Policy strategies, initiatives and practices to prepare VET systems for digitalisation and future of work technologies

Slovakia

DRAFT

Please cite this publication as:
Vantuch, J.; Jelínková, D. (2019). *Adapting VET to digitalisation and the future of work: Slovakia.* Cedefop ReferNet thematic perspectives series. http://libserver.cedefop.europa.eu/vetelib/2018/adapting_VET_digitalisation_future_work_Slovakia_Cedefop_ReferNet.pdf

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Reviewed by Cedefop

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This thematic perspective was prepared based on data/information from 2018. The opinions expressed here do not necessarily reflect those of Cedefop and the interviewed experts who kindly advised authors of this report. Any possible inaccuracies or misinterpretations are ours.

Thematic perspectives are co-financed by the European Union and ReferNet national partners.

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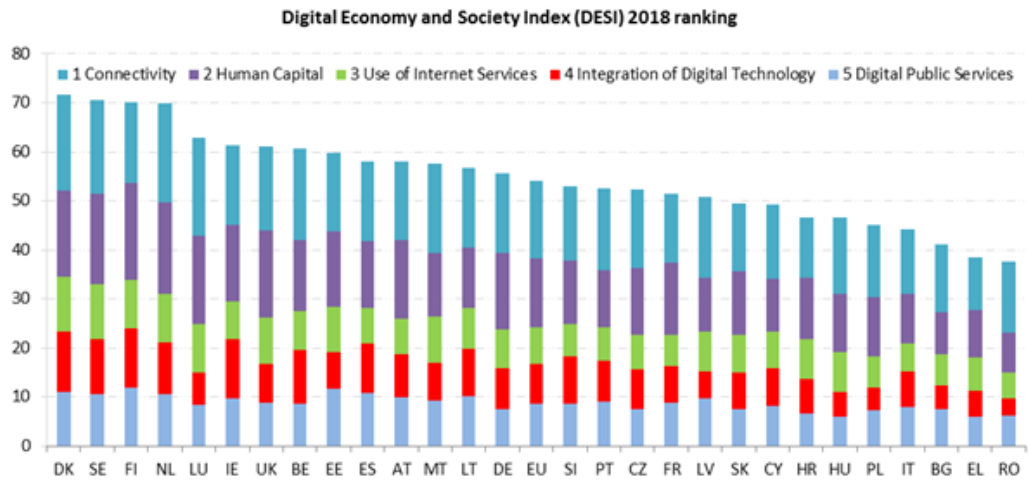
Chapter 1. Introduction

Slovakia scored 20th out of 28 EU member states in the 2018 Digital Economy and Society Index (DESI 2018) ([1]), belonging to the low-performing cluster of EU countries. It is only one step behind the medium-performing cluster of countries (places 10th to 19th).

Figure 1. **Digital Economy and Society Index 2018 ranking**



Source: The Digital Economy and Society Index (DESI) 2018.

Nevertheless, trends in human resources development measured within DESI are not favourable. While in 'Basic Skills and Usage' (DESI sub-dimension 2a) Slovakia scores similarly to EU28, the gap in 'Advanced Skills and Development' (DESI sub-dimension 2b) has increased (from -2.3 in 2016 to -4.5 points in 2018) ([2]). Slovakia is also deteriorating compared to EU28 in a share of employed persons with ICT specialist skills (from -0.6 in 2016 to -0.8 point in 2018) ([3]). Slovakia seems to have also problematic prospects due to severe deterioration compared to EU28 in relative numbers of Science and Technology graduates (from

([1]) The Digital Economy and Society Index (DESI) 2018; https://ec.europa.eu/digital-single-market/en/desi

([2]) DESI Human Capital Dimension 2b; 20.7 in Slovakia compared to 25.2 in EU28 in 2018.

([3]) DESI 2018 (Eurostat data): Percentage of total employment (LFS); 2.9% in Slovakia compared to 3.7% in EU28 in 2018.

-0.4 in 2016 to -2.5 points in 2018) ([4]). Slovakia also features a very high gender gap in ICT-related studies graduates, as the number of male graduates (6.7%) is more than 10 times higher than that of females (0.6%) ([5]). In contrast to this, there are no gender gaps between males and females with regard to basic digital skills ([6]). 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 inevitable, as currently only 10% of active IT specialists are females (see a good practice example in Section 2.4).

