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Analysis of the Opinions of Students of High Schools (With a Focus on Engineering) on Teaching with Digital Technologies in their Studies and their Self-Assessment of their Own Digital Competences Acquired during their Studies

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Abstract:

The aim of the paper is to introduce the issues solved within TAČR project (Technology Agency of Czech Republic). The title of the project is "Education in engineering branches and its optimization for the needs of the labor market". Its content focuses on the current needs of workers in engineering companies and innovation centers. The project proposal resulted from an analysis of the current situation in the field of technical education and the situation on the labor market in the sphere of technical professions. The paper also brings the partial results of an analysis of engineering high schools students' opinions on their equipment with specific tools for digital control of production processes, use of the tools by teachers of vocational subjects, application of students' already acquired digital competences in learning and their assessment of schools' contribution of to their further development. The survey took place at the end of 2019 at two high schools with engineering focus.

Keywords: *Digital Competence, Engineering, European Framework for the Digital Competence of Educators, High school students' opinions, Technologies.*

I. INTRODUCTION

The number of students graduated at high schools with focus on engineering has been slowly decreasing for a long time in Czech Republic. However, this is not due to the loss of interest in engineering courses by students, but rather to demographic developments, where the overall number of pupils and students is decreasing. For the last 10 years, the share of machine engineering graduates has been around 9 - 10 %, which means that every tenth graduate of high school (without a follow-up course) has an engineering focus [1].

The importance of digital literacy on the labour market has been discussed in the Czech Statistical Office Report "Sample survey of the workforce" [2], which points out the increase in the demand for services connected with digital technologies, which presents a certain challenge to revise the national curricula and school education programmes, especially at high schools with technical (for example, mechanical engineering) focus.

II. DIGITAL COMPETENCES

Increased connectivity increases the importance how to become responsible digital citizens. We need to guide the development of competences to use digital technologies in ways that are productive, meaningful, respectful and safe [3].

Mastering the relevant competences associated with

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the use of technology is already considered by default to improve the position of a person both in the labor market and in acquiring or exchanging qualification. Education in a society based on information, knowledge and information technology is becoming a necessary condition for the success of individuals and the basic characteristics of the developing society [4].

