Modernization and Internationalisation of Iranian HEIs via collaborative TEL-based curriculum development in engineering and STEM

UNI-TEL Project

Industry-relevant Skills and Competencies

1.7. Roadmap on industry-relevant Skills and competences

Project	UNITEL
WP	WP1: Baseline Analysis
WP Activity	1.1. Analysis and synthesis of data - State of the Art of HEIs in Engineering and STEM studies (Institutional level) 1.2. Analysis and synthesis of data - State of the Art of HEIs in Engineering and STEM studies (National level) 1.3. Analysis and synthesis of data - State of the Art of HEIs in Engineering and STEM studies at EU level 1.4. Addendum for Skills and competences of the Universities' lecturers in line with the digital education era 1.5. Comparative analysis of state of the art in PC and EU for harmonization of curriculum development purposes 1.6. Preparation of Guidelines with recommendations about current practices in partner countries for curricula modernization ***1.7. Roadmap on industry-relevant Skills and competences***
Date	January 13, 2022
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Dissemination Level	☒ Institution ☒ Local ☒ Regional ☒ National ☒ International
Version	Version 12 April 2022

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1. Introduction

UNI-TEL project is a joint project founded by Erasmus+ programme of European Union and carried out for modernization and internationalization of Iranian higher education institutes. Partners of this project are listed in below table:

Partner No.	Institute / Company	Country
01	Università degli Studi Guglielmo Marconi	Italy
02	TURUN YLIOPISTO	Finland
03	UNIVERSIDADE ABERTA	Portugal
04	Prisma Electronics ABEE	Greece
05	IMAM KHOMEINI INTERNATIONAL UNIVERSITY	Iran
06	UNIVERSITY OF SISTAN AND BALUCHESTAN	Iran
07	SHIRAZ UNIVERSITY	Iran
08	University of Isfahan	Iran
09	UNIVERSITY OF TEHRAN	Iran
10	SHAHID CHAMRAN UNIVERSITY OF AHVAZ	Iran
11	Sharif University of Technology	Iran
12	Namvaran P&T	Iran

Based on specified goals in the UNI-TEL project, different work packages have been defined and task 1.7 within WP1 has been considered to identify required skills and competencies in the industry. In this regard, the following activities have been carried out:

1- PRISMA (Partner#4) has performed a study and provided obtained results.
2- Namvaran P&T (Partner#12) has performed an internal survey and provided obtained results.
3- Sharif University of Technology (Partner#11), as part of additional activities foreseen within WP1, has prepared a questionnaire (which has been reviewed and commented by other partners and distributed among companies) and provided obtained results.

2. Preface: Incentives for competency-based education

The UNI-Tel project aim to advance acquisition of industry-relevant skills and competences is connected to a larger discourse in educational policy, motivated by the need to reduce the gap between education and the world of work.

In terms of policy development in the European context, the single most important effort for competency-based education has been the Tuning project and it's extensions from Europe to other countries and regions in the world. The Tuning project, or Tuning Educational Structures in Europe, was carried out between 2000 and 2005 in the European Union member states to facilitate implementation of the Bologna Process objectives for creating an European area of Higher Education. Tuning focused on introducing the competency-based approach to curricula. However, as Lamboley (2017) remarks, tuning the educational process was not only seen in the sense of tuning teaching and learning on a single course level, but to a large extent promote compatibility, comparability and competitiveness in the educational system. Therefore, the tuning philosophy extended from the request of writing course descriptions in the language of learning outcomes to stressing the role of the learner, enhancing student mobility, and relevance of employability to the educational process. In short, opening the educational process to discuss the needs of the learners and the employers.

However, competence is not a clearly defined concept in educational literature (Želvys & Akzholova, 2016). In the European Union educational policies, and in the Tuning project in particular, “Competences represent a dynamic combination of cognitive and metacognitive skills, demonstration of knowledge and understanding, interpersonal, intellectual and practical skills, and ethical values” (Gonzalez, Wagenaar (eds.), 2008). The concept of competences has become to refer both to pre-professional and more generic, transferable competences.

Due to broadening of the Bologna Process to countries beyond Europe, the use of the competence-approach has been reflected in various cultural and social contexts. Želvys & Akzholova (2016) point out in their study that in contexts where centrally governed higher education system are in place, learning outcomes and competences may be understood as synonymous. Stemming from their analysis of a project development with Central Asian countries, researchers observed that educators stressed the need of the educational process to meet a nationally governed, definite set of standards. To contrast this view, they pinpointed that competences are qualities developed by the learner, whereas learning outcomes are determined by academic staff, and implemented in the framework of various courses and the curricula (Želvys & Akzholova, 218, 2016).

In the field of engineering, the Tuning approach has been tested e.g. in Russia (see Lunev et. al., 2013). In comparison to the European and American educational systems, the approach resulted into good level of concordance of the national engineering education towards the international benchmarks. In Russia, as in other countries and regions, competence development has been assessed in the dimensions of importance and achievement of a set of competences. Importance and achievement has been evaluated by teachers, students and employers. Hence, these assessments describe the level of agreement of necessary competences for the industry, and how the employers see the students are able to achieve those competences. For example, in the Russian context, research detected greater gaps in student performance in the areas of ability to plan and manage time, ability to evaluate and maintain the quality of work produced, and ability to focus on quality. (Lunev et. al., 2013.)

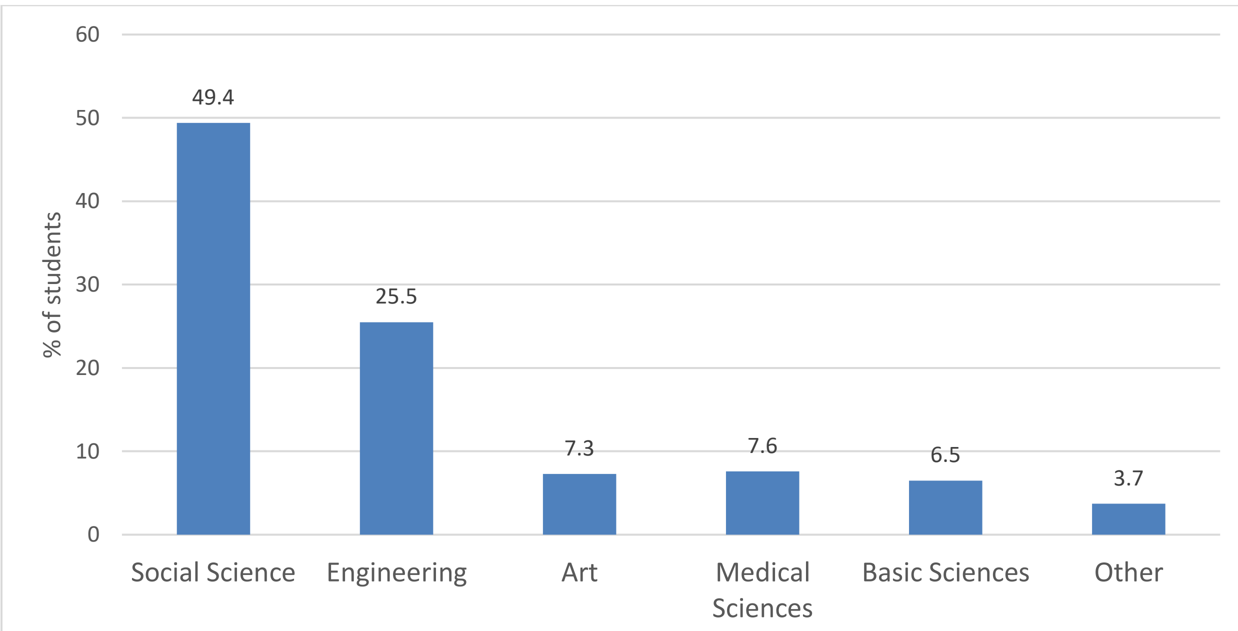
Working-life relevance is not the only concern of competence development in education. Sackey et. al. (2014) bring to attention that competence development in engineering education has wider perspectives than those of students, teachers and employers, namely the society at large. In their analysis of the Tuning approach in engineering education in Africa, greatest gap between importance and achievement of mechanical engineering students' competences was detected in entrepreneurial talent and self-confidence. Contextual analysis across mechanical engineering companies detected employer preference for importing, not developing, technology in Africa. While all stakeholders agreed on importance of the mechanical engineering competences related to applying knowledge to conceive, design, analyze and manufacture products and systems, they ranked levels of achievement lower to levels of importance. Interestingly, research pointed out that risk management, efficient use of natural resources, life cycle assessment and working in multi-diciplinary teams were amongst the largest gaps between levels of importance and achievement. In the African context, researchers argued that low ranking of competences in safety, risk management, quality control and life cycle assessment mirrored the low level of technological development in the continent.

Furthermore, competence development may also be assessed beyond the level of application. In the context of architecture and design in the Tuning-MEDA project, Hakky (2016) investigated student achievement to analyze, synthesize and evaluate. The researcher brought to attention the often faced challenge in the teaching culture amongst higher education institutions in Syria and the MEDA countries (Middle East, North Africa), where teacher and learner focus is on memorization, with the purpose of preparing student for examination and getting grades passed. Interestingly, this study brought to the front not only the mentioned levels of students' achieved competences (knowledge, comprehension, application and beyond) but also the importance of participation to a community of future practitioners, the positive effects of collaborative learning, and efforts in building a relevant body of knowledge and understanding of the level of mastery that is relevant for the industry.

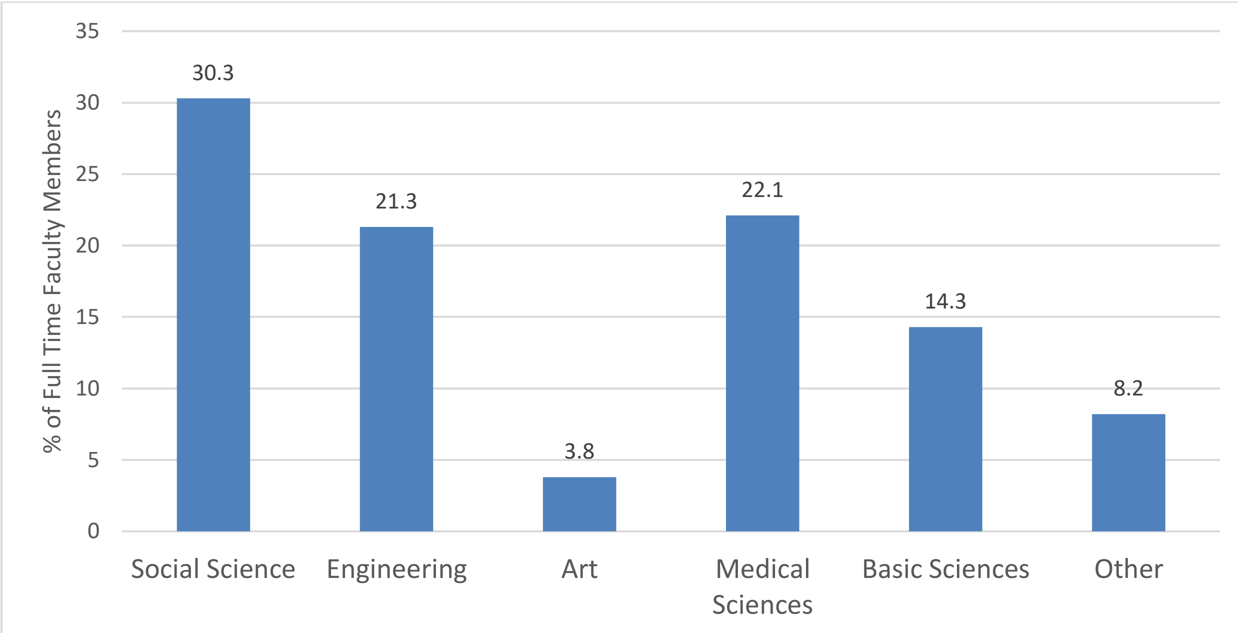
Research reviewed in Europe, Russia, the Middle East and Africa shows that regional, national or even wider cultural and societal circumstances have an impact on how the concept of competences are perceived. Hence, it is crucial to explore the experiences of different stakeholders – teachers, students and employers – in order to understand what competences are needed and in which level and under which circumstances they can be developed to the optimal level.

3. Statistics; Number of Students and Academics in Iran

The official published bulletin by the Institute for Research and Planning in Higher Educations (IRPHE) affiliated to the Ministry of Science, Research and Technology of Iran (MSRT) shows that at the end of Iranian year of 1399 (March 2021), total number of students at universities and other higher education institutes is approximately 3.2 million. The graph below shows the distribution of students in different fields of study:



Iranian higher education institutes have more than 87,000 full time faculty members, who are active in different fields of study and research, as shown in below picture.



