VOCATIONAL EDUCATION AND TRAINING FOR THE FUTURE OF WORK

CROATIA
Vocational education and training for the future of work: Croatia

Policy strategies and initiatives to prepare vocational education and training (VET) systems for digitalisation and future of work technologies
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CHAPTER 1.
Introduction

Although a unique overarching strategic framework for digitalisation does not exist in Croatia, a number of strategic and policy documents foresee different digitalisation activities in response to the changing demands of the future labour market and the Industry 4.0. The education and training system, in particular, actively addresses the challenges of digitalisation. The strategic policy framework in Croatia proposes measures to improve education system performance in teaching digital and new technology skills. Croatia's efforts to keep abreast with the challenges of the digital economy and the Industry 4.0 have thus far strongly relied on flagship initiatives in education which aimed to advance the infrastructural environment and digital skills, update curricula, promote quality and excellence in VET through investments in technology and equally support innovative VET school initiatives for technical skills development. In this regard, the e-Schools project represents the flagship public initiative for digital transformation of Croatian schools, while the comprehensive curricular reform in primary and secondary education, the modernisation of VET curricula and the network of regional competence centres in VET focus on investments in technology, curricula development and excellence in education.

The strategic framework for education reflects similar priorities. While the Strategy for education, science and technology (2014) emphasised the widespread introduction of ICT in education, better infrastructure and equipment in schools, as well as digital competencies of students and teachers, the draft Strategy for the digital maturity of schools (in 2018) expanded the national strategic scope onto comprehensive digital transformation of schools by 2030. Its priority areas focus on a digitally mature environment, digitally mature and confident teachers, support to integration of ICT in teaching and learning and evidence-based leadership and decision-making. In view of the marked shortage of ICT professionals and the emigration of young, highly educated workforce in recent years, the national coalition for digital skills and jobs, also established in 2018, aims to increase the number of qualified ICT professionals and advance digital skills of students, teachers and the workforce in general. Finally, there are important government efforts to link different databases in labour and education, managed by different public authorities, for the purposes of education and labour market monitoring, professional guidance and career development.

According to the Digital economy and society index (DESI) 2019 country report, Croatia ranks 20th out of the 28 EU Member States according to digitisation progress and thus belongs to the low-performing cluster of countries (European Commission, 2019). Digital skills of Croatian citizens are below EU-28 average
with 41% individuals who had basic or above basic overall digital skills in 2017 (1).
The older the age group, the more the Croatian workforce lags behind digitally advanced EU counties in terms of advanced digital skills (McKinsey&Company, 2018). According to DESI 2019, Croatia is performing closer to EU-28 average when it comes to digital awareness of individuals and companies in contrast to public initiatives, such as connectivity (rank 27) and digital public services (rank 22). Namely, among all dimensions, Croatia ranks highest in the human capital (rank 13) and the use of internet services by citizens (rank 15). In EU-28, it has the eight highest share of ICT graduates, which is continuously increasing. However, one fifth of Croatian citizens are not yet online, and only 4% of internet users did an online course in 2017 (EU-28 average: 9%). The number of ICT specialists had been increasing and it reached 3.3% of the total employment in 2017, which was somewhat lower than the EU-28 average (3.7%) (2). Despite this, employers still report difficulties in finding ICT specialists. Croatian companies are medium performers in digital technologies, ranked 18 in DESI 2019. Close to the European average, 10% of Croatian enterprises analyse big data from different sources and 18% of SMEs sell online. Enterprises are above average users of cloud services (22%) (European Commission, 2019).

In terms of digital maturity of the education system, the final evaluation of the e-Schools pilot project revealed that only 4% of Croatian schools were digitally mature (level 5), 32% of schools were digitally advanced (level 4), 62% of schools were digitally competent (level 3) and under 3% of schools were digital beginners (level 2) in 2018 (Commission for the development of a proposal of the strategy for the digital maturity and close team of the Commission, 2018).

The IMD world digital competitiveness ranking 2019 places Croatia (rank 51) at the lower end of 63 assessed countries, a drop from rank 44 in 2018. Croatia is performing poorly according to the future readiness criteria (rank 60), which measure adaptive attitudes of citizens, business agility and IT integration in the public sector (IMD World Competitiveness Centre, 2019). Similarly, Croatia is performing poorly in technology environment (rank 50), which assesses regulatory framework, investment and technological framework. Conversely, Croatia is performing best in the knowledge dimension (rank 42), with an improving ranking in talent (58) and training and education (31), as well as a fair score in scientific concentration (33). The talent dimension, among others, includes PISA results in Math (rank 38), student mobility (55) and digital/technological skills (57). In training and education, best scores are awarded to student-to-teacher ratio at the tertiary level (8), women with degrees (5) and graduates in sciences (23), with lower scores for employee training (63), higher education achievement (43) and public expenditure on education (29). In the science dimension, best scores are in high-tech patent grants (9) and female researchers (11), and the lowest scores are

(1) Eurostat (2018). Individuals’ level of digital skills [isoc_sk_dskl_i]
given to R&D productivity by publication (48), expenditure on R&D (42) and robots in education and R&D (40) (IMD World Competitiveness Centre, 2019).