IMD World Digital Competitiveness Ranking ([7]) is important due to offering a detailed picture about preconditions for mastering digital transformation. Unfortunately, Slovakia's results are disappointing. In 2018 it ranked 50th out of 63 economies, deteriorating from 43rd place in 2017 and 40th in 2014. This index is composed of three factors – 'Knowledge', 'Technology' and 'Future Readiness', and it is a warning signal that Slovakia scored worst exactly in the third factor (53rd place) assessing 'Future Readiness' that examines the level of preparedness of economy and society to assume its digital transformation. In the following three items of the 'Future Readiness' factor Slovakia performed extremely poor: knowledge transfer (62nd), attitudes toward globalization (60th), cyber security (58th).

The second worst place in assessment of cooperation between companies and universities and the fourth worst assessment in coping globalization challenges indicate strong institutional weakness, and together with insufficient addressing cyber security seem to indicate a sort of encapsulation and low preparedness for digital transformation.

It is significant that three items with the worst results in the 'Knowledge' factor – international experience (57th), foreign highly-skilled personnel (61st), net flow of international students (56th), all refer also to specific encapsulation concerning human resources. Slovakia scored relatively very well in digital/technological skills (28th), 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.

([4]) DESI 2018 (Eurostat data): Number per 1 000 inhabitants aged 20-29 years; 16.6 in Slovakia compared to 19.1 in EU28 in 2018.

([5]) Iclaves, SL. (2018). Figure 2 'ICT graduates out of total graduates in 2015 by sex and country'.

([6]) Ibid. Figures 26-28.

([7]) Institute for Management Development – IMD World Competitiveness Centre (2018).

Three items with the worst performance in the 'Technology' factor are as follows: development and application of technology (62nd), scientific research legislation (62nd), funding for technological development (61st). Two items, where Slovakia scored the second worst, indicate obstacles in the legal environment that hampers technology progress and innovations. The third item – critically low funding and unfavourable legislation, undoubtedly contributes to low attractiveness of Slovakia for foreign specialists and the most serious obstacle to address immediately. This result fully complies with brain drain of best students and skilled professionals, signalled from universities and professional associations. Data related to individuals are substantially better. In items internet retailing and internet users Slovakia scored 27th and in the smartphone possession it scored 36th. Thus, regular citizens are apparently more open to digitalisation challenges than institutions. In items digital/technological skills and high-tech patent grants Slovakia scored 28th and in female researches it scored 18th. Thus, intellectual potential is, despite brain drain, still promising.

IMD World Talent Ranking 2018 ([8]) confirms serious obstacles for Slovakia to cope with future challenges exactly with regard to human resources. Slovakia ranked 59th out of 63 economies, heavily deteriorating 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 (56th). Finally, the 'Readiness' factor quantifies the quality of the skills and competencies that are available in the country (60th).

Some of the 'Appeal' factor related items confirm difficulties in human resource development: attracting and retaining talents (62nd place), severe brain drain hindering competitiveness (62nd), country's low attractiveness for foreign highly-skilled personnel (61st). Some of the 'Readiness' factor related items indicate serious systemic weaknesses: the educational system does not meet the needs of a competitive economy (62nd), university education does not meet the needs of a competitive economy (61st), management education does not meet the needs of the business community (60th). There is also a lack of skilled labour and competent senior managers (both 62nd).