All aforementioned data are available online at:

https://irphe.ac.ir/index.php?sid=25&slc_lang=fa&slct_pg_id=769

4. Similar Studies

Several studies about competencies and required skills at labor market have been carried out by others and have briefly reviewed in this section. Competencies and skills required for engineers and other experts in the labor market are changing due to many reasons and continuous tracking of needs and skills is prominent. STEM experts are required to have strong technical/scientific skills and good intrapersonal, social, intercultural, and sustainability competencies. As already mentioned in the Preface, several projects have investigated skills and competencies that are more useful to engineers and scientists in different labor markets. Some examples are:

- Global People, Measuring and Comparing Achievements of Learning Outcomes in Higher Education in Europe (CALOHEE)
- Time to Assess Learning Outcomes in E-Learning (TALOE)
- Program for International Student Assessment (PISA)
- Tools for Enhancing and Assessing the Value of International Experience for Engineers (TAVIE)
- Etc.

What distinguishes STEM experts from other disciplines is that there is almost a common understanding throughout the world of what STEM experts (e.g., an engineer) are supposed to know and be able to do. Unifying such understanding needs international formalization; however, special attention shall be given to local market demands, economic condition, and local cultures.

4.1. Studied Competencies & Skills

Below competencies and skills that have been considered in previous studies, based on defined goals in each project, to recognize current and future needs.

- Communication in local language
- Communication in foreign languages
- Decision making
- System thinking
- Teamwork
- Negotiation
- Conflict management

- Problem solving
- Encouraging others
- Motivating others
- Cooperation within a team
- Holistic thinking
- Long term vision
- Ethical orientation
- Etc.

4.2. Studied Attitudes and Personal Traits

Following attitudes have been surveyed in previous studies and projects:

- Empathy and sympathy
- Openness to new experiences
- Openness to changes
- Acceptance of differences
- Flexibility and resilience
- Adaptability
- Curiosity
- Sociability
- Self-awareness
- Initiative
- Creativity
- Stability and perseverance

- Relation building
- Etc.

4.3. Applied Methods

In different projects, questionnaires have been prepared and distributed among target institutes and companies, and experienced personnel from companies and universities have been interviewed. Results of surveys reveal the weak points and what is missing.

4.4. Typical Solutions

Based on goals of studies, different solutions have been proposed in finalized projects. Although a proposed solution may be applicable to a specific study (depending on targeted society), it can be a guideline for UNI-TEL project while proposing solutions and road map.

Some of the interesting solutions, which may also be applicable to UNI-TEL are reviewed in this section.

- **Training & Continual Professional Development (CPD)**

It is necessary for stakeholders (society, companies, engineering professional bodies, employers, and engineering schools) to have engineers with competences, knowledge, skills, and attitudes that foster trust in engineering activities and ensure the proper qualification of engineers. It is prominent to guarantee that STEM experts competences and skills are consistent with requirements. In addition to good training, their knowledge shall be updated continuously to make them ready to face new challenges. While basic engineering knowledge and principles stay the same, some parts of the engineering knowledge acquired at school/university is outdated after only a few years.

Some European countries, such as Denmark, Finland, France, Germany, Ireland, Sweden, and United Kingdom, in addition to commitment for good training, have traditionally invested in the CPD of engineers. The Federation of European National Engineering Organizations (FEANI – www.feani.org) adopted a system of measuring CPD in terms of credits and a process to record those achievements. In addition to a standard set of competences, many professional engineering organizations and regulation bodies mandate ongoing training and competence development to maintaining standards for mostly the safety of citizens.

- **To recognize and register CPD achievements**

A system to measure and quantify the periodic CPD can be adopted allowing comparison of engineers' qualifications. Periodic CPD shall be mandatory for all engineers given the social responsibility of the activities and the legal and economic consequences of underperformance.

- **To establish a unique framework for STEM professionals**

While it is crucial to educate specialists, it is even more important to have a greater focus on the basic STEM and engineering programs. A foundation for a framework is needed in a society.

- **To educate the educators**

There should be opportunities for educators at all levels to acquire competences in teaching based on new requirements. New demands amplify the necessity to better understand education system change and adopt with new requirements.

- **To focus on skills and competences via national policies**

The national policies must encompass the development of education and competences, as well as upskilling and reskilling within the lifelong learning framework.

- **To conduct more research on the demand for skills**

Researching which skills and competences are needed in the future can help preventing skills mismatch and provide a clear picture of the demands. For instance, if the national policy is based on green technology and circular economy, relevant skills shall be recognized and receive significant attention and budget.

- **To provide funding for higher education institutions to enable the transition to the new requirements**

The transition into new requirements is dependent on a mindset change. Funding should be made available to enable existing academic staff to acquire competences. Public funding for higher education institutions' research, development and innovation activities could be focused on new requirements.

- **To create spaces for upskilling**

Due to the formal constraints that higher education institutions operate within, they may not change education and re-education quickly enough. By creating spaces for upskilling, employers (companies and universities) could increase shared understanding of current constraints and new principles and requirements.

- **To train graduate engineers and STEM professionals**

It is necessary to build new and expand existing collaborations between the private sector, companies, STEM professionals, and universities. Established programs should be further supported to offer flexible re-education through more short courses and study modules explicitly developed for lifelong learning opportunities.

- **Promote STEM professionals as leaders**

There is a need to step up the awareness-raising of the opportunities for young people to make an impact towards a more sustainable future through STEM professions. This could increase the attraction of the engineering and STEM professions.

- **To modify STEM programs**

Education system must reflect the change that is taking place on all levels of life. Digitalization, internationalization, and the need for interdisciplinary approaches demand different skills and mindsets. Higher education institutions (in cooperation with employers, companies, and engineering associations) must react and adopt their STEM programs to include major trends.

4.5. References

Below references have been used for preparation of this section:

- Isabel Ortiz-Marcos, Valeria Breuker, Rocío Rodríguez-Rivero, Björn Kjellgren, Frédéric Dorel, Marco Toffolon, Diego Uribe and Virna Eccli, "A Framework of Global Competence for Engineers: The Need for a Sustainable World", Sustainability 2020, 12, 9568; doi:10.3390/su12229568
- Thomas Kiefer, "THE UN SUSTAINABLE DEVELOPMENT GOALS; A summary of FEANI's approach, September 2021, available online at www.faeni.org
- A. Soeiro, K. Sunderland, "How to promote, based on education and training, from a lifelong learning perspective, the skills needed for Europe to establish a more just, more cohesive, more sustainable, more digital and more resilient society", European Economic and Social Committee Opinion piece, January 2020.
- Sine Beuse Fauerby, Jussi-Pekka Teini, Robert Nyheim-Jomisko, Kristoffer Boesen, Ludvig Vraadal, "TOWARDS A CIRCULAR ECONOMY; Skills and competences for STEM professionals", Association of Nordic Engineers, Nov. 2021.

5. Studies by PRISMA

PRISMA (Partner#4), a European company in the field of electronics and based in Greece, has performed some studies, and provided obtained results. To make the evaluation quantitative, PRISMA has defined below levels for each skill.

Level	Explanation
1	lack
2	merely present
3	present

4	confidence
5	expert

Difference of target level and today level shows criticality of each skill. If criticality is 3 or higher for a skill, that skill shall receive more attentions. Below formula shows how criticality is calculated:

$$Criticality = Target\ Level - Today\ Level$$

5.1. Technical Skills

PRISMA has provided below table for required technical skills and evaluated available level, target level and criticality for each skill.

	Technical skills	Skills breakdown	Level today	Level targeted	Criticality
1	Embedded SW	Serial Protocol identification	1	4	3
		Digital sensor manipulation	3	4	1
		Analog sensor manipulation	2	4	2
		Time synchronization	1	4	3
2	Software	Cloud computing	3	4	1
		API development	3	4	1
		Services development	2	4	2
		Dockerised architecture	1	4	3
		Real time data manipulation	2	4	2
3	Hardware	Sensor identification	2	4	2
		High frequency data manipulation	1	4	3
		Filter design	3	4	1
4	Data analysis	Descriptive data analysis	3	4	1
		Inferential data analysis	2	4	2
		Benchmarking	2	4	2
		System comparisons	1	4	3
5	Responsible AI	Data preparation	2	4	2
		Validation of outcome	1	4	3
		Data use	1	4	3
		Method selection	3	4	1
		Responsibility issues	1	4	3

5.2. Soft Skills

PRISMA has provided below table for required soft skills and evaluated available level, target level and criticality for each skill.

	Soft skills	Skills breakdown	Level today	Level targeted	Criticality
1	Remote working ability	ICST knowledge	3	4	1
		Asynchronous working status	1	4	3
		Unsupervised working status	1	4	3
		Resilience and self-discipline	2	4	2
		Social communication online	2	4	2
2	Collaboration	Team working	2	4	2
		Cross-functional operation	2	4	2
		Presentation Skills	2	4	2
		Feedback acceptance/provision	1	4	3
3	Multi-tasking ability	Multi-tasking design	2	4	2
		Inductive/Deductive Reasoning	2	4	2
		Prioritization	2	4	2
		Deliverable submission on time	2	4	2
		In time reporting of status	1	4	3
4	State of the art review	Review of technology	3	4	1
		Review of academic works	2	4	2
		Critical assessment of solutions	1	4	3
5	Sustainability in design	Experimentation	2	4	2
		Commercial Awareness	2	4	2
		Independent Thinking	1	4	3
		Lifecycle management	1	4	3
		Environmental Awareness	2	4	2
6	Working environment	Communication	3	4	1
		language skills	3	4	1
		Adaptability	3	4	1
		Multiple perspectives	2	4	2

6. Studies by Namvaran P&T

Namvaran P&T (NPT), an Iranian company in the field of gas, oil and petrochemical industries based in Tehran (Partner#12), has performed an internal survey and details of study have been provided in report P238-GRP-0001. In this study, 19 experienced NPT's personnel have participated and they have been asked to provide their viewpoint regarding importance of each required skill/parameter for employment at NPT and evaluation of university graduates and employed fresh engineers based on these skills / parameters.

6.1. Results of Survey

Results have been summarized in below table:

Skill / Parameter	Importance	Skill
Working with Computer and General Software	84.74	55.26
Familiarity with Professional Engineering Software	71.05	45.79
Proficiency in English (or other Foreign Languages)	74.21	52.11
Familiarity with Engineering Documents and Drawings	64.74	27.89
Familiarity with Engineering Standards and Procedures	66.84	26.84
Team Work Skills	81.58	44.74
Social Behavior	80.53	52.11
Problem Solving Skills	75.26	45.79
Personal Time Management Skills	75.26	43.68
Management and Leadership Skills	61.58	38.42

In the above table, importance of skill and available skill level have been quantified between 0 and 100 (based on received replies from NPT's senior personnel) to show lowest and highest importance / level. Above table reveals that NPT is generally evaluating university graduates for employment based on below check list:

1- Working with Computer and General Software

2- Team Work Skills

3- Social Behavior

4- Personal Time Management Skills

5- Problem Solving Skills

6- Proficiency in English

7- Familiarity with Professional Engineering Software

8- Familiarity with Engineering Standards and Procedures

9- Familiarity with Engineering Documents and Drawings

10- Management and Leadership Skills

6.2. Priority Detection

A priority index has been defined as presented below, to identify which skill requires more attentions and investment based on importance and available skills within university graduates.

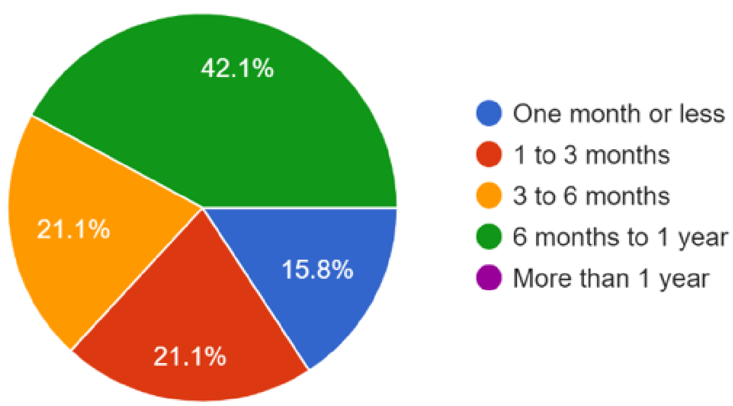
$$Priority\ Index = Importance\ Number\ \times (100 - Available\ Skill\ Number)$$

Skill / Parameter	Priority Index	Priority
Working with Computer and General Software	3,790.86	9
Familiarity with Professional Engineering Software	3,851.80	7
Proficiency in English (or other Foreign Languages)	3,554.29	10
Familiarity with Engineering Documents and Drawings	4,667.87	2
Familiarity with Engineering Standards and Procedures	4,890.03	1
Team Work Skills	4,508.31	3

Skill / Parameter	Priority Index	Priority
Social Behavior	3,856.79	6
Problem Solving Skills	4,080.06	5
Personal Time Management Skills	4,238.50	4
Management and Leadership Skills	3,791.97	8

6.3. Training of Employed University Graduates

Based on received replies from experienced personnel of NPT, employed university graduates are not completely qualified as fresh engineers and considerable time (and cost) shall be spent by NPT to train them. Below graph shows average time spent at NPT to train university graduates to reach fresh engineer level.

