ЄВРОПЕЙСЬКІ НАУКОВІ СТУДІЇ

DOI: 10.28925/2311-2409.2021.356

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STUDENTS OF TECHNICAL HIGH SCHOOLS IN THE REALITY OF DIGITAL LEARNING ENVIRONMENT

The article briefly presents several national and transnational strategic documents dealing with the development of digital literacy and digital education. It analyzes the content of the concept of digital literacy, which is a prerequisite for learning and education in the digital age and the use of all the benefits and components of the digital learning environment. The authors involved in the grant task of the Technology Agency of the Czech Republic entitled "Education in Engineering Field and Its Optimization for the Need of the Labor Market" deal with many issues related to digital literacy and the use of digital technologies at secondary technical schools in a selected region of the Czech Republic. The article presents the results of empirical research, which answers the following main research questions: a) Does the view of students of these schools on the use of digital technologies in teaching affect the level of their digital competencies? b) Does the professional orientation of students according to the RIASEC method influence the self-assessment of digital competences and the use of digital technologies in teaching? c) Does the development of artificial intelligence applications in mechanical engineering influence the decision to start high school and the students' opinion on their future career in mechanical engineering? Using statistical methods, partial research hypotheses were verified and the obtained data will be used for the optimization of the school digital learning environment as well as for the process of creating digital literacy of teachers and students.

Key words: *digital learning strategy, digital learning environment, digital competencies, technical high schools.*

Introduction

Digitization as a rapidly ongoing process of application of computer, automation and robotic tools in all areas of human activity is also of interest to customers of graduates of secondary technical education. Digital literacy is required as part of the overall qualification of technical staff and its formation takes place not only in specialized subjects at primary, secondary or higher education institutions, e.g. Computers, Informatics, but it takes place in many other subjects through the use of these technologies in school teaching, in students' independent learning or their applications in practical training in manufacturing companies. As part of researching the possibilities of adapting secondary technical education through its optimization in accordance with current labor market requirements, the research team of the University of Ostrava dealt with students' views on the use of digital technologies in their teaching, digital technologies in industry as a source of motivation for technical studies and subsequent work in the field and also with the contribution of the school to the formation of digital competence of students.

Digital education strategies

The Czech Republic has accepted Digital Education Strategy until 2020 (Under the responsibility of the Ministry of Education) in 2014. Strategy is focused on putting in place suitable conditions and setting up processes so that the education complies with the latest findings and current requirements of society and the labour market that are affected by the development of digital technologies and the information society. Digital Education Strategy until 2020 formulates objectives on which the first interventions will focus:

I. opening-up education to new teaching methods and techniques through the use of digital technologies;
II. improving students' competencies in working with information and digital technologies;
III. developing computational thinking amongst students.

Seven main directions of intervention, aimed at fulfilling the three priority objectives are:

1) Ensure non-discriminatory access to digital learning resources.
2) Ensure conditions for the development of digital competencies and computational thinking amongst students.
3) Ensure conditions for the development of digital competencies and computational thinking amongst teachers.
4) Ensure the construction and renovation of educational infrastructure.
5) Support innovative procedures, monitoring and evaluation and the dissemination of their results.
6) Put in place a system to help schools to develop in the integration of digital technologies in teaching and in school life.
7) Increase the understanding of the aims and processes involved in integrating technology into education among general public.

Strategy of Digital Literacy of the Czech Republic for the Period 2015–2020 (under the responsibility of the Ministry of Labor and Social Affairs) was approved in 2015. Strategy objectives were determined as follows: 1) developing optimal tools to prepare new workers for employment; 2) support for current employees facing changes in information and communication technologies. Wider impact of the Strategy is to develop digital literacy of the citizens of the Czech Republic so that they are ready to use the potential of digital technologies for their lifelong personal development, for increasing the quality of life and for social application.

The current document responds to educational promises and challenges of artificial intelligence OECD (2020). It states that "Digitalisation has been one of the main drivers of innovation in education practices in the classroom in the past decade. While most innovation in the past decade related to an increased use of computers and the internet in the classroom, the next wave will be based on AI, or on combinations of AI and other technologies." (p. 4). "Digital technologies such as artificial intelligence (AI), the Internet of Things (IoT) and other advances in information and computer technology (ICT) provide opportunities to improve the education process. The education technology industry, often simply referred to as 'EdTech', is growing. It develops a wide range of digital solutions for education institutions and stakeholders, from online platforms to robots and smart devices. The use of digital technologies increases both the production and value of data, creating new opportunities to improve education and education policies, but also new challenges." (p. 3–4). "Education systems have started to change their curriculum and skills requirements and put a stronger emphasis on skills for innovation and citizenship in a digital era. The skills required to enter and progress in the labour market are undergoing profound changes, with more demand and emphasis on complex skills (OECD, 2019)."

