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VOCATIONAL EDUCATION AND TRAINING FOR THE FUTURE OF WORK

SLOVAKIA

CEDEFOP REFERNET THEMATIC PERSPECTIVES

Vocational education and training for the future of work: Slovakia

Policy strategies and initiatives to prepare vocational education and training (VET) systems for digitalisation and future of work technologies

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Authors: Juraj Vantuch and Dagmar Jelínková

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Table of contents

List of tables and figures

Tables

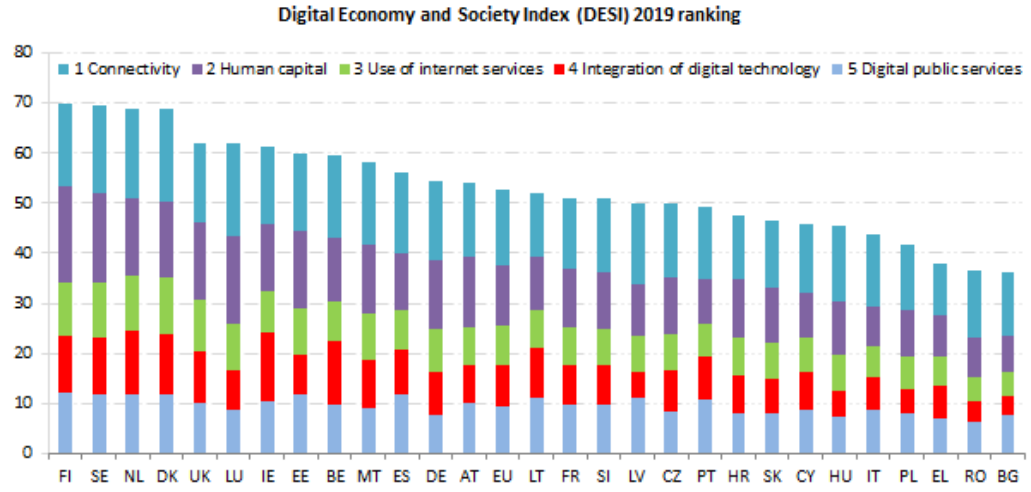
Figures

CHAPTER 1.

Introduction

Slovakia scored 21st out of 28-EU member states in the 2019 Digital Economy and Society Index (DESI, 2019) ([1]), belonging to the low-performing cluster of EU countries.

Figure 1. Digital Economy and Society Index 2019 ranking



Source: The Digital Economy and Society Index (DESI) 2019.

Despite the improved overall score, Slovakia decreased by one place in ranking compared to 2018 and remained below the EU average in all five dimensions in DESI 2019. Slovakia performs comparably well in an open data indicator (74% compared to 64% in the EU, ranked 8th), shopping and selling online (ranked 9th and 6th, respectively). Positive are results in the 'human capital' component, as a share of people with above basic digital skills is over the EU average (33% compared to 31% in the EU) and a share of people with at least basic skills is also over the EU average (59% compared to 57% in the EU). The share of people who never used the internet has declined, but with 13% it is still over the EU average with 11%. Relative numbers of Science and Technology graduates are below the EU average with a deteriorating trend (from 18.0 in 2013 to 14.7 in 2017) ([2]). Slovakia also features a very high gender gap in ICT-related studies graduates. In 2017, there were 1 485 male graduates in ICT while only 206

([1]) DESI, 2019. https://ec.europa.eu/digital-single-market/en/desi

([2]) Eurostat [educ_uoe_grad04]: Number per 1 000 inhabitants aged 20-29 years.

female graduates from ISCED 5-8 ICT programmes ([3]). In contrast to this, there are no gender gaps between males and females with regard to basic digital skills ([4]). Thus, there is a place for career guidance and counselling and fighting stereotypes in professional choice. Making the IT sector more attractive for females is a way forward, as visible from a low share of females among ICT specialists (12.3% in 2018) ([5]). See a good practice example in Chapter 5.

IMD World Digital Competitiveness Ranking ([6]) is important due to offering a detailed picture about preconditions for mastering digital transformation. Unfortunately, Slovakia is currently underperforming. Despite improvement in 2019 (47th out of 63 economies) compared to 2018 (50th), it is still below placements in years before 2018 (e.g. 40th in 2014). This index is composed of three factors – 'Knowledge', 'Technology' and 'Future Readiness'. The strongest improvement is visible is the factor 'Future Readiness' that examines the level of preparedness of economy and society to assume its digital transformation (from 53rd in 2018 to 47th in 2019). The slightest improvement is visible in the factor 'Knowledge' (from 49th in 2018 to 48th in 2019). In the following three items of the 'Future Readiness' factor Slovakia does not perform well: knowledge transfer (60th), opportunities and threats (60th), attitudes toward globalisation (59th).

The fourth worst place in assessment of cooperation between companies and universities, in ability of companies to respond quickly to opportunities and threats and the fifth worst assessment in coping globalisation challenges indicate strong institutional weakness and low preparedness for digital transformation.

It is significant that three items with the worst results in the 'Knowledge' factor – international experience (56th), foreign highly-skilled personnel (60th), net flow of international students (57th), all refer also to specific encapsulation concerning human resources. Slovakia scored comparably well in digital/technological skills (25th), thus it is apparently not due to the low quality of domestic personnel, but due to unfavourable conditions in Slovakia that hamper progress in the aforementioned 'internationalisation' related items. Slovakia seems not to be attractive for students, foreign experts and experienced Slovaks returning from abroad.

([3]) Eurostat [educ_uoe_grad02].

([4]) Iclaves, SL. (2018). Figure 2 'ICT graduates out of total graduates in 2015 by sex and country'. Figures 26-28.

([5]) Eurostat [isoc_sks_itsps].

([6]) Institute for Management Development – IMD World Competitiveness Centre (2019). See also Institute for Management Development – IMD World Competitiveness Centre (2018).

Three items with the weakest performance in the 'Technology' factor are as follows: funding for technological development (61st), development and application of technology (60th), immigration laws (59th). The first two items indicate unfavourable conditions with insufficient financial and legal backing. This indicates obstacles in the legal environment that hamper technology progress and innovations. This result fully complies with brain drain of best students and skilled professionals, signalled from universities and professional associations. Slovakia has at the same time difficulties to attract foreigners, as mentioned earlier, and have not done enough to make their integration easier, as visible from the third item.

The data related to individuals are substantially better compared to the data related to institutions. In items internet retailing and internet users Slovakia scored 31st and in the smartphone possession it scored 36th. Thus, regular citizens are apparently more ready for digitalisation challenges than institutions. In items digital/technological skills and high-tech patent grants Slovakia scored 25th and in female researchers it scored 19th. Thus, intellectual potential is, despite brain drain, still promising.

IMD World Talent Ranking 2019 ([7]) confirms serious obstacles for Slovakia to cope with future challenges, exactly with regard to human resources. Slovakia ranked 57th out of 63 economies, significantly lower compared to the 2016 results (39th). This ranking is based on three factors: the 'Investment and Development' factor measures the resources committed to cultivate home-grown human capital (47th). The 'Appeal' factor evaluates the extent to which a country attracts local and foreign talents (54th). Finally, the 'Readiness' factor quantifies the quality of the skills and competencies that are available in the country (59th).

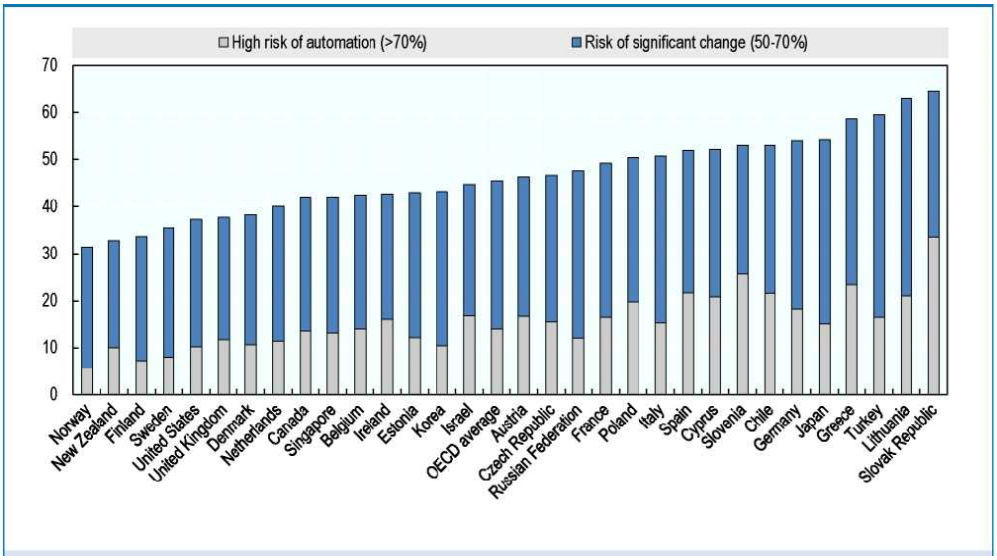
Some of the 'Appeal' factor related items confirm difficulties in human resource development: attracting and retaining talents (61st place), severe brain drain hindering competitiveness (61st), justice (61st), country's low attractiveness for foreign highly-skilled personnel (60st), worker motivation (60th). Some of the 'Readiness' factor related items indicate serious systemic weaknesses: the educational system does not meet the needs of a competitive economy (university education ranked 62nd and primary and secondary education ranked 60th).

According to OECD (Nedelkoska and Quintini, 2018, p. 45), 'the median worker in Slovakia has 62% probability of being automated'. Slovakia is at the highest risk of automation among the OECD countries ([8]).

([7]) Institute for Management Development (2019).

([8]) OECD (2018). See also OECD (2019a) – high risk of automation (meaning likelihood at least 70%) 33.6% of jobs, significant risk of change (meaning likelihood between 50% and 70%) 30.8% of jobs (Figure 2.6).

Figure 2. Jobs at risk of automation or significant change (%)



Source: OECD (2018), Chart 1. Survey of Adults Skills (PIAAC) 2012, 2015.

All the aforementioned unfavourable data and trends made automation and Industry 4.0 impact a hot issue for debates in media, among experts and also among politicians (Frey and Osborne, 2013) and (Arntz et al., 2016) ([9]). These negative findings have probably contributed to the vigorous production of strategy papers.

Apparently, further progress of Slovakia is fully in hands of politicians. Policies aimed at human resource development, improvements in legislative framework and more generous investment in support of STEM (science, technology, engineering, mathematics) related higher education, research and development are the crucial preconditions for further progress. The country also needs to diversify its economy and its dependence on manufacturing.

Since 2016, the government has prepared a bunch of strategic papers (see Chapter 2), and partial educational reforms related to the fourth industrial revolution are in progress (see Chapter 3). Good practice examples are presented in Chapter 5.

