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Mangné Kardos Zita

Measuring Career Orientation Activities and Training Efficiency in Technical Higher Education

Supervisor:

Dr. Vámosi Tamás

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My doctoral dissertation is the result of several years of research. I have overcome many difficulties in my research journey, starting from selecting the topic, exploring and processing relevant Hungarian and international literature, determining the methodology and formulating hypotheses, and finally conducting and processing the research. Although the doctoral research is an independent endeavor, I would like to acknowledge that this dissertation could not have been completed without the invaluable help of my supervisor, family, colleagues, and the students who participated in the research.

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1. Introduction – Research Background

"If you choose a job you love, you'll never have to work a day in your life," wrote Confucius, the ancient Chinese philosopher. Nothing proves how right this wise man was, who lived thousands of years ago, better than the fact that in the 21st- century society, in the knowledge-based economy, people's active career paths have come into the spotlight.

2. Summary of the Dissertation Topic

The second half of the 20th century saw intensified competition among economic players due to explosive globalization processes in the world economy. The rapid rise of information and communication technologies (ICT) marked the beginning of the third industrial revolution, leading to structural changes in the economy. The emergence and proliferation of computers, programmable controls, automation in the manufacturing industry, computer networks, and robotics increased productivity, efficiency, and the division of labor. The rapid development of new technologies accelerated internationalization and the flow of information within and between transnational companies. By the turn of the millennium, the traditional economy had transformed into an "information economy," and society into an "information society," marking the beginning of the fourth industrial revolution (Castells, 2005). In the employment sector, a significant shift towards tertiarization was observed (Csugány, 2019). The added value of services increased due to the productivity of knowledge-based services that require highly qualified labor (Szalavetz, 2008). In this new economic environment, standardized mass-produced goods cannot generate extra income, and the global markets created by mass production are being replaced by those that allow for mass customization of products, making this growing market share increasingly dependent on satisfying different consumer preferences (Erdős, 2018).

Since then, development has been unstoppable and growing exponentially. Although Industry 3.0 is still present today and many businesses are still operating at this level of development, the beginning of Industry 4.0 was publicly announced at the Hannover Industrial Fair in 2011. Industry 4.0 essentially marked the emergence of new technologies and business models (such as the transition from mass production to mass customization) in the industrial sector (Benitez, 2019). At the same time, sustainability is receiving increasing emphasis, which has been one of the world's greatest challenges since the first industrial

revolution, but in its current interpretation, it is not exclusively limited to environmental protection, but also includes the preservation of economic and social resources (Beier, Niehoff, Ziems, & Xue, 2017). In fact, to simplify somewhat, Industry 4.0 involves taking Industry 3.0 to a higher level. On the one hand, the digitization and optimization of processes are achieved with the prerequisite of real-time availability of information. On the other hand, the value chain is raised to a new level throughout the entire life cycle of products, fulfilling horizontal and vertical integration, with smart products and human beings at the center (Szóka, 2018).

The impact of technological development is fundamentally changing economic processes in the labor market, affecting the relationship between companies and workers. As a result, the content and format of work are being realigned, with new demands being placed on workers due to constant pressure for innovation. In addition to new skills and specialized knowledge, the ability to promote worker flexibility and adaptation in unpredictable and constantly changing situations has become crucial. Although labor has always played a prominent role in economic processes as a production factor, its role is being reconfigured due to technological changes. With new technologies, human labor can be partially or completely replaced, leading to the disappearance of some jobs and occupations. However, there are also huge opportunities alongside the risks. There is a growing need for the creativity and innovation potential of human resources, which is likely to lead to the creation of new, previously non-existent jobs (Szalavetz, 2018). Moreover, technological changes have led to more flexible, classically atypical forms of employment, such as telecommuting, fixed-term employment, or part-time employment. Even more "atypical" platform-based work is becoming prominent, where the service provider connects with the client through a digital platform and provides various services through these interfaces (Rácz, 2021). It has become an essential employer expectation that workers demonstrate flexible adaptability, autonomy, responsibility, and a self-sustaining attitude. To maintain competitiveness in the labor market and shape individual opportunities, it is essential to utilize lifelong learning as widely and consciously as possible (Vámosi T., 2013).

Although knowledge has always been a prerequisite for development, upon which civilized societies have been building since ancient times, it now seems that it is needed from a very different perspective and on a much larger scale. The global market is extremely complex, but open, liberal, and deregulated, and the speed of business transactions is ensured by

advanced information and communication technologies. The innovative and intangible dimensions of goods and services - those that represent added value or "smart" features - provide access to competitive advantage. As a result, products, services, and the processes necessary for their production and delivery must become more knowledge-intensive in today's economy. Labor-intensive industries are being replaced by knowledge-intensive industries, and thus, skilled labor will become knowledge-based labor, who are also key players in modern economies. However, the knowledge expected of knowledge workers is not merely theoretical, but encompasses a diverse range of knowledge, skills, abilities, and attitudes that enable them to analyze and solve complex problems, as well as to create new ones (Nyhan, 2002).

As a result, today's labor market puts increasing emphasis on informally acquired skills, in addition to formal qualifications. This includes skills such as proficiency in foreign languages, knowledge, and application of modern technology, and cognitive and social skills (Vámosi T., 2013). The importance of the latter has become even more pronounced in recent years, as they not only facilitate an individual's social integration but also enhance flexible and cooperative work in the workplace. Furthermore, these are the skills that make human labor irreplaceable.

The above changes must also be reflected in the education system, as the competencies expected and signaled by the economic sphere indicate that theoretical knowledge is no longer sufficient, and the relevance of practical knowledge is more important than ever. Higher education is a strategically significant resource in the knowledge economy as it contributes to the expansion of human capital at both the national and regional levels, creates jobs, builds communities, transfers cultural capital, and serves the development of the given region (Hudson, 2011). In this regard, higher education has a triple function of education, research, and economic and social responsibility. As educational institutions, universities are knowledge distributors through their teaching function. As research and development institutions, they create new knowledge and become constant participants in the innovation process. Through their market-driven competency building activities, they collaborate with external companies and can launch spin-off ventures, ultimately contributing significantly to increasing the competitiveness of the local economy (Erdős, 2018).