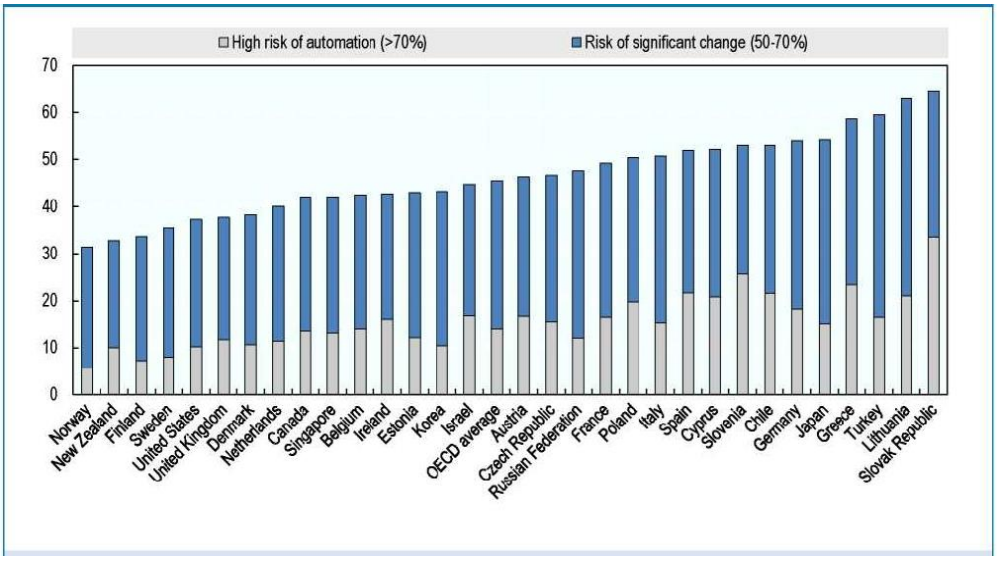
According to OECD ([9]), 'the median worker in Slovakia has 62% probability of being automated'. Slovakia is at the highest risk of automation among the OECD countries ([10]).

([8]) Institute for Management Development (2018).

([9]) Nedelkoska, L.; Quintini, G. (2018). p. 45

([10]) OECD (2018).

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 ([11]). 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 Section 2.1), and partial educational reforms related to the fourth industrial revolution are in progress (see Section 2.2). Good practice examples are presented in Section 2.4.

([11]) Frey, C. B., Osborne, M. A. (2013) and Arntz, M. et al. (2016) findings were debated extensively, quoted also by the 'Learning Slovakia' paper (Ministry of Education expert group (2017)).

Chapter 2. Description of strategies, VET initiatives, research activities and learning practices

2.1. Strategies and policies

Slovakia was among the EU early starters in developing smart specialisation strategy (RIS3) ([12]). Adopted in 2013, 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 ([13]), defining financial framework ([14]) 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 ([15]), however translation into practice is still slow.

A strong impulse came from the 2016 Government manifesto that contained commitment of the government 'to approach the information society and digital single market agenda systematically' ([16]). The Manifesto declares importance of responding to Industry 4.0 challenges, provision of secure eGovernment and other electronic/digital services, and also suggests enhancing supply of digital educational content, as well as supporting the development of digital skills of children, students and pedagogical staff ([17]).

Industry 4.0 strategy gradually developed into the policy agenda of the Ministry of Economy, Ministry of Education, Science, Research and Sport (Education Ministry) and of professional bodies. A very important draft action plan on the smart industry addressing digital skills and ICT sector development was prepared by IT Association of Slovakia (ITAS) and presented to the Education Ministry on 26 February 2018, containing SWOT analyses including a SWOT

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

([13]) 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.

([14]) 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).

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

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

([17]) Ibid. p. 34.

analysis of the education system from the labour market perspective. The draft proposal contained numerous proposals aimed at alignment of the education system to labour market needs, however without the fiscal impact and clarified implementation processes. Within the last two years there were many documents developed or are under development, directly or indirectly addressing this issue elaborated by sectoral ministries. Sectoral fragmentation and a lacking synergy was significant for this period.

In 2019, a strategy paper titled 'Strategy for digital transformation of the Slovak Republic' is under preparation by the Office of the Deputy Prime Minister of the Slovak Republic for Investments and Informatisation. This paper is hoped to fill a gap by offering a comprehensive overarching strategy containing also measures aimed at adjustment of VET system to digitalisation. On 20 December 2018, theses of the 'Strategy for digital transformation of the Slovak Republic' were presented to the professional audience. ITAS and the Slovak Society for Informatics (SIS), both important organisations representing the voices of industry and academic world, offered cooperation to the governmental team in finalising this comprehensive paper. Existence of an umbrella document was explicitly supported by the audience. Links between this umbrella document and sectoral documents, such as