The importance of digital competences for the current and future labor market is also emphasized by a new study CEDEFOP (2020) "Cedefop analysed over 70 million online job advertisements in all Member States and languages. The data show which jobs employers offer and what skills they demand within and across countries. Adapting to change is at the top of the list across the board. Working in a team, using a computer, English and assisting customers are also in high demand."

In her political guidelines, President von der Leyen highlighted the need to unlock the potential of digital technologies for learning and teaching and to develop digital skills for all. Education and training are key for personal fulfilment, social cohesion, economic growth and innovation. They are also a critical building block for a fairer and more sustainable Europe. Raising the quality and inclusiveness of education and training systems and the provision of digital skills for all during the digital and green transitions is of strategic importance for the EU. Rapid digitalisation over the past decade has transformed many aspects of work and daily life. Driven by innovation and technological evolution, the digital transformation is reshaping society, the labour market and the future of work. Employers face difficulties in recruiting highly skilled workers across a number of economic sectors, including in the digital sector. Too few adults are up- and re-skilling to fill these vacancies, often (European Union, 2020, p. 1).

To support the digitization of education and work there was created The Digital Skills and Jobs Coalition, which brings together Member States, companies, social partners, non-profit organisations and education providers, who take action to tackle the lack of digital skills in Europe. One of the four main ones Coalition targets is supporting Digital skills in education, i.e. transforming teaching and learning of digital skills in a lifelong learning perspective, including the training of teachers.

Digital literacy and acquiring digital literacy

Digital literacy (according to UNESCO, 2018) is a set of competencies needed to

- identification;
- understanding;
- interpretation;
- creation;
- communication;
- purposeful and safe use of digital technologies (their technical properties and content)

for a purpose

- maintaining or improving your quality of life
- and the quality of life of their surroundings, e.g. for the purpose of work and personal self-realization, development of their potential and maintaining or increasing participation in society).

Digital literacy has four dimensions:

1) Physical access (equipment availability, quality of equipment);
2) Motivational dimension (attitudes, perceived usefulness, centrality);
3) Competence dimension (tool control, work with information);
4) Strategic dimension (evaluiatin the effectiove use of digitzal technologies).

We will mention only two of them. To the motivational dimension we add that excellent mastery of digital technologies does not have the necessary effect if: a) the individual lacks the motivation to use technology in their daily lives and further develop digital literacy and b) or if the individual moves in a social environment with lower added value from the use of digital technologies.

The motivational dimension includes:

1) *Attitudes* that the individual has towards digital technologies and their use, i.e. motivation to use, ambitions or, conversely, concerns about their management, perception of security and legal risks, responsibility, etc.
2) *Perception* of the potential benefits of using digital technology. The discrepancy between reality and the subjective perception of the benefits of digital technologies is often caused by ignorance of the possibilities that the technology offers. Attitudes and perceptions of the benefits of digital technology are often the main reason for its non-use or low levels of digital literacy.
3) *The centrality of digital technologies* in the life of an individual, ie the degree of surrounded by an individual with digital technologies in his everyday life. This component is expressed by three factors: (1) Necessity (certain levels) of DG in the field of professional qualifications; (2) Level of use of digital technologies in the immediate environment (friends, family, work); (3) Pressure on the use of digital technologies by institutions and in the individual wider social environment (by mass media, authorities, schools).

Competence dimension is the ability to apply knowledge and skills in digital technology responsibly, independently and appropriately in the context of work, entertainment or education; is divided into:

1. Competencies related to the control of the given digital technology (computers, internet browsers, touch screens, etc.);
2. Competencies related to working with content — working with information, online communication and content creation.

There are three basic ways to develop digital literacy:

1. Informal learning at individual level (e.g. trial and error).
2. Learning through informal communities (group of friends, family, hobby club, library, online communities).
3. Formal / formalized education (using manuals, school teaching or official courses).