Robust development has highlighted the need to acquire and apply skills in mathematics, sciences, engineering, and information technology. To understand and manage the benefits

and challenges of globalization and the knowledge economy, and to pursue a successful career path, it is essential to develop STEM skills from the elementary level, as these areas strengthen creativity, innovation, collaborative competence, critical thinking, and problem-solving. However, there is a great need for highly qualified professionals in these fields (primarily technical and IT) to meet the growing demands of the economy, according to the Ministry of Human Resources (Emberi Erőforrások Minisztériuma, 2016). STEM is an acronym for Science, Technology, Engineering, and Mathematics, which are areas on which industry and the economy heavily rely. There is also a great need for graduates and technicians in these fields for scientific research and development. Ensuring a supply of talent in STEM fields, particularly in IT, is the key to the country's competitiveness, and the pay for mid- and senior-level professionals in these fields is significantly higher than in other fields. Despite this, the number of applicants to STEM fields is not increasing, with low application rates and no real competition for admission. The number of graduates is significantly affected by high dropout rates, as well as those who remain in the system beyond the planned training period (Állami Számvevőszék, 2021). The greater participation of women could somewhat compensate for the shortage of applicants in these fields, but there are still many obstacles in their path to making these programs popular for them.

Career choices, especially those related to higher education, represent a significant milestone in the lives of young individuals. Although the linear career path is a thing of the past and individuals are now expected to learn and try out new professions throughout their professional lives or embark on shorter and longer career paths, the decision to choose a particular career still have a defining impact on an individual's life trajectory.

Some people know what they want to achieve in life from a very young age, with clear goals and a consistent path. However, this is only true for a small percentage of people, as preferences constantly change, people learn and experience new things while growing up and becoming more mature. Generally, people are not aware of their own abilities, skills, attitudes, strengths, weaknesses, and their interests are diverse. Therefore, creating a career path that matches their interests and abilities poses a great challenge for them. For many individuals, the decision to pursue a particular career path comes too soon. Later, they may not reassess their choice, and even with a diploma in hand, they may question whether they have started on the right path (Lukács É. F., 2012). Career development is a conscious and ongoing process of building and managing one’s learning, work, and all other areas of life,

with the aim of selecting the right profession. However, in addition to proper self-assessment, a thorough and up-to-date understanding of the education and training market, as well as the labor market, is necessary.

Effective career orientation started in elementary school can greatly reduce the likelihood of wrong career choices and school dropout. However, career orientation is also of paramount importance in active adulthood because the current world is constantly changing, full of uncertainty, ambiguities, and is extremely complex. Professions that exist today may disappear in a few years, and new ones may take their place, so individuals must constantly update their acquired knowledge through various retraining and further education opportunities. Lifelong career guidance, therefore, supports individuals in making their active career path successful.

Scientific and technological advancements have made it necessary for education to undergo a paradigm shift, which requires the coordinated movement of multiple segments. The process of content modernization, or the range of lexical knowledge that needs to be acquired, has changed, with an increasing emphasis on the need for modern, practice-oriented curricula related to specialized knowledge. Basic expectations now include language skills, communication, information and communication technology, and management knowledge. Furthermore, students must develop skills expected by the labor market, such as creativity, teamwork, problem solving, risk-taking, emotional intelligence, motivation, and entrepreneurship. It is important for individuals to understand the necessity for continuous self-improvement, which is a requirement of lifelong learning. The knowledge to be acquired should include the development of complex thinking, interdisciplinary perspectives, social responsibility, and sustainable development. To produce creative and innovative professionals for the job market, opportunities must be created for intensive collaboration between teachers and students, such as joint research, development, and other educational tasks (e.g., student teaching or demonstrating assignments). The presence of various student communities can significantly enhance student motivation, not to mention their role in supporting learning.

In addition to content development, educational efficiency can be improved through the development of teaching methodologies. The era of traditional frontal education has already passed, although most educational institutions still function this way. To promote student activity, various new teaching methodologies are available, such as the flipped classroom

method. The range of digital opportunities is increasingly being incorporated into educational technology, providing many opportunities for development. Non-traditional teaching methods proved extremely useful during the Covid-19 pandemic for maintaining the continuity of education, and it would be advisable to consider their further application within a blended teaching approach. Finally, education must ensure equal opportunities, overcome disadvantageous situations, and nurture talent (Török, 2018)."

I have chosen to investigate the career orientation of students interested in technical higher education and examine the effectiveness of educational and training methods based on the opinions of students participating in technical higher education programs for my dissertation and research area, due to the relevance and timeliness of these issues. Given the vast knowledge and diversity of the STEM field, I have narrowed down the research area to technical higher education.

3. Research Objectives and Research Questions

The complex ideas outlined above were approached from two directions in order to reveal the problems they presented. Firstly, to ensure that the vocational choices of high school seniors applying to technical higher education align with their personality type, they must meet two conditions:

• on the one hand, they must be aware of their own areas of interest, personality traits, and have a good understanding of the educational and job market opportunities provided through effective career guidance, which should start in elementary school;

• on the other hand, they must be motivated enough to choose their future direction of study based on their own ideas.

The second study targeted students who were already enrolled in technical higher education programs during the Covid-19 pandemic outbreak in March 2020. The closures, minimal personal contacts, and synchronous online learning caused learning difficulties for many students, which were exacerbated by inadequate teaching methods.

Thus, the research objectives were formulated in two directions:

Research objective No. 1.: to understand the vocational and institutional motivations of high school seniors who plan to pursue technical higher education, and to explore whether young people are preparing for a career that matches their interests, and what their expectations are for their future job.

The first research objective was examined through the following main questions:

• What factors (external and internal) motivate young people to study in technical fields?
• Do they choose the program that matches their primary and secondary personality traits?
• What factors do they consider when selecting an institution?
• What values do they consider when thinking about their future work?

Research objective No.2.: to understand the changes in motivation, self-efficacy, knowledge acquisition, and the implementation of practical and laboratory classes in strongly practice-oriented engineering education during the synchronous online learning period from the perspective of students, as well as to identify the reasons for satisfaction or dissatisfaction with synchronous online education and explore solutions.

The second research objective was examined based on the following main questions:

• To what extent and in what direction did the changed training conditions affect the students' motivation, knowledge acquisition, self-esteem, and self-efficacy? Did the online student platforms and pre-prepared educational materials help with knowledge sharing and acquisition?
• Could the education meet the expectations of synchronous remote course delivery through the online platforms, and what were the positives and negatives?
• What were the student experiences related to the implementation of practical and laboratory classes?