([9]) Findings were debated extensively, quoted also by the 'Learning Slovakia' paper, Ministry of Education expert group (2017).

CHAPTER 2.

VET policy strategies to adapt to digitalisation

Slovakia was among the EU early starters in developing smart specialisation strategy (RIS3) (Ministry of Education, Science, Research and Sport and Ministry of Economy, 2013). 'Automation, Robotics and Digital Technology' was identified as the first among five prospective areas of specialisation ([10]). Adopted quite early, it attracted attention in the country and also abroad, however, translation into practice was hampered by conflicting opinions of stakeholders. Finally, the 'Implementation plan for the RIS3 strategy' was only approved in 2017 ([11]), defining financial framework ([12]) for supporting research and innovation under the RIS3 policy measures and the system for monitoring and evaluating the RIS3 policy measures. Fulfilling the criteria for the RIS3 conditionality opened the window for further progress in programming the European Structural and Investment Funds ([13]).

An initiative that was complementary to documents aimed at governance and financing research and innovations was announced by the concept paper to smart industry adopted by the government on 26 October 2016 ([14]). In this document the Ministry of Economy explicitly examines possible benefits of Internet of Things, big data, cloud computing and open data.

As a result of stakeholders' reflections, a specialised expert group elaborated an action plan of smart industry adopted by the government on 10 October 2018 ([15]). 35 measures for 2018-20 were set in five priority areas ([16]). Here are

([10]) Ministry of Education, Science, Research and Sport; Ministry of Economy (2013), p. 48.

([11]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation; Ministry of Education, Science, Research and Sport; Ministry of Economy; Government Office of the SR (2017). The document was approved by the Slovak Government Council for Science, Technology and Innovation on 30 June 2017.

([12]) See e.g. Public national resources for R&I in Slovakia in 2016-20 (€m) offered in English in Table 1 in Baláž, V. et al. (2018).

([13]) Government Office of the SR (2014).

([14]) Ministry of Economy (2016).

([15]) Ministry of Economy (2018a).

([16]) The Ministry of Economy has announced evaluation of fulfilling of respective measures by the first quarter 2020, followed by the elaboration of the action plan for the 2021+ period.

some topics addressed by the measures focusing on the priority area ‘labour market and education’:

(a) systemic change of the education system to increase mathematical, technical and digital literacy in primary and secondary schools;
(b) implementation of a new model of financing higher education with a private co-financing in order to secure additional funding, ensuring greater industry impact on the content of education as well as on the higher education governance;
(c) enhancement of young people's knowledge and skills for the digital era;
(d) establishment and development of a functional system of lifelong learning.

While there is improvement in mathematics, according to PISA 2018 ([17]), and further progress can be expected from new proposals suggested by an expert group active under the National Institute for Education ([18]), there is no progress visible concerning other issues.

The smart industry action plan is important, as it contains the commitment of the government towards a ‘systemic change’ in the education system that indirectly indicates the need for a revision of the earlier adopted education reforming strategy, the ‘National programme for the development of education’ ([19]).

Many measures of this action plan were translated into a comprehensive ‘strategy for digital transformation’ adopted by the government in 2019 (and commented later in Chapter 6).

Moreover, changes in enterprises induced by challenges of the smart industry are extremely relevant for VET schools that face a more urgent need for digital transformation than general education.

Initiated by this action plan the Ministry of Economy commissioned a survey (N=251 companies) aimed at studying responsiveness of companies to the challenges of smart industry. The situation in enterprises is as follows:

(a) 80% of the companies surveyed confirmed a lack of human resources for the implementation of smart industry;
(b) 94% of companies see modern technologies as a way of addressing the problem of skills shortages;

([17]) There is a significantly better score of Slovak pupils in 2018 compared to 2015, according to OECD (2019b).

([18]) The National Institute for Education joined the Digital Coalition signing the memorandum containing the commitment to submit a concept paper aimed at improvement of mathematical education at basic and secondary schools. See National Institute for Education (2019).

([19]) Ministry of Education, Science, Research and Sport (2018).

(c) 68% of businesses have seen their employees lack skills and competencies and are not ready to work in an intelligent industry environment;
(d) 30% of companies have fully or at least partially prepared a plan to adapt employees' skills to the requirements of the intelligent industry environment.

More than 88% of enterprises confirmed the shortage of secondary VET school graduates (most notably for medium-sized enterprises, more significant shortage for high-tech enterprises). More than 90% of enterprises also confirmed the lack of secondary VET school graduates with 3 to 4-year experience (most notably for large enterprises, both high tech and low tech). Similar results are in the case of a shortage of tertiary educated professionals with experience of 3 to 4 years ([20]).

The 'Strategy of economic policy of the Slovak Republic until 2030' elaborated by the Ministry of Economy in cooperation with stakeholders was approved by the government in June 2018 ([21]), followed by the '1st Action plan' for this strategy adopted by the government on 11 December 2019. This strategy does not address digitalisation challenges in education in detail, but it speaks about the need for substantial reforming of education at all levels and stresses the need to align education to the labour market needs. This of course also encompasses improvement in digital skills. Therefore, the '1st Action plan', specifying tasks for the period until 2021, speaks about encouraging learning of mathematics, improving digital skills and (diverse) ([22]) literacies in a larger volume ([23]). Induced by the 2016 Government manifesto that contained a commitment of the government 'to approach the information society and digital single market agenda systematically' ([24]) a series of strategies were adopted by respective ministries, as reported above. Suddenly, a need for coordination has been clearly visible. The Office of the Deputy Prime Minister as an ultimate coordinating body focused on the development of a 'vision' titled 'Strategy of the digital transformation of Slovakia 2030'. This strategy was approved by the government on 7 May 2019 ([25]). Subsequently, the 'Action plan for digital transformation of Slovakia for 2019 –

([20]) Findings of this survey elaborated by the Slovak Innovation and Energy Agency (SIEA, en.siea.sk) have not yet been published, but the data were kindly offered by the Ministry of Economy.

([21]) Ministry of Economy (2018b).

([22]) E.g., financial literacy is also explicitly addressed elsewhere in that paper.

([23]) Ministry of Economy (2019), p. 10.

([24]) Government of the SR (2016).

([25]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a).

2022' was approved by the government on 3 July 2019 ([26]). See more on this pair of documents describing the 'digital transformation of Slovakia' in Chapter 6. The digital transformation of Slovakia as set by these two documents envisages elaboration of sectoral strategies. Education most relevant are two new strategies in the pipeline:

(a) a new strategy paper 'School informatisation programme with a view to 2030' ([27]) that is under preparation in cooperation of Education Ministry and ITAS, replacing the currently valid 'Concept paper for informatisation and digitalisation of the education sector until 2020'; and

(b) 'Work 4.0' document to be prepared by the Ministry of Labour, Social Affairs and Family (Labour Ministry) in cooperation with Trexima Ltd. managing the national ESF project 'Via sector-based management of innovation towards efficient labour market in the Slovakia' ([28]).

The aforementioned strategies, already developed by the Ministry of Economy, also contain important education related components:

The 2016 'Concept paper to smart industry for Slovakia' explicitly declared the need 'to innovate all state educational programmes (national curricula) at all levels of education and to include into curricula developing highly specialised skills related to robotics, Internet of Things, open data, programming, intelligence, security and protection of privacy' (Ministry of Economy, 2016, p. 36). Support for STEM related subjects and creative design has been highlighted, and introducing applied informatics into all upper secondary study programmes has been envisaged.

The 2018 'Action plan for smart industry' (Ministry of Economy, 2018a) declared digitalisation of industry and digitalisation processes in individual companies. Its ultimate goal contains five priority areas, each containing SWOT analysis and a list of measures. Research and development and innovation, and labour market and education are two of these priorities. Four out of five highlighted 'pain points' endangering successful digital transformation addressed education and read as follows:

(a) an ineffective system of lifelong learning (with a comparably very low adult participation rate);

([26]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b).

([27]) A Slovak title of this paper is 'Program informatizácie školstva s výhľadom do roku 2030'.

([28]) A Slovak title of this project is 'Sektorovo riadenými inováciami k efektívnemu trhu práce v Slovenskej republike'.

(b) mismatch between acquired knowledge/skills during formal study and labour market needs;
(c) weak labour market intelligence and low readiness of schools and universities to respond to the labour market demands;
(d) lack of skilled labour force in key sectors of the national economy;
(e) low labour market flexibility.

Fourteen measures were suggested with relevance to education and labour market (see Annex 1) reflecting a detailed SWOT analyses (Ministry of Economy, 2018a, Part 3.3.1).

The need to restructure the Slovak economy also translates into investment priorities, as visible from the activities of the Slovak Investment and Trade Development Agency (SARIO, www.sario.sk). Although SARIO traditionally promotes investment in the strongest sectors of Slovak economy (mechanical engineering, chemistry, electrical engineering, wood processing and food processing) a change has been signalled: Two new sectors in strong progress - Information and Communication Technology and Business Process Outsourcing ([29]) - create the most jobs, mostly for young people, according to SARIO. There are over 65 business service centres already established in Slovakia with over 37 thousand employees, with the average age of 33 years, offering services belonging to advanced customer operations, financial and IT services ([30]).

The currently valid 'Concept paper for informatisation and digitalisation of the education sector until 2020', elaborated by the Education Ministry, was approved by the government on 24 September 2014 (Ministry of Education, Science, Research and Sport, 2014). Three of five key measures are worth highlighting here:

(a) systemic support for the development of key and digital competences, including adaptability and flexibility;
(b) support for the development of digital skills of students and pedagogical staff in specialised contexts;
(c) training pedagogical staff to cope with challenges of digitalisation of education/learning.

Subsequently, the Education Ministry developed action plans that were however only prepared as internal documents, thus, the links to other sectors have not been addressed and a potential synergy effect has not been achieved.

([29]) See sectoral analyses at https://www.sario.sk/sk/investujte-na-slovensku/sektorove-analyzy

([30]) SARIO (2019).

On 10 January 2019, theses of the updated strategy with validity until 2030 were discussed with professional audience, and positively assessed by ITAS that is directly involved in preparing this document and SISp that declared its interest in participation. Specialised working groups composed of social partners' representatives are expected to work under the leadership of an acknowledged expert in the field. A final version of the strategy paper should be prepared by a renowned consultation firm that should be selected via public procurement in 2020. Comparison of the structures of the 2014 and 2020 policy papers is offered in Annex 3.

In parallel to the governmental efforts, industry and professional organisations are developing their own activities under the leadership of ITAS. ITAS has also initiated the creation of the Digital Coalition (https://digitalnakoalicia.sk/) as a response to the similar European initiative. A memorandum of founding members of the Digital Coalition was signed on 26 September 2017. By the end of November 2019 it has expanded to 83 members. The Digital Coalition plays a prominent role in updating the aforementioned 'Concept paper for informatisation and digitalisation of the education sector until 2020'. Besides this, many other tasks of individual members of the Digital Coalition are noteworthy, as they are instrumental for updating this paper ([31]). No doubts, the Digital Coalition is an inhibitor of progress. Bringing together public and private entities a platform is created not only for fruitful discussing of plans, but also for assessment of translation of governmental measures into practice.