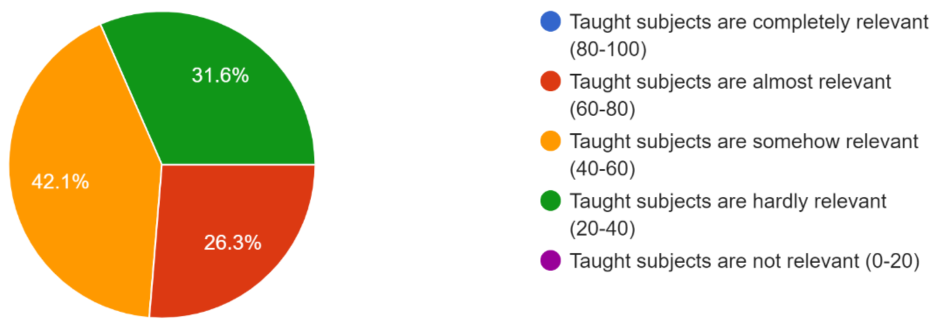


6.4. Evaluation of Universities

NPT's senior staff have been asked to evaluate universities (taught subjects, professors, and facilities). Results have been summarized hereunder:

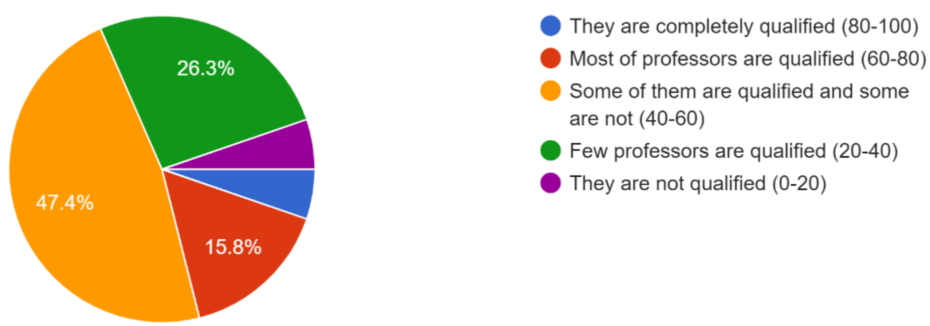
1- How taught subjects at universities are preparing students to work at your company (or similar companies) after graduation?

19 responses

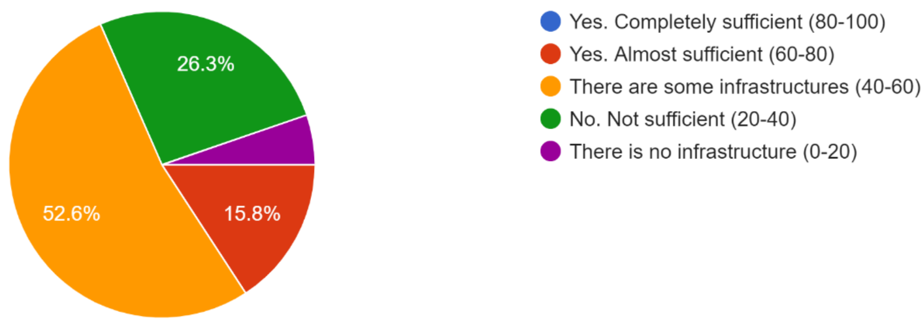


2- Are universities professors qualified to teach students subjects and skills your company needs?

19 responses



3- Are universities infrastructures (laboratories, software, computers, etc.) sufficient to help students gain required skills?
19 responses



7. Studies by Shahid Chamran University of Ahvaz

7.1) Methodology:

The survey, done by the Sharif University of Technology, seeks to determine the most critical transferable abilities and skills required on the job market today by European education standards and education policy.

In this respect, a questionnaire was developed in partnership with three European universities and seven Iranian universities, and once its validity and reliability were confirmed, it was given to partner companies were collaborating with seven Iranian universities to collect the necessary data.

The questionnaire included two sections. In the first part, fundamental information processing abilities, advanced cognitive skills, specific skills of the field and job, and emotional-communication skills of science, technology, engineering, and mathematics students were tested, and in the second part, soft and hard skills of students of science, technology, engineering, and mathematics were measured.

The data acquired via these surveys were examined by the Shahid Chamran University of Ahvaz.

7.2) Data Analysis:

7.2.1) Company Name Information:

1. Zarin Ghazal Company (Daity-Apada)
2. Sharif Agrobot
3. Saramadan Rastin Kavoshgaran Farda (2)
4. Tosan Energy Company
5. Vesta Electronic Industry
6. Test
7. Ideh Pardazan Sharif
8. Rahbord Energy Consultants
9. Kourosh Petrochemical
10. Namvaran Pazhouhesh va Tose
11. Javid Energy Parto
12. Research Institute of Petroleum Industry
13. Hamsan
14. Makran Petroleum Refining
15. Tehran International Experts Company
16. HEDCO
17. OIEC
18. Petrochemical
19. Namvaran Pazhouh
20. Isfahan Chamber of Commerce

21. Fidar Teb Vira

22. University of Tehran

23. Sistan and Baluchestan Science and Technology Park

7.2.2) Organizational Post Information:

- Electrical lead engineer
- Foreign Technical Inspection Manager
- Head of Civil Dep.
- Head of FS Dept.
- Lead Process Engineer
- Project Manager
- Information
- Test
- Chairman of the Board
- Expert
- Safety Expert
- Expert in the Office of Industry-University Relations
- IT Expert
- Expert in charge of training
- Managing Director
- Manager
- Project Manager
- Director of Economic Research and Studies
- Managing Director

- Managing Director
- Project Manager
- Senior Project Engineer

7.2.3) Specialty Information:

- Feasibility Study
- HSE
- Inspection
- Oil & Gas
- Process
- Project management
- Supervision for Electrical design & Construction
- Information
- Economy
- Electronic
- Energy
- Establishing bilateral relations between the university and industry
- Medical Equipment
- Analysis of industrial accidents, training of fire engines
- Test
- Agrobot
- Metal Industry
- Process design
- Process

• IoT Information Technology

• Experts

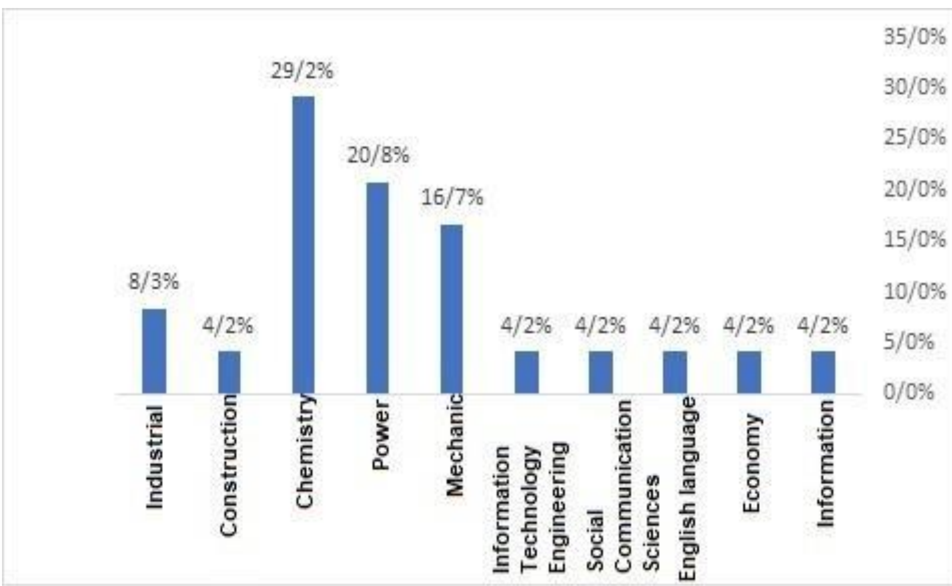
• Mechanics Department

• Electrical Engineering

• Process Engineering

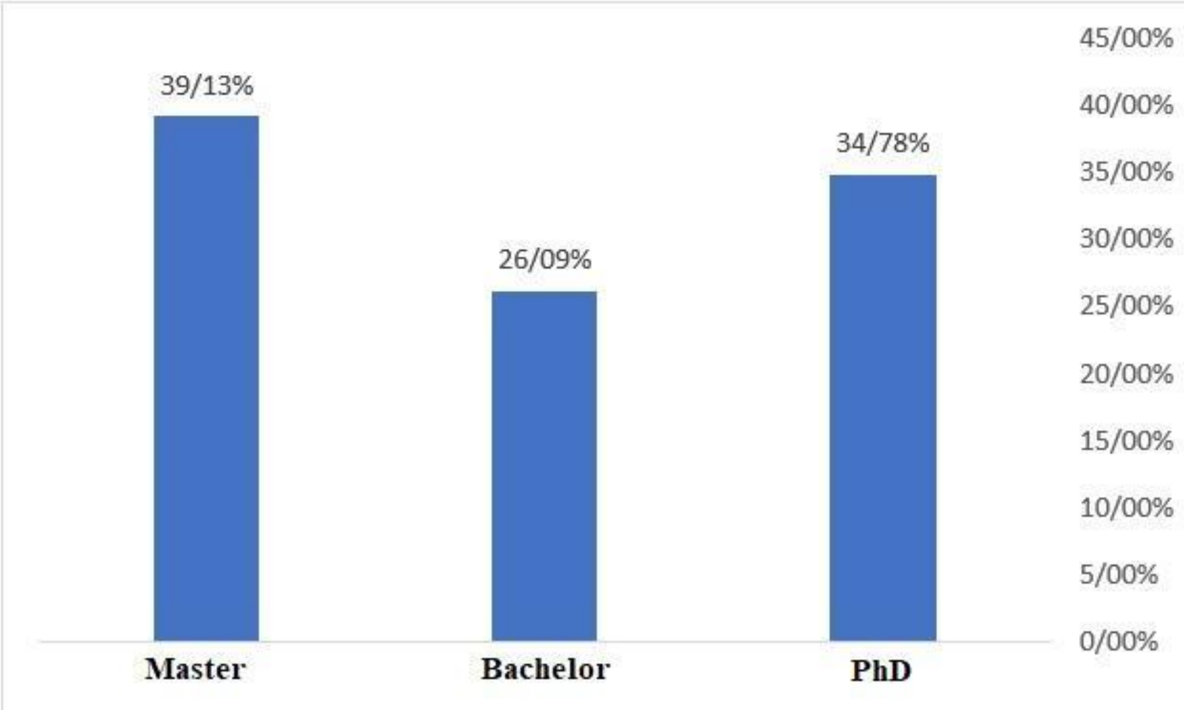
7.2.4) Course information:

This survey included 24 company representatives. Four of these twenty-four individuals have expertise in mechanics, five in electrical, seven in chemical engineering, and one in industrial engineering. 1 person in industrial safety, 1 person in communication technology engineering, 1 person in the subject of economics, 1 person in the field of social communication sciences, and 1 person remains unknown.