4. Research Hypotheses

In the previous section, I formulated six hypotheses to examine the research objectives and research questions outlined as follows:

I assume that high school seniors preparing for technical fields primarily make their career choices based on their interests. (H1)

I assume that in the case of individuals interested in technical fields, personality traits that arise from the specific job characteristics of technical work will be the most common. (H2)

I assume that creating a personal vision is always easier and more nuanced when we make the information related to the profession, its content, and the nature of the work experience centered. (H3)

I assume that in the case of girls, the decision to choose technical fields will lean towards work activities that require creative and artistic competencies. (H4)

I assume that individuals with a stronger internal commitment to their studies were more flexible in applying the methodological changes in education that were forced by environmental circumstances in a short period of time. (H5)

I assume that the student's self-assertiveness greatly influences the knowledge transfer processes, and the informal spaces established and maintained by the students play a key role in both information sharing and community needs and feedback. (H6)

5. Research Methods

To achieve my research goals and validate my preliminary assumptions, I conducted primary and secondary research.

The secondary research involved processing relevant international and Hungarian literature. During this process, I reviewed literature databases, books, journals, and online sources, which enabled me to outline the theories and pillars of career orientation, clarify conceptual and interpretive frameworks, and present a detailed overview of Industry 4.0 and its relevant areas of impact. Accordingly, I examined the educational and training sector, the labor market, the fields of STEM (mathematics, technology, engineering, and informatics), particularly higher technical education, and women's attachment to STEM fields.

The outcomes of secondary research must thoroughly support the structure, methods, and results of empirical research. This forms the second main part of my thesis. Both primary research studies were conducted using quantitative data collection and questionnaire surveys, which are the most common primary information gathering techniques in sociology. The questionnaire survey had several advantages: Firstly, due to pandemic-related closures, I was only able to contact students through online platforms. Secondly, this method allowed for large-scale sampling, and the surveys were conducted relatively quickly. The first questionnaire contained only closed questions, while the second questionnaire included both closed and open-ended questions. For closed questions, I requested respondents to choose from predefined options, and for attitude surveys, I requested respondents to indicate their preferences on a five-point Likert scale. This allowed me to quantify the responses and enabled me to analyze the data and uncover relationships between the variables studied. I

categorized the responses to open-ended questions into thematic categories, allowing me to establish correlations. It is important to note that individual responses were very diverse, so in many cases, the categories overlapped, making them not entirely exclusive.

In addition to assessing the socio-economic status, career and institution selection motivations of high school seniors preparing for technical higher education in the first questionnaire, I also conducted a comparative study of interest, professional environment, and career knowledge production areas using two questionnaires frequently used in career orientation activities.

For the first study, the total population size was 580, and the sample size (N) was 146, of which 95 were male and 51 were female. Sampling was random and voluntary, with 25% of participants taking part, making it non- representative. Nevertheless, since all respondents were interested in the STEM fields of study, it is suitable for analyzing the motivations, areas of interest, and value preferences of those intending to continue their studies in the given institution. Data collection took place at two times in December 2021 and January 2022. In the data analysis, I used the following statistical methods:

• Univariate analyses (mean, mode, median, standard deviation, lower and upper quartiles)

• Association tests (Chi-squared test, Pearson correlation analysis)

The second questionnaire was sent out through the Neptun system to active Hungarian and foreign students in the technical programs at the University of Pécs during the 2nd semester of the 2020/2021 academic year, both in full-time and correspondence courses. Participation was voluntary. The sample size (N) was 398, of which 346 were Hungarian students and 52 were foreign students. Among the foreign students, there were 2 from Brazil, 1 from Cambodia, 6 from China, 1 from Croatia, 3 from Egypt, 1 from France, 1 from Georgia, 1 from Germany, 1 from Hungary-Israel, 4 from India, 7 from Jordan, 1 from Kazakhstan, 2 from Kenya, 1 from Macedonia, 2 from Mongolia, 2 from Morocco, 1 from Pakistan, 6 from Syria, 1 from Thailand, 1 from Thailand-Sweden, 2 from Tunisia, and 4 from Turkey. Each questionnaire was fully completed and therefore usable for analysis. The data collection took place in April 2021.

In the data analysis, the following statistical methods were used:

- Univariate analyses (mean, standard deviation, lower and upper quartiles)
- Association tests (Pearson correlation analysis)

6. Structure of the Dissertation

The structure of the dissertation follows the classical format. In the introduction, I briefly introduce my doctoral research topic, highlighting its relevance and timeliness. Following this, I outline the aim and structure of the dissertation, and briefly discuss the rationale for a holistic approach to the topic, given its complexity.

The theoretical chapters present the literature that I have reviewed. At the beginning of the dissertation, I felt it was important to convey the process-oriented thinking in which career orientation, starting from individual results, leads to macroeconomic growth through several intermediate steps. In my opinion, with the paradigm of lifelong learning in mind, every society should recognize the potential of career orientation, which is not only relevant for promoting economic growth, but is also crucial for the development of society and well-being.

The second subchapter of the topic systematizes the career orientation and choice theories that have been developed so far. At the beginning of the subchapter, I discuss the modern interpretation and motivation of work, and the novelty of the latter is provided by the 21st century new model of Maslow's hierarchy of needs, the Kaufmann sailboat model of needs led by psychologist Scott Barry Kaufmann. This is followed by an introduction to various career choice theories based on the categorization by Klára Szilágyi. The different groups were defined based on the psychological characteristics that determine career choice. The classic career suitability theories are no longer suitable for matching individuals with careers, they may only be applicable in job suitability tests (Klein, 2019). The theories based on the psychodynamic conception of personality examine the motivating factors of behavior in the career search process. Donald E. Super's career development theory and John F. Holland's personality typology were given more detailed explanations among the theorists presented here, since the two career orientation questionnaires discussed in the empirical part are associated with their names. When discussing decision theories that focus on the process of career decision-making, I present the views of Ries, Tiedermann and O'Hara, Lange and Buschoff. Among the career development theories that examine the personality traits relevant to the given career in certain stages of the life path, Ginzberg's theory receives attention, and we can also learn about the views of Kohli, Dahaeim, and Musgrave when discussing sociocultural theories that examine the role of various social influences in career choice.

Following this, we can gain insight into modern career orientation theories. Lent and his colleagues have introduced the concept of self-efficacy, which is a central element of their social-cognitive model, into the topic of career building. Savickas' constructivist approach has re-evaluated the significance of self and career awareness, which are now the main pillars of modern career orientation.

In Hungary, numerous professionals have conducted significant research and formulated various theoretical theses on the topic in parallel with international career and orientation theories. Among them, the names of János Csirszka, Pál Rókusfalvy, Pál Völgyesy, Pálné Ritoók, Klára Szilágyi, and András Zakar stand out primarily.

