical standards.

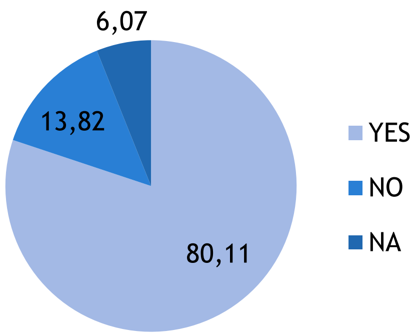
Q 1. Would you be interested in collaborating with our university and students to complete the practical parts of the subjects on the given topics directly in your company?



POL %	SLV %	TUR %	UKR %	Avg %	
70,59	100,00	87,5	80	**84,52**	Yes
17,65	0,00	6,25	20	**10,97**	No
11,76	0,00	6,25	0	**4,50**	NA

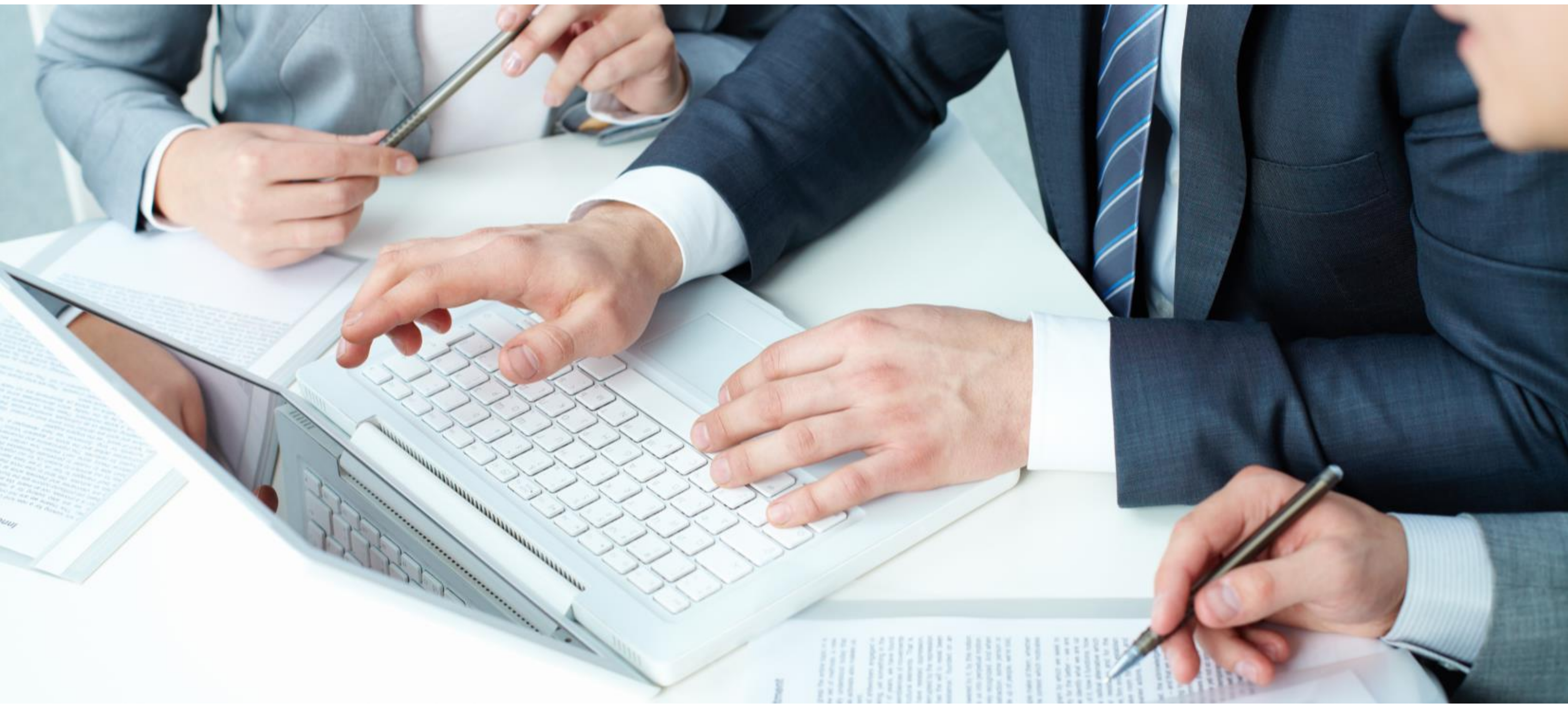
Figure 4.21. Pie chart of results from "collaboration with university" and corresponding table showing the results with respect to countries