On the other hand, the McKinsey&Company report The rise of digital challengers (3) places Croatia among so-called ‘digital challengers’, ten Central and Eastern Europe countries presently with relatively small shares of digital economy, yet with a strong potential for growth in the digital economy. At present, the digital economy is still not very advanced in Croatia: it accounted for only about 5% of GDP in 2016. However, the report predicts that the digital economy could be the new growth driver and contribute up to 8.3 billion Euros in GDP to the Croatian economy by 2025, totalling over 10 billion Euros or 16% of GDP.

According to this report, most Croatian sectors achieved low levels of digitalisation. Contrasted with relatively high shares of GDP, significant automation potential exists in six sectors that could account for 72% of the entire automation potential of Croatian economy in the long term: manufacturing, trade, accommodation and food services, transportation and warehousing, agriculture and construction. The overall automation potential in Croatia is estimated at up to 52% of working hours by 2030. The report suggests that automation could lower the demand for workers in economic sectors with the highest job vacancy rates and automation potential, particularly in accommodation, food services and construction (McKinsey&Company, 2018). Even though the report suggests that some jobs would become obsolete, at the same time, automation implies new jobs with higher productivity. In order to address wider macroeconomic implications, mitigating labour market policies need to be developed. A strong focus on technology and social skills should accompany the shift towards highly productive jobs of the digital age. Measured by the change in working hours from 2016 until 2030, the report forecasts a decrease in the use of basic cognitive, physical and manual skills, accompanied by a pronounced increase in technological skills by 52%, as well as social and emotional skills by 22%. Consequently, concerted efforts are necessary in support of digital growth, including the improvement of the overall performance of the education system, ICT infrastructure and connectivity, digital skills and entrepreneurial environment that would ease the operation of digital businesses (Novak et al., 2018).

In conclusion, the McKinsey&Company formulates ten recommendations to support digitalisation in all digital challenger countries, including Croatia. In order to build a skillset for the future, the public sector is advised to develop a wide-ranging reskilling strategy, improve education and actively counteract brain drain. The education system should ensure standard digital infrastructure, integrate digital tools and resources at schools (including online courses, virtual reality, gamification) and advance digital skills of teachers. The pre-university level curricula should be updated for the future with a greater focus on skills such as programming, entrepreneurship, leadership and communication skills. It is further

(3) Further information is available at: https://digitalchallengers.mckinsey.com/
recommended to promote STEM (science, technology, engineering and mathematics), build the ICT talent pool and encourage women to study technology to close the existing gender gap. Finally, the formal education system should enhance cooperation with the private sector to create innovative education programs and support apprenticeships.

With regard to lifelong learning, it is advised to support adults in re/up-skilling through the promotion of lifelong learning, practical trainings or incentives, support during the transition period and assistance in job seeking. In addition, English language proficiency of adults should be improved to widen access to global knowledge resources. The recommended measures for counteracting brain drain include internship and scholarship opportunities for ICT specialists. In order to capture the benefits of the independent work economy, the public sector could also analyse the gig work platforms and consider the need for policies for the platform economy, in addition to worker protection issues. The recommended cross-border digital collaboration should focus on talent pool issues, such as the brain drain and digital skills at all levels of education. Greater support to start-ups could reflect on embedding entrepreneurship in formal education, especially in STEM, and linking entrepreneurial education to start-ups and business accelerators.

The private sector is urged to prepare their talent strategy for the digital economy, update their recruitment approach and actively support re/up-skilling. Finally, individuals are encouraged to engage in lifelong learning, develop competencies with low automation risk, including digital, social and emotional skills, and use digital tools and platforms to access global knowledge. They should also be ready to take on several job opportunities or change sectors and occupations, build personal presence online and use digital platforms to find freelance jobs and gain additional sources of income (Novak et al., 2018).