The components of career orientation are self-awareness, knowledge of professions and careers, as well as knowledge of the labor and education markets. These are the elements on which counseling is built. In this sub-chapter, I found it essential to discuss the description of life-career management skills because they are the competencies acquired that help an individual successfully direct their career path.

As the closing of the first chapter, I interpret the various expressions used in the field of career orientation and life path counseling. In Hungarian, there are several concepts and names in use, which somewhat complicates the unified understanding of the field.

The chapter titled "The Significance of STEM Areas in the World of Work and Their Impact on the Training System" serves a dual purpose. On the one hand, it prepares the empirical part with scientific findings and previous research results, and on the other hand, it embeds the examined area - technical higher education - into its surrounding, complex environment. In this chapter, I tried to present in detail the far-reaching effects of the scientific-technological revolution, Industry 4.0, and Industry 5.0, examining the changes occurring in society, the economy, the labor market, and education from multiple perspectives. As an introduction to the chapter, I discuss the current economic and social environment, and then, based on Wallerstein's world-system theory, I illustrate the hierarchical and spatial division of labor, and the diverse localization of economic activities, presenting two theories - the dual or segmented labor market theory and the theory of transaction costs.

In the third subsection, I outline the impact of the scientific super-revolution on the labor market, providing a detailed picture of the expectations for current and future employees. The following section presents the envisioned approach to education, Education 4.0, in sufficient detail. Essentially, it examines the necessary and desirable changes that, once implemented, will bring the education system into line with the expectations of Industry 4.0. The vivid diagram at the end of the subsection summarizes the tasks facing education, which

may seem large-scale, but undoubtedly point to the indispensable application of highly trained labor to ensure the provision of critical employment sectors and reduce labor shortages.

In the fifth subsection, the focus is on the difficulties related to the education of STEM areas. The sixth subsection primarily examines the so-called STEM paradox, which means that the growing demand for professionals with STEM qualifications cannot be met by supply. The seventh subsection deals with women as one possible source of STEM channels. In this section, I describe the problems that hinder women's orientation towards STEM areas. In the final theoretical subsection, I briefly look at the current challenges facing technical higher education. Due to the complexity of the topic, the limitations of the work's scope, and my research topic, I narrowed down the area to be examined.

The chapter "Presentation of My Own Research" presents the results of two studies. In both cases, the aim of the research, its induction, the presentation of two career orientation questionnaires, hypotheses, methodology, and sample are described. The chapter includes the responses to the survey related to the dissertation and the results of the questionnaires.

The section on "Testing Hypotheses" partly formulates and evaluates my theses.

In the chapter "Development Ideas", I present the most important findings of the dissertation and make suggestions on what changes would be useful in the future to improve efficiency and quality.

The section "Literary Sources" lists Hungarian and international publications used in the dissertation.

The sections "List of Figures" and "List of Tables" contain lists of figures and tables mostly representing the results of the research in the thesis.

The chapter "Attachments" includes the two questionnaires used in the research, with the second questionnaire in both Hungarian and English.

7. Summary of Research Findings, Hypothesis Testing

I assume that high school seniors who are preparing for technical careers primarily make their career choices based on their interests. (H1). My assumption is based on the idea that when applying for higher education, seniors have already developed their self-image and the parental role, which dominates when applying for secondary education, is replaced by individual decision-making, which is complemented by the direction of further studies formulated by curiosity, inclination, and ability.

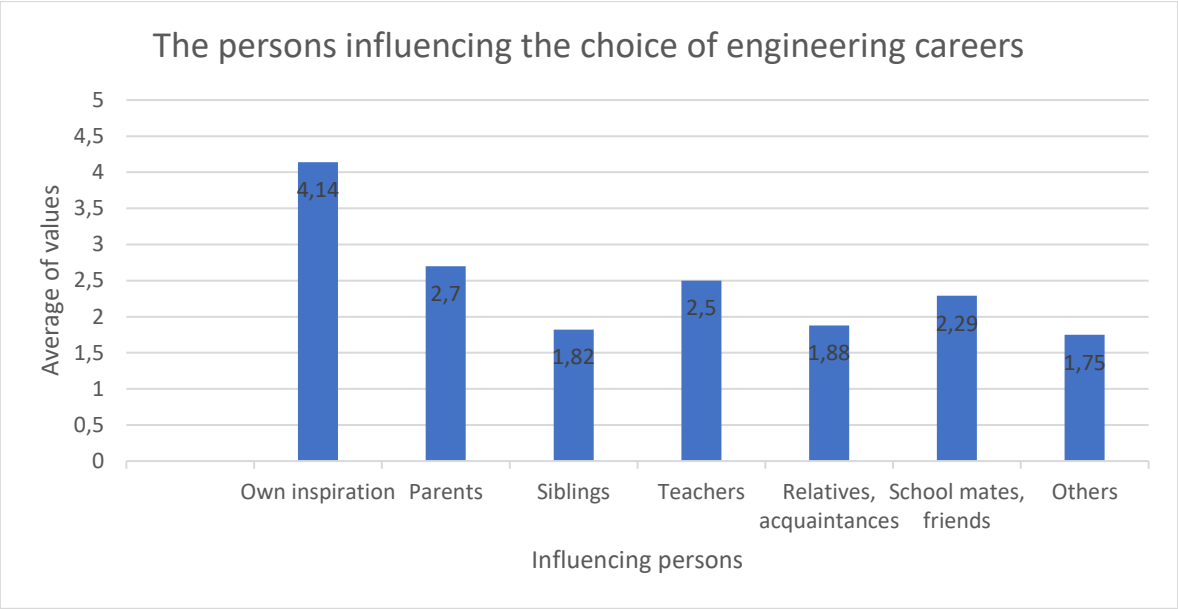

Figure 1: Average values of persons influencing the choice of engineering careers
Source: Based on the data of the 2021 and 2022 surveys, own editing.

The results obtained clearly show the validity of my hypothesis, as the role of individual decision-making has achieved significantly higher average values than that of the other individuals influencing the career choice - such as siblings, teachers, classmates and friends, relatives, and acquaintances.