Q 2. Would you be able to submit a proposal for bachelor's or master's theses that address your company's current issues through our University)?



POL %	SLV %	TUR %	UKR %	Avg %	
52,94	100,00	87,50	80,00	**80,11**	Yes
35,29	0,00	0,00	20,00	**13,82**	No
11,76	0,00	12,50	0,00	**6,07**	NA

Figure 4.22. Pie chart of results from "project proposal collaboration with university" and corresponding table showing the results with respect to countries;



Conclusions and recommendations

Part 1: Student survey

Section 1: Quality of the study program

1

In the opinion of students, the developed study programs were of good quality. However, this opinion does not coincide with the later answers to the questions. Most students get to know the curricula, modules, and topics and generally say their choice was right - a good one. However, going into the details of the program evaluation, it appears that there are too few practical classes. They are generally satisfied with the level of specialists/lecturers. The excellent quality of the programs may be proved by the fact that approximately 70% of respondents would undertake these studies again and/or recommend them to others, and the knowledge gained during their study affects finding employment. However, the number of answers for "slightly" and "not at all" increases threefold when the application for a job abroad is concerned. One of the reasons is the insufficient quality of English language teaching, in particular technical.

Conclusion:

The research and the collected results show that the developed programs are at a reasonable level. However, they require improvement and modernization following the modern labor market in materials engineering.

Recommendation:

To maintain the overall outline of the program with an increase in the number of practical classes and specialized English.

2

It was varied on to the specific thematic blocks of the curricula that were most useful in the opinions of students and alumni. Similar differentiation occurred in the assessment of unhelpful blocks. However, among the respondents' responses, it could be seen that the modules related to Materials characterization, Materials Science Engineering, Quality control, Structure of Materials / Crystallography, and testing labs are a strong point of the currently functioning programs. Basic subjects such as Crystal chemistry, colloid chemistry, and physical chemistry were not selected from the proposal. On the other hand, the blocks of modules related to management/economics, philosophy/sociology, mathematics/statistics, Physics, mechanics / Engineering/technology / electrical, according to the respondents, did not contribute anything necessary to obtain knowledge, skills, and competencies helpful in obtaining a job.

Conclusion: Summing up this part, it can be concluded that the humanities and basic sciences modules are not crucial in receiving a job in the field of materials science.

Recommendation: These modules should be reduced to a minimum or their parts should be incorporated into engineering modules where a given issue is discussed with the addition of basic knowledge.

3

According to about 12% of respondents, it is unnecessary to introduce IT tools/skills tools. The respondents claim that they have general knowledge and can use them. However, almost 20% believe that the MS Office suite is needed and used practically, as well as: Online resources, engineering drawings or atom/molecule modeling. Programming is of less interest as well as distant learning tools, robot control software, and data processing.

Conclusion: Education at the earlier stages provides students with a small part of tools used in second-cycle studies and is useful in further work. Generally, software packages are needed for processing and editing data (application for laboratories), and specialized software is required depending on the specialization and completed diploma and final theses.

Recommendation: Increasing work using tools such as editing packages, calculation, and simulation packages.

4

Conclusion: In the case of results related to basic needs that could help in the work carried out or continuing education, the respondents emphasize the importance of skillful solving practical problems and working in laboratories. In addition, they note the importance of research tools.