(a) the 'Action plan for smart industry of the Slovak Republic', elaborated by the Ministry of Economy and adopted by the government on 10 October 2018, that followed the 'Concept paper to smart industry for Slovakia' from 2016 ([18]);
(b) a new 'Concept paper for informatisation and digitalisation of the education sector until 2030' 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';
(c) 'Work 4.0' document to be prepared by the Ministry of Labour, Social Affairs and Family (Labour Ministry);

are envisaged. This raises fears of a lack of time for harmonising positions of different players (respective ministries, the business and academic worlds) and for agreement about action plan measures that are clear and measurable.

The both aforementioned documents developed by the Ministry of Economy 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,

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

security and protection of privacy' ([19]). 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' ([20]) 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);
(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 ([21]).

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 ([22]). 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 were not addressed and a potential synergy effect has not been achieved. On 10 January 2019, theses of the updated strategy with validity until 2030 were

([19]) Ibid. p. 36.

([20]) Ministry of Economy (2018).

([21]) Ibid. Part 3.3.1.

([22]) Ministry of Education, Science, Research and Sport (2014). This concept paper is also called 'Digipedia 2020'.

discussed with professional audience, and positively assessed by ITAS that is directly involved in preparing this document and SIS that declared its interest in participation. Details of this new strategy will be elaborated by specialised working groups in the second quarter of 2019. They will be composed of social partners' representatives and will also capitalise on a review of fulfilling the 2020 strategy goals that is already in progress. The new policy paper will be subjected to public debate with professionals in autumn 2019. Comparison of structures of the 2014 and 2019 policy papers is offered in Annex 2.

In parallel to the governmental efforts, industry and professional organisations are developing their own activities under the leadership of ITAS. ITAS has also initiated creation of the Digital Coalition (https://digitalnakoalicia.sk/) as the response to the European initiative. A memorandum of founding members of the Digital Coalition was signed on 26 September 2017. Since then it has expanded to 52 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 worth mentioning, as they are instrumental for updating this paper ([23]).

A 'National artificial intelligence (AI) strategy' that should be prepared in mid-2019 responding to the EU initiative ([24])([25]) is another opportunity to rethink the future of the Slovak economy. It will apparently identify serious weaknesses. The following can be assumed: Slovakia is 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 ([26]) 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

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

([24]) European Commission (2018a).

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

([26]) 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

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 promoted. ([27])

2.2. VET 4.0 initiatives and reforms

The 'Learning Slovakia' reforming theses issued in October 2016 ([28]) warned against underestimation of the impact of 'the digitalisation, automatization 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' ([29]).

The 2017 'Learning Slovakia' ([30]) was the first education sector paper that in detail thematised challenges of new technologies. Some relevant measures are in Annex 3.

In contrast to this narrative visionary document, the 'National programme for the development of education' (NPDE) ([31]), interlinked to 'National investment plan of Slovakia for the years 2018-30' ([32]), 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

([27]) 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 neighbouring 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/

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

([29]) Ibid, p. 15. Objective RŠ-3-1.

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

([31]) Ministry of Education, Science, Research and Sport (2018). NPDE was approved by the government on 27 June 2018.

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

the development of a central repository of digital educational content licensed for the free distribution (CC-BY). ([33])

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 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') ([34])) 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 ([35]). 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 is in need of highly skilled specialists (ISCED 5+), also cooperates with universities in adjusting content of education and IT graduates' profiles to meet labour market needs ([36]). T-Systems' commitments concerning VET and university education are listed at the Digital Coalition portal ([37]). The

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

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

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

([36]) 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

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

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 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 2.4) and building 'CÚDEO', a repository of digital educational contents.

Many already completed ESF projects ([38]) 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 ([39])). The creation of CÚDEO is backed by several policy papers, inter alia, the 'Action plan of open governance partnership for 2017-19' ([40]), '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 ([41]), the new platform will be mobile access friendly ('bring your own device') and all learning contents stored in CÚDEO will comply with SCORM

([38]) 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.

([39]) The name comes from the acronym of the Slovak title 'Centrálne úložisko digitálneho edukačného obsahu'.