([31]) See https://digitalnakoalicia.sk/zavazky/

CHAPTER 3.

VET 4.0 initiatives and programmes

The 'Learning Slovakia' reforming theses issued in October 2016 ([32]) warned against underestimation of the impact of 'the digitalisation, automation and increasing importance of additive production (e.g. 3D printing)' on VET by stating that 'Slovakia has not sufficiently responded to the challenges of transition from the industrial to information society and to the impact of new technologies on the need for new skills' ([33]).

The 2017 'Learning Slovakia' ([34]) was the first education sector paper that in detail thematised challenges of new technologies. Some relevant measures are in Annex 4.

In contrast to this narrative visionary document, the 'National programme for the development of education' (NPDE) (Ministry of Education, Science, Research and Sport, 2018) ([35]), interlinked to 'National investment plan of Slovakia for the years 2018-30' ([36]), contains an implementation plan with time bound measures and financing until 2027 agreed with the Ministry of Finance. Although reflecting 'Learning Slovakia' and explicitly making the reference to this document, NPDE is restrictive to meet priorities approved by the government.

NPDE explicitly confirms the important role in the modernisation of the education system played by digitalisation and the use of information and communication technologies. NPDE therefore supports the 'digitisation of educational content and the enhancement of the use of digital technologies in teaching and testing'. Measure 37 of the 'Implementation plan to NPDE' targets the development of a central repository of digital educational content licensed for the free distribution (CC-BY) ([37]).

In contrast to the situation a few years ago, the impact of new technologies in VET is taken seriously and e.g. the State Institute of Vocational Education's 2019 work programme contains a task aimed at identification of Industry 4.0 relevant

([32]) Ministry of Education expert group (2016).

([33]) Ibid, p. 15. Objective RŠ-3-1.

([34]) Ministry of Education expert group (2017).

([35]) NPDE was approved by the government on 27 June 2018.

([36]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2018). Approved by the government on 12 September 2018.

([37]) The implementation plan is directly accessible in a separate document at https://www.minedu.sk/data/att/13289.xls

competences and analysis of new IVET programmes amid Industry 4.0 requirements.

VET for the IT sector is expected to undergo the most turbulent changes. Already in 2015, a working group was created to revise VET programming in order to better face challenges induced by the labour market requirements. As a result, a new major field of study (Code 25, 'Information and communication technologies') ([38]) and a new state educational programme (national curricula) have been created. New programmes have been developed and partly also provided in cooperation with IT businesses that lack supply of graduates.

A front-runner in business-school cooperation was T-Systems Slovakia. Since the 2013/14 school year, a three-year post-secondary programme (ISCED 554) has been offered by the secondary VET school in Košice, completed with a 'diploma specialist' certificate and a German 'Fachinformatiker' certificate issued by the German-Slovak Chamber of Industry and Commerce ([39]). Long-term cooperation starting back in 2006 and strengthened by establishing of 'IT lab' in this school in 2016 resulted in provision of a dual form of VET. This study is practice-oriented with 30% of theory and 70% of practice, preparing for professions of net specialist, operation system specialist and applied specialist (programmer). Now, this kind of programme is offered in 16 VET schools. Students signing contracts on future employment are offered 1 530 hours of practice directly in the company. T-systems, that needs highly skilled specialists (ISCED 5+), also cooperates with universities in adjusting content of education and IT graduates' profiles to meet labour market needs ([40]). T-Systems' commitments concerning VET and university education are listed at the Digital Coalition portal ([41]). The Digital Coalition platform also contains commitments of other IT companies (including the giants like Microsoft or Cisco).

A paradigmatic change comes with a new upper secondary programme 'Intelligent and digital systems', elaborated in cooperation of social partners and starting from the 2019/20 school year. Focusing on intelligent systems graduates will be able to offer services related to Internet of Things (IoT) and in support of

([38]) Until then it was part of the major study field Electrical engineering.

([39]) A promotion video about Secondary VET School of Electrical Engineering, Komenského street, Košice, is available at https://www.spseke.sk/skola/index.php/prezentacia-skoly

([40]) See also the 2013-15 national ESF project 'Higher education institutions as a driving force of the knowledge-based society', http://www.cvtisr.sk/cvti-sr-vedecka-kniznica/projekty/vysokoskolaci-do-praxe.html?page_id=6837

([41]) See https://digitalnakoalicia.sk/zavazky/ > T-Systems.

Smart Factories, Smart Homes and Smart Cities. Focusing on digital systems graduates will be able to assist in digital transformation of companies in industry and service sectors.

Two initiatives affecting VET, but not targeting exclusively VET, are worth stressing: the 'IT academy' project (see Section 5.1) and building a repository of digital educational contents.

Many already completed ESF projects ([42]) contained a component aimed at development of digital educational contents. All these digital educational contents have been subjected to technological revision before migration into a new Central repository of digital educational content (CÚDEO/Viki) ([43]). The creation of CÚDEO/Viki ([44]) is backed by several policy papers, inter alia, the 'Action plan of open governance partnership for 2017-19' (Ministry of Interior, 2017), 'Learning Slovakia' and, of course, by the NPDE.

The creation of the central repository is an Education Ministry initiative financed from the state budget. Technological solutions are delivered by private subjects Atos IT Solutions and Services s.r.o. and AGEMSOFT, a.s. The project activities were already presented to audience, inter alia, within the Open governance week organised by the Office of the Plenipotentiary of the Government for the Development of the Civil Society in December 2018. In contrast to the 'Planet of knowledge' portal, the content of which has also been migrated into CÚDEO/Viki ([45]), the new platform is mobile access friendly ('bring your own device') and all learning contents stored in CÚDEO/Viki comply with SCORM standards. In addition to supply of ready-to-use learning contents, CÚDEO/Viki will also offer support for teachers from schools without functional LMS. Although many schools already use LMS Moodle, the expansion of this LMS is hampered by a

([42]) Learning contents were developed within the national ESF projects 'Modern education – digital education for general subjects' run by the Slovak Centre of Scientific and Technical Information, see learning contents at https://predmety.iedu.sk, 'Development of secondary VET' run by the State Institute of Vocational Education, see http://rsov.iedu.sk, and 'Activation methods in Education' run by the Methodological-Pedagogical Centre, see https://vychovy.iedu.sk. Learning contents were also developed within the project focused on teaching the English language, see https://anglictina.iedu.sk.

([43]) The acronym of CÚDEO comes from the Slovak title 'Centrálne úložisko digitálneho edukačného obsahu'. The new name 'Viki' has been considered by the Education Ministry more attractive despite criticism indicating a risk of mixing up 'Viki' with wiki and Wikipedia.

([44]) https://viki-test.iedu.sk/landing.

([45]) The 'Planet of knowledge' was the first major project focused on digitalisation of educational content, backed by the 'Concept paper for informatisation and digitalisation of the education sector until 2020' also called 'Digipedia 2020'. See http://planetavedomosti.iedu.sk

lack of administrative support. CÚDEO/Viki is ambitious to offer a central LMS for those without the fully functional school-based LMS. CÚDEO/Viki will offer a place for individualised activities of teachers, but also a publicly accessible resources. Learning contents are technologically assessed before placement into CÚDEO/Viki, organised by respective educational levels and subjects. Topics-related full-text searching should be available as well, which can support lifelong-learning of individuals regardless of their age. CÚDEO/Viki was officially launched in November 2019 together with offers of teacher training.

Quality of learning objects might be however a problem. The National Institute for Education and the State Institute of Vocational Education that are responsible for preparing national curricula have no capacities for assessment of methodological quality of learning contents and their class-readiness. Involvement of experienced practitioners is inevitable, however payment for their services has not been clarified yet. Experienced digital educational content hunters on the internet are also needed to cater CÚDEO/Viki with learning contents from open sources already successfully used abroad. Digital educational content specialists suggested by 'Learning Slovakia' to be identified from the experienced practitioners, as well as digital ambassadors/ICT coordinators suggested by ITAS need to be discussed with the pedagogical audience ([46]). Otherwise, there is a risk that technological solutions will dominate over pedagogical quality of learning contents.

The Education Ministry urgently needs to improve its own capacities. Responsibility for digitalisation is currently shared between three Education Ministry divisions (informatics, regional schooling, higher education) with no clearly defined ownership and no sufficient capacities (digital content specialists). In contrast to higher education, regional schooling is more in need of assistance, and, therefore, employment of digital learning content specialists is necessary to serve the Section of Regional Schooling of the Education Ministry.

([46]) A draft proposal of profiles of ICT coordinators have been already elaborated by the Education Ministry. Introduction of ICT coordinators into schools should be supported by the ESF project 'Transforming education and school for digital time'.

CHAPTER 4.

Using 4.0 intelligence for VET

Despite some improvement, anticipation of skills needs in Slovakia is the Achilles' heel of VET ([47]). There is a solid macroeconomic forecasting in place and there are also new data and analyses announced by the Labour Ministry and Trexima Ltd. in a dedicated portal (www.trendyprace.sk) offering the information available on the labour market (including wages), as well as the labour market forecasting within the 5-year horizon to contribute to 'optimising the education system'. There are also some analyses of job portals data available. Nevertheless, there is still only limited information about graduates' skills matching labour market need ([48]). Slovakia was still not able to absorb the traditional graduate tracking know-how, and tracer studies are very rare. Currently, only the Labour Ministry in cooperation with Trexima works on graduate tracking data ([49]). Paradoxically, the macroeconomic forecasting data of Trexima are used for regulation of secondary education. Employers' lobbyists have enforced into the Act on VET (61/2015) ([50]) an extremely hard regulation from the 2019/20 school year (prescribed numbers of places for enrolment into each programme for each secondary school), despite the criticism of the inappropriateness of using the macroeconomic model for such a detailed regulation. A systemic change can also be supported by a 'Catching-up regions initiative' of the World Bank and the European Commission in the Prešov and Banská Bystrica regions containing genuine employer surveys ([51]).

There is no evidence about direct using Big Data and AI analytics for the purposes of better understanding changing skills needs in professions/jobs and adapting VET provision. There is evidence about Big Data related commercial activities, where value added in terms of increased profit is immediately visible (e.g. in diverse remarketing and retargeting activities). There are however also activities aimed at improving public services, a frontrunner being the Ministry of Transport and Construction that commissioned a study analysing mobile operators' data to

([47]) See http://itakademia.sk/zakladne-informacie/. See part 3.1 Anticipating skill needs in Vantuch, V., Jelinkova, D. (2018).