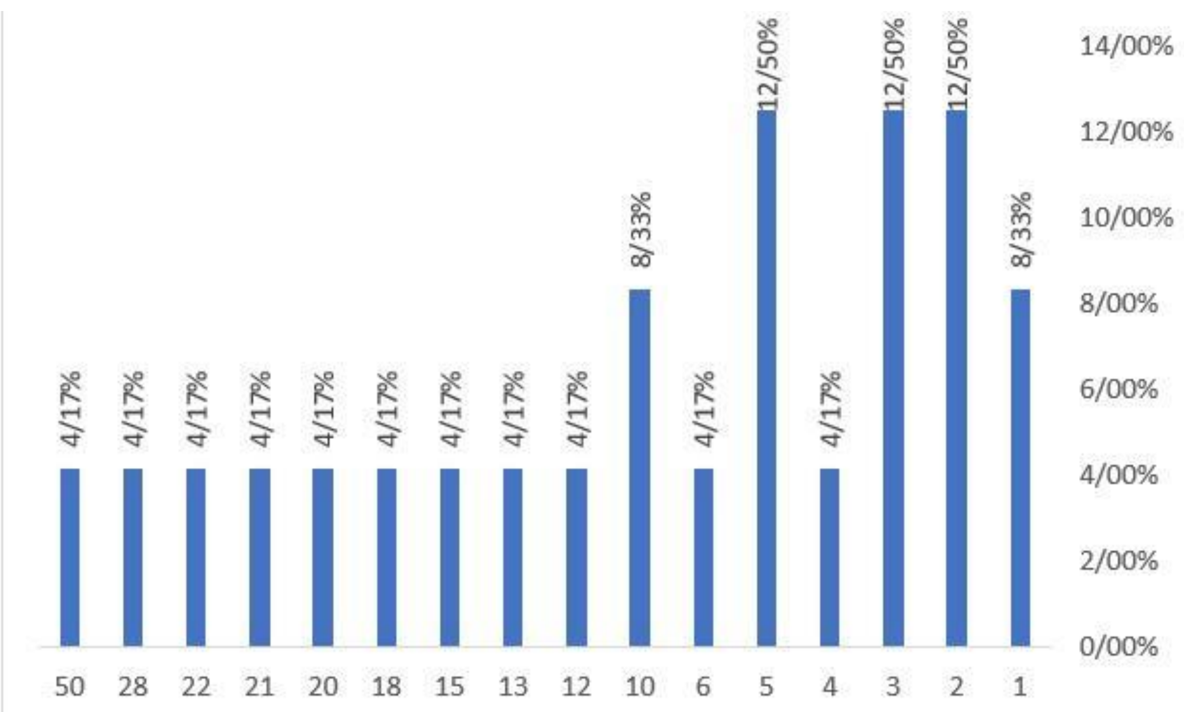


7.2.5) Education Information:

In this survey, 39.13% of the 24 company representatives studied for a master's degree, 26.09% for a bachelor's degree, and 34.78% for a doctorate.



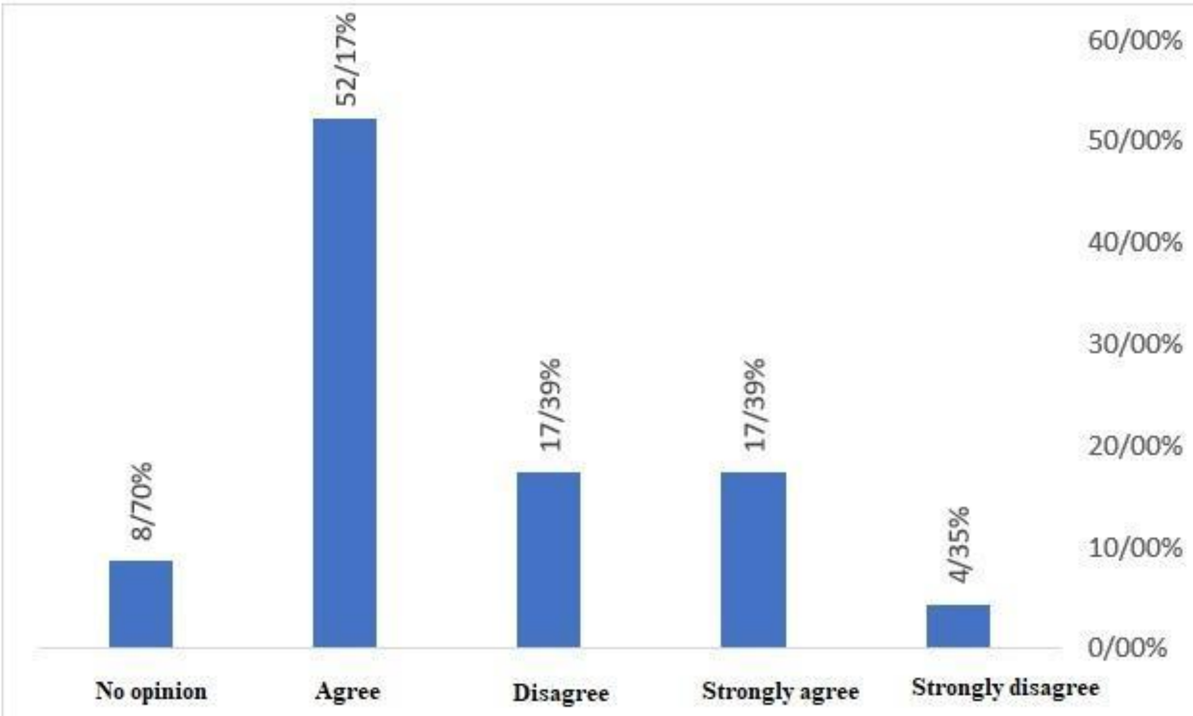
7.2.6) Company's History Information:



7.2.7) The Subject of Discussion: STEM

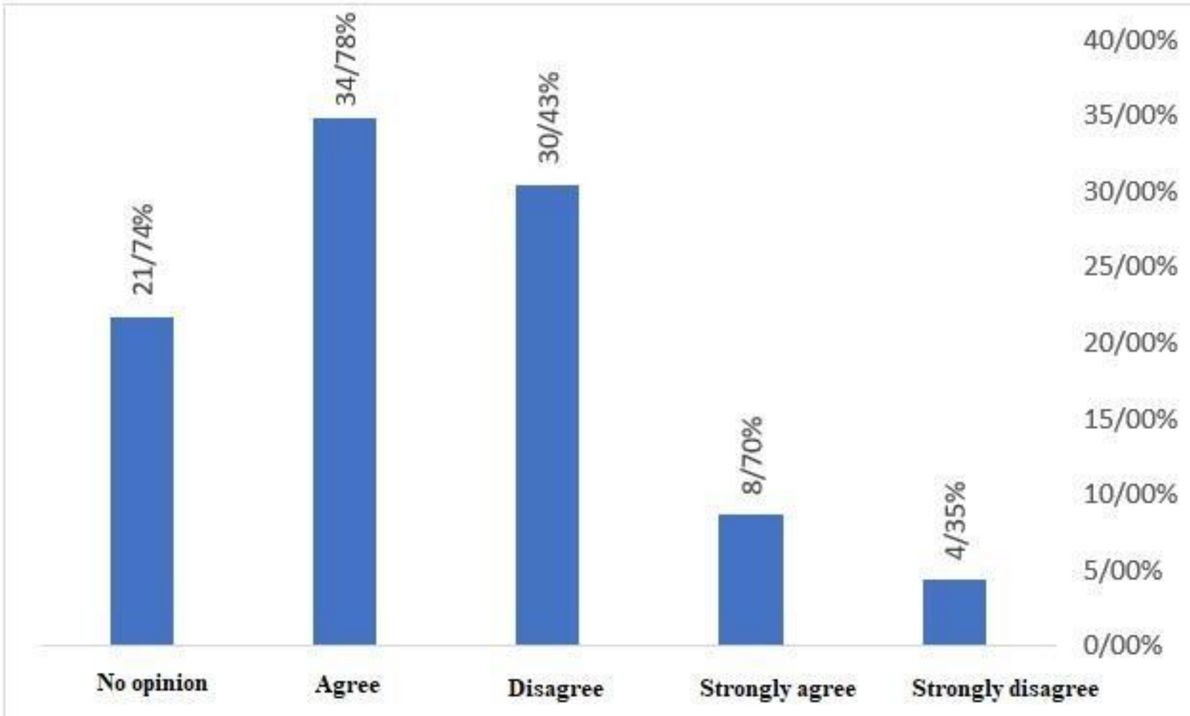
1) Senior engineers and corporate management understand STEM basics.

Sixty-nine point fifty-six percent of respondents feels that the company's senior engineers and managers are familiar with the basics of STEM. Twenty-one point seventy-five percent of respondents say that senior engineers and corporate executives lack fundamental STEM knowledge, while 8.70% had no opinion.



2) Students employed by the firm are familiar with STEM basics.

Forty-three point forty-eight percent feel that students employed by the organization are knowledgeable about STEM fundamentals. Thirty-four point seventy-nine percent of respondents say that students employed by the company are unfamiliar with fundamental STEM knowledge. Twenty-one point seventy-four percent of respondents had no opinion.



3) In your perspective, what function do engineers' STEM fundamentals have in performing their jobs within the organization?

• It is essential

• Made for practical function

• I don't see much of an impact

• It will have a significant impact

• This topic promotes psychological cohesiveness and methodical decision-making from a psychological perspective, and those with the most active brains are required to learn about it. On the other hand, certain situations, particularly problem solving, need knowledge of science fundamentals.

• This is crucial since it may save time and speed up the project's execution.

• Makes work perform more precisely

• Very

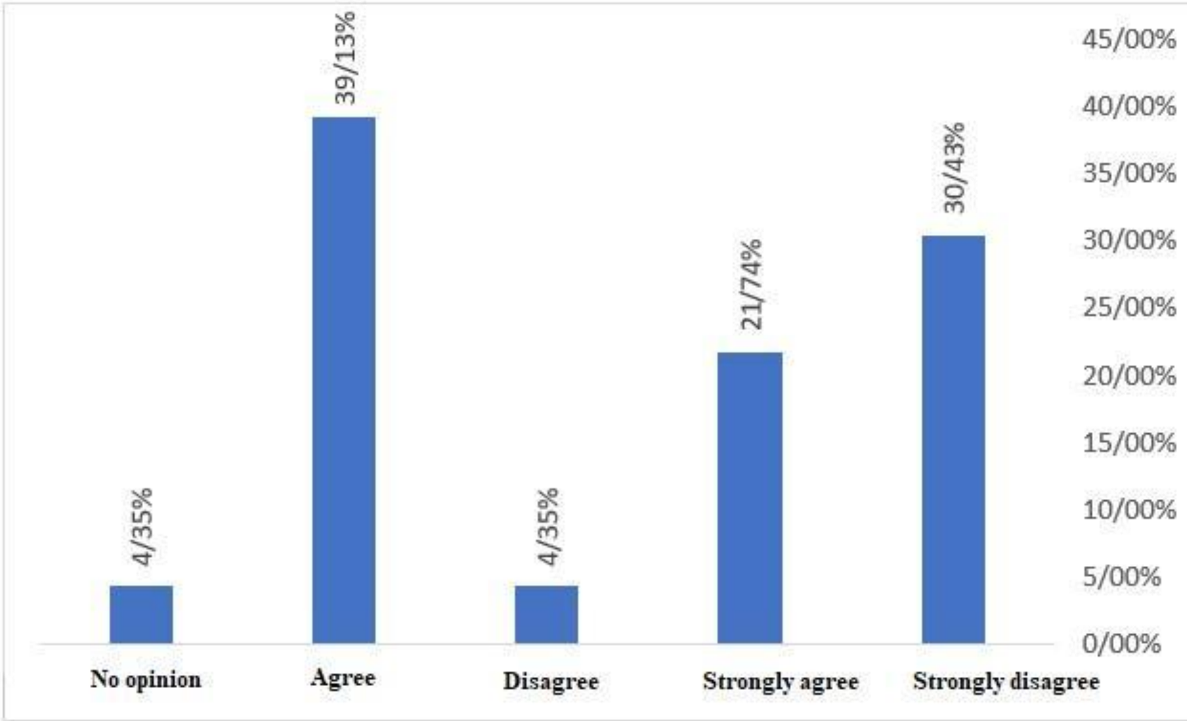
• It is highly significant

• Very much

- It is pretty practical and facilitates the final choice to choose a superior option.
- It has a significant influence
- Correct analysis
- Cost savings
- Facilitation
- Greater interactivity and accelerated work pace
- Very
- Very effective
- Has a fundamental deficiency in comprehending phenomena, processes, and planning.
- Knowledge and awareness of this information will undoubtedly be ineffective in advancing organizational goals. The more engineers and employees know the latest science and knowledge and utilize them to achieve organizational goals, the more effective they will be in advancing corporate objectives. Combining this cutting-edge science with the experience and knowledge of the organization's professionals will unquestionably provide many superior outcomes.
- Help make better management choices
- No opinion
- Fundamental role

4) The university collaborates with your company to educate students on technical skills.

Sixty point eighty-seven percent of respondents say the institution collaborates with the industry to give students technical skills training. Thirty-four point seventy-four percent of respondents felt that the institution does not cooperate with businesses to provide students with technical skills training. Four point thirty-six percent have no definite view.



5) What are the barriers to your company's collaboration with the university, in your opinion?

• According to 39.1% of respondents, there is no incentive to contact universities in the workplace.

• Thirty point four percent of respondents say there is often insufficient money to build such relationships.