Technological, communication and digitalisation developments are transforming skills demand in Croatia, according to Cedefop’s 2018 skills forecast. This is expected to negatively affect administrative and commercial managers, sales and clerical workers in the future labour market. On the other hand, legal, social, cultural and teaching professionals would be in higher demand. Moreover, occupations in declining industries, such as agriculture and manufacturing affected by automation, are expected to decrease, similarly to workers in agriculture, food processing, wood working, garment, crafts and related trades. (Cedefop, 2019).

In 2019, the study on Digital transformation of the labour market in Croatia analysed the implications of nine new forms of employment in connection with 4.0. industry and digital economy, as defined by Eurofound (Butković and Samardžija, 2019). Based on a survey from 2018, the study revealed that half of the respondents participated in at least one new form of employment – mostly young people aged 25-34 with secondary or tertiary education. A high majority was familiar with new forms of employment and around two thirds were also willing to engage in new forms of employment. In terms of the respondents’ experience, the most common new forms of employment were casual, on-demand, work (25%),
ICT-based mobile work (18%), job sharing (16%) and crowd employment (11%). Somewhat less common forms included collaborative employment and interim management (10%), employee sharing (9%), portfolio work (8%) and voucher-based work (5%); the latter only regulated in agriculture in Croatia. The most common reasons for engaging in new forms of employment reflected personal choice, such as means for improving income and professional motivation (around 70%). Less often, it reflected a necessity, such as the need for gaining work experience (especially for youth (61%)) or to improve income (51%), as well as insufficient opportunities for standard employment (41%). Further 40% preferred to work in new forms of employment and 43% perceived it as an opportunity to start their own business, especially young people. New forms of employment represented the only employment opportunity for only 25% of respondents. In terms of their benefits for the labour market, over 70% of respondents considered that the new forms of employment combatted high taxes, red tape and low wages. Respondents with prior experience in new forms of labour also mentioned they prevented low employment and emigration (Butković and Samardžija, 2019).

Within this study, the interviews with labour market and digitalisation experts, employers in ICT, unions, employers’ association and freelancers revealed a number of shortcomings in the labour legislation that inadequately regulated new forms of employment. These included inadequate protection mechanisms for workers, as well as low flexibility for employers, which hampered digital competitiveness of Croatian companies. Based on its findings, the study formulated several recommendations, including a revision of the labour and tax legislation, which would clearly regulate new forms of employment, offer fair conditions for workers and simplify employment procedures. The introduction of voucher-based work could be considered in other sectors as well, in addition to agriculture. Social partners could propose a new model of employment that would allow more flexibility in defining working hours and location. Unions should devise strategies for including more freelancers and other non-standard workers in their membership. Finally, the study stressed that an education reform with a focus on developing digital, communication and STEM skills at all levels of education was paramount. This included increasing the number of STEM graduates and reforming VET to include higher shares of work-based learning and employers’ involvement in the education process. It also proposed targeted professional guidance, increased participation in lifelong learning and facilitated validation of informal and non-formal learning (Butković and Samardžija, 2019).
CHAPTER 2.
VET policy strategies to adapt to digitalisation

2.1. Strategic framework in education and training

At present, Croatia has not set out to elaborate a dedicated national policy document targeted at VET reform in response to the changing labour market demands of the digital age and the fourth industrial and information revolution. However, there are several strategic documents in different policy domains, which envision the education system contribution to developing skills for the future to some extent.

The *Strategy for education, science and technology* (SEST) from 2014 focuses on the development of digital educational contents, tools and methodology for the application of ICT in teaching and learning, teacher training and independent development of digital materials by teachers. Most importantly, SEST introduces e-Schools, the flagship government project aimed at comprehensive digitalisation of Croatian schools and regional competence centres in VET, further discussed below (Republic of Croatia, 2014b). In line with the strategic objectives, the Operational programme efficient human resources 2014-20 sets funding priorities for the European Social Fund in Croatia, which include the e-Schools project, quality pre-service and in-service teacher training for ICT integration in education, the development of general education outcome-based curricula, as well as innovative teaching and e-learning tools. The Operational programme priorities for VET focus on regional competence centres, digitisation of the continuous professional development system for VET teachers and innovative VET school initiatives for introducing advanced technical skills development in VET curricula (Republic of Croatia, 2014a).