([48]) There are only analyses trying to compare fields of study and working positions accepted after graduation. See e.g. Trexima Ltd. (2019).

([49]) First data are expected in early 2020.

([50]) See https://www.slov-lex.sk/pravne-predpisy/SK/ZZ/2015/61/20180901

([51]) See more at https://www.worldbank.org/en/region/eca/publication/slovakia-catching-up-regions

identify tourists' preferences and to suggest priorities of tourism development strategy ([52]). Besides institutions making use of Big Data for commercial purposes and businesses ready to offer services relevant to public services, there are also institutions with some experience with Big Data already having the history of cooperation with the Labour and Education Ministries.

(a) Comenius University and Slovak Governance Institute specialists published Big Data related methodological studies, e.g. discussing using online job vacancy data and voluntary web-based surveys to analyse the labour market (Kureková Mýtna et al., 2014);
(b) Institute of Economic Research of Slovak Academy of Sciences participated in the international cooperation concerning the development of an unemployment rate forecasting model with Big Data (Google search) (Tuhkuri, 2016) ([53]);
(c) Trexima Ltd., a long-term partner of the Labour Ministry, offers Big Data related analyses on employment ([54]).

National authorities only slowly reflect the need to improve labour market intelligence and skills governance. A 'Skills governance report' of Cedefop submitted to the Education Ministry in December 2019 will hopefully contribute to a substantial improvement in labour market intelligence by offering relevant data on graduates and on labour market needs to inform VET schools ([55]). Despite the main focus on tracer studies know-how, the Cedefop's experience with Big Data can also be helpful. Similarly to skills governance per se, Slovakia needs to rethink institutional backing and support for building capacities. The aforementioned digital transformation and national artificial intelligence strategies to be elaborated in 2019 could be helpful in this.

([52]) This analysis has been elaborated by Marketlocator (www.marketlocator.com) in cooperation with mobile operators, (see more at http://www.marketlocator.sk/miniterstvo-dopravy-vyuzije-big-data-od-market-locatora/); in the future, using mobile data for better adjusting public transportation services to the mobility of residents and commuters can be attractive for municipalities.

([53]) Documenting the participation of Mr. Marek Radvansky.

([54]) See more at https://www.trexima.sk/portfolio/big-data-business-inteligence/

([55]) This report is the main outcome of the project 'Governance of EU skills anticipation and matching systems: in-depth country reviews: Slovakia' in progress since 2017.

CHAPTER 5.

VET 4.0 learning practices

Six good practice examples have been selected, one representing a complex project and other five representing simple, but valuable bottom-up initiatives in three specific areas. 'IT academy' offers inspirational digital learning contents for basic and secondary schools financed by ESF. Virtual Medicine application offers innovative way to learning, 'IT Fitness test' can be helpful for pupils, students, and teachers and in fact any interested individual in self-evaluation of their IT skills. ECDL sees a strong revival in recent years and promising cooperation with self-governing regions in testing teachers and students. 'Aj ty v IT' is a passionate initiative of women aimed at supporting girls and women to be familiar with IT and to enter IT careers. Openlab is an example of unique cooperation of schools and companies aimed at developing digital skills of secondary school students.

5.1. IT academy

The national 2016-20 ESF project 'IT academy', run by the Slovak Centre of Scientific and Technical Information in partnership with five large universities, should make IT more attractive for young people. A lack of specialists hampers further development of two IT centres – Bratislava and, in particular, Košice. A strategic objective of this project reads as follows: 'Developing a model for education and training focused on informatics and ICT to meet up-to-date and prospective needs of a knowledge-based society and the labour market' ([56]). This project targets lower and upper secondary students to encourage them to cooperate with IT companies to develop digital skills and/or to study new progressive university programmes related to Data Science, Internet of Things (IoT), computer networks and enterprise information systems. Teachers are retrained to make use of new methodologies merging ICT and inquiry-based learning. Students and teachers are also offered ECDL testing for free.

The project goals are to affect/involve 33 000 basic and secondary school students, 3 000 students of higher education institutions, 2 100 pedagogical and professional staff members from regional schools and 20 university teachers. By November 2019, 40 000 basic and secondary school students and 2 500 students of higher education institutions have been already involved.

([56]) See http://itakademia.sk/zakladne-informacie/

500 teachers and 6 500 upper secondary students are expected to get free ECDL testing. By November 2019, 385 teachers and 3 953 students were involved, out of which 160 teachers and 1 350 students have been already certified.

Innovative methodologies consisting of methodological guidance for teachers, teaching materials, supporting and supplementary materials for basic school and secondary school subjects adjusted to the national curricula, are being developed with support of 200 experts and evaluated in 30 secondary schools and 60 basic schools equipped with the 'IT ScienceLab'. A list of items for respective subjects and education levels is available at the project portal ([57]). Additional schools can participate without offered equipment. As of 25 October 2019, 261 basic schools and 205 secondary schools – the so-called 'IT academy partners', were already have been contracted. For teaching seven subjects at basic schools and 10 subjects at secondary schools, there are 898 research-oriented innovative methodologies available, of which 390 for basic schools and 508 for secondary schools.

From 1 September 2018, eight new courses for computer science classes and two new motivational subjects, 'Informatics applied in natural science and mathematics' and 'Internet of Things' for mainstream classes, are being piloted. Based on the project experience a new study programme for grammar schools specialising on informatics is to be launched from the 2021/22 school year.

Similarly to other national ESF projects the impact of this project must be assessed. In addition to regular evaluation forms addressing stakeholders, parents, directors and teachers some specific instruments will be applied. A digital literacy index (composed of 27 items) was developed and applied for cooperating teachers allowing for identification of value added after retesting of teachers at the end of the project. Two specific tests will be applied to measure performance of students targeting inquiry skills and digital thinking.

5.2. 3D application for human anatomy learning

Tomáš Brngál, the 2016 Student Business Award (Comenius University, 2016) winner represented Slovakia at the second edition of 'Ideas from Europe' competition (European Commission, 2017) with a unique medical education application. This application targets medicine students and doctors, making easier human anatomy learning based on the virtual and augmented reality. He translated his student vision into a business practice now being a co-founder and CEO of the company Virtual Medicine Ltd. (www.medicinevirtual.com) 'composed of

([57]) See http://itakademia.sk/overovanie_metodik/

programmers, graphic designers and medical doctors with passion for making education more effective and intriguing experience'. High-detailed 3D models with more than 5 000 structures and precise English/Latin labels of human anatomy allow students to visualise the human body in a more complex form. Besides a unique presentation of the human body it also offers gaming-based learning (e.g. assembling respective parts of the body). The application has been firstly systemically used at the Comenius University virtual lab, but later also in secondary schools. Since then, it has been used by subjects in about 150 countries.

5.3. IT Fitness test

This self-testing online instrument has been developed in cooperation of Comenius University (content of testing), Technical University of Košice (technical solution and maintaining the portal) and ITAS (promotion and certification of self-testing). From 2019, the National Institute for Certified Educational Measurements, the national testing authority experienced in national testing of primary and secondary students and international PISA and PIAAC testing, cooperates in this testing. Tests are open and available for free ([58]), allowing assessment in five domains and in two versions: the first one for basic school pupils (ISCED 1-2) focuses on readiness of pupils to enter upper secondary studies, the second one for other students and any other interested individuals focuses on employability and meeting employers' requirements related to IT. Testing started in 2010 and over 200 000 individuals in total have been self-tested by 2019.

Table 1. IT Fitness test results in 2017, 2018 and 2019

Categories of testees	Average score (%)		
	2017	2018	2019
Basic schools, aged 7-13	34.08	41.08	44.94
Basic schools, aged 14-16	39.56	51.17	57.07
Secondary school students and adults*	42.59	36.13	49.87

NB: * Although teachers, higher education students and other adults participated, secondary school students had a dominant share.

Source: Kučera, P., Jakab, F. (2019).

Results of basic school pupils improved, however, there are strong regional disparities visible. While the Bratislava region pupils were best with 56.19%, the Trenčín region pupils only achieved 49.02% in 2019. It apparently reflects the

([58]) See www.itfitnesstest.sk

quality of IT education in basic schools. Intervention of Trenčín region municipalities that are establishers of basic schools, as well as of the regional in-service training institution is needed. Results of secondary students (and adults) decreased by over six percentage points in 2018, but it steeply increased in 2019. The following table presents the scores in two samples broken by the respective testing domains.

Table 2. IT Fitness test results in respective domains in 2019

Domains	Average score (%)	
	Basic school pupils	Secondary school students*
Internet	70.46	58.97
Security	43.15	58.47
Comprehensive tasks	51.60	48.22
Office productivity software	41.89	36.51
Collaboration tools and social networks	51.02	47.19

NB: * Although teachers, higher education students and other adults participated, secondary school students had a dominant share.

Source: Kučera, P., Jakab, F. (2019).

Compared to 2018, results in the domain Security improved significantly, but as analysts stressed in their commentary, respondents are better aware of risks, but still in need of improvement in applying their knowledge into practice ([59]). The 2019 results in mastering Office software related tasks are very disappointing, in particular in the sample of secondary school students and adults. Non-student testees had the lowest results in the same category, however they performed substantially better compared to students. This can have two reasons: longer period of practice, but also a bias caused by the sample, as, apparently, teachers and other adults with low skills declined to participate in testing.

Authors of the test suggest paying increased attention to activities aimed at critical thinking, analysing and assessing information, and to comprehensive projects interlinking IT with other school subjects. Despite improvement, special attention must be paid to computer security and to weaknesses identified in 2019 related to the work with text and table editing.

IT Fitness test is a valuable contribution to identification of weaknesses in formal education, but it also offers the opportunity for adult people to better understand their strengths and weaknesses in IT that can influence their employability.

([59]) Kučera, P., Jakab, F. (2019), p. 65.

5.4. ECDL revival

The number of registered candidates entering ECDL in 2004-19 was 46 261, of which 38 480 were certified ([60]). The total number of completed examinations (modules tested) was 238 422. After previous stagnation a remarkable increase can be seen in years 2018 and 2019. E.g., ECDL candidates completed 6 783 tests (modules) in 2018, while only 2 871 in 2017. Moreover, 16 719 tests were completed in 2019 (preliminary data as of 19 December 2019). Noteworthy is also a recent increase in the number of advance testing, e.g. from two-digit numbers in the start of the decade to 260 in 2018 and 651 in 2019 (preliminary data as of 19 December 2019).

Particularly notable are two regional projects, initiated the Slovak Society for Computer Science and accepted by two self-governing regions, aimed at testing secondary school students and teachers in 2019. It is worth stressing that the Bratislava and Nitra self-governing regions covered costs of these projects from their own budgets.

The following are results of teachers: 29 teachers from the Bratislava self-governing region and 41 teachers from the Nitra self-governing region were tested (in 6 modules in average). Only two teachers scored below the threshold of 75%.