In the recently updated Council Recommendation of 22 May 2048 on Key Competences for Lifelong Learning (European Union, 2018), digital competence is considered one of the eight key competences. "Digital competence involves the confident, critical and responsible use of, and engagement with, digital technologies for learning, at work, and for participation in society. It includes information and data literacy, communication and collaboration, media literacy, digital content creation (including programming), safety (including digital well-being and competences related to cybersecurity), intellectual property related questions, problem solving and critical thinking".

Digital learning environment

A digital learning environment is *'an integrated collection of digital services and applications that supports students and teachers in their work'*. Digital learning environments therefore always consist of multiple components. Some components are available to all students and teachers at an institution, and others need autorization. The components are also interchangeable and expandable, so that the learning environment can always be adapted to the latest developments in education and to technological innovations.

Next generation digital learning environment-NGDLE (Johnson, Adams Becker, Estrada, Freeman, 2015) should be shaped by the wording five core principles of a NGDLE:

— *Interoperability:*
supporting integration between different components of the solution.
— *Personalization*:
moving away from a one-size-fits-all approach common in education.
— *Analytics, advising, and learning assessment*:
essentially measuring performance and learning for actionable data.
— *Collaboration:*
supporting working together across time and space.
— *Accessibility and universal design*:
including everyone in educational opportunities.

In schools, currently the most popular are *interactive whiteboards, classroom management programs*, such as MasterEye, NetSupportSchool, Netop Vision, etc. (which allow to monitor the screen on student devices), *ozobot* (a miniature robot that is used as a teaching aid and helps to develop logical thinking; consists of a motherboard with a microprocessor and auxiliary circuits; can move quickly and accurately; includes five optical sensors that allow it to orient itself in space; can also recognize colors and see lines), *Moodle* (which is used to create electronic courses on the Internet; can be used as a supplement to the classic frontal teaching, for example for homework, exercises, etc. in Czech schools; is one of the open source software; allows easy publication of teaching materials, collection tasks, creating online tests, setting up discussion forums etc.), *School Information systems* (in the Czech Republic, the most used systems include, for example, Bachelors, SAS, aSc Timetables, ISchools and others; information systems allow remote access from anywhere via the Internet) and *tablets* (which can be used, for example, with electronic interactive textbooks, they can be used for team collaboration between students, they also can be used for writing notes).

The use of digital technologies is also taken into account in all four scenarios for the development of education systems, which have been defined by a recent study (OECD, 2020). One of the features of the first scenario called "schooling extended" is that "international collaboration and technological advances support more individualized learning" and the description of the scenario further states that "as digitization allows students to work more autonomously, school staff can focus more intensely on supporting learners' emotional needs and motivation for learning" (p. 43). The second scenario, called "education outsourced", is characterized by the fact that "learning takes place through more diverse, privatised and flexible arrangements, with digital technology and a key driver." (p. 46) In the third scenario called "schools as learning hubs", we find in its features that "schools are the centerpiece of wider, dynamically evolving local education ecosystems, mapping learning opportunities across and interconnected network of educational spaces. Diverse individual and institutional players offer a variety of skills and expertise that can be brought in to support student learning (p. 49) The fourth "learn-as-you-go" scenario fundamentally incorporates digital technologies into education in the future: "Education takes place everywhere, anytime. Distinctions between formal and informal learning are no longer valid as society turns itself entirely to the power of the machine. This scenario builds on the rapid advancements of artificial intelligence, virtual and augmented reality and the Internet of Things. Vast connectivity powered by an extensive and rich digital infrastructure and abundance of data have completely changed our perception of education and learning. Learning opportunities are widely available for "free", marking the decline of established curriculum structures and dismantling of the school system. Digitization has made it possible to assess and certify knowledge, skills and attitudes in a deep and practically instantaneous manner, and the intermediary role of trusted third parties (e.g. educational institutions, private learning providers) in certification is no longer necessary." (p. 52)

Research

In this study, we present three areas of our research. The first area is focused on examining the opinion of secondary technical school students on school equipment and the use of digital technologies in school teaching and their contribution to the formation of digital competencies of students. The second area is about exploring the relationship between students' professional orientation according to the RIASEC method and students' views on the use of digital technologies in teaching and self-evaluation of digital competencies. The intention of the third area is examining the influence of the development of applications of artificial intelligence in mechanical engineering on the decision-making of applicants for secondary school studies and on the opinion of students on their future career in mechanical engineering.