• Thirty point four percent of respondents answered that we do not know with whom to collaborate.

• According to 21.7% of respondents, our organization is unfamiliar with environmental, space, and academic developments.

• Seventeen point four percent of respondents said that the academic and business timetables do not coincide.

• Furthermore, 8.7% of respondents concur that we are unaware of the possibilities of contacting the university.

• Additional Comments:

1. In current projects, the period of activities is unrealistically short, and as a result, there are insufficient possibilities for firms to connect with academic departments.

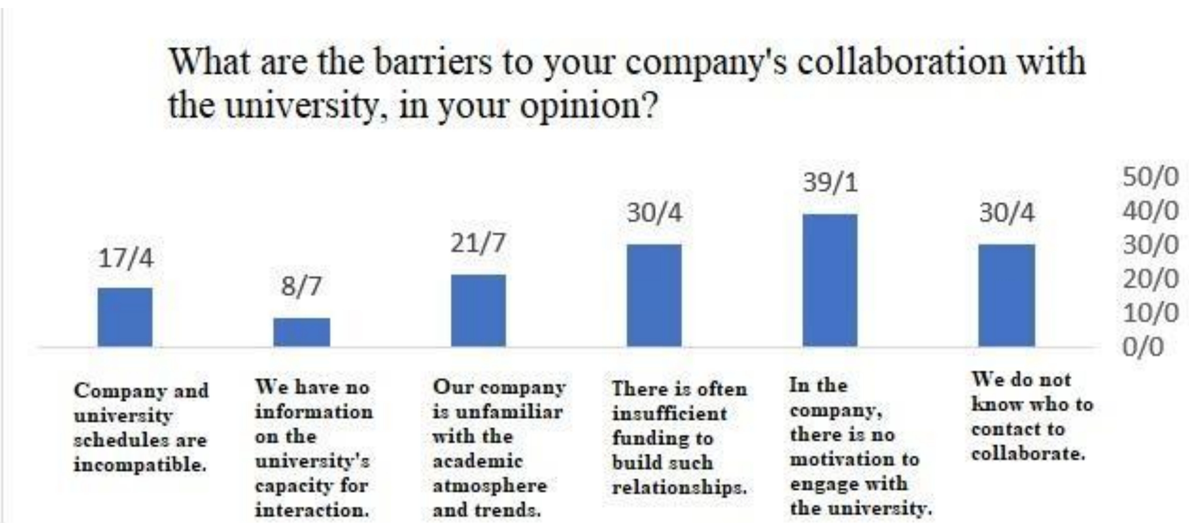
2. The existing educational framework in Iran is focused solely on pure theory and documentarian, with no connection with the business.

3. The innovation of the Chamber of Commerce has a very tight connection with the university and derives the most benefit from the graduates' and professors' influence.

4. There are no explicit instructions; there is no presentation; there is no website; illiterate and inept managers feel they have common sense and see academics as dandy and inexperienced. This is too far apart to connect the two.

5. Academic labor usually aims to produce an article and does not provide value. Another aspect is the slow pace of work and lack of time management in collaboration with the institution, which usually is critical for businesses.

6. It is not an impediment.



6) How does your company collaborate with the university?

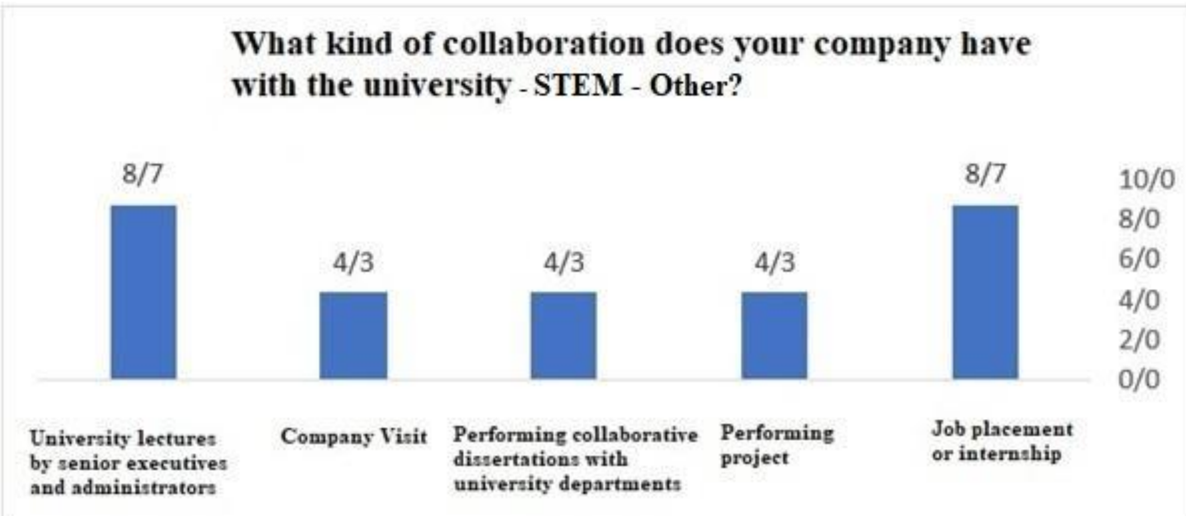
• Job search or internship was chosen by 8.7% of respondents as a collaboration between the employer and the institution.

• The remarks of senior engineers and managers at the university have determined the collaboration between the industry and the institution for 8.7% of the respondents.

• Four point three percent of respondents have decided on a project collaboration between the company and the university.

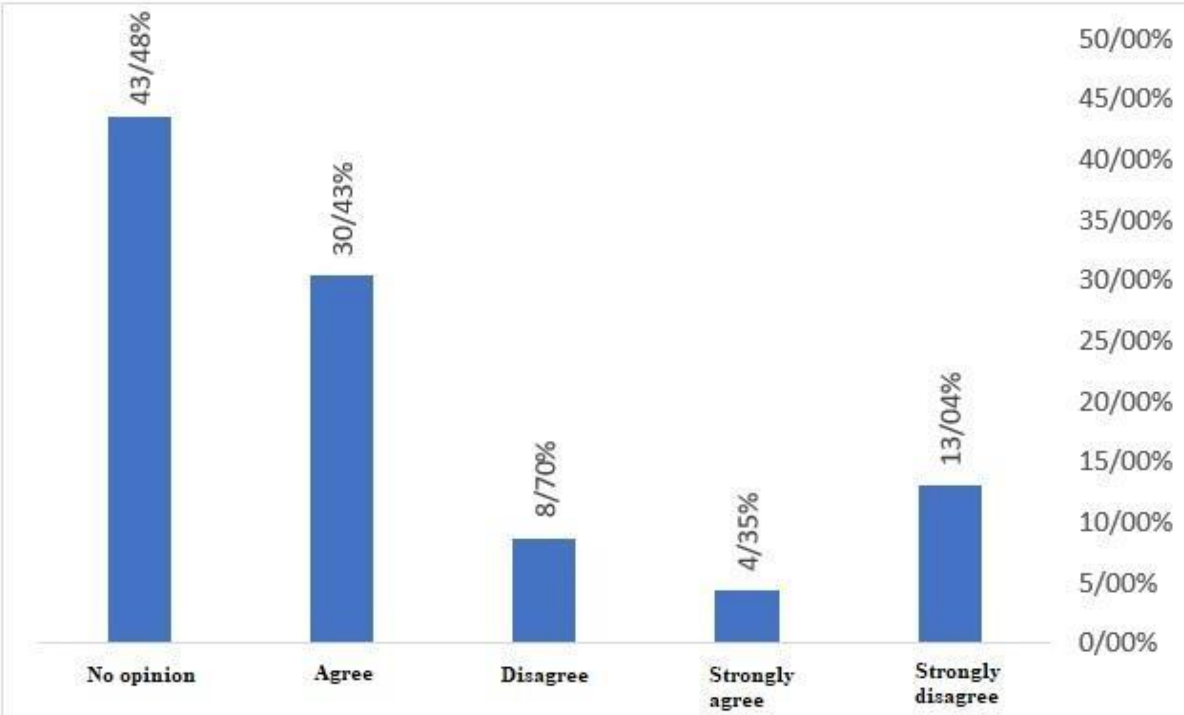
• As a collaboration between the company and the university, 4.3% of respondents have decided to pursue joint dissertations with the university department.

• Four point three percent of respondents go to the company to determine the collaboration between the company and the university.



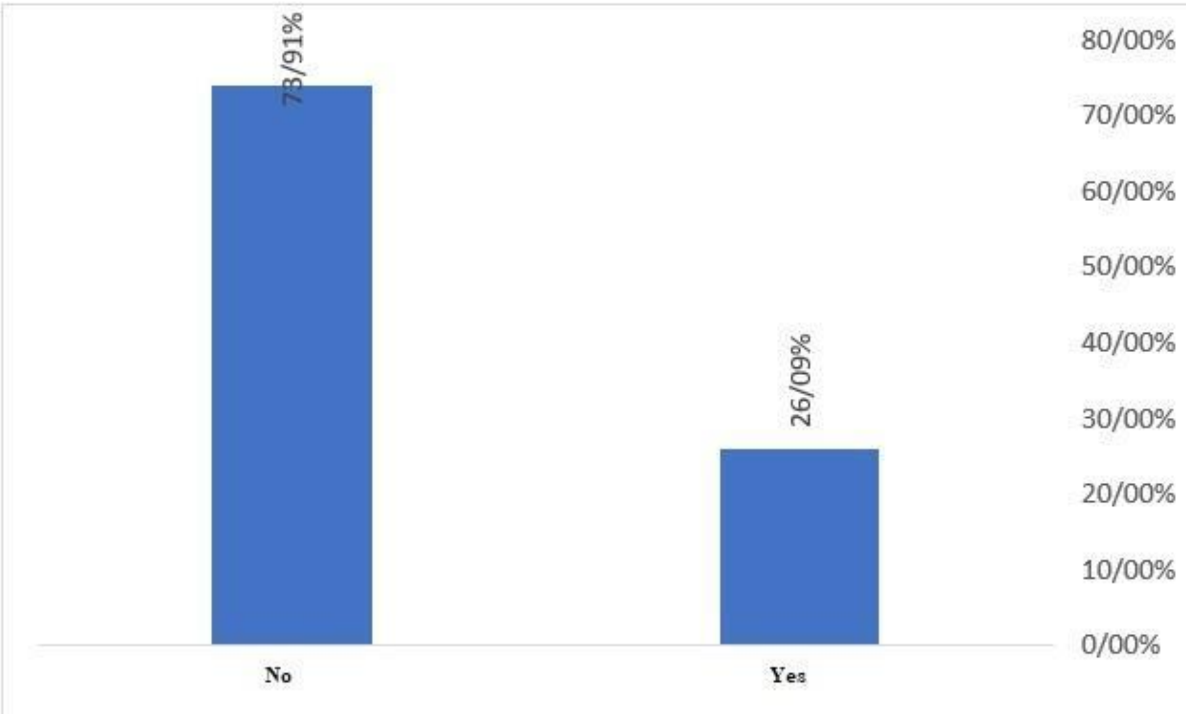
7) The university we collaborate with has a protocol for managing R&D initiatives in the industry.

Thirty-four point seventy-six percent of respondents feel that the partner university has a system for managing industry research and development initiatives. According to 21.74% of respondents, the partner institution lacks a system to manage research and development initiatives in the industrial sector. Forty-three point forty-eight percent of respondents had no opinion.



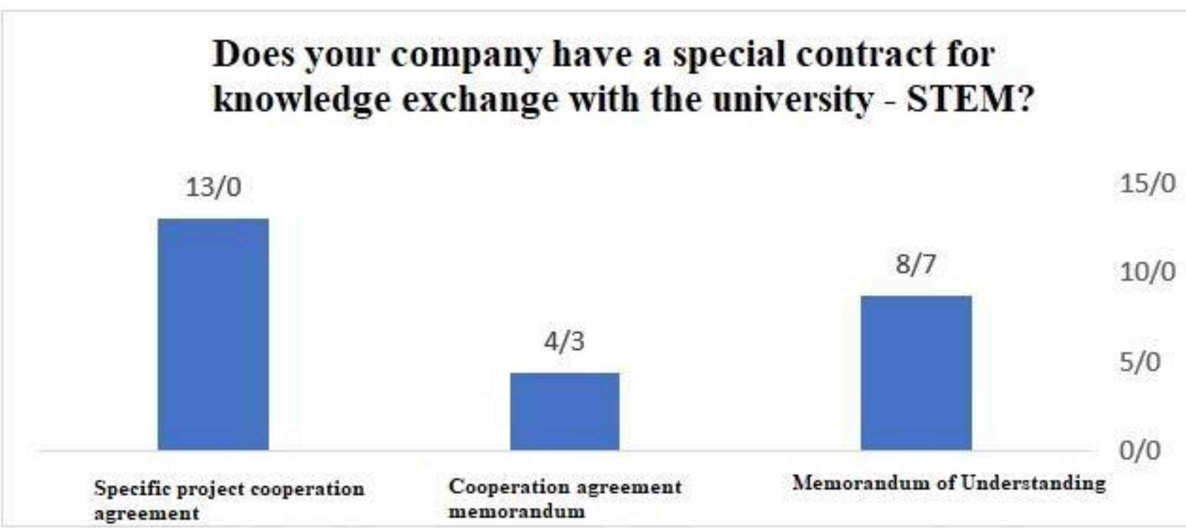
8) Does your company have a particular agreement with the university for information exchange?