In Bratislava region (N= 526 students), students successfully completed 1 253 tests (modules) out of 1 876. Thus, the Bratislava region students' cumulative success rate was 66.8%. In Nitra region (N= 568 students), students successfully completed 2 435 tests (modules) out of 2 553. Thus, the Nitra region students' cumulative success rate was 95.2%. Students in Nitra outperformed students from Bratislava significantly. The two projects can be seen as interesting pilots opening the door for assessment of digital skills (as measured by ECDL) in individual schools. The ECDL agency is open to offer expansion of testing to all schools nationwide. Self-governing regions are most important founders of secondary schools and expansion of projects to all self-governing regions is therefore under discussion.

([60]) The difference between the number of candidates and the number of certified is caused by diverse reasons. It does not necessarily mean their failure in testing. Some candidates are still in process and some candidates simply failed to ask for a certificate despite successful testing.

5.5. Aj Ty v IT (You in IT, too)

Launched in 2012, the initiative does an excellent job by working with girls (8 to 14 years old), female students (15 to 19 years) and women (20 to 99 years) to motivate, educate and get them for a career in IT ([61]). Altogether 12 000 girls from 30 towns throughout Slovakia has already participated in their long-term or one-day workshops. 'Aj Ty v IT' is also a local organiser of international Girl's day that connects secondary school students with IT businesses. Every year the Girl's day offers 1 200 interested girls with a unique opportunity to visit IT companies, schools offering IT programmes and other relevant institutions from the list of IT partners. The ambition of this initiative is to reach girls and women regardless of their education and age, as visible from the following activities.

'Academy of Programming' ([62]), organised with the support of Microsoft and AT&T, blends workshops of programming with micro:bits that connects creativity with technology. The workshops are organised at schools as well as open workshops to catch the youngest girls from nine years of age. The Academy also offers further training for teachers of informatics interested in making their classes more innovative.

'Scratchaton' ([63]) and 'Scratch ([64]) Match' competition for girls up to 15 years of age, organised with the support of Accenture Technology Solutions – Slovakia and SAP Slovensko, is aimed at developing programming skills. Three-hour training workshops for pupils and students are offered directly in interested schools to increase their chances in the competition.

'Coding Clubs' ([65]), organised with the support of Google.org for secondary school students on a monthly basis in seven Slovak cities (Košice, Bratislava, Žilina, Trenčín, Prešov, Banská Bystrica, Martin) cover workshops of practical IT skills, programming in Python or AI introduction.

'Women Academies' ([66]) offer training to women interested in entering IT jobs. In 2019, courses are for the first time offered also outside Bratislava. Initial data

([61]) See more on this initiative at www.ajtyvit.sk

([62]) See www.akademiaprogramovania.sk

([63]) See https://www.facebook.com/pg/AjTyVIT/photos/?tab=album&album_id=2896957433670898

([64]) Scratch is a programming language available online or in the offline version at https://scratch.mit.edu

([65]) See https://www.ajtyvit.sk/news/uz-po-druhy-raz-otvarame-aj-ty-v-it-coding-clubs/

(66) See https://eduworld.sk/cd/ts/5554/zeny-sa-zacinaju-obzerat-po-it-zmenit-karieru-mozete-aj-vy

science courses (48 hours of certified programme with Slack backed tutoring) as well as tester academies, targeting women interested in junior tester jobs, are offered in Košice and Žilina. The brand-new Machine Learning, Automated Testing or Python Academy are offered to interested women in the Slovak capital.

5.6. Openlab

OpenLab is a team-based technological accelerator for secondary school students powered by a non-profit platform, which creates unique partnerships between local companies and schools. Each OpenLab is formed in collaboration with a firm specialized on certain technology. An expert is identified from within the firm's employees or externally to be the LabMaster – a mentor leading the OpenLab. Throughout the school year, students spend five to seven hours a week in OpenLab acquiring knowledge and practical skills in specific digital technology and work on real projects in teams with firms - OpenLab partners.

Created on principles of open source and democratic society, OpenLab creates a safe environment where experimentation is encouraged and creativity valued. Developed by experts, open source methodology is freely available and regularly updated with latest tech hacks.

First, students receive necessary theoretical knowledge for respective team roles, which they apply and test on practical assignments. Next, they settle with roles they find most appealing, form teams and work on projects assigned by companies - OpenLab partners. Those partners represent clients and projects are products companies pay for. Hence, the OpenLab is sustainable and demand-driven. Most importantly, OpenLab is implemented as part of the mandatory school curriculum, thus it increases the quality of Slovak education instead of being just another voluntary after-school activity. By scaling OpenLab, a systemic change can be introduced: a demand-driven team-based talent accelerator focused on soft and digital skills within the wide range of technologies of the 21st century in Slovakia ([67]).

([67]) Rusiňáková, B. (21 May 2019)

CHAPTER 6.

Adapting to artificial intelligence and automation

6.1. National artificial intelligence strategy

On 7 May 2019 the government approved the 'Strategy of the digital transformation of Slovakia 2030' ([68]). Subsequently, the 'Action plan for digital transformation of Slovakia for 2019-22' was approved by the government on 3 July 2019 ([69]). The aforementioned strategy is presented as a vision of change. An artificial intelligence related vision is based on the following five principles:

(a) Increasing the transparency of artificial intelligence;
(b) Identification and correct addressing the social risks of artificial intelligence;
(c) Adjusting education and training to the digital age;
(d) Regulating and improving data processing;
(e) Adapting the protection of rights and freedoms to the requirements of the digital age.

The third of them has the highest relevance to education. The following is highlighted:

(a) close cooperation between teachers, entrepreneurs and policymakers to improve education and training in digital skills;
(b) improving the quality of higher education in all accredited programmes while all fields - technical, social and human - are considered equally necessary for the digital era ([70]).

Nevertheless, when discussing the weaknesses within the SWOT analysis the strategy criticises a low share of STEM students and an extremely low share of female STEM students. Slovakia lacks professionals with digital skills and, in particular, professionals with advanced digital skills ([71]). It must be therefore stressed that increased numbers of graduates from ICT programmes and in

([68]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a).

([69]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b).

([70]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a), p. 40.

([71]) Ibid, p. 18.

general from STEM programmes are extremely needed ([72]). Discussing the opportunities within the SWOT analysis the following is highlighted:

(a) expanded provision of learning opportunities focused on digital skills and related technologies at all levels of education;
(b) retraining of all inhabitants (in particular those at risk of unemployment) aimed at improving their digital skills;
(c) improved human resource management resulting in preventing brain drain abroad, making Slovakia more attractive for returning Slovaks working abroad and for the talented foreigners ([73]).

It is worth mentioning that the strategy explicitly refers ([74]) to the European Commission's 'Coordinated plan on artificial intelligence' ([75]). The specialised Annex 7 of the strategy titled 'Infobox: Recommendations for the development of artificial intelligence in Slovakia' contains 18 recommendations.

The strategy is considered a response to the European Commission call to prepare until mid-2019 a 'National artificial intelligence strategy' ([76]). While the strategy itself might be seen as too visionary, the subsequent action plan for digital transformation is expected to support translation into practice. The action plan covers measures that can be implemented in the short term; from 3Q 2019 to the end of 2022. Their funding is linked to the ESIF programming period 2014-20. Monitoring of this action plan implementation will be submitted to the government on an annual basis (as of 30 September). Future action plans valid from 2023 will be developed on the basis of the implementation of this action plan, taking also into account the EU priorities. The action plan capitalises on the earlier strategies, and many measures refer to the 2018 Action plan of smart industry ([77]) commented above.

The measures cover all areas of the strategy for digital transformation. Strategic goals are set as follows:

([72]) See the respective Eurostat data discussed in Chapter 1, justifying this need.

([73]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a), p. 18.

([74]) Ibid, p. 46.

([75]) European Commission (2018b).

([76]) This has been confirmed in interviews with representatives of both academic and business worlds.

([77]) Ministry of Economy (2018a).

(a) Promoting the digital transformation of schools and education to enhance and improve employment prospects and acquire the digital skills and competences needed for the digital era;
(b) Creating the foundations for a modern digital and data economy and for the digital transformation of the wider economy;
(c) Improving the capacity of the public administration to innovate and use data for the benefit of citizens;
(d) Supporting the development of artificial intelligence ([78]).

Embedding artificial intelligence within formal education is addressed within Strategic goal 1, where the following measure is explicitly set: 'to support higher and specialised skills for IoT, data science, artificial intelligence, programming, for STEM studies (science, technology, technology and mathematics), teamwork and collaborative and co-creative processes, creative design and business, but also for other sectors of the economy, the economy and public administration with a view to their digital transformation' ([79]).

Within Strategic goal 4, several measures address artificial intelligence research and education, e.g.

4.1.1 Involvement of the Slovak Republic in the EU Initiative concerning building European Artificial Intelligence Excellence Centres;

4.1.2 Creating an expert group to coordinate educational activities in artificial intelligence;

4.1.5 Defining and announcing calls for grant schemes for basic and applied artificial intelligence research;

4.1.6 Introduction of joint training of experts on selected aspects of artificial intelligence.

It is worth stressing that one of the most important impulses of the strategy is related to institution building. Establishing education quality management centres (centrá manažérstva kvality výučby) at universities supported by the National Innovation Lab and HUB for Education Quality Management (Národný inovačný Lab a HUB pre manažérstvo kvality výučby) and the Slovak Research Centre for Artificial Intelligence (Slovenské centrum pre výskum umelej inteligencie) was envisaged ([80]). The Slovak Research Centre for Artificial Intelligence

([78]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b), p. 4.

([79]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b), item 1.1.8, p. 25.

([80]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a), p. 46.

(Slovak.ai) ([81]) has meanwhile prepared and on 17 December 2019 submitted to the Office of the Deputy Prime Minister for Investments and Informatisation two analytical studies:

(a) Analysis and proposal of Slovakia's involvement in the EU initiative in the building EU Artificial Intelligence Excellence Centres;

(b) Manual for companies to introduce artificial intelligence.

The second study is instrumental for the digital transformation of companies and, therefore, also creates preconditions for reforming VET. Nevertheless, there is no manual available yet for the digital transformation of schools. This transformation has been envisaged by the strategy for digital transformation and by the pending 'School informatisation program with a view to 2030'.

The following can be concluded: Slovakia is still a periphery of the AI world having no financial resources for support of AI and relevant innovations, and at the same time, it is attractive for foreign investment in manufacturing rather than AI. A long period of underfinancing research and development and reluctance of national authorities to a radical change ([82]) resulted in unfavourable environment for advanced research, business-universities cooperation and start-ups-universities collaboration. The national economy structure, dependence on the automotive industry and traditional industry in general, result in deformation of the labour market requesting high amounts of blue-collar workers rather than high-end professionals able to respond to the challenges of new technologies. Brain drain of domestic talents and experts abroad and low attractiveness of Slovakia for foreigners makes Slovakia a country extremely at risk of remaining out of the AI mainstream, unless its unsound dependence on manufacturing is changed and diversification in national economy at least initiated ([83]). The 'Strategy of the digital transformation of Slovakia 2030' being a 'National artificial intelligence strategy' started a serious initiative to change the future of the Slovak economy.