Research methods and sample

All three research areas were examined using two questionnaires:

1) Author's questionnaire of grant researchers;

2) Questionnaire of professional orientation based on John Holland's theory (RIASEC methodology).

The following selected questions were analyzed from the author's questionnaire for the purposes of this study:

1. In the students' opinion, what is the equipment of the secondary school with technology enabling digital control of production processes?
2. To what extent do teachers of professional engineering subjects use the possibilities of digital technologies?
3. How can students apply their current skills using digital technologies in high school teaching?
4. To what extent has the secondary school, at which respondents are currently studying, contributed to the development of their digital competences?
5. How do the students themselves assess the level of acquisition of digital competencies?
6. To what extent have the current possibilities of automation and robotization of engineering production influenced students in choosing a secondary industrial school of mechanical engineering?
7. To what extent do students want their future work to be linked to applications of digital technologies in mechanical engineering?

The offered answers to the above questions were selected by the respondents from the appropriate five-point scale.

John Holland's theory is based on the assumption that the process of choosing a profession is a process of progressive interest differentiation, as well as personality differentiation. In the next stage of decision-making, it leads to a distinct favouring of one occupational group from six occupational classes — **R, I, A, S, E, C**.

— *Realistic* (personality with motor (manual technical) life orientation.

— *Investigative* (individuals prefer analytical, intellectual and investigative activities);

— *Artistic* (artistic personalities are characterised by original, intuitive and imaginative thinking);

— *Social* (individuals with this personality orientation are social, kind, persuasive and sociable, willing to cooperate);

— *Entrepreneurial* (individuals are ambitious, energetic, self-confident, relying on themselves, adventurous, oriented on profit or social success reached via economic, organisational or political means);

— *Conventional* (individuals are highly efficient, prone to great diligence, but conformal and adaptable in their opinions, work conscientious).

The research group consisted of 320 students of secondary engineering schools in the Moravian-Silesian Region.

Data collection took place at the end of 2019 at 2 secondary schools.

Form of inquiry: paper and pencil.

Results

The results obtained by both methods are presented in graphs and tables with commentary formulating only the essential findings.

1. Students' opinions on the school's digital equipment for production process control

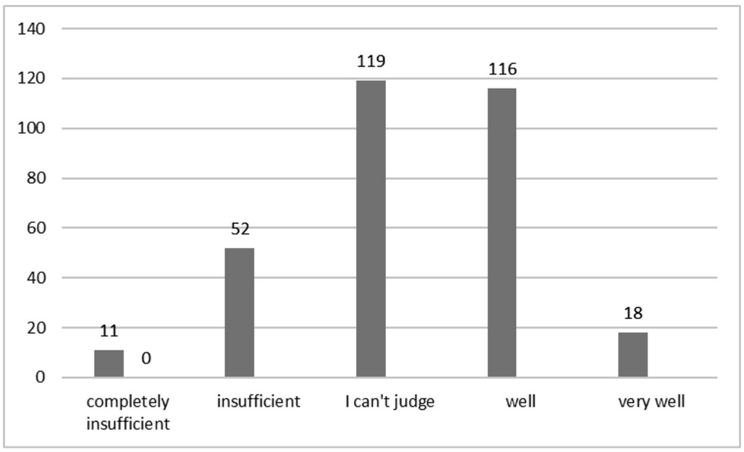

Table 1. Own table

Only a third of students consider school facilities to be good and highly equipped, and a large proportion of students cannot judge them.

2. Students' opinions on the use of digital technologies in learning

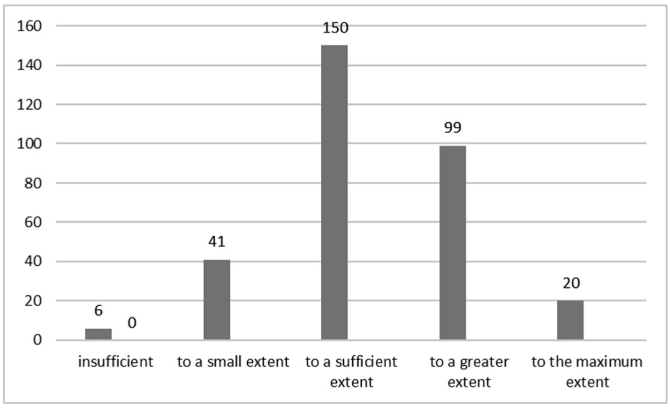

Table 2. Own table

Most students rate the use of digital technology by vocational subject teachers as sufficient up to maximum.