I assume that in the case of individuals interested in technical fields, personality traits that arise from the specific job characteristics of technical work will be the most common (H2). In Holland's (1963) personality typology, classical engineering careers are primarily recommended for individuals with analytical, and secondarily for those with object-oriented personality traits, as individuals of this type are characterized by the search for deeper theoretical connections, seeking theoretical and practical solutions for design tasks and problem-solving**.**

Ranking of preferred majors	Boys	Girls
1.	Computer Science Engineering BSc (44)	Architectural Engineering BSc (28)
2.	Architectural Engineering BSc (13), Civil Engineering BSc (13), Computer Science Engineering MSc (13)	Architectural Artist BA (13)
3.	Mechanical Engineering BSc (12)	Civil Engineering BSc (11)
4.	Television Production Assistant Higher Level Vocational Training (7)	Environmental Engineering BSc (10), Architect (undivided training offering a master's degree) (10)
5.	Environmental Engineering BSc (6)	Interior and Spatial Design BA (9)
6.	Industrial Design Engineeringi BSc (4)	Industrial Design Engineering BSc (7), Computer Science Engineering BSc (7)

1. Table: Ranking of preferred majors by gender distribution
Source: Based on the data of the 2021 and 2022 surveys, own editing

From the table, it is clear that among boys, computer science is by far the most popular major, with the other classic engineering majors following far behind, but chosen by respondents in roughly equal proportions. These majors include electrical engineering, mechanical engineering, civil engineering, and architecture. The faculty offers two types of higher education vocational training: Television Production Assistant Vocational Training and Technical Vocational Training. The Television Production Assistant Vocational Training is primarily a creative, artistic major, and after graduation, the 90 credits obtained in the training can be counted towards communication and media bachelor courses. The Technical Vocational Training specifically promotes further studies in technical undergraduate programs with various specializations, and the faculty also provides these undergraduate programs. Nevertheless, we can say that only one boy and two girls are interested in this major. It would be worth conducting further research to find out the reason for this, as many students cannot enter undergraduate programs due to the requirements for advanced level exams and language proficiency, and vocational education could be a good bridge for them to obtain a diploma. This number is slightly higher for the Television Production Assistant Vocational Training, where there were 9 boys and 2 girls interested in the program. Not surprisingly, in the case of girls, the architecture and architectural artist field is the most attractive, although there are increasingly more female students in civil and

environmental engineering majors. The "more engineering" majors, such as electrical and mechanical engineering, are no longer considered attractive.

	Mean	Mode	Median	Standard deviation
Realistic	11,377	16	14	3,48
Investigative	14,189	13	14	3,22
Artistic	13,716	16	14	3,43
Social	12,916	12	13	3,52
Enterprising	14,105	14	14	3,31
Conventional	14,75	18	15	3,61

2. Table: The mean, mode, median, and variance of personality types among boys.
Source: Based on data from the 2021 and 2022 surveys, own editing

	Mean	Mode	Median	Standard deviation
Realistic	12,860	15	13	3,626
Investigative	12,940	14	14	3,776
Artistic	16,902	20	18	3,139
Social	13,588	15	14	3,557
Enterprising	14,392	14	14	2,974
Conventional	15,117	15	15	3,05

Table 3: The mean, mode, median, and variance of personality types among girls.
Source: Based on data from the 2021 and 2022 surveys, own editing

In terms of means, boys are primarily characterized as conventionals. According to Holland, people with this type of personality prefer well-defined, clear-cut tasks that can be thoroughly examined in detail. They are rule followers, meet deadlines precisely, require top-down direction, and follow familiar, consistent solutions. Because they strive to meet deadlines accurately, they do not like to abandon a task once started. Administrative, legal, and economic positions are recommended for people with this personality type. Investigative personality types, who are interested in understanding the world and seeking connections, are the second most typical personality type for boys. They enjoy research work, scientific and design activities, analysis, or logical tasks. Technical and scientific activities are recommended job positions for investigative types.

When examining the modes, the highest, most frequently occurring value is 18, which also occurs in the Conventional personality type. A similar result was found when examining the median, with the highest middle value being 15, which is also present in the Conventional personality type. Examining the standard deviations of each personality type, we can say that the elements of the sample are located at roughly the same distance from the mean value.

Based on the obtained values, it can be concluded that boys are preparing for careers that match their interests, as while their orientation towards the classic engineering profession ranks second according to their personality traits, the obtained average value is very close to the dominant personality type, and with appropriate career guidance, they can be directed towards engineering careers.

The table shows that a significant portion of girls seeking engineering education primarily look for art-related programs. The artistic branches of building sciences emphasize aesthetic skill development in addition to classical engineering knowledge, which is why applicants must participate in a drawing aptitude test. This career is primarily recommended for individuals with a creative personality type who use their previously acquired knowledge, skills, and abilities to develop new solutions and prefer to solve tasks independently and in a creative manner. Aesthetics, independence, and the ability to express themselves are important to them. They are emotionally intuitive and usually rely on their feelings even in decision-making and require the act of creation. On average, girls are primarily creative personality types, with a very high value of 16.9. The second most common personality type is the implementer, with an average value of 15.12. The difference between these two main types in girls is much greater than in boys (1.78 for girls and 0.56 for boys), and they fit perfectly with the personality traits required for the chosen profession with high means.

Their mode is the maximum point of 20, which is the most frequently occurring number in the sample. This is a very good result because it means that they fully meet the personality criteria. In terms of median, the creative personality trait is the highest, and since the median is the middle number that "cuts" the population in half, it can be said that at least 50% of the sample scored 19 or 20 points. There is a slightly greater difference in the standard deviation of each personality type than in boys, where the difference between the lowest and highest values is 0.79. Therefore, my assumption has been proven to be well-founded.

I assume that creating a personal vision is always easier and more nuanced when we make the information related to the profession, its content, and the nature of the work experience centered (H3). I based my assumption on the fact that decisions made solely on a theoretical level are less well-founded than if the information is augmented with personal experience, since in many cases it can be observed that a false impression develops based on theoretical information. On the other hand, experiential learning always has a deeper and more lasting effect on the individual. It is no coincidence that experiential-centeredness has

become an important aspect of career orientation events. We observed the same in the case of the survey participants, that they were able to make their choices clearer with the help of practical knowledge gained through experiential learning. Therefore, my assumption proved to be well-founded.

I assume that in the case of girls, the decision to choose technical fields will lean towards work activities that require creative and artistic competencies (H4).

Értékkörök	Mean	Mode	Median	Standard deviation
Creativity	13,37	15	14	1,67
Way of Life	13,22	14	14	1,8
Variety	13,02	15	13	1,77
Economic return	12,71	15	13	2,31
Aesthetic	12,37	13	13	2,31
Altruism	12,29	12	12	2,27
Intellectual Stimulation	12	12	12	1,87
Associates	11,86	13	12	2,23
Independence	11,8	13	12	2,09
Prestige	11,76	15	12	2,59
Achievement	10,71	10	11	1,97
Supervisory Relationships	10,65	11	11	2,64
Playfulness	9,25	9	9	2,23
Management	9,1	10	9	2,84
Human values	8,41	7	8	2,36

Table 4: The ranking, mean, mode, median, and standard deviation of work value categories by girls.
Source: Based on data from the 2021 and 2022 surveys, own editing.