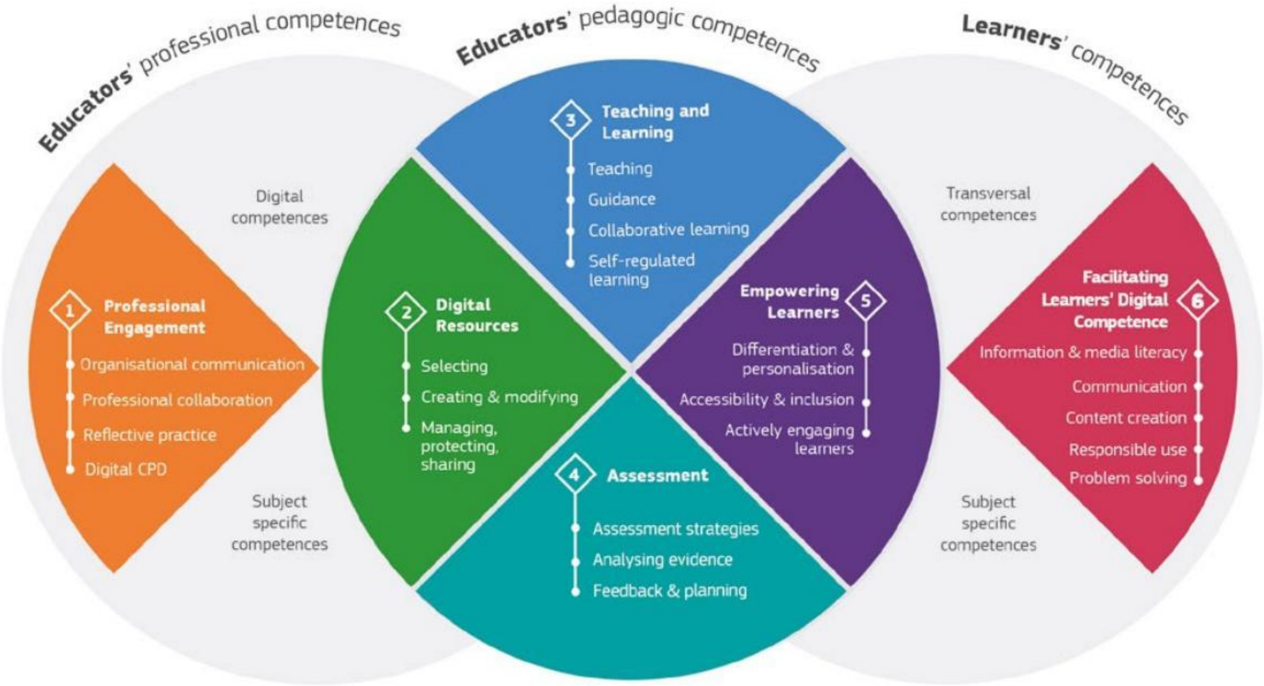

Figure 1 European Framework for the Digital Competence of Educators (DigCompEdu) [6]

The future success of individuals can largely depend on the level of their digital competences, so the availability of digital technologies and the opportunity to learn to use it should be as broad as possible. This implies the need to integrate digital technologies and the development of digital competences in conjunction with the development of critical and creative thinking, problem-solving skills, information thinking and creativity in the content and process of education in schools and in the system of lifelong education. This integration has been emphasized in the long term in strategic, conceptual or curricular documents and is also considered as one of the current priorities of the educational strategies of developed countries.

All these terms highlight the need to handle technology in the digital age [5].

On international and national level a number of frameworks, self-assessment tools and training programmes have been developed to describe the facets of digital competence.

European Framework for the Digital Competence of Educators (DigCompEdu) is the output of the long-term research activities of the European Commission's Joint Research Center. The Centre's task is to provide independent scientific advice and thus contribute to the European Union's policy-making. This document is a recommendation of the European Commission to Member States on how to define the required digital competences of teachers. It builds on the previous frameworks - The Digital Competence Framework for Citizens and The Digital Competence Framework for Consumers and the definition of digitally functioning educational organizations (Framework for Digitally Competent Educational Organizations). DigCompEdu aims at all levels of education, from early childhood to higher and adult education, including general and vocational education and training, special needs education, and non-formal learning contexts [6].

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I. A BASIC INSIGHT INTO THE SOLVED ISSUES

The National Institute for Education in Czech Republic (NÚV) deals with the issue of vocational education of students and their subsequent employment in the present and future labor market. Every year, information on the development of the discipline structure of students at secondary and tertiary professional schools, as well as data on unemployment among school leavers, are prepared. Employees' opinions on the preparedness of school leavers for practice and the opinions of graduates themselves on the use of acquired skills are also examined at intervals of several years. The National Institute for Education employers had the opportunity to comment on the key competences they think schools should focus more on [1].

Partial results from the questionnaire survey among employers, in which their staffing needs, their views on the preparedness of graduates for employment or attitudes to the admission and non-recruitment of graduates were surveyed, show that 46.2 % of respondents recommend that vocational schools should focus more to the proficiency in digital technology. For 35 % of respondents, employing a computer is crucial for hiring graduates, and for 33 % of respondents' knowledge of new technologies is crucial.

The use of the digital technologies of young individuals for the next level of education is an important factor influencing their choice of the field of study or a particular school. Connecting studies and subsequently professional life can be viewed as a certain part of the "digital attitude" [7], since the results of secondary analyses in international surveys ICILS 2013 and PISA 2012 showed that Czech pupils use a computer for their leisure purposes over proportionally in the international comparison, even most frequently from all the OECD countries [8].

Digital tools take an important but differentiate role in education as well as teachers. Therefore, the contemporary education paradigm requires different demands from teachers. Teacher responsibility is to set up an environment and opportunities for deep educational experiences that can expose and boost students' capacities. Teachers become activators of meaningful education, not just facilitators. Teachers are team players, understanding and evolving their own and others potential to the full, they are also alchemists who submit strategies, techniques and resources to ignite students' creativity; teachers are mentors who create relationships of trust; orchestrators of individual and group learning; welders who connect pieces of knowledge and activities into a meaningful whole - teachers need to cope all these roles [9].

Vocational High School is an educational institution that aims at generating qualified graduates for professional working circumstances, possessing entrepreneurial passion, qualified skill, and able to compete in the global market. The vocational education system is designed to produce learning outcomes that correspond to the needs of the world of work [10]. Therefore the development of a vocational education curriculum is required to be adaptable to the changing needs of the professional working circumstance and society's lifestyle to enable the learners mastering a field of expertise in terms of soft as well as hard skills.