3. Students' opinions on the possibility of applying their current digital skills in learning

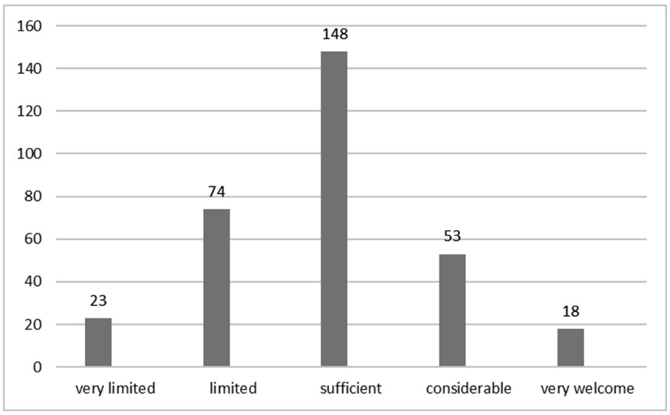

Table 3. Own table

Nearly half of the students considered the possibilities to apply their digital skills as sufficient, but nearly a third of the students felt that these possibilities were limited or very limited.

4. Students' opinions on the school's contribution to the development of their digital competences

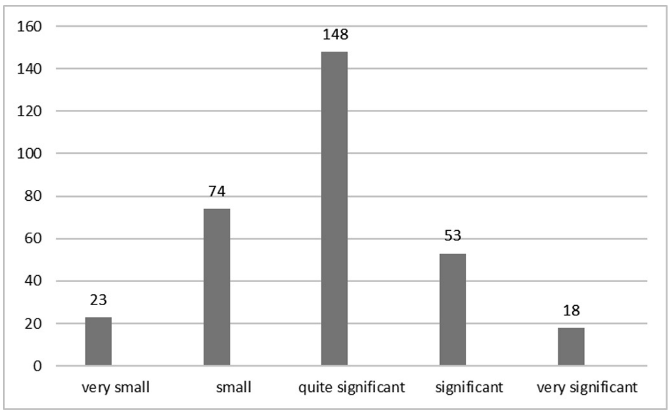

Table 4. Own table

Almost 60 % of students consider the school's contribution to the development of their digital competences to be quite significant or very significant, but 40 % of students consider this contribution to be small or very small.

5. Opinions on the four previous questions according to years of study in high school

Final year students are more critical
a) in their assessments of school facilities;
b) in the assessment of the use of digital technologies by teachers;
c) in the assessment of the ability to apply their digital competencies in learning;
d) and in the assessment of the contribution of schools to the development of their digital competences than lower grade students.

6. Dependence of the occurring indicators of RIASEC on the scale of the adaptation on digital technologies (digital competences)

	Abs. Frequencies					Rel. Frequencies						Testing Hypothesis		
Max / Q41	a	b	c	d	e	a	b	c	d	e	Sum	Criterium	DF	*p*-value
Max is R_{max}	13	40	86	13	5	4.29%	13.20 %	28.38 %	4.29%	1.65%	51.82 %	17.113	20	0.6347
Max is I_{max}	2	5	9	3	3	0.66%	1.65 %	2.97%	0.99%	0.99%	7.26%			
Max is A_{max}	1	3	12	1	1	0.33%	0.99 %	3.96%	0.33%	0.33%	5.94%			
Max is S_{max}	1	7	8	0	0	0.33%	2.31 %	2.64%	0.00%	0.00%	5.28%			
Max is E_{max}	4	21	44	10	4	1.32%	6.93 %	14.52 %	3.30%	1.32%	27.39 %			
Max is C_{max}	0	3	3	0	1	0.00%	0.99 %	0.99%	0.00%	0.33%	2.31%			

p - Significance Value $^*p \leq 0.05$ $^{**}p \leq 0.01$ $^{***}p \leq 0.001$

*In terms of my digital competences acquisition, I consider myself (offered answers):
a — a complete beginner; b — a beginner; c — an instructed user; d — a user of common software tools; e — a user of the particular field software tools.

Table 5. Own table

Students' self-evaluation of their digital competences is homogenously structured. The influence of the amplitudes of any personal types of students is not apparent.