The background for my assumption is the research-supported fact that there is significant under-representation of women in engineering education, and those women who choose engineering fields are often not interested in the classical, "masculine" engineering disciplines, but rather those that require creative inclinations. Based on our survey, we found that the personality type of women is predominantly the Creative personality type. The table of work values shows that for girls, the values related to creative work are clearly dominant, which is strongly represented by the creativity domain in first place with a high average value. Creative people generally score higher in terms of intellectual curiosity, openness, and sensitivity to new things. Creativity stimulates flexible thinking, finding new

approaches, and developing problem-solving skills. Self-assertion, with a slightly lower value, is also a characteristic attitude of the creative personality type, indicating a desire for individuals to work that fits their own values and personality. This demand for alignment is not surprising because this type of work usually results in greater satisfaction and harmony, thus increasing individual work performance. Diverse tasks represent new challenges, provide opportunities for adaptation and development, and maintain motivation. The importance of material goods, financial rewards, and financial security is not surprising either, as emphasizing the material aspect of work values increases focus and identification with work-related values. Aesthetics, sensitivity to beautiful things and their appreciation, create harmony between people and their environment, and a pleasant and inspiring work environment induces better mood and productivity. Altruism, intellectual stimulation, associates, independence, and prestige occupy the middle third. This result is somewhat surprising, as intellectual stimulation includes motivation and desire for new challenges, while independence represents independent work and decision-making, and these values belong to creative people. The values of achievement, supervisory relationships, playfulness, management, and human values are in the bottom third. Playfulness as a work value may be surprising, as this value symbolizes the importance of creativity and innovation.

When examining the modes, creativity, variety, and economic returs achieved the maximum value, which means that most people considered these work values to be the most important. Therefore, it has been proven to be well-founded.

I assume that those individuals with a stronger commitment to their studies were better able to adapt to changes in teaching methods required by environmental conditions and to cope with changing circumstances more flexibly (H5). This hypothesis is based on the idea that students who choose their career based on their own opinion are more committed to completing their studies and are better able and willing to adapt to changing conditions and circumstances**.**

Based on the research and analysis, this hypothesis has been found to be justified, especially in the case of students participating in Hungarian-language programs. The decision to choose a profession based on one's own ideas shows a much more significant correlation with the quality and diversity of education, the reputation of the university and the faculty, and the opportunities for further training than other received results. This feedback shows that

students are committed to acquiring an engineering profession and are willing to take on challenges and difficulties to achieve this goal.

I assume that a student's ability to assert themselves greatly influences the knowledge transfer process, and that the informal spaces established and maintained by students play a key role in this, both in terms of information transmission and meeting community needs and feedback (H6). My assumption is based on the sudden change in life situation, which was unusual for everyone due to lockdowns and the consequent introduction of distance education, which caused mental problems for many students. Self-assertion was limited, and this significantly affected the learning process.

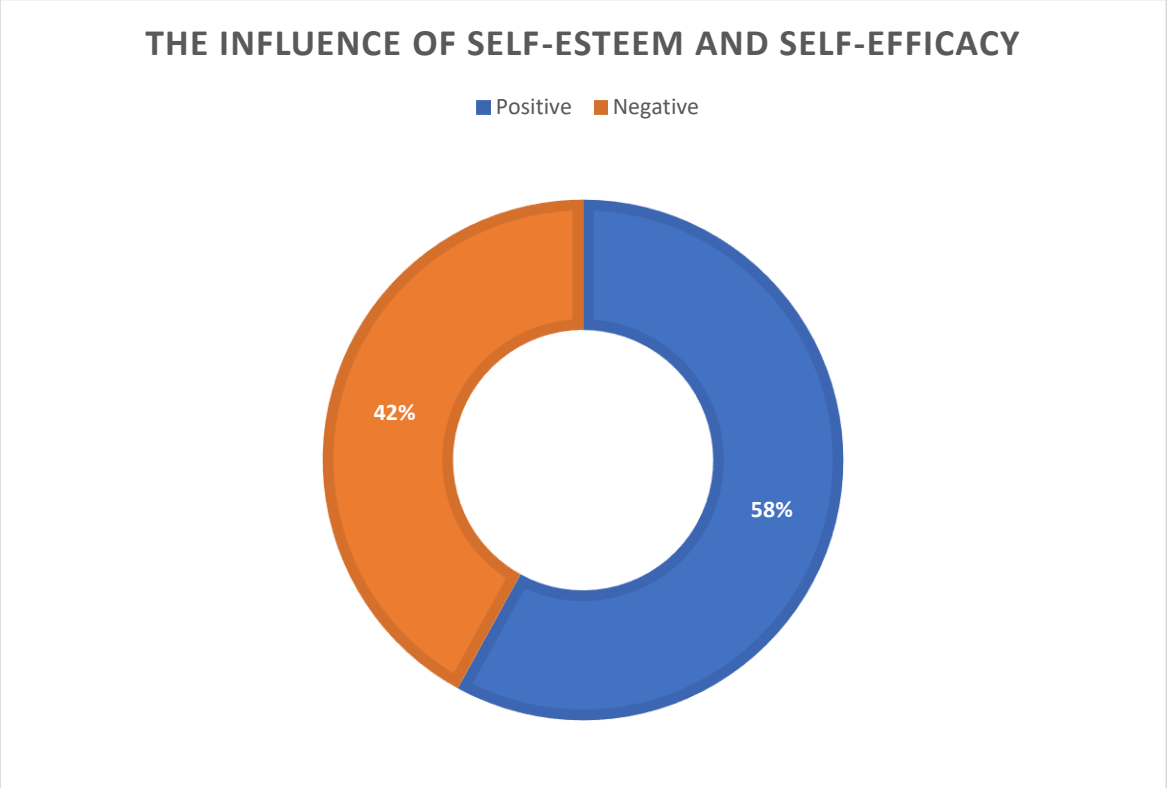

Figure 2: The impact of the current pandemic situation on self-esteem and self-efficacy among Hungarian-speaking students in education programs.
Source: Based on data from a survey conducted in April 2021, own editing.