Twenty-six point zero-nine percent of respondents said that the firm has a knowledge exchange agreement with the university, while 73.91 percent reported that the company does not have a knowledge exchange agreement with the university.



9) Select its type:

Knowledge exchange agreements between companies and universities take the form of memorandums in 8.7% of cases, formal collaboration agreements in 4.3% of cases, and project agreements in 13% of cases.

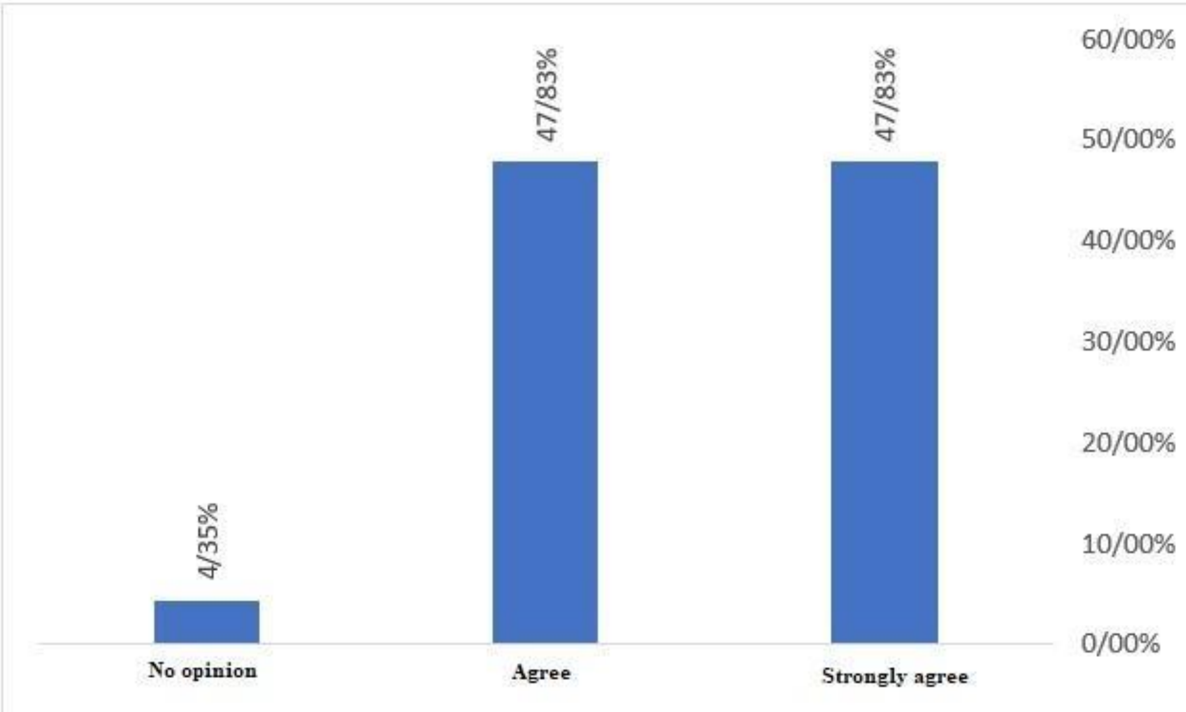


10) There is a gap between students' theoretical and practical knowledge, in my opinion.

• Forty-seven point eighty-three percent of responders agree wholeheartedly with this proposition.

• Forty-seven point eighty-three percent of respondents agree with this proposition.

• Four point thirty-five percent of respondents had no opinion about this proposition.

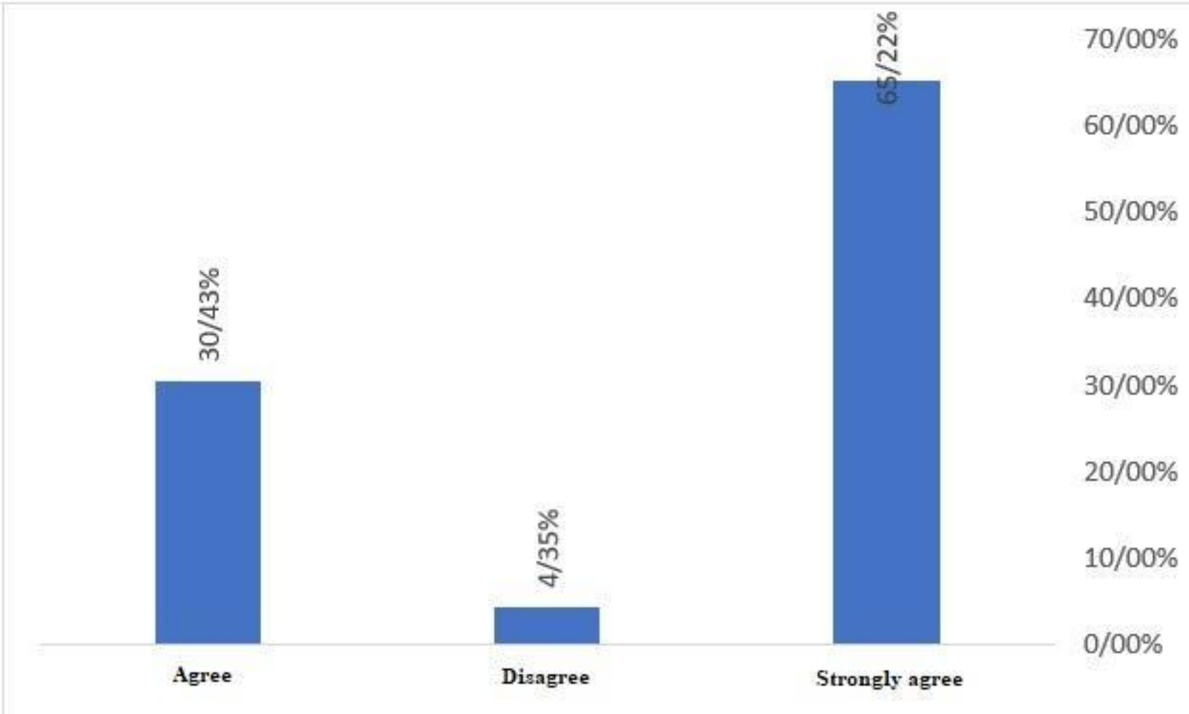


11) After graduation, newly-hired engineers must get practical training.

• This proposition is highly supported by 65.22% of respondents.

• This proposition is supported by 30.43% of respondents.

• This proposition is opposed by 4.35% of respondents.

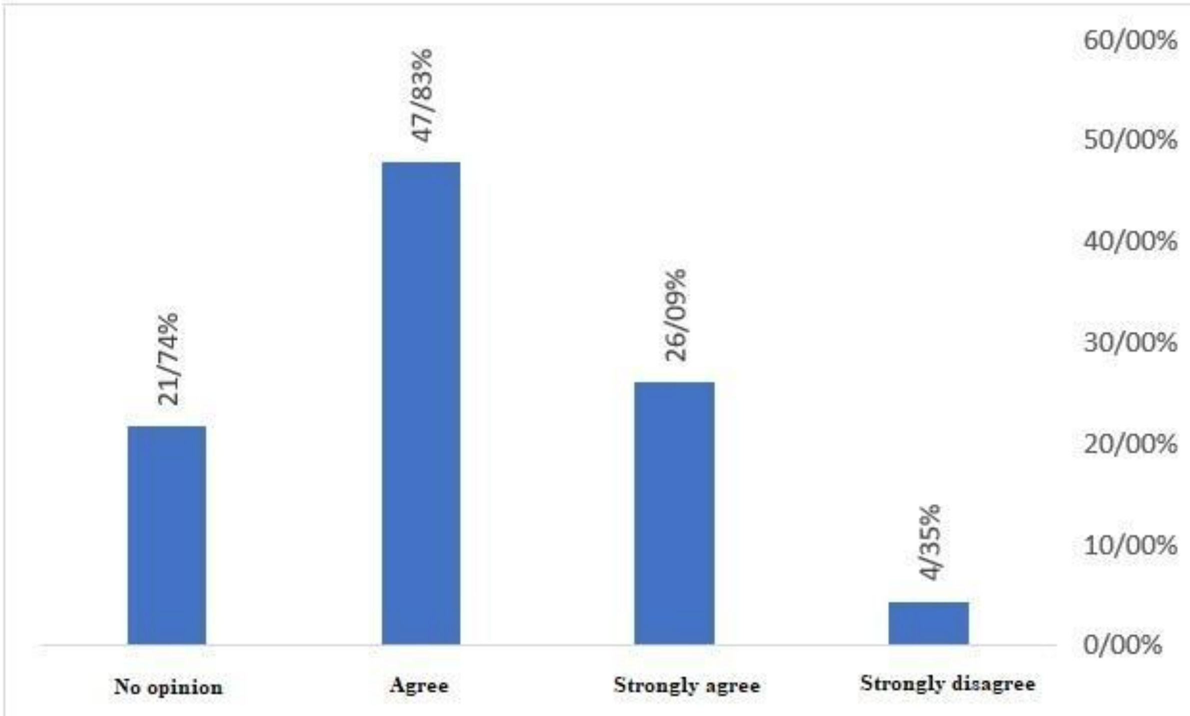


12) While academics may collaborate extensively with industry in research, they are less interested in doing so in education.

• According to 73.92% of respondents, there is less interest in combining education with industry.

• In this case, 21.74% of respondents are undecided.

• This proposition is opposed by 4.35% of respondents.

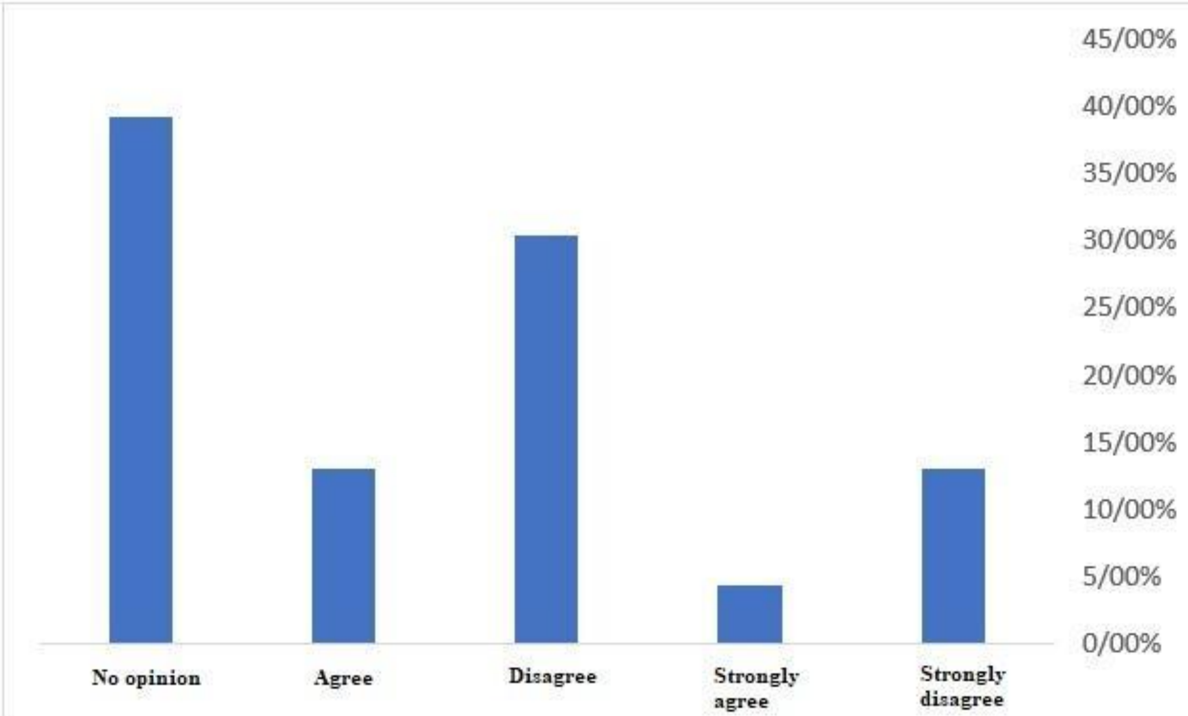


13) Academics and entrepreneurs with networking mindsets may develop productive industrial interactions.