([40]) Ministry of Interior (2017).

([41]) 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

standards. In addition to supply of ready-to-use learning contents, CÚDEO 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 lack of administrative support. CÚDEO is ambitious to offer a central LMS for those without the fully functional school-based LMS. CÚDEO will offer a place for individualised activities of teachers, but also a publicly accessible resources. Learning contents are technologically assessed before placement into CÚDEO, 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. Technological solution should be presented to professionals in March 2019, followed by official launching in autumn 2019. Teacher training is envisaged also in 2019.

No doubt, technological solution and respective infrastructure will be functional already in 2019. Quality of learning objects might be 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 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/coordinators suggested by ITAS need to be discussed with the pedagogical audience. 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.

2.3. Industry 4.0 intelligence for VET

Despite some improvement, anticipation of skills needs in Slovakia is the Achilles heel of VET ([42]). There is a solid macroeconomic forecasting in place and there are also new data and analyses announced by the Labour Ministry and Trexima Ltd. launching a new 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 'optimizing 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 needs. ([43]) Slovakia was still not able to absorb the traditional graduate tracking know-how, and tracer studies are very rare. Paradoxically, the macroeconomic forecasting data are used for regulation of secondary education. Employers' lobbyists have enforced into the Act on VET (61/2015) ([44]) 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.

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 identify tourists' preferences and to suggest priorities of tourism development strategy. ([45]) 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.

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

([43]) There are only analyses trying to compare fields of study and working positions accepted after graduation. See e.g.Trexima Ltd. (2018).

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

([45]) 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.

(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 ([46]);
(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) ([47]);
(c) Trexima Ltd., a long-term partner of the Labour Ministry, offers Big Data related analyses on employment ([48]).

National authorities only slowly reflect the need to improve labour market intelligence and skills governance. The Education Ministry however already cooperates with Cedefop ([49]) concerning improvement of skills governance. 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.

2.4. VET 4.0 learning practices

Four good practice examples have been selected, one representing a complex project and other three 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. '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.

IT academy

The national 2016-20 ESF project 'IT academy', run by the Slovak Centre of Scientific and Technical Information, should make IT more attractive for young people. A lack of specialists hampers further development of two IT centres –

([46]) Kureková Mýtna, L. et al. (2014).

([47]) Tuhkuri, Joonas (2016), documenting the participation of Mr. Marek Radvansky.

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

([49]) 'Governance of EU skills anticipation and matching systems: in-depth country reviews: Slovakia' project has been in progress since 2017.

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.' ([50]) This project will affect 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 will be 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 will 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. 500 teachers and 6 500 upper secondary students will be offered free ECDL testing. First certificate holders received certificates related to four of eight modules (based on free choice) on 4 December 2018. 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 ([51]). Additional schools can participate without offered equipment. By the end of November 2018, 215 out of the envisaged 300 basic schools and 179 out of the envisaged 200 secondary schools – the so-called 'IT academy partners', were already involved with contracts signed or in the process of signing. For teaching 7 subjects at basic schools and 10 subjects at secondary schools, there are 899 research-oriented innovative methodologies available, of which 224 were pilot-tested in the 2017/18 school year.

From 1 September 2018, 8 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.

3D application for human anatomy learning

Tomáš Brngál, the 2016 Student Business Award ([52]) winner represented Slovakia at the second edition of 'Ideas from Europe' competition ([53]) with a unique medical education application. This application targets medicine students and doctors,

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

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

([52]) Comenius University (2016).

([53]) European Commission (2017).

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 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 the Secondary School of Health in Michalovce. Since then, it has been introduced to more schools and it has been used by subjects in about 150 countries.

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). It is available for free ([54]), allowing assessment in five domains: Office productivity software, Internet, Security, Collaboration tools and social networks and Comprehensive tasks, 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 180 000 individuals in total have been self-tested by 2018.

Table 1. **IT Fitness test results in 2017 and 2018**

Categories of testees	Average score (%)	
	2017	2018
Basic schools, aged 7-13	34.08	41.07
Basic schools, aged 14-16	39.56	51.17
Secondary schools and higher education institutions	42.59	36.60

Source: ITAS

Results of basic school pupils improved, however, there are strong regional disparities visible. While the Bratislava region pupils were best with 54%, the Trenčín region pupils only achieved 32%. It apparently reflects the quality of IT

([54]) See www.itfitnesstest.sk.