([81]) The English version of the website is at https://slovak.ai/?lang=en

([82]) Slovakia ignored the EU efforts to increase investment in research and development up to 3% in 2020, setting the national 2020 target 1.2%, and achieving poor 0.88% in the Eurostat GERD (Gross domestic expenditure on R&D as % of GDP) in 2017, see https://ec.europa.eu/eurostat/tgm/table.do?tab=table&init=1&language=en&pcode=t2020_20&plugin=1

([83]) It is significant that Slovakia highly values investment in the traditional automotive industry (a new Jaguar Land Rover plant in Nitra, Slovakia opening in 2018), while more sophisticated jobs were attracted by a neighboring country offering better environment and human resources (Jaguar Land Rover engineering centre with about 100 jobs in Budapest, Hungary), see the Tata Motor Press release from 2 November 2018 for more, https://www.tatamotors.com/jlr-press-release/jaguar-land-rover-confirms-technical-engineering-office-in-hungary/

6.2. Enabling adults to cope with AI

There is no national training programme with a specific focus on enabling adults to understand the implications of AI or to learn AI methods. There are however several relevant initiatives in the pipeline, of which the following two are worth mentioning.

The Office of the Deputy Prime Minister for Investments and Informatisation launched a call for a national project supported from the ESIF aimed at assessment of digital skills of all citizens over 15 years of age, i.e. regardless of their labour status and age. The office explains expected results as follows: 'Creating a unified system for assessment and certification of digital skills is the purpose of the project 'National system for testing and certification of digital competences - eSMART'. … Thanks to the project, employers will be able to define exactly what digital skills they require from their employees' ([84]). Certification of digital competences of adults will naturally create pressure for targeted digital education of adults. The president of Association of Adult Education Institutions (AIVD, www.aivd.sk) confirmed that AIVD can cover the demand for retraining, if specified ([85]).

The aforementioned project obviously requires the creation of an appropriate reference framework, which ITAS has long promoted in Slovakia pointing to a parallel with the Common European Framework of Reference for Languages (CEFR) ([86]). Inspired by CEFR, Slovakia intends to set a reference framework containing similar levels:

A1 - A2 = basic level of informatics control;

B1 - B2 = specific / general level of control of computer science;

C1 - C2 = level of computer science specialisation;

that on the one hand accurately describes the cognitive levels of critical thinking in computer science and at the same time sets the minimum threshold necessary for professions threatened by automation to perform these professions at the time of automation.

6.3. Employees endangered by automation

Slovakia is extremely at risk of automation, as also discussed earlier, and this threat is taken very seriously. The aforementioned assessment of digital skills of

([84]) https://www.vicepremier.gov.sk/aktuality/informatizacia/digitalny-ekosystem-inkluzie-vyhodnoti-digitalne-kompetencie-nezamestnanych-i-dochodcov

([85]) An interview with the president of AIVD.

([86]) See https://www.coe.int/en/web/common-european-framework-reference-languages/level-descriptions

citizens over 15 years of age and the creation of the competence framework should be helpful in particular for employees at risk of losing jobs due to automation or at risk of substantial retraining needed by new jobs. The digital competence framework and certification of digital skills should create a basis for smooth coping with new challenges.

The main objective of the new ESF project 'Get employed, be COMPetent!' (Zamestnajte sa, buďte KOMPetentní!) ([87]) is 'to establish, by 2023, a centralised management framework for increasing digital competences (workers) and for their certification. The aim of the project is to unify the requirements of the labour market and exploit the potential of the workforce' ([88]). The project expects retraining and certification of 5 000 unemployed or employed at risk of dismissal.

([87]) See the draft proposal at https://siov.sk/wp-content/uploads/2019/02/Zamer_NP_KOMP_25102018.pdf

([88]) Ibid, p. 17.

CHAPTER 7.
Conclusions

In October 2016, 'Learning Slovakia' theses ([89]) warned against underestimation of the impact of 'the digitalisation, automatisation and increasing importance of additive production (e.g. 3D printing)' on VET, and 'Learning Slovakia' final text ([90]) suggested research and analyses necessary for evidence-based policy making.

In contrast to the situation a few years ago, impact of Industry 4.0 on society, economy and VET in particular is taken seriously. There are many policy paper adopted or under preparation. There is strong effort visible for strengthening inter-sectoral approach. 'National investment plan of Slovakia for the years 2018-30' ([91]) and the 'Strategy of the digital transformation of Slovakia 2030' is its action plan orchestrate sectoral efforts. This paper filled a gap by offering a comprehensive overarching strategy containing also measures aimed at adjustment of the VET system to digitalisation. Nevertheless, there is a risk of lack of data for evidence-based policy making and for adoption of clearly set measures. Research, inter alia suggested by 'Learning Slovakia' (see Annex 4) facilitating coping with Industry 4.0 challenges, is insufficient.

Conclusion 1

Translation of ideas of strategy papers into clearly set measures needs targeted support. Interdisciplinary discussions are necessary to identify missing research and the already identified challenges and adequate responses to gradually convert all insufficiently specified objectives into clear time-bound measures.

The following are some examples of measures in urgent need of clarification:

(a) while the importance of inclusion of Data Science into tertiary education is urgent and, in essence, clear, inclusion of Data Science into secondary education needs clarification in terms of content, training of teachers and respective funding;

(b) while the importance of improvement of digital skills cannot be questioned per se, there is a need to specify what kind of digital skills training should be offered to regular citizens, to diverse teachers and trainers, to all the population in contrasts to digital natives;

([89]) Ministry of Education expert group (2016), p. 15.

([90]) Ministry of Education expert group (2017).

([91]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2018).

(c) While a lack of IT specialists in the national economy and schools and brain drain specialists and scholars knowledgeable about new technologies is a correctly recognised threat, clearly set preventive measures are still missing.

Thus, it can be finally stressed that translating strategies (and visions) into practice must be much more pronounced. There is a justified fear of lack of time for harmonising positions of different players (respective ministries, business world and academic world) for agreement about implementation of strategy papers.

In contrast to dominant topics a few year ago, changes in VET induced by Industry 4.0 are seriously discussed. There is a progress visible in improving of infrastructure in society (access to internet), as well as schools (internet, ICT equipment and supply of digital educational contents). Although further improvement is still needed, making use of new learning environment opportunities efficiently is developing into a serious problem. There are thousands of digital contents already stored in the centralised repository and also in other smaller repositories, but their quality (in terms of class-readiness and value added concerning hard to acquire skills and knowledge) has remained unclear. While technical quality, e.g. compliance with SCORM, is seriously tested before migration into the central repository, quality of pedagogical testing can be questioned.

Conclusion 2

It is necessary to pay more attention to the quality of learning environment. The following must be taken into account:

(a) missing research;
(b) revision of already gathered digital educational contents by experienced practitioners;
(c) supporting assistance to regular teachers to master new technologies by creation of new positions: school internal ‘digital educational contents specialist’ suggested by ‘Learning Slovakia’ to be identified from the experienced practitioners, as well as digital ambassadors/ICT coordinators suggested by ITAS as school internal or school external promoters of innovations;
(d) identification of successful international digital contents that are class-ready after localisation (specificities and the language of instruction) and their translation into practice should be considered as contribution and a proof of professionalisation supported by financial bonuses for individuals and dissemination workshops aimed at good practice sharing;
(e) activities of initial teacher training institutions aimed at improving of learning environment in schools, delivery of digital educational contents, learning applications and other specific assistance aimed at mastering new

technologies should be valued in processes of external evaluation comparably to high-level research results;

(f) provision of in-service training (that is not obligatory for initial teacher training institutions) should be considered obligatory or at least an asset within an accreditation procedure;

(g) creation of a cross-cutting body within the Education Ministry responsible for improving learning environment for schools, as well as regular inhabitants, should be created to prevent fragmentation of responsibility, as technical solutions, teacher training, as well as learning contents, all result in quality of learning environment for all;

(h) learning contents initially aimed at using at schools and collected via publicly funded activities should be made accessible together with additionally gathered open resources for all inhabitants in a user-friendly way.

Finally, the following additional aspects of coping with Industry 4.0 challenges are worth mentioning. Slovakia needs to consider restructuring of its economy as it is currently among the most vulnerable EU countries. Furthermore, almost all skills governance data and subsequent governmental regulations relate to traditional professions training and short-term skills needs and the tendency to subordinate graduate profiles to the current structure of industry. Information about skills needs complying with future areas of smart specialisation of the country is missing. Although Slovakia was among the first EU countries that developed RIS3 strategy (Ministry of Education, Science, Research and Sport; Ministry of Economy, 2013) its impact on human resource development has still remained unclear. The country needs a funding scheme and research capacities for better understanding changing skills needs. There are no relevant results available either from a traditional research or from a new technology based research (Big Data and AI Analytics).

Conclusion 3

Restructuring the national economy needs to be seriously taken into account with regard to human resource development relevant for Industry 4.0 challenges. Identification of individual skills unquestionably or very likely needed and/or useful due to transferability is an inevitable first step for improving learning environment for all individuals and for better targeting and supporting learning activities of all individuals – pupils, students, employees and job seekers.