• Academics with a networking mindset and entrepreneurs developing efficient industrial relations are not theoretically important to 39.13% of respondents.

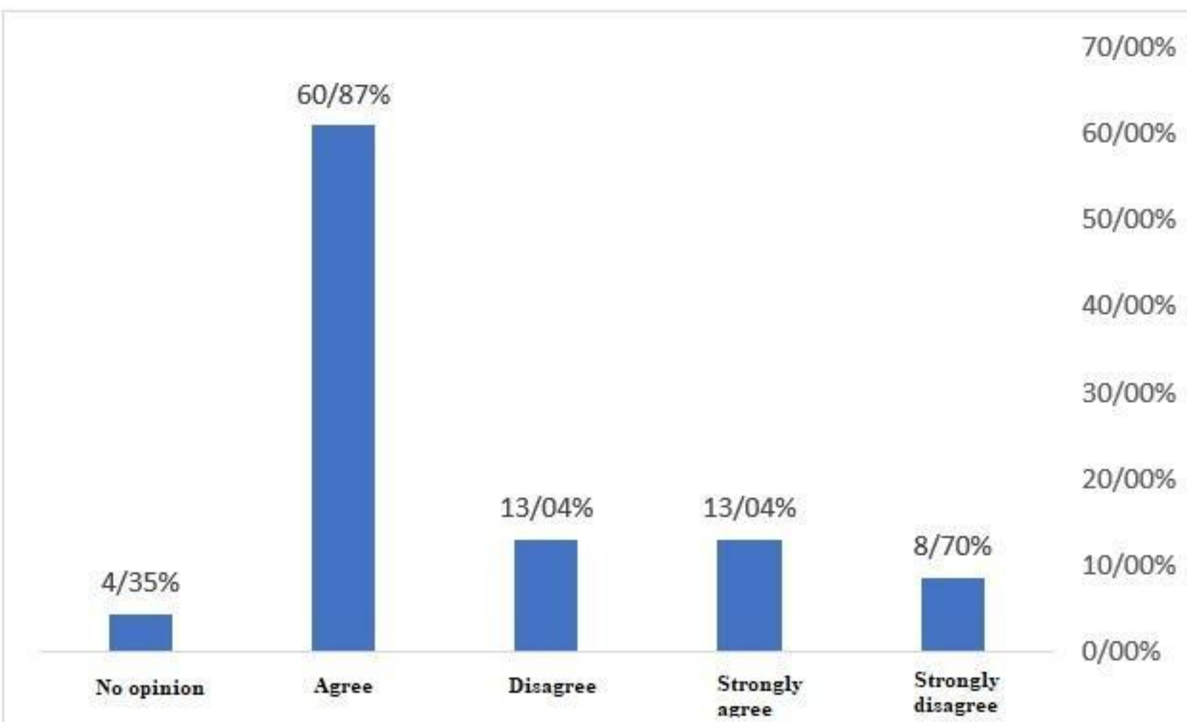
• This proposition is opposed by 43.47%.

• Additionally, 17.39% agree with this proposition.



14) Engineering graduates lack workplace skills such as problem-solving.

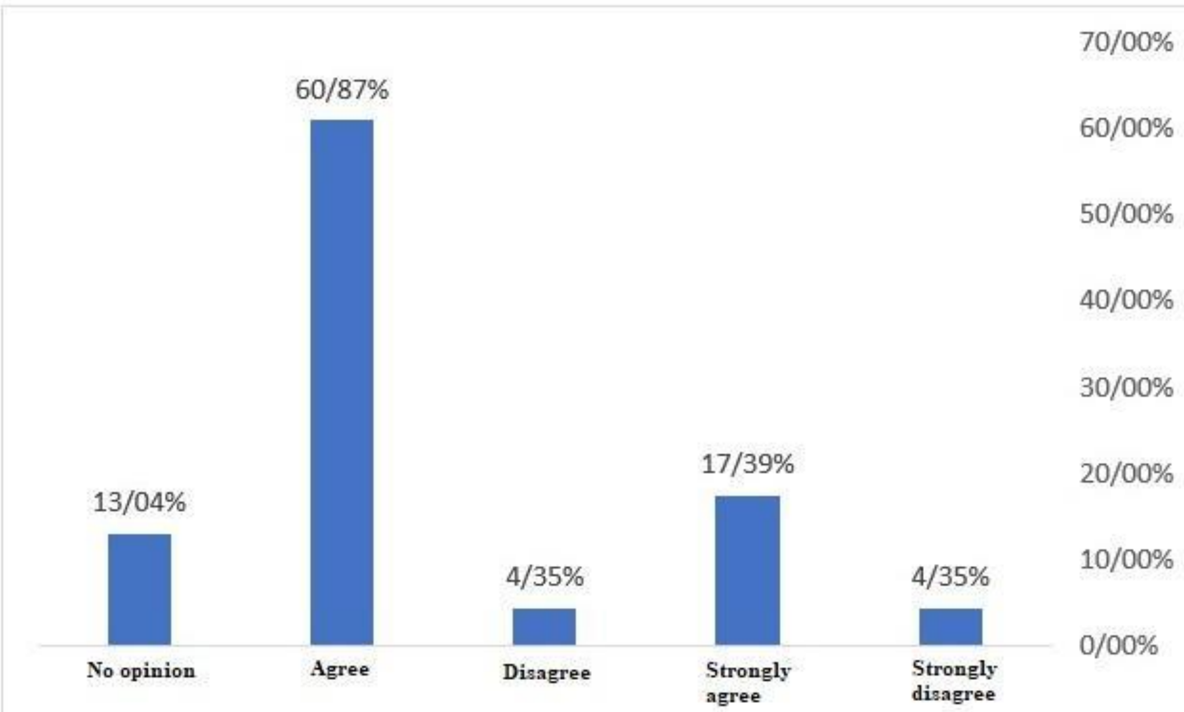
Seventy-three point ninety-one percent of respondents say that engineering graduates lack job abilities such as problem-solving. 21.74 percent of respondents oppose this remark, while 4.35% have no opinion.



15) Engineering graduates with expertise in technology-enhanced learning (TEL) have improved teamwork and communication abilities.

• Engineering graduates with technology-enhanced learning (TEL) experience had improved collaboration, teamwork, and communication skills, according to 78.26% of respondents.

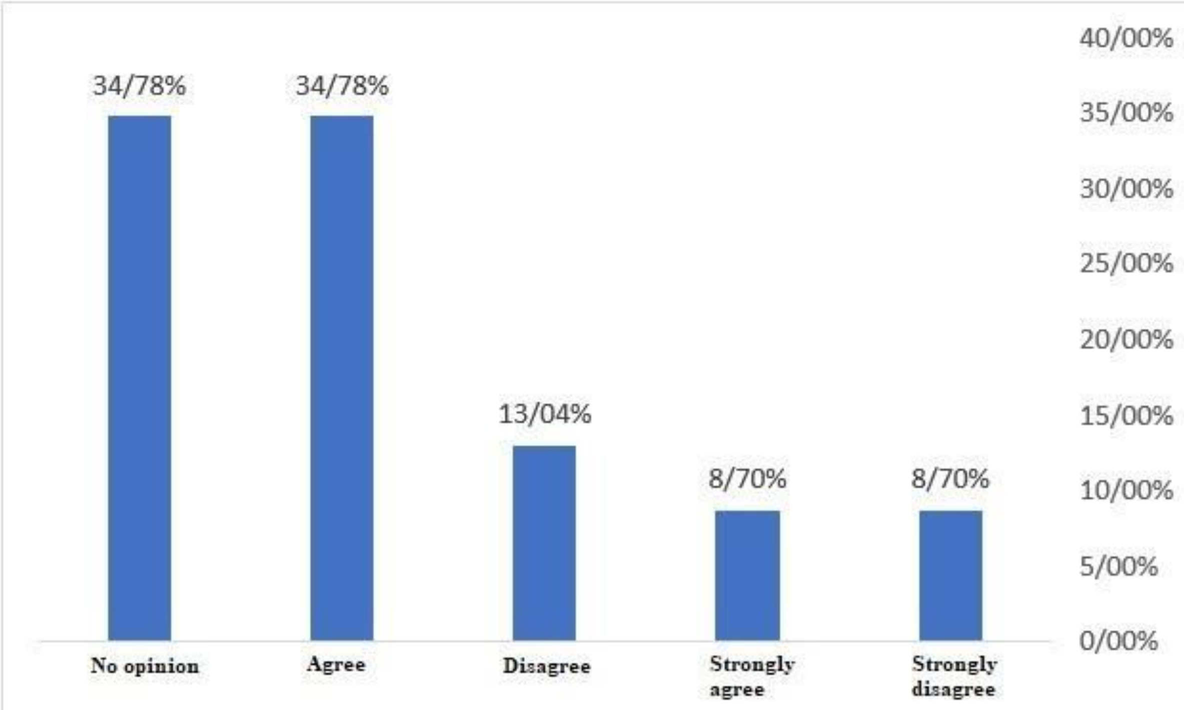
• Eight point seven percent are opposed to this remark, while 13.04% have no opinion.



16) We are satisfied with the engineering interns' performance.

Forty-three point forty-eight percent of respondents are happy with the engineering interns' performance at this company. While 21.74% of respondents are unsatisfied with trainee students' performance.

Additionally, 34.78% of respondents had no opinion on the matter.

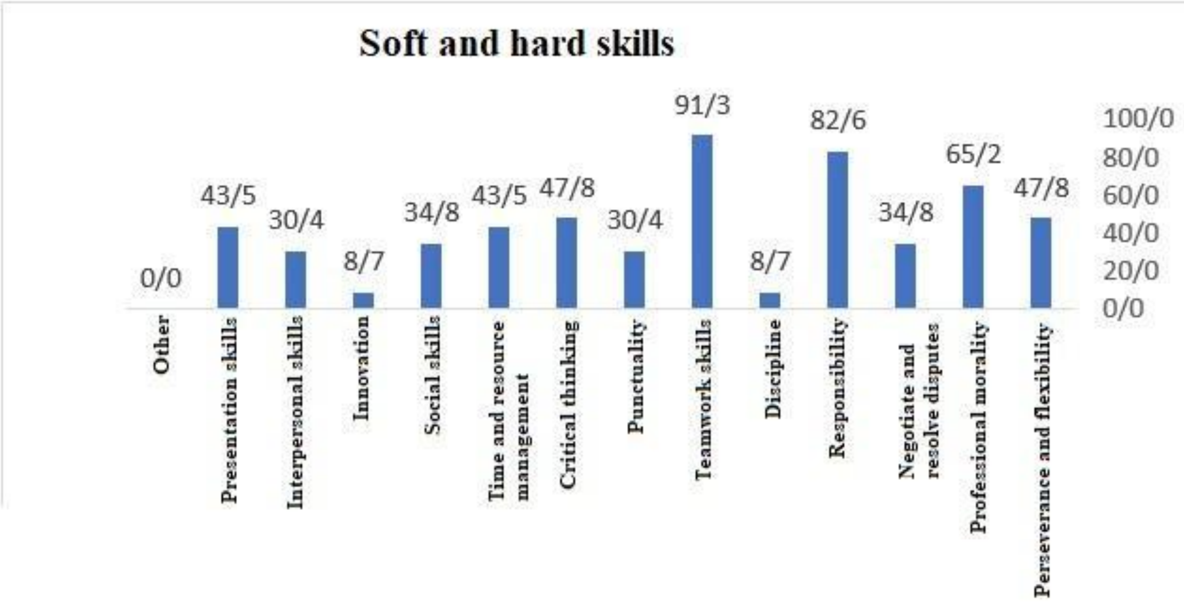


7.2.8) The subject of Discussion: Soft & Hard Skill

17) Soft skills are necessary for students to perform well in the workplace. Which soft skills, in your opinion, should the university focus on the most?