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 and tertiary students decreased by six percentage points. Critical is the low score of students in the Security domain (20.82%), followed by Office productivity software (29.51%) and Comprehensive tasks (30.8%). Non-student testees had the lowest results in the same categories.

Authors of the test suggest to pay increased attention to activities aimed at critical thinking, analysing and assessing information, and to comprehensive projects interlinking IT with other school subjects. Very worrying is the result of teachers in the Security domain (35.37%). Not only pupils and students presented difficulties concerning understanding and reaction to computer security warnings. This signals the need for massive in-service training aimed at computer security. 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.

Aj Ty v IT (You in IT, too)

Launched in 2012, the initiative does an excellent job by working with girls and female students to get them for a career in IT ([55]). 800 girls from 103 schools participated in the international Girl's day organised in Slovakia by 'Aj Ty v IT' with IT businesses. Girl's day offers 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.

'Coding in #minecraft', organised with support of Microsoft, blends programming with a popular game playing to catch the youngest girls from 9 years of age.

'Scratch ([56]) Match' competition for girls up to 16 years of age, organised with 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.

'Women Data Academies' offer training to women interested in entering IT jobs. In 2019, courses are for the first time offered also outside Bratislava. Initial data science courses (48 hours of certified programme with Slack backed tutoring), targeting women interested in data analyst jobs, are offered in Košice and Žilina.

([55]) See more on the website of this initiative at www.ajtyvit.sk.

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

Chapter 3. Conclusions

In October 2016, 'Learning Slovakia' theses ([57]) warned against underestimation of the impact of 'the digitalisation, automatization and increasing importance of additive production (e.g. 3D printing)' on VET, and 'Learning Slovakia' final text ([58]) 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' ([59]) and Digital transformation strategy under preparation by the Office of the Deputy Prime Minister of the Slovak Republic for Investments and Informatisation, should orchestrate sectoral efforts. This paper is hoped to fill 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 3) facilitating coping with Industry 4.0 challenges, is insufficient.

Conclusion 1

Translation of ideas of strategy papers into clearly set measures needs supporting targeted interdisciplinary discussions 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;

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

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

([59]) 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 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 can be suggested:

(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/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 professionalization 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 ([60]) 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

RIS3 and potential restructuring the national economy needs to be 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.

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

List of abbreviations

AI	artificial intelligence
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)
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
SIS	Slovenská informatická spoločnosť (Slovak Society for Informatics)
SR	Slovak Republic
STEM	science, technology, engineering and mathematics
SWOT	strengths, weaknesses, opportunities and threats
VET	vocational education and training

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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 ([61]):

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 ([62]).
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.
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.

([61]) Ministry of Economy (2018).

([62]) 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.

Annex 2.

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 concept paper for informatisation and digitalisatio of the education sector until 2030 (the programme for digital transformation of schools and education)
1	**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	**ICT infrastructure from central level to regional level** • Information systems in the government cloud → internet (vision of the high-speed internet) → network elements → local network → terminal equipment a schools (vision of the digital transformation of schools)
2	**Electronic services of the sector at central and regional levels**	**Electronic services and internal information systems of the education sector** • focus on: Education Ministry Office and education sector organisations
3	**Digital educational contents** • development and access to digital educational contents	**Digital technologies and educational content in instruction and ICT and information systems for education institution management** • digital educational contents organised in CÚDEO and developed by teacher • digital technologies in education for skills acquisition
4	**Digital skills and competences** • adjusting state educational programmes (national curricula), enhancing the quality of in-service training of educators, innovative education centres	**Skills and competences for digital economy** • focused on teachers, future teachers and initial teacher training institutions • education proposals competition according to the preferences of innovative teachers, schools, a professional view of the education sector and profession public
5	**Cross-sectoral, inter-ministerial and international cooperation**	**Information security** • the current emphasis on cybersecurity and youth protection

Source: Andrej Bederka, Education Ministry

Annex 3.

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. Furthemore, 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.