Abbreviations and acronyms

AI	artificial intelligence
AIVD	Asociácia inštitúcií vzdelávania dospelých (Association of Adult Education Institutions)
CC-BY	Creative Commons Attribution license
CÚDEO	Centrálne úložisko digitálneho edukačného obsahu (Central repository of digital educational content)
DESI	Digital Economy and Society Index
EU	European Union
IoT	Internet of Things
ICT	information and communication technology
IMD	Institute for Management Development
ISCED	International Standard Classification of Education
IT	information technology
ITAS	IT Asociácia Slovenska (IT Association of Slovakia)
IVET	initial vocational education and training
LMS	learning management system
NPDE	National programme for the development of education (Národný program rozvoja výchovy a vzdelávania)
NÚCEM	Národný ústav certifikovaných meraní vzdelávania (National Institute for Certified Educational Measurements)
OECD	Organisation for Economic Co-operation and Development
PIAAC	Programme for the International Assessment of Adult Competencies
RIS3	research and innovation strategies for smart specialisation
R&I	research and innovation
SARIO	Slovenská agentúra pre rozvoj investícií a obchodu (Slovak Investment and Trade Development Agency)
SISp	Slovenská informatická spoločnosť (Slovak Society for Computer Science)
SR	Slovak Republic
STEM	science, technology, engineering and mathematics
SWOT	strengths, weaknesses, opportunities and threats
TUKE	Technická univerzita Košice (Technical University of Košice)
VET	vocational education and training

Bibliography

URLs accessed 20.12.2019

Arntz, M. et al. (2016). *The risk of automation for jobs in OECD countries: a comparative analysis.* OECD Social, Employment and Migration Working Papers, No. 189. Paris: OECD Publishing. http://dx.doi.org/10.1787/5jlz9h56dvq7-en

Baláž, V.; Frank, K.; Ojala, T. (2018). *RIO country report 2017: Slovak Republic*. Luxembourg: Publications Office. https://rio.jrc.ec.europa.eu/en/country-analysis/Slovakia/country-report

Comenius University (2016). *Comenius University medical student Tomáš Brngál wins the 2016 Student Business Award* [Press release]. 6 December. https://uniba.sk/en/news-detail/browse/14/back_to_page/aktuality-1/article/medik-uk-tomas-brngal-vitazom-studentskej-podnikatelskej-ceny-2016/

European Commission (2017). *European ideas that will change the world* [Press release]. 15 November. https://blogs.ec.europa.eu/promotingenterprise/ideas-from-europe-smeassembly2017/

European Commission (2018a). *Artificial intelligence for Europe. Communication from the Commission to the European parliament, the European council, the Council, the European economic and social committee and the Committee of the regions*. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2018%3A237%3AFIN

European Commission (2018b). *Coordinated plan on artificial intelligence. Communication from the Commission to the European parliament, the European council, the Council, the European economic and social committee and the Committee of the regions.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM:2018:795:FIN

Frey, C. B.; Osborne, M. A. (2013). *The future of employment: how susceptible are jobs to computerisation?* Oxford: Oxford Martin School. www.oxfordmartin.ox.ac.uk/downloads/academic/future-of-employment.pdf

Government Office of the SR (2014). *Partnership agreement of the SR for the years 2014-20.* Bratislava: Government Office of the SR. www.partnerskadohoda.gov.sk/data/files/108_partnership-agreement-of-the-sr-for-the-years-2014-20_en.docx

Government of the SR (2016). *Manifesto of the Government of the Slovak Republic.* Bratislava: Government Office of the SR. www.vlada.gov.sk/data/files/6489.pdf

Iclaves, SL. (2018). *Women in the digital age: final report.* A study prepared for the European Commission DG Communications Networks, Content &

Technology. --: European Union. http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=50224

Institute for Management Development – IMD World Competitiveness Centre (2018a). *IMD world digital competitiveness ranking 2018*. Lausanne: IMD World competitiveness Centre. www.imd.org/globalassets/wcc/docs/imd_world_digital_competitiveness_ranking_2018.pdf

Institute for Management Development (2018b). *IMD world talent ranking 2018.* Lausanne: IMD https://www.imd.org/globalassets/wcc/docs/release-2018/talent-2018/talent_ranking_2018.pdf

Institute for Management Development – IMD World Competitiveness Centre (2019a). *IMD world digital competitiveness ranking 2019*. Lausanne: IMD World competitiveness Centre. https://www.imd.org/globalassets/wcc/docs/release-2019/digital/imd-world-digital-competitiveness-rankings-2019.pdf

Institute for Management Development (2019b). *IMD world talent ranking 2019.* Lausanne: IMD https://www.imd.org/globalassets/wcc/docs/release-2019/talent/imd_world_talent_ranking.pdf

Kučera, P., Jakab, F. (2019). *Správa o výsledkoch IT Fitness Testu 2019* [Report on IT Fitness Test 2019 results]. Bratislava; Košice: TUKE; NÚCEM; ITAS. https://www.nucem.sk/dl/4519/IT%20Fitness%20Zaverecna%20Sprava%202019_final.pdf

Kureková Mýtna, L.; Beblavý, M.; Thum, A.-E. (2014). *Using internet data to analyse the labour market: a methodological enquiry.* IZA discussion papers, No. 8555, Bonn: Institute for the Study of Labor (IZA). http://hdl.handle.net/10419/104645

Ministry of Economy (2016). *Koncepcia inteligentného priemyslu pre Slovensko* [Concept paper to smart industry for Slovakia]. Bratislava: Ministry of Economy. https://www.mhsr.sk/uploads/files/DIBTWTJL.docx

Ministry of Economy (2018a). *Akčný plán inteligentného priemyslu SR* [Action plan for smart industry of the SR]. Bratislava: Ministry of Economy. https://www.mhsr.sk/uploads/files/8U6RKSS5.pdf

Ministry of Economy (2018b). *Stratégia hospodárskej politiky Slovenskej republiky do roku 2030* [Strategy of economic policy of the Slovak Republic until 2030]. Bratislava: Government Office of the SR. https://rokovania.gov.sk/RVL/Material/23019/1

Ministry of Economy (2019). *1. akčný plán pre realizáciu opatrení vyplývajúcich zo Stratégie hospodárskej politiky Slovenskej republiky do roku 2030* [1st action plan for implementation of measures resulting from the Strategy of economic policy of the Slovak Republic until 2030]. Bratislava: Government Office of the SR. https://rokovania.gov.sk/RVL/Material/24027/1

Ministry of Education expert group (2016). *Návrh cieľov Národného programu rozvoja výchovy a vzdelávania: Učiace sa Slovensko* [Proposal for the

objectives of National programme for the development of education: Learning Slovakia]. Bratislava: Ministry of Education, Science, Research and Sport. www.minedu.sk/data/att/10448.pdf

Ministry of Education expert group (2017). *Učiace sa Slovensko* [Learning Slovakia]. Bratislava: Ministry of Education, Science, Research and Sport. www.minedu.sk/data/files/7532_uciace-sa-slovensko2017.pdf

Ministry of Education, Science, Research and Sport (2014). *Koncepcia informatizácie a digitalizácie rezortu školstva s výhľadom do roku 2020* [Concept paper for informatisation and digitalisation of the education sector until 2020]. Bratislava: Ministry of Education, Science, Research and Sport. www.minedu.sk/informatizacia-a-digitalizacia-skolstva/

Ministry of Education, Science, Research and Sport (2018). *Národný program rozvoja výchovy a vzdelávania* [National programme for the development of education]. Bratislava: Ministry of Education, Science, Research and Sport. www.minedu.sk/17786-sk/narodny-program-rozvoja-vychovy-a-vzdelavania/

Ministry of Education, Science, Research and Sport; Ministry of Economy (2013). *Through knowledge towards prosperity: research and innovation strategy for smart specialisation of the Slovak Republic*. Bratislava: Ministry of Education, Science, Research and Sport; Ministry of Economy. https://rio.jrc.ec.europa.eu/en/library/strategy-smart-specialisation-slovak-republic-ris3

Ministry of Interior (2017). *Návrh akčného plánu Iniciatívy pre otvorené vládnutie v Slovenskej republike na roky 2017 – 2019* [Action plan of open governance partnership for 2017 – 2019]. Bratislava: Government Office of the SR. https://rokovania.gov.sk/RVL/Material/21789/1

National Institute for Education (2019). *Slovenská digitálna koalícia rozšírená o ŠPÚ a ďalších 15 nových členov* [Slovak Digital Coalition expanded to include NIE and 15 new members]. Bratislava: National Institute for Education. Aktuality 26.11.2019 [News 26.11.2019]. http://www.statpedu.sk/sk/aktuality/novinky-main/slovenska-digitalna-koalicia-rozsirena-spu-dalsich-15-novych-clenov.html

Nedelkoska, L.; Quintini, G. (2018). *Automation, skills use and training*. OECD Social, employment and migration working papers, No. 202. Paris: OECD Publishing. http://dx.doi.org/10.1787/2e2f4eea-en

OECD (2018). *Putting faces to the jobs at risk of automation*. Policy brief on the future of work. Paris: OECD Publishing. https://www.oecd.org/employment/Automation-policy-brief-2018.pdf

OECD (2019a). OECD e*mployment outlook 2019: the future of work*. Paris: OECD Publishing. https://doi.org/10.1787/9ee00155-en

OECD (2019b). *PISA 2018 results (volume I): what students know and can do*. Paris OECD Publishing, https://doi.org/10.1787/5f07c754-en

Office of the Deputy Prime Minister of the SR for Investments and Informatisation; Ministry of Education, Science, Research and Sport; Ministry of Economy;

Government Office of the SR (2017). *Implementačný plán Stratégie výskumu a inovácií pre inteligentnú špecializáciu Slovenskej republiky* [The implementation plan for the RIS3 document]. Bratislava: Slovak Government Council for Science, Technology and Innovation, https://www.vedatechnika.sk/SK/VedaATechnikaVSR/Rada%20vldy/10.%20rokovanie%20rady%2030-6-2017/IMPLEMENTACNY-PLAN_SK_final_EK.pdf

Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2018). *Národný investičný plán SR na roky 2018-30: pilotná verzia* [National investment plan of Slovakia for the years 2018-30: pilot version]. Bratislava: Government Office of the SR. https://rokovania.gov.sk/RVL/Material/23132/1

Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019a). *Akčný plán digitálnej transformácie Slovenska na roky 2019-22.* [Action plan for digital transformation of Slovakia for 2019-22]. Bratislava: Office of the Deputy Prime Minister of the SR for Investments and Informatisation. https://www.vicepremier.gov.sk/wp-content/uploads/2019/07/Akcny-plan-DTS_2019-22.pdf

Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b). *Stratégia digitálnej transformácie Slovenska 2030* [Strategy of the digital transformation of Slovakia 2030]. Bratislava: Office of the Deputy Prime Minister of the SR for Investments and Informatisation https://www.vicepremier.gov.sk/wp-content/uploads/2019/06/Strategia-digitalnej-transformacie-Slovenska-2030.pdf

Rusiňáková, B. (21 May 2019). *OpenLab zvyšuje kvalitu digitálneho vzdelávania na stredných školách* [OpenLab enhances the quality of digital education in secondary schools]. DennikN, blog. Retrieved from https://dennikn.sk/blog/1474556/openlab-zvysuje-kvalitu-digitalneho-vzdelavania-na-strednych-skolach/

SARIO (2019). *Shared Services & Business Process Outsourcing Centers in Slovakia*. Bratislava: SARIO. https://www.sario.sk/sites/default/files/content/files/sario-ssc-bpo-centers-in-slovakia-2019-10-15_0.pdf

Trexima Ltd. (2019). *64% absolventov stredných škôl sa uplatňuje mimo odbor vzdelania, ktorí študovali* [64% of secondary school graduates enter jobs outside the field of their study]. Trexima Press release of 15 January 2019. Bratislava: Trexima. https://www.trexima.sk/64-absolventov-strednych-skol-sa-uplatnuje-mimo-odbor-vzdelania-ktori-studovali/