7. The Most Frequently Occurring Indicators of RIASEC and Utilization of Digital Technologies in Technical Courses

	Abs. Frequencies				Rel. Frequencies					Testing Hypothesis		
Max / Q23	1	2	3	4	1	2	3	4	Sum	Criterium	DF	*p*-value
Max is R_{max}	48	83	26	0	15.84%	27.39%	8.58%	0.00%	51.82%	14.616	15	0.4443
Max is I_{max}	4	12	6	0	1.32%	3.96%	1.98%	0.00%	7.26%			
Max is A_{max}	3	10	5	0	0.99%	3.30%	1.65%	0.00%	5.94%			
Max is S_{max}	4	7	5	0	1.32%	2.31%	1.65%	0.00%	5.28%			
Max is E_{max}	17	43	21	2	5.61%	14.19%	6.93%	0.66%	27.39%			
Max is C_{max}	1	3	3	0	0.33%	0.99%	0.99%	0.00%	2.31%			

p - Significance Value $^*p \leq 0.05$ $^{**}p \leq 0.01$ $^{***}p \leq 0.001$

*Question asked about the way teachers of technical subjects use digital technology in teaching (offered answers):
1 — very often; 2 — often; 3 — occasionally; 4 — never.

Table 6. Own table

Students' evaluation of the frequency of the utilisation of the digital technologies in technical courses was distributed approximately homogenously. The influence of the amplitudes of any personal types of students is not apparent.

8. Predominant professional orientation, self-assessment of students' digital competencies and opinions on the frequency of use of digital technologies by teachers

In research group:

157 (51,8 %) students have the highest score in Realistic personality and 83 (27,4 %) in Enterprising personality;

57 % of students consider themselves to be moderately digital literate — "an instructed user";

This statement is surprisingly identical to the finding that the proportion of young people aged 16–19 who report they have above-basic digital skills improved substantially between 2015 (41 %) and 2017 (52 %), nearly reaching the EU average (57 %). (European Union, 2019, p. 10).

52 % of students believes that the teacher of technical coures utilise digital technologies "often" and 25 % — "very often" .

9. The degree of influence of the applicant's choice of secondary mechanical school by the current possibilities of automation and robotization of engineering production

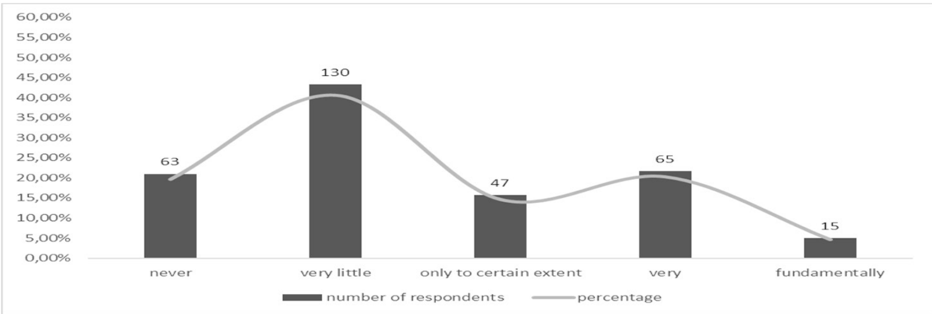

Table 7. Own table

The answers show that about 60 % of respondents evaluate the possibility of automation as a very little or no motivating factor at all.

10. The degree to what extent do respondents want to link their future to digital technology applications in mechanical engineering

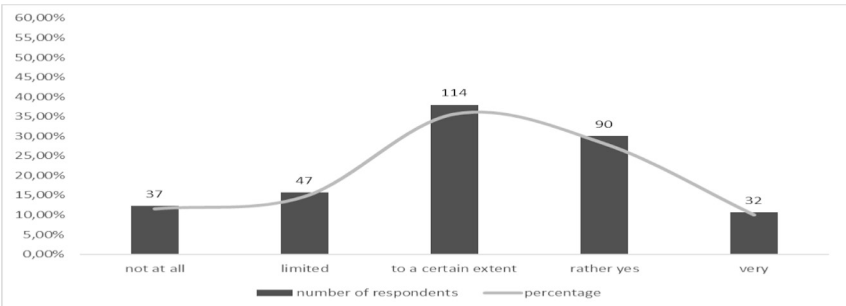

Table 8. Own table

Over 70 % of respondents expect, at least to a certain extent, to apply digital technology in the future.

11. Significance of the relationship between students' self-assessment of digital competence and their views on technological development and future work

We have not observed any dependency between the influence of current possibilities of automation and robotisation when choosing a school and pupils' level of digital competences.