The use of technology in learning must be tailored to the needs of the educational environment or where the learning process takes place. With appropriate technology, the function of digital technologies as a learning facility can achieve the goal of improving learning performance. The digital technologies used in education are focussed on learning, facilitating, therefore all existing technologies and educational technology products must be selected and built on the need of a particular learning environment analysis. All elements and learning objectives must be determined as a whole, so that the learning objectives to be achieved can be fulfilled [11].

In Australia, research on the role of the schools in helping students to develop technology skills has been conducted for the past few decades. During the 1980s, 1990s and 2000s, schools were considered to be an important place for young people to gain experience of using computer and internet technology. However, the 2010s has seen growing criticisms that schools are now falling well behind the increasingly diverse nature of students' out-of-school personal uses of digital technology. One of the most strongly supported ideas throughout the whole of the survey, with 86.3 % of respondents agreeing with the statement: "It is important for schools to teach students IT skills that are relevant for future jobs". This support was consistently expressed across the sample, regardless of background and demographic characteristics [12].

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To bridge the gap between the skills of vocational students as prospective workers with the expectation of labor market, it is necessary to develop an attitude to be able to adapt to the current situation. Various information, data, and knowledge of both fact and opinion can be easily obtained. Therefore, the ability to select, process, and interpret the acquired digital information is very important for the master. These skills are called digital literacy skills [13].

There is a consistent approach to defining digital competence as a key competence across Europe. Nearly half of the European education systems refer to the European key competence definitions for digital competence: 11 education systems use exclusively their own national definition of digital competence, eight other countries (Austria, Albania, Cyprus, Estonia, France, Lithuania, Malta and Serbia) use both the European definition and a national one. In lower secondary education the number of countries teaching digital competences as a compulsory separate subject increase to over half of the education systems. In upper secondary, the number of countries teaching digital competences as a cross-curricular topic decreases slightly in relation to lower secondary and fewer countries offer compulsory separate subjects for all students in this area. In upper secondary education, students can usually choose more optional subjects and these can also include subjects related to digital competence. Half of the European education systems are currently reforming the curriculum related to digital competence. The revisions aim either at introducing digital competence into the curriculum where it had not previously been solved. Some reforms are also about updating content or changing the curriculum approach, strengthening particular areas such as computational thinking, safety or coding [14].

II. Project Solved within Technology Agency of Czech Republic

The project ‘Education in engineering branches and its optimization for the needs of the labor market’ focuses on the current needs of workers in engineering companies and innovation centers. The issues are solved within program of Technology Agency of Czech Republic (TAČR).

In the history of the Faculty of Education (University of Ostrava), this is the first project awarded in the grant contest of the Technology Agency. This project belongs to the Zeta sub-program, which is focused on supporting academic and business cooperation through the involvement of students and students of master's and doctoral degree programs at universities and young researchers up to 35 years of age.

The project proposal resulted from an analysis of the current situation in the field of technical education and the situation on the labor market in the sphere of technical professions.

The target of the research project responds to the problems of engineering companies regarding the lack of workers. The declining interest of the young generation in technical education is a long-standing problem, which is reflected in the unsatisfied demand of engineering companies for graduates with technical education [15].

III. Research

The research was carried out at the end of 2019 in the Moravian-Silesian Region of Czech Republic. The respondents were represented by students from two high schools studying mechanical engineering. Using the questionnaire survey, we collected data from 316 respondents who attended all four years of study. The majority of respondents in sample were boys (98,13 %), which is usual in that field of study.

Four questions were selected for analysis in this paper:

1. *In my opinion, the school where I am studying is equipped with technology enabling digital control of production processes*: (offered answers) a) wholly insufficiently, b) insufficiently, c) I cannot say, d) well, and e) very well.
2. *Teachers of vocational mechanical engineering subjects use the potential of digital technologies* (offered answers): a) insufficiently, b) to a small extent, c) sufficiently, d) to a large extent, and e) maximally.
3. *The possibilities to use my current digital competences in learning are*: (offered answers) a) very limited, b) limited, c) sufficient, d) significant,

and e) very welcome and supported.

4. *In my opinion, the high school where I am studying contributed to the development of my digital competences* (offered answers): a) very little, b) a little, c) quite significantly, d) significantly, and e) very significantly.

The research aimed to find answers to ***the following research questions:***

1. According to students, how well-equipped is the high school with technology enabling digital control of production processes?
2. According to students, to what extent do teachers of vocational mechanical engineering courses use the digital technologies potential?
3. To what extent can students use their current digital competences in learning at their high school?
4. According to students, to what extent has the high school where they are studying contributed to the development of their digital competences?
5. Are students' answers influenced by their year of studies?