Tuhkuri, J. (2016). *ETLAnow: a model for forecasting with Big Data: forecasting unemployment with Google searches in the EU*. Helsinki: Research Institute of the Finnish Economy. https://www.etla.fi/wp-content/uploads/ETLAnow_Report.pdf

Vantuch, J. Jelinkova, D. (2018). *Vocational education and training in Europe – Slovakia.* Cedefop ReferNet VET in Europe reports, to be available at https://cumulus.cedefop.europa.eu/files/vetelib/2019/Vocational_Education_Training_Europe_Slovakia_2018_Cedefop_ReferNet.pdf

Weblinks

URLs accessed 29.12.2019

Association of Adult Education Institutions (Asociácia inštitúcií vzdelávania dospelých), http://www.aivd.sk
Digital Coalition (Digitálna koalícia), https://digitalnakoalicia.sk/
Government Office of the SR (Úrad vlády SR), https://www.vlada.gov.sk/
Institute of Economic Research of Slovak Academy of Sciences (Ekonomický ústav Slovenskej akadémie vied), http://www.ekonom.sav.sk/
IT Association of Slovakia (IT Asociácia Slovenska), https://itas.sk/
Methodological-Pedagogical Centre (Metodicko-pedagogické centrum), https://mpc-edu.sk/
Ministry of Education, Science, Research and Sport of the SR (Ministerstvo školstva, vedy výskumu a športu SR), http://www.minedu.sk/
Ministry of Economy of the SR (Ministerstvo hospodárstva SR), https://www.economy.gov.sk/
Ministry of Finance of the SR (Ministerstvo financií SR), https://finance.gov.sk/sk/
Ministry of Labour, Social Affairs and Family of the SR (Ministerstvo práce, sociálnych vecí a rodiny SR), https://www.employment.gov.sk/sk/
Ministry of Transport and Construction of the SR (Ministerstvo dopravy a výstavby SR), https://www.mindop.sk/
National Institute for Certified Educational Measurements (Národný ústav certifikovaných meraní vzdelávania), https://www.nucem.sk/
National Institute for Education (Štátny pedagogický ústav), http://www.statpedu.sk/
Office of the Deputy Prime Minister of the SR for Investments and Informatisation (Úrad podpredsedu vlády SR pre investície a informatizáciu), https://www.vicepremier.gov.sk/
Office of the Plenipotentiary of the Government for the Development of the Civil Society (Úrad splnomocnenca vlády SR pre rozvoj občianskej spoločnosti), http://www.minv.sk/?ros SARIO – Slovak Investment and Trade Development Agency (Slovenská agentúra pre rozvoj investícií a obchodu), https://www.sario.sk/
Slovak Government Council for Science, Technology and Innovation (Rada vlády SR pre vedu, techniku a inovácie), https://www.vedatechnika.sk/SK/VedaATechnikaVSR/Stranky/RadaVladySRpreVeduaTechniku.aspx
Slovak Society for Computer Science (Slovenská informatická spoločnosť), https://www.informatika.sk/
State Institute of Vocational Education (Štátny inštitút odborného vzdelávania), http://www.siov.sk/
Trexima Ltd., https://www.trexima.sk/

Annex 1.

Action plan for smart industry selected measures

The following are 2018 Action plan for smart industry of the Slovak Republic education and labour market related measures (Ministry of Economy, 2018a):

Measure 1: Identification of business requirements in terms of quantity and profiles of human resources relevant to the smart industry until 2025 and with the outlook up to 2030.

Measure 2: Identification of the current offer of education and training programmes relevant to the smart industry.

Measure 3: Elaboration of the study on the impact of digital transformation and the smart industry and recommendations at national level on employment, qualifications and forms of work - Work 4.0.

Measure 4: Systemic change of the education system preparing workers for the needs of practice and the smart industry in particular.

Measure 5: Update of the concept paper for informatisation of the education sector until 2020 with the outlook up to 2030.

Measure 6: The need to increase the knowledge and skills of young people for the digital age within the formal education.

Measure 7: Practice as part of the study in technical programmes at secondary schools as well as higher education institutions.

Measure 8: Co-financing of higher education from private sources.

Measure 9: Lifelong learning ([92]).

Measure 10: Programmes and projects to adapt labour force skills, including of unemployed job seekers, to meet the key requirements of smart industry for the development of soft skills, sectoral (hard) skills, and programmes aimed at development of digital skills with engagement of employers.

([92]) A functional lifelong learning system with multi-source funding is envisaged within this measure, as visible from further explanation under this dry title of the measure.

Measure 11: Anticipation of skills needs in line with the developments on the labour market, provision of labour market forecasts and better identification of demand for skilled labour force.

Measure 12: Initiating establishment of the Digital Innovation Centres in Slovakia.

Measure 13: Supporting the Digital Coalition.

Measure 14: Support for the activities of university incubators.

Annex 2.

Action plan for digital transformation of Slovakia for 2019-22

Education and training (including adjusting to AI challenges) most relevant measures ([93]) are clustered in two out of four priorities (Strategic goals 1 and 4).Strategic goal 1: Supporting the digital transformation of schools and education to improve employment prospects (of learners) and to acquire (their) digital skills and competences needed for the digital era.

Strategic goal 4: Supporting the development of artificial intelligence.

Here are the relevant measures for Strategic goal 1:

1.1.1 Preparation of the program of informatisation of the education sector by 2030.

1.1.2 A systemic change in the education system to prepare workers for the needs of practice and the economy.

1.1.3 Lifelong learning – a comprehensive systemic change, strategy and implementation of legislative measures.

1.1.4 Establishment of a working group to create a coordinated mechanism to combat misinformation.

1.1.5 Elaboration of an analysis of the state of digital skills in Slovakia with a proposal of specific measures.

1.1.6 Support for activities leading to an increase in the share of women (skilled) in IT and (working) in the digital sector.

1.1.7 Conducting a study on the effects of digital transformation with recommendations for national authorities on employment, qualifications and the division of labour – Labour 4.0 ([94]).

1.1.8 Supporting the enhancement of young people's competences for the digital age in formal education.

([93]) Office of the Deputy Prime Minister of the SR for Investments and Informatisation (2019b). Summary on pages 68-71, a detailed description on pages 19-67.

([94]) Labour 4.0 is a working title of the strategy to be prepared by the Labour Ministry.

1.1.9 Initiating actions to assess the impact of the use of intelligent systems and digital technologies on human development, health and human behaviour.

1.2.1 Making the conditions for employment of IT specialists in the state and public administration more attractive.

1.2.2 Promoting the acquisition of talents from abroad, for both study and employment, for universities and industry.

Here are the relevant measures for Strategic goal 4:

4.1.1 Involvement of the Slovak Republic in the EU Initiative in Building European Artificial Intelligence Excellence Centres.

4.1.2 Creating an expert group to coordinate educational activities on artificial intelligence.

4.1.5 Defining and announcing calls for grant schemes for basic and applied artificial intelligence research.

4.1.6 Introduction of joint training of experts on selected aspects of artificial intelligence.

4.2.5 Developing a manual for companies to introduce artificial intelligence.

4.2.6 Encouraging increased investment by foreign and Slovak companies in research activities.

Annex 3.

Comparison of strategic domains in 2020 and 2030 informatisation strategies in education

Concept paper for informatisation and digitalisation of the education sector until 2020	**Draft structure of the School information programme with a view until 2030** ([95])
• **Infrastructure of related equipment for informatisation and digitalisation of the education sector** Central level (Education Ministry sector), regional level and connectivity (school/science), sustainable operation • **Electronic services of the sector at central and regional levels** • **Digital educational contents** development and access to digital educational contents • **Digital skills and competences** adjusting state educational programmes (national curricula), enhancing the quality of in-service training of educators, innovative education centres • **Cross-sectoral, inter-ministerial and international cooperation**	• ICT infrastructure from central to regional level • Electronic services and information systems of the resort • Digital technologies for innovation and improving the quality of education • Development of competences and skills for digital transformation • Transforming the school into a digital (school), improving data management and ICT • Cybersecurity.

Source: Andrej Bederka, Education Ministry

([95]) This is a wording according to Measure 1.1.1 of the Action plan for digital transformation of Slovakia for 2019 - 2022 adopted on 3 July 2019.

Annex 4.

Some Industry 4.0 related ‘Learning Slovakia’ measures

1-12.07. Create a central repository of Creative Commons licensed digital educational contents.

1-12.12. Establish a working group, and/or support research aimed at promoting the formation of ‘digital literacy’ and a variety of other relevant competences of the population via everyday life activities, inter alia by:

(a) targeted support and promotion of using on-line public services and suitable mobile applications;
(b) creation of new or adapting existing free self-testing tools and interlink digital skills audits with recommendations on freely available education;
(c) creation a well-organized repository of learning contents allowing for independent non-formal learning of inhabitants aimed at improving their digital literacy;
(d) promoting self-assessment of digital competences with regard to Europass CV creation;
(e) involving educated seniors in adapting existing and creating new digital educational contents.

1-12.13. Establish a working group, and/or support research aimed at

(a) assessing impact of multiple types of computer games on the development of children's and youth's knowledge, skills and competences, and the assessment of risks of development harmful values and habits;
(b) identification of games with an educational effect that can attract young people, e.g. concerning the acquisition of digital, organisational and other relevant skills.

3-01.01. Initiate an interdisciplinary research ‘Slovakia at the crossroads: how to face the challenges of the fourth industrial revolution and the information society’. In order to make it clearer what kind of workforce will be requested, what would be required from VET, it has been proposed first to formulate a detailed commissioning of the research focusing on the

(a) risks of the current structure and on anticipation of changes in the society and the economy, in case of no governmental interventions;

(b) incoming changes in society and the economy due to increasing digitalisation (influence of social networks, the Internet of Things), automation and robotics;
(c) demand for knowledge, skills, attitudes and habits of the labour force under the conditions of the fourth industrial revolution, in particular for widely applicable so-called ‘portable’ or ‘transversal’ skills.

It has been proposed to initiate based on the earlier explicitly set assignment

(a) to deliver analyses of the expected impact of the fourth industrial revolution and the information society on the economy, society and education and specifically on the labour market and on vocational education and training in Slovakia;
(b) to suggest draft measures responding to the challenges of the fourth industrial revolution and information society by respective sectors.

3-03.04. Enhancing the learning environment at secondary VET schools, promoting the dissemination of digital learning materials.

It was explicitly stated that 86 (about 20%) of textbooks were missing in vocational education in the 2016/17 school year. Furthermore, it was suggested to consider introducing new school internal career positions of ‘digital educational content specialist’, specialist in searching, adjusting and testing suitable materials from a variety of external sources – and open educational resources published under the public license ‘Creative Commons’ and to systematically support administration and enriching schools’ learning management systems (such as Moodle) with pedagogically valuable content.