It has been proved that there is a dependency between the level of pupils' self-assessment of digital competences and their wish to use digital technologies in their future work. The highest correlation between these variables has been noted in pupils from the last year of study.

Conclusion

The COVID 19 pandemic has been preventing the collection of further research data in schools for 9 months. But research into the use of digital technologies in secondary technical schools continues until 2021. The data collected so far on the reality of the digital environment at mechanical schools in the Czech Republic are valuable for the reflection of the national strategy of digital education, in terms of European plans for the development of digitization and artificial intelligence in education, but also because digital competences are considered by the current labor market as one of the three main requirements for a new employee.

Acknowledgement

This study was created as part of the research task of the Technology Agency of the Czech Republic entitled "Education in Engineering and Its Optimization for the Needs of the Labor Market", ID TJ02000083.

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СТУДЕНТИ ТЕХНІЧНИХ ЗВО У ЦИФРОВІЙ РЕАЛЬНОСТІ ОСВІТНЬОГО СЕРЕДОВИЩА

У статті представлено кілька національних і міжнародних стратегічних документів, що стосуються розвитку цифрової грамотності та цифрової освіти. Здійснено аналіз змісту концепції цифрової грамотності, яка є передумовою для навчання і виховання в цифрову епоху й максимально використовує можливості компонентів цифрового середовища навчання. Автори, які беруть участь у грантовому завданні Технологічного агентства Чеської Республіки під назвою «Освіта в галузі інженерії та її оптимізація для потреб ринку праці», займаються багатьма питаннями, пов'язаними з цифровою грамотністю і застосуванням цифрових технологій у середніх технічних школах у вибраному регіоні Чехії. У статті представлені результати емпіричного дослідження, яке дає відповіді на такі основні дослідницькі питання: а) чи впливає мотивація учнів цих шкіл до використання цифрових технологій в навчанні на рівень розвитку їхніх цифрових компетенцій? б) чи впливає професійне навчання учнів за методикою RIASEC на активне використання ними цифрових технологій? с) чи впливає розробка додатків штучного інтелекту в машинобудуванні на рішення учнів вступити до середньої технічної школи і на їхню мотивацію до кар'єрного зросту в машинобудуванні? За допомогою статистичних методів були перевірені часткові дослідницькі гіпотези. Отримані дані будуть використані для оптимізації шкільного цифрового середовища навчання та для процесу підвищення цифрової грамотності вчителів й учнів.

Ключові слова: *стратегія цифрового навчання, цифрове середовище навчання, цифрові компетенції, технічні ЗВО.*

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СТУДЕНТЫ ТЕХНИЧЕСКИХ ВУЗОВ В ЦИФРОВОЙ РЕАЛЬНОСТИ ОБРАЗОВАТЕЛЬНОЙ СРЕДЫ

В статье кратко представлены несколько национальных и международных стратегических документов, касающихся развития цифровой грамотности и цифрового образования. В ней анализируется содержание концепции цифровой грамотности, которая является предпосылкой для обучения и воспитания в цифровую эпоху и использования всех преимуществ и компонентов цифровой среды обучения. Авторы, участвующие в грантовом задании Технологического агентства Чешской Республики под названием «Образование в области инженерии и его оптимизация для нужд рынка труда», занимаются многими вопросами, связанными с цифровой грамотностью и использованием цифровых технологий в средних технических школах в выбранном регионе Чехии. В статье представлены результаты эмпирического исследования, которое дает ответы на основные исследовательские вопросы: а) влияет ли мотивация учеников этих школ к использованию цифровых технологий в обучении на уровень развития их цифровых компетенций? б) влияет ли профессиональное обучение учеников по методике RIASEC на активное использование ими цифровых технологий? с) влияет ли разработка приложений искусственного интеллекта в машиностроении на желание учеников поступить в среднюю техническую школу и на их мотивацию к карьерному росту в машиностроении? С помощью статистических методов были проверены частичные исследовательские гипотезы. Полученные данные будут использованы для оптимизации школьной цифровой среды обучения, а также для процесса повышения цифровой грамотности учителей и учеников.

Ключевые слова: *стратегия цифрового обучения, цифровая среда обучения, цифровые компетенции, технические вузы.*

Стаття надійшла до редакції 18.12.2020 р.

Прийнято до друку 24.12.2020 р.