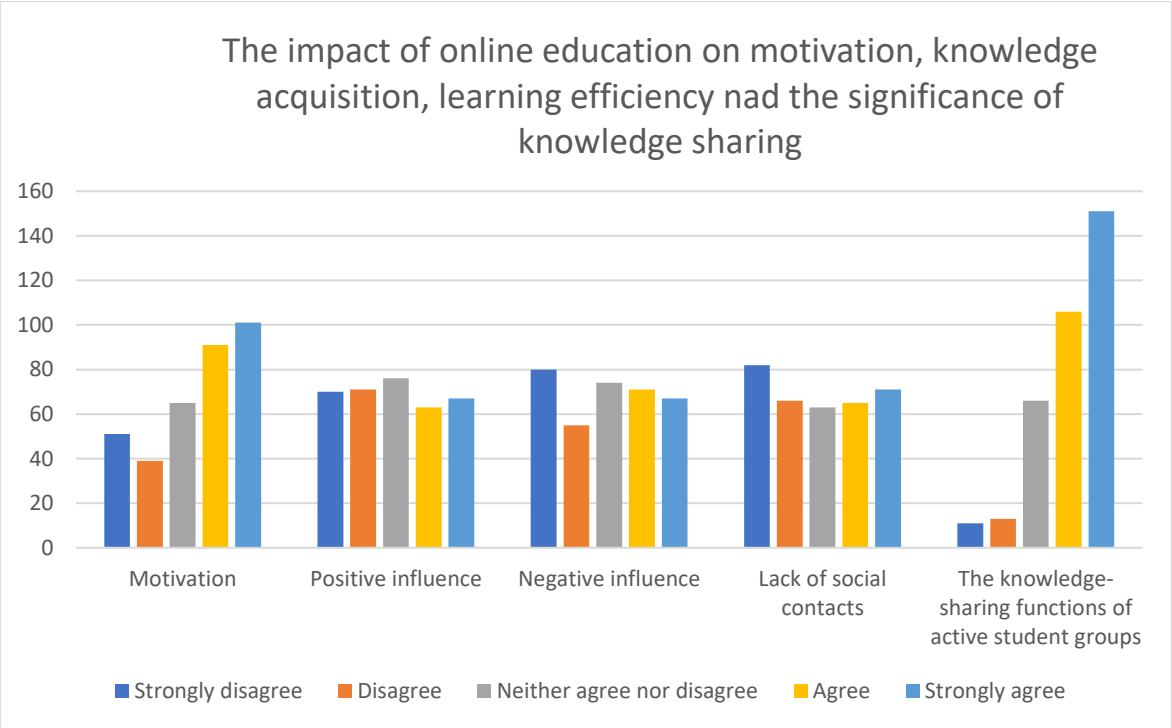

Figure 3: The impact of online education on motivation, knowledge acquisition, learning efficiency, and the significance of knowledge sharing among students in the Hungarian language programs
Source: Based on data from a survey conducted in April 2021, own editing

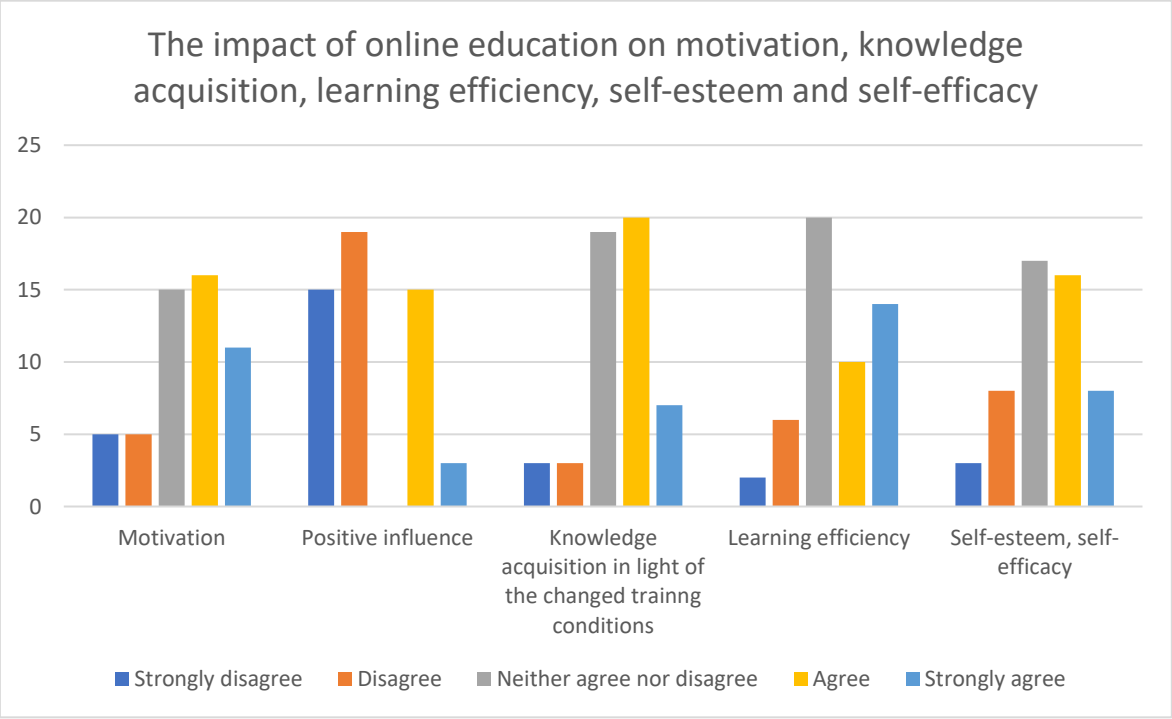

Figure 4: The impact of online education on motivation, knowledge acquisition, learning efficiency, self-esteem and self-efficacy among students in the English language programs
Source: Based on data from a survey conducted in April 2021, own editing

Based on my research, I have found that more than half of the students were significantly or completely affected in terms of their self-esteem and self-efficacy by the changed training conditions, and nearly three-quarters indicated that the existence of active student groups is very significant in terms of knowledge sharing. The role of these groups is not only to function as channels for knowledge sharing, but student communities also serve as a good goal for strengthening relationships and reducing feelings of loneliness. Through these communities, there are also opportunities for receiving community feedback and sharing experiences for the sake of self-validation. Therefore, my assumption has been proven to be well-founded.

8. Possible Directions for Further Research

During the two studies, we examined high school students interested in technical fields who were about to graduate, as well as students who were already enrolled in technical training programs. In the surveys related to professional and institutional choice, we obtained results that were similar to other studies on this topic. In terms of career choice, individual decision-making and personal preference were dominant factors, while quality and diversity of education, good employment opportunities, later educational opportunities, and institutional reputation were all important factors in institutional choice. The results of the career orientation surveys showed a high level of congruence between women's chosen professions and their interests, indicating that they pursued professions that matched their interests. For men, only the second personality trait was congruent with classical engineering disciplines, but we did not observe significant deviations from the primary personality type. Career counseling can help resolve these contradictions.