The *Smart specialisation strategy* defines five thematic priority areas for smart, inclusive and sustainable development of Croatia for 2016-20 which rely on advanced technologies and top research and development (R&D) expertise. The priority areas are: health and quality of life (e.g. regenerative medicine, preventive medicine and diagnostics), energy and sustainable environment (e.g. smart cities, smart buildings, smart grids), transportation and mobility, security (including cybersecurity), and food and bioeconomy. The proposed technological solutions involve advanced ICT and key enabling technologies (KET), automation systems, computer vision, machine learning, robotics, sensor technology and the Internet of Things (IoT), big data analysis, cloud solutions, autonomous vehicles, 3D printing, and machine-to-machine communication. With regard to education, the *Smart specialisation strategy* focuses on smart skills development. The implementation instruments encompass mid-term skills anticipation and the application of the Croatian qualification framework (CROQF) mechanisms for the development of
educational programmes based on mid-term and future skills forecasts. The main indicators include outcome-based sector curricula in VET priority areas and qualifications developed in line with CROQF (Republic of Croatia, 2016).

2.2. Strategy for the digital maturity of schools

As the most recent targeted policy initiative, the *Strategy for the digital maturity of schools* in Croatia was drafted in 2018. Based on the results of the e-Schools pilot project, the Strategy defines priority actions that would steer future investment in digital technologies in education and define the upcoming funding priorities of the European structural and investment funds in Croatia. It fits into the broader framework of SEST and the upcoming *National development strategy* for the period up to 2030, which proposes digital society among its priority areas.

The first strategic area, digitally mature environment, focuses on infrastructure, equipment and cybersecurity at schools, including data protection and cyberbullying. The second strategic area focuses on digitally mature and confident teachers as the main drivers of ICT integration in teaching and learning. It prioritises teacher training in digital competencies, rewards to teachers for integrating ICT in education and support to communities of practitioners for peer learning among teachers. The third strategic area involves the development of student-oriented methodology for ICT integration in education, also adapted to students with special needs, along with digital educational contents and tools. It equally proposes to establish a student achievement monitoring system for the digital assessment of learning outcomes and learning analytics, including e-Portfolio, a digital tool for the presentation of learning outcomes and extracurricular activities of students. Finally, the fourth strategic area proposes digital leadership training for school directors, leadership of digitally mature schools as a requirement in the future licensing system of school directors and support to autonomous management of the school digitalisation process. Moreover, the Strategy proposes to establish a system of open and shared data in education to support evidence-based decision-making. It would rely on data collection and analysis from different sources in the education system for the purposes of monitoring and raising the quality of education provision. Furthermore, this strategic area foresees a skills anticipation system, which would support the activities of the *National council for development of human potential* and further development of the *National curriculum for VET*. Lastly, scholarships, awards and international competitions would serve to promote digital jobs and skills, in particular occupations in ICT. Finally, the Strategy encourages teachers to innovate and experiment with ICT, as well as further research of the impact of ICT on teaching and learning outcomes, student health, personal development and social interaction.

The Strategy provides for grant schemes for cooperation with innovative initiatives outside the formal education system (e.g. civil society organisations that
promote the integration of robotics in teaching and learning). Furthermore, the Strategy foresees the establishment of creative spaces, open creative spaces and specialised classrooms in Croatian schools by 2026. Creative spaces represent cooperative workspaces that support learning, experimenting and exchange by using advanced technology such as 3D printers, laser cutters and CNC machines or even simple art education supplies. The spaces would be open to students, adults and entrepreneurs and foster creative exploration and development of the 21st century skills in STEM, electronics, 3D modelling and printing, programming, robotics, etc. Creative spaces would also support critical thinking and entrepreneurship or serve as business accelerators. Open creative spaces are dedicated areas where students may borrow or use ICT equipment to work on their homework or projects with the professional support of teachers. Specialised classrooms are intended for teaching subjects that require special ICT equipment or classroom set-up. For example, they include ICT and STEM classrooms equipped with 3D printers, sensors, robots and 3D glasses or art classrooms with ICT tools for creating audio-visual content (Commission for the development of a proposal of the Strategy for the digital maturity and close team of the Commission, 2018).

2.3. Framework for the digital maturity of schools

As the background document for the strategy, the framework for the digital maturity of schools (4) was developed in line with the European framework for digitally competent educational organisations (DigiCompOrg) as a part of the e-Schools pilot project. The Framework offers tools for the self-evaluation and the external evaluation of digital maturity of schools. Its purpose is to guide policy makers and schools in the effective use of digital technologies and in successful integration of ICT in teaching, learning and school administration. The Framework defines five areas and five levels of digital maturity: digitally unaware, digital beginners, digitally competent, digitally advanced and digitally mature. Schools are assessed in areas of leadership, planning and management, ICT in learning and teaching, development of digital competences, ICT culture and ICT resources and infrastructure (Begićević Ređep et al., 2018).