IV. Results

Table 1. Students' opinions on the school's digital equipment

Categories	Frequency	Percentage
Wholly insufficiently	11	3.5 %
Insufficiently	52	16.5 %
I can't assess	119	37.7 %
Well	116	36.7 %
Very well	18	5.7 %

Referring to the students' opinion on the schools' digital equipment enabling digital control Table 1 shows that 42.4 % of respondents rate them to be good or very good, and only 20 % of them consider them as insufficient or wholly insufficient.

The relatively high proportion of 'I cannot assess' answers (37.7 %) can be interpreted in two ways. The first may be based on the students' limited orientation on current processes of digitization of engineering production, the second possible interpretation is based on students' less experience in using these technologies in learning or practice.

Table 2. Students' opinions per year of study on the digital equipment of the school

Year of study	Categories	Frequency	Percentage	Average value
1.	Wholly insufficiently	0	0 %	*Ø 3.46*
	Insufficiently	7	7.4 %	
	I can't assess	45	47.4 %	
	Well	35	36.8 %	
	Very well	8	8,4 %	
2.	Wholly insufficiently	3	4.4 %	*Ø 3.34*
	Insufficiently	6	8.8 %	
	I can't assess	27	39.7 %	
	Well	29	42.6 %	
	Very well	3	4.4 %	
3.	Wholly insufficiently	2	2.7 %	*Ø 3.18*
	Insufficiently	18	24.3 %	
	I can't assess	21	28.4 %	
	Well	31	41.9 %	
	Very well	2	2.7 %	
4.	Wholly insufficiently	6	7.6 %	*Ø 2.97*
	Insufficiently	21	26.6 %	
	I can't assess	26	32.9 %	
	Well	21	26.6 %	
	Very well	5	6.3 %	

Findings in Table 2 show a year-by-year view, the number of students who are not able to assess the school's digital equipment is decreasing with advancing years of study.

The findings also illustrate quantified average value, which gradually decreases from the first to the fourth year.

The diversity of students' responses increases with the year of study and this could reflect the fact that the curriculum of the study program does not include learning material focusing on criteria for assessing the state of digitization of engineering industry, thus students are not able to find a common benchmark for expressing their views.

Table 3. Students' opinions on the utilization of digital technologies potential by teachers

Categories	Frequency	Percentage
Insufficiently	6	1.9 %

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To a small extend	41	13 %
Sufficiently	150	47.4 %
To a large extend	99	31.3 %
Maximally	20	6.3 %

Referring to students' opinions on to what extent teachers of vocational mechanical engineering courses use the potential of digital technologies Table 3 shows that item was answered positively by the most of students (85 % of students).

Table 4. Students' opinions per year of study on the utilization of digital technologies potential by teachers

	Categories	Frequency	Percentage	Average value
1.	Insufficiently	0	0 %	Ø 3.28
	To a small extend	10	10.5 %	
	Sufficiently	52	54.7 %	
	To a large extend	29	30.5 %	
	Maximally	4	4.2 %	
2.	Insufficiently	0	0 %	Ø 3.35
	To a small extend	7	10.3 %	
	Sufficiently	34	50.0 %	
	To a large extend	23	33.8 %	
	Maximally	4	5.9 %	
3.	Insufficiently	1	1.3 %	Ø 3.42
	To a small extend	11	14.9 %	
	Sufficiently	26	35.1 %	
	To a large extend	28	37.8 %	
	Maximally	8	10.8 %	
4.	Insufficiently	5	6.3 %	Ø 3.05
	To a small extend	13	16.5 %	
	Sufficiently	38	48.1 %	
	To a large extend	19	24.0 %	
	Maximally	4	5.0 %	

Table 4 shows the final average of the positive responses increases year after year, but a significant decline can be seen in the fourth year. The fourth year of study assessment can be explained by the behavioral aspects of stage of personality development of the students in last grade.

Table 5. Students' opinions on to what extent they can apply their current digital competences in learning

Categories	Frequency	Percentage
Very limited	23	7.3 %
Limited	74	23.4 %
Sufficient	148	46.8 %
Significant	53	16.8 %
Very appreciated	18	5.7 %

Findings in Table 5 shows possibilities of using digital skills in learning are considered mostly as sufficient by 46.8 % of the respondents. The distribution almost corresponds to Gaussian normal distribution. However, nearly a third of students (30 %) considers the options on to what extend they can use their current digital competences in learning are limited or very limited.