Recommendations: Introduce the form of seminar classes or replace the form of lectures with examples in conjunction with the theory focusing on the so-called "case study". The analyzed cases should come from actual incidents that have occurred/encountered in the industry. The analysis of the questionnaires shows the need to maintain an increase in classes covering research methods and techniques. The application of the of acquired knowledge in practice is at an average or poor level (most answers), hence there is a need to reduce the inflow of theoretical knowledge and increase the practical knowledge.

5

Conclusion: The results regarding the form of conducting classes show that the contact form is preferred during lectures, while the seminars should be remote. The same is valid for exams. However, conducting remote examinations shows a decrease in knowledge and the level of knowledge.

Recommendations: introducing seminars in a remote form, maintaining the contact form in the case of lectures and exams.

Section 2: Teaching quality

The respondents' answers regarding the quality of education indicate that it is generally conducted at a reasonable level. Approach to students and their stimulation, student-teacher communication, and the availability of teachers are usually good or excellent (about 64%). However, this analysis should not be generalized but should approach the results of individual project partners. Some lecturers do not meet academic standards. Thus university or faculty authorities, knowing these facts, should take preventive steps.

6

Conclusion: The quality of teaching, as assessed by students, is at a reasonable level, and this is not a reason for students from leaving the university or not taking up studies.

Recommendation: Appropriate selection of academic teachers meeting the highest academic standards is required.

Section 3: Learning resources/student's support

Most often, for reasons related to student support and university facilities, the respondents indicated boredom/disinterest, no prospect of a career, and lack of support from lecturers and administration. The latter factor is in contradiction with the results obtained in section 2.

7

Conclusion: The factors mentioned above are not a common reason for leaving the studies, or they are not in the first place when it comes to not choosing the field of material engineering.

Recommendation: Increasing the attractiveness of the education program, e.g., by organizing scientific visits, educational trips, internships, or study visits to industrial centers or inviting industry representatives or specialists from other universities to attend activities.

Part 2: Company/Industry survey

Section 1: Knowledge and engineering skills

The questions have been arranged according to the principle of closed questions with an appropriate assigned scale. First, the industry's expectations and the employed graduate's quality were concerned.

1

Conclusion: The comparison of the obtained results shows that the level of knowledge and engineering skills expected by the employers is high, while the employed candidate has features on the rating scale lower than expected.

Recommendation: Increase the candidate's level of knowledge and skills

Section 2: Competences gap in organizational skills and others

2

Conclusion: The situation is similar in the case of organizational competencies as above: the comparison shows that the expected level is high, and the candidate is characterized by organizational skills one step lower.

Recommendation: Raising the level of competencies and organizational skills of the student.

Section 3: Lectures suggestions

3

Conclusion: The industry is generally open to collaboration with universities in materials science. The shortcomings revealed in sections 1 and 2 mobilized industry representatives to propose modules that could increase the employed materials engineering graduate's knowledge, skills, and competencies. These were in particular: Microstructural Characterization and Analysis, numerical modeling in

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heat treatment, Image processing in Material science and engineering, Microstructure and property interactions, Testing standards in Quality control procedures, Surface science/tribology/mechanism.

Recommendations: Maintain these modules in the curriculum or, if there is none then introduce them.

Section 4: Comments regarding materials science education

4

Conclusion: Among the three significant problems/gaps in materials science education at universities mentioned by employers, the respondents primarily indicated: lack of practical and theoretical knowledge in the field of materials and manufacturing/processing methods, problems with personal development of the student, or Wide range of Industry Branches/R&D. On the other hand, the responses from industry respondents show that students are well supplied with Basic Sciences and Basic Vocational/Technical knowledge.

Recommendation: Increasing the level of practical knowledge.

Section 5: Collaborations with Industry and University

5

Conclusion: The industry is open to cooperation with universities and will welcome it.

Recommendation: Focusing the subject of diploma theses on the problems faced by the industry. Joint implementation of such works. Increasing practical classes, but with the use of industrial facilities.

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