The skills that participants deemed most important for the job are:

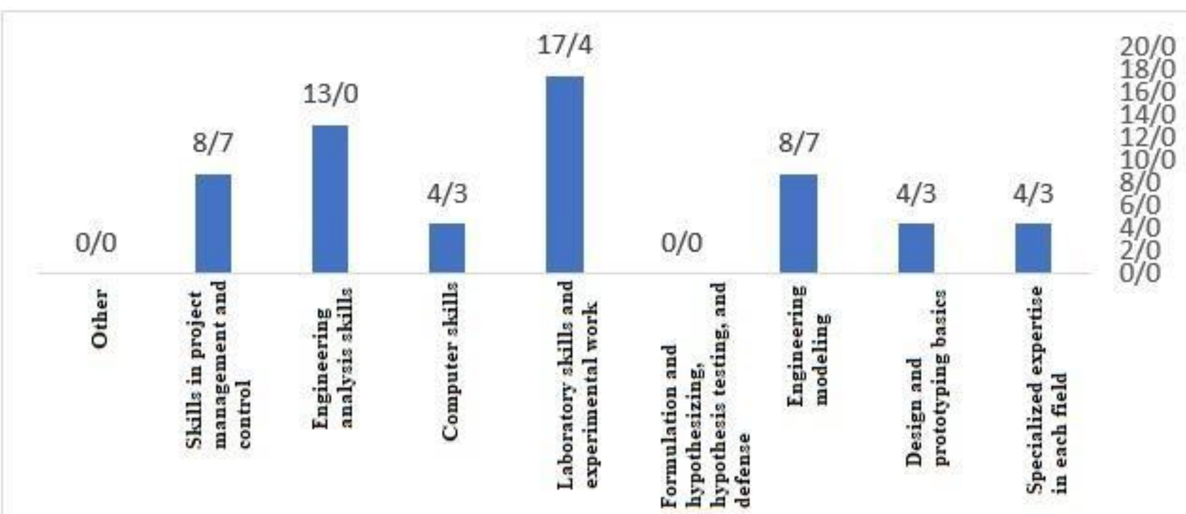
Teamwork skills, responsibility and accountability, professional ethics, perseverance and flexibility, critical thinking, time and resource management, presentation skills, negotiation and dispute resolution, social skills, interpersonal skills, and punctuality



18) Hard skills are students' fundamental abilities to complete a task. Which skills do students struggle with the most, and do you spend a lot of time and money educating new recruits on these skills?

The following are the challenging skills that students will need to complete the task:

Experimental and laboratory work skills, engineering analysis skills, project management and control skills, engineering modeling, computer skills, design and prototyping skills, and specialized skills in each field

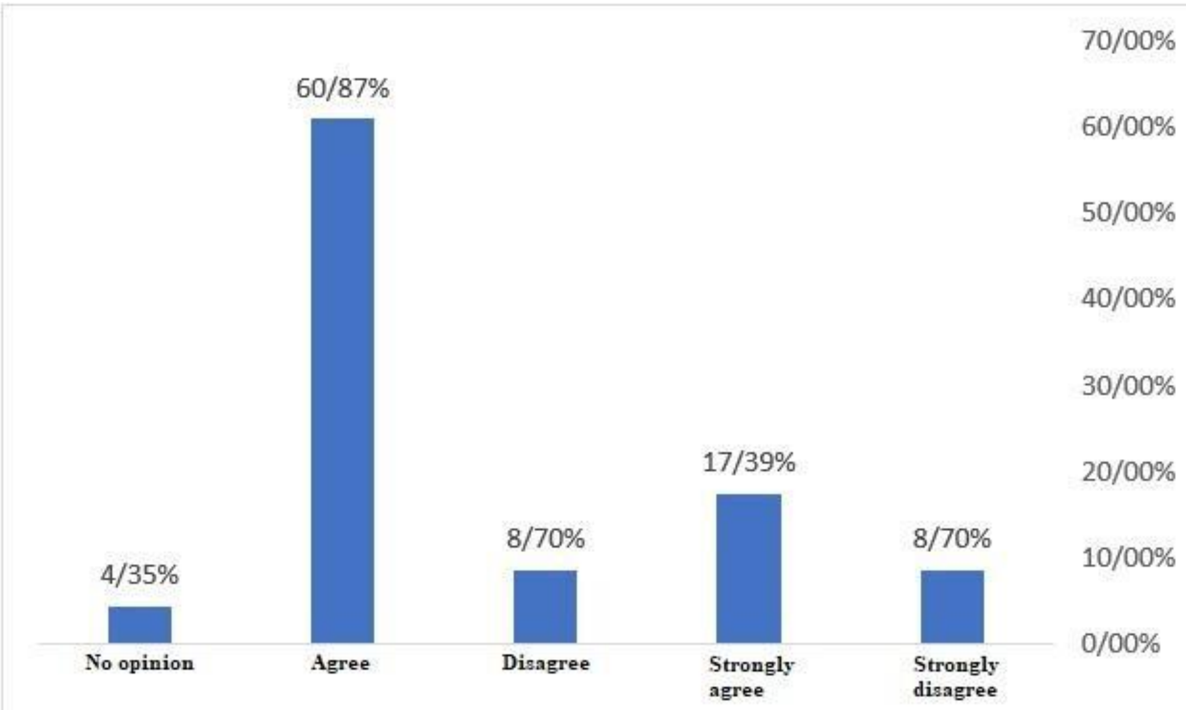


19) At our company, you may develop vital engineering skills that you wouldn't have learned at university.

• Around 78.26% of respondents think that corporations provide an opportunity to gain critical engineering skills that aren't taught at universities.

• This proposition is opposed by 17.4% of participants.

• Approximately 4.35 percent of responders had no opinion.



Is there anything left unsaid concerning the questionnaire's content that you want to discuss?

Please put down your information if you like to participate in the following phases' interview (mobile phone number or telegram ID).

7.3) Discussion:

The questions on the company questionnaire may be divided into four groups.

1. The first category consists of demographic questions about respondents' personal and occupational characteristics.
2. Questions about the scientific and professional assessment of STEM students and graduates comprise the second category.
3. The third category consists of questions about evaluating the university's relationship with businesses and their collaboration.

4. The fourth category contains questions that test students' soft and hard skills.

7.3.1) Demographic information:

This survey was completed by representatives of 23 enterprises and organizations collaborating with the institution. The majority of those who took part in this survey held management or expert positions within their organizations. The majority of the participants in this survey (19 people) were engineering grads, while some were humanities graduates. The level of education of the participants was determined by the frequency of bachelor's, master's, and doctorate degrees, in that order. In addition, the participants had an average of 15 years of job experience.

7.3.2) Academic and professional assessment of STEM Students:

The following is how the participants evaluated the academic standing of STEM students and graduates:

- Around 70% of respondents said that top engineers and corporate leaders grasped the fundamentals of STEM.
- Nearly half of the respondents (more than 40%) said the company's pupils knew fundamental STEM concepts.
- Regarding the effect of engineers' knowledge of STEM-based information on their tasks, however, the survey participants believed that engineers' knowledge of STEM-based information is required to perform their functions and lead to better decisions when performing their work. Consequently, project management and planning are better in terms of time and money, intra-group interactions are improved, the power of comprehending the issue is raised, and, as a result, the stated objectives are met with better outcomes.

The following are the most relevant outcomes from the discussion of the participants' evaluations in the survey on the job situation of STEM students and graduates:

- The great majority of respondents (more than 90%) believe there is a gap between pupils' academic and practical understanding.
- The majority of respondents (over 90%) agreed that freshly recruited engineers need hands-on training.
- The majority of respondents (over 70%) stated that engineering graduates lacked workplace-relevant abilities, such as problem-solving.

- The significant majority of respondents (more than 70%) claimed that engineering graduates with TEL-based learning experience had superior collaboration, teamwork, and communication abilities.
- Nearly half of the respondents (more than 40%) said they are pleased with the performance of engineering interns.

7.3.3) Assessment of University-Business Relationship:

The following are some of the findings from the participants' assessments of the university-business relationship and how they collaborate:

- Over 60% of respondents said the university collaborates with companies to educate students on technical skills.
- The participants ranked the impediments to business-university collaboration in the following order of importance:

1. There is little incentive to contact universities in the company.
2. There are often insufficient finances to carry out such communications.
3. We do not know who to reach out to for collaboration.
4. We are unfamiliar with our organization's atmosphere, space, and university trends.
5. The company's and university's timetables are incompatible.
6. We are unaware of any communication options with the university.

- In addition, the following were the participants' additional remarks on the impediments to collaboration with the university:
    - Universities often teach theoretical courses and give degrees, and their training is not aligned with industry standards.
    - Company bosses' ignorance of the necessity to collaborate with universities
    - Lack of corporate managers' confidence in the university
    - Absence of explicit company directives to work with the university
    - Failing to promote firms to the institution to increase communication
    - Companies and colleges have distinct objectives when dealing with one another. Economic value creation is the objective of businesses, whereas scientific value creation is the objective of universities.

- Participants in the survey recognized the following items as types of collaboration between the company and the university:

1. University-based job search or internship/lecture for senior engineers and managers
2. Execution of the project
3. Conducting collaborative dissertations with university departments
4. Visiting the company

- More than 40% of respondents did not remark on the need to handle research and development initiatives in the university's industrial sector. This might indicate that the university's method for assessing industry-related research initiatives is unclear.
- Furthermore, most participants (more than 70%) reported that the enterprise had no formal knowledge exchange agreement with the university. The following is the sequence in which companies who have a knowledge exchange agreement with the university have launched it:

1. Parties' formal cooperation agreement, project contract, memorandum
2. The great majority of respondents (more than 70%) also stated that academic professionals in education were less interested in engaging with industry.
3. Finally, Over 40% of respondents claimed that academics lack the networked and entrepreneurial attitude necessary to build productive relationships with industry.

7.3.4) Soft & Hard Skill of Students:

From the perspective of survey participants, the following are the top soft skills necessary for students to perform well in the workplace:

1. Teamwork skills
2. Responsibility and accountability
3. Professional ethics
4. Perseverance and flexibility / critical thinking
5. Time management and resources/presentation skills
6. Negotiation and dispute resolution / social skills
7. Interpersonal skills/timing

On the other hand, according to survey participants, students have greater trouble with the following challenging abilities in the order listed, and a lot of time and money is spent training them into new recruits.

1. Expertise in experimental and laboratory work
2. Skills in engineering analysis
3. Skills in project management and control/engineering modeling
4. Computer skills / basic design and prototyping skills / specific skills in each field

- In addition, the significant majority of respondents (over 70%) claimed that enterprises provide possibilities to develop essential engineering skills not taught in university.

8. Conclusion

Performed surveys in Iranian market and within Iranian companies are indicating that higher education system in engineering and science sectors, requires significant modifications and improvements. There are considerable deficiencies and companies believe that there is significant gap between what they need and what is taught to students.

In addition to deficiencies related to technical issues, which has been mentioned by companies, there are other skills that should receive more attentions. Skills related to teamwork, problem solving, responsibility, accountability, flexibility, etc. (addressed in previous sections) are extremely needed by companies but they are not developed by universities.

Limited collaborations and contacts between companies and universities indicate that companies and universities are not aware of weaknesses, requirements and strengths of other side and they are working almost separately.

References

Gonzalez, J., Wagenaar, R. (eds.). (2008). Universities' contribution to the B ologna process. An introduction. Bilbao: Publicaciones de la Universidad de Deusto.

Hakky, R. (2016). Improving Basic Design Courses through Competences of Tuning MEDA. Tuning Journal for Higher Education, 4(1), 21–42.

Lamboley, J.-L. (2017). Tuning History: The French Experience. Arts and Humanities in Higher Education: An International Journal of Theory, Research and Practice, 16(4), 371–384.

Lunev, A., Petrova, I., & Zaripova, V. (2013). Competency-Based Models of Learning for Engineers: A Comparison. European Journal of Engineering

Education, 38(5), 543–555.

Sackey, S. M., Ancha, V. R., Chinyama, M. P. M., Onana, C. A., Danwe, R., Megahed, M. M., Delpouve, B., Chama, S., Mahomed, N., Kayibanda, V., Mukeba Yakasham, L. K., & Müller, A. (2014). Collaborative Meta-Profile Development to Harmonise Mechanical Engineering Education in Africa. Tuning Journal for Higher Education, 2(1), 161–178.

Želvys, R., & Akzholova, A. (2016). Problems of Introducing a Competence-based Learning within the Context of Bologna Process. Pedagogy Studies / Pedagogika, 121(1), 187–197. https://doi.org/10.15823/p.2016.13

Resources

Global People, Measuring and Comparing Achievements of Learning Outcomes in Higher Education in Europe (CALOHEE), https://www.calohee.eu/

Time to Assess Learning Outcomes in E-Learning (TALOE), https://taloe.up.pt/

Program for International Student Assessment (PISA), https://www.oecd.org/pisa/

Tools for Enhancing and Assessing the Value of International Experience for Engineers (TAVIE), https://blogs.upm.es/tavie/whats-ta-vie/