The most important principle in making STEM training attractive is to provide students with the proper knowledge and freedom of choice. However, there are currently many obstacles to achieving this. It is clear that stimulating interest is the most important intervention for improving recruitment in STEM areas. Career orientation is tasked with helping individuals choose occupations that best fit their attitudes, personality, and primarily their interests. Therefore, it is necessary to introduce students to the various job opportunities that can be pursued with different qualifications from the beginning of basic education. It is often the case that many university students realize that their decision was wrong after completing several semesters. Unfortunately, the possibility of correction is quite limited, considering

the limited number of state-funded semesters. Additionally, a decrease in enthusiasm clearly leads to a loss of motivation.

The wider recruitment of women in engineering courses is essential for the field's expansion. It is necessary to have more effective and targeted outreach to ensure a supply of new talent, as women represent an untapped labor force in this field. The "glass ceiling" phenomenon, which historically hindered mobility between male and female professions, is increasingly disappearing. In addition to the fact that more and more women are doing traditionally male jobs and vice versa, such as male flight attendants, childcare providers, and nurses, women's participation in engineering fields is socially completely accepted, but their numbers are still negligible. While it is not the responsibility of career guidance to artificially balance the genders in engineering professions, it is clear that there is a noticeable gap in targeting women. To address this, several grant programs support women's enrollment in engineering fields, using special resources to market engineering professions to women. The goal is to increase the number and proportion of female students in MTMI training areas and support female students already enrolled in universities. The partnership method involves marketing and engineering professions within the university, as well as between universities and professional marketing agencies. The key to a successful strategy is to show that it is natural for a woman to be an engineer and that it is natural for a specialist in the engineering profession to be a woman.

Education should increasingly focus on experiential learning. It is well-known that theoretical knowledge alone does not provide a comprehensive understanding. In our constantly changing, virtual world with excessive stimuli and instant access to information, there is an increasing need for tangible, real experiences. Experiential demonstrations and games can be incorporated into career guidance to introduce specific education programs more effectively.

The second study, conducted during the pandemic period, examined the effectiveness of online education from the students' perspective. Based on their textual responses, we concluded that engineering education cannot be done exclusively online. The quality of online education depends on several critical success factors, including a well-designed, learner-centered, interactive, technology-based, flexible, and inclusive learning environment that prioritizes continuous quality improvement. The joint support of several segments is required to develop solutions that account for pedagogical, learner, technical, and institutional factors. The survey also revealed that educational activities and course materials were not adequately adapted to the digital environment. However, online learning provides

greater flexibility and accessibility in terms of time and location, as well as access to educational resources and opportunities for collaboration, promoting self-regulated learning. Our current students belong to the category coined by Mark Prensky (2001) as "digital natives," who possess entirely different thinking and information processing skills compared to the "digital immigrants" who educate them. Fundamental differences arise because the digital immigrant generation tries to adapt to the new environment but still retains its "accent," i.e., its roots in the past. Therefore, the most critical task for a paradigm shift in teaching methodology is primarily overcoming language barriers. For instructors who speak the language of the pre-digital era, conveying both the inherited, i.e., traditional, and the future, i.e., all things digital and technology-based, curricula in the language of digital natives presents a tremendous challenge.

Another essential element of development is to improve students' self-efficacy. Building self-confidence, believing in one's abilities and potential for growth can be fully realized in a learner-centered educational environment. However, instructors need to consider students' needs and provide up-to-date learning content. With the acceleration of information flow, it is advisable to develop increasingly shorter and more interactive, so-called micro-learning materials, to achieve effective learning. Numerous advantages arise from this approach, such as short but informative study materials, allowing instructors to receive immediate feedback on students' progress, as well as helping with challenging curricula. With the elimination of time and place constraints, learning materials can be viewed anywhere and anytime, and the use of visual aids ensures a more efficient acquisition.

Making the learning environment interactive, rich in stimuli, and diverse - for example, by incorporating gamification - can also have a positive effect on student motivation. In addition, it may be justified to introduce diverse learning assessment methods that reveal the potential of students in different areas. The results obtained can be used to stimulate multidimensional and multilevel educational goals that correspond to cognitive and emotional needs, as well as skills. The aforementioned gamification can help make the now somewhat outdated numerical evaluation system more effective, so that students can receive direct and immediate feedback on their performance, and they can perceive evaluation - even in case of poorer results - not as failure, but as an opportunity for development.

It is a regrettable fact that Hungarian education is uniform in nature, which makes it difficult, if not impossible, to develop individual learning methods. Although it is not the responsibility of higher education to introduce modern and effective learning support methods to students, it is often proven in higher education that incoming students have not

learned how to learn, making the first exams a serious challenge and often leading to failures. A good tool for this could be the use of cooperative learning tasks already mentioned in the questionnaire, as well as the formation of student groups. Through such tasks or channels, thinking patterns, confidence, constructive attitudes, skills, self-belief, and through interactions, the system of social competencies can develop. The responses received in the questionnaire already expressed a need for an online community learning space, where knowledge sharing could be achieved, and where students could receive numerous feedback on their work and learning, which would increase their motivation.

One possible direction for development could be the so-called "blended learning," a combination of in-person and online education, which can enhance the benefits and reduce the drawbacks of both types of education. Blended learning can be implemented in several ways, with four main approaches known. The rotational method involves using various learning methods, at least one of which takes place online. The "flex" type has the internet as the primary educational platform, but also offers opportunities for personal consultation. The third type is "self-blend," which is based on traditional classroom teaching but also allows for participation in online courses. Finally, the "enriched virtual" type involves some education taking place online and the rest in a traditional format, and after a few semesters, if the appropriate academic results are achieved, it can switch to a fully online mode – models (Komló, 2013).

In the questionnaires, we received suggestions mainly from distance learning students that the distance learning programs should be transformed into online forms. For these learners, it is usually extremely costly and time-consuming to travel to the training center and stay there for a short period of time. Additionally, actively working students can mostly only participate in the training at the expense of their vacation time.

Overall, it can be said that there are numerous opportunities to address the problems of technical higher education. Along the two lines discussed in this thesis, an effective, experience-centered career orientation starting from primary school would support the appropriate recruitment base, while the change of mindset and methodology is the most critical factor in terms of training efficiency.

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10. List of Figures

11. List of Tables

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