By broadening the use of experiential learning in high schools, more space should be opened to group or individualized student activities in which students themselves would decide on digital technologies application.

Table 6. Students' opinions per year of study on to what extent they can apply their current digital competences in learning

	Categories	Frequency	Percentage	Average value
1.	Very limited	4	4.2 %	Ø 3.04
	Limited	20	21.0 %	
	Sufficient	45	47.4 %	
	Significant	20	21.0 %	
	Very appreciated	6	6.3 %	
2.	Very limited	4	5.9 %	Ø 3.04
	Limited	16	23.5 %	
	Sufficient	28	41.1 %	
	Significant	13	19.1 %	
	Very appreciated	7	10.0 %	
3.	Very limited	4	5.4 %	Ø 2.88
	Limited	17	23.0 %	
	Sufficient	39	52.7 %	

	Significant	12	16.2 %	
	Very appreciated	2	2.7 %	
4.	Very limited	11	13.9 %	Ø 2.63
	Limited	21	26.6 %	
	Sufficient	36	45.6 %	
	Significant	8	10.1 %	
	Very appreciated	3	3.8 %	

Findings in Table 6 bring interesting results. In the first and second year of study, the distribution of answers is perfectly normal, with the highest average score of 3.04. In the following years, a decrease in the average value was found, students' opinions per year of study on to what extent they can apply their current digital competences in learning were evaluated more negatively.

Table 7. Students' opinions on to what extent their high school contributed to the development of their digital competences

Categories	Frequency	Percentage
Very little	31	9.8 %
Little	97	30.7 %
Quite significantly	117	37.0 %
Significantly	60	19.0 %
Very significantly	11	3.5 %

Referring to the contribution of the high school to the development of students' digital competences the results could be divided into significant and insignificant ones (Table 7). 59.5 % of respondents consider it to be quite significant, significant and very significant. However, 40.5 % of students answer the contribution of school to the development of digital competences is little or very little.

This finding could be explained by the age of respondents, Generation Z (aka Gen Z, iGen, or centennials), refers to the generation that was born between 1996-2010, following millennials. This generation has been raised on the internet and social media, from an early age, children are used to work with digital technologies, probably they will require a different, more demanding and more in-depth approach to information shaping and digital thinking.

Table 8. Students' opinions per year of study on to what extent their high school contributed to the development of their digital competences

	Categories	Frequency	Percentage	Average value
1.	Very little	5	5.3 %	Ø 2.94
	Little	28	29.5 %	
	Quite significantly	37	38.9 %	
	Significantly	18	18.9 %	
	Very significantly	7	7.4 %	
2.	Very little	8	11.8 %	Ø 2.84
	Little	19	27.9 %	
	Quite significantly	19	27.9 %	
	Significantly	20	29.4 %	
	Very significantly	2	2.9 %	
3.	Very little	6	8.1 %	Ø 2.77
	Little	22	29.7 %	
	Quite significantly	31	41.9 %	
	Significantly	13	17.6 %	
	Very significantly	2	2.7 %	
4.	Very little	12	15.2 %	Ø 2.46
	Little	28	35.4 %	
	Quite significantly	30	38.0 %	
	Significantly	9	11.4 %	
	Very significantly	0	0.0 %	

Findings in Table 8 point to serious and alarming results, we can see a gradual decline in the average evaluation of a school's contribution to the development of a student's digital competences with an increasing year.

In the fourth year, out of a total of 76 students, none of them found that "the school contributed very significantly" and only 9 of them found that "the school contributed significantly" to their development of their digital competences. The opinion that "the school contributed very little or little" prevails, 50.6 % of respondents agreed with this point of view, which is really disturbing.

CONCLUSION

The results of the analysis of the opinions of students of high schools (with focus on engineering) on teaching with digital technologies in their studies and their self-assessment of their own digital competences acquired during their studies are difficult to discuss due to the absence of similar research findings. The assessment of the level of school facilities is usually built on questioning the school management, not students, and mostly non-specifically, with no relation to the field of study.

In our case, digital technology was bound to use in engineering industry production and comparable data focused on the same research problem with the comparable research sample cannot be found.

The same problem is the case of choosing responses to an item that determines the level of use of digital technology by teachers of vocational education. The respondents are in most cases teachers, not their students.

It would certainly be interesting to find a research finding on this matter that would be fed by questions to teachers and their students in parallel.

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