2.4. National coalition for digital skills and jobs

In December 2018, the National coalition for digital skills and jobs in Croatia (5) was established with a memorandum of understanding signed by the Ministry of

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(5) https://digitalnakoalicija.hup.hr/
science and education, the Ministry of labour and pension system, the Croatian employers’ association as the coordinator of the national coalition, and other stakeholders. It stems from the European Commission initiative *Digital skills and jobs coalition* as one of the actions under the *New skills agenda* for Europe (National Coalition for Digital Skills and Jobs, 2018a). The coalition’s charter on digital jobs states the following objectives: (a) increase the number of ICT specialists in Croatian companies; (b) advance human potential for digital transformation of traditional industries and occupations; (c) foster digital citizenship; (d) support digitally mature education and science for competitive economy; (e) keep digital specialists in Croatia; (f) integrate strategic objectives of the Coalition into strategic, legislative and funding framework; and (g) monitor progress and promote digital skills and jobs.

In particular, the Charter proposes to steer the unemployed toward ICT careers and to increase the number of highly educated ICT specialists in the labour market. It also suggests raising digital competencies of professionals in non-ICT occupations, supporting digital leaders and fostering creative digital society (science, technology, engineering, arts and mathematics - STEAM). Digitally mature education and science imply digitally competent teachers in primary and secondary schools, digitally advanced programmes and educational contents in VET schools and the development of a graduate tracing system. The Charter advocates for continuous professional development of digital specialists through promotion of lifelong and workplace learning and mentorship. Finally, the promotion of digital skills and careers should focus on primary and secondary schools as well as targeted engagement of women in digital careers (National Coalition for Digital Skills and Jobs, 2018b).
CHAPTER 3.
VET 4.0. initiatives and programmes

In 2018, flagship government initiatives to support the development of digital and Industry 4.0 skills through education and training at all levels focused on the introduction of obligatory ICT classes as of 5th and 6th grade of primary schools, STEM scholarships in higher education, the launch of the experimental stage of the comprehensive curricular reform and the e-Schools project. Moreover, the initiative to establish regional competence centres announced significant investments in technology and modernisation of teaching in VET schools.

3.1. E-Schools: flagship initiative for digital transformation of schools

E-Schools, the largest public initiative for digital transformation of education, are designed to prepare a strategic framework to systematically integrate ICT in primary and secondary schools by 2022. Along with the public policy aspect, the initiative is directed at improving ICT infrastructure in schools, raising digital competencies of teachers and students, introducing digital educational contents in teaching and learning, and developing data management systems. 10% of Croatian schools took part in the pilot stage of the project from 2015 to 2018, including 29 VET schools out of 151 schools in total. The majority of participating schools had raised their level of digital maturity in between the initial and the final assessments in 2016 and 2018. Namely, at the beginning of the e-Schools project, 82% of schools were digital beginners (level 2 out of 5), and by the end, 98% of schools had reached at least the level of digitally competent schools or higher (levels 3 to 5) (Commission for the development of a proposal of the strategy for the digital maturity and close team of the Commission, 2018).

During the pilot project, IT infrastructure was improved in all participating schools, with five schools selected to serve as regional educational centres, including two VET schools, equipped with ICT tools for collaborative meetings and opened to the broader educational community. Training courses were developed and delivered to school directors, teachers and the administrative staff. Digital educational contents, teaching scenarios for creative ICT use were created to enable wider access and exchange of teaching and learning materials. In addition, a community of practitioners was established for peer collaboration among teachers. Furthermore, learning analytics and educational data mining system is foreseen for the collection, analysis and reporting of student learning data. The ensuing learning analytics and data visualisation are intended to support learning and allow predictions of student achievement. The application would allow
personalised insight in teaching and learning or in general education trends. For example, it would allow school directors to supervise teaching or assign tasks, parents to monitor their children’s learning achievement and government officials to quickly extract data and create reports.

Finally, education management application (EMA) was developed as an online platform for organisation and monitoring of applications to professional training opportunities organised by public institutions such as the Croatian academic and research network (CARNET), the Agency for vocational education and training and adult education (AVETAE) and the Education and teacher training agency (ETTA). In March 2018, UNESCO (⁶) listed the Croatian e-Schools project among the top 12 projects in the world introducing ICT in education in 2017, in competition with 143 projects from 79 countries. In 2019, the European Commission also acknowledged the e-Schools pilot project for its relevance to all EU member states that are planning large-scale investment in ICT in education. The initiative was particularly recognized for high transferability of the digital maturity framework and teaching scenarios, as well as support networks and purposeful use of technology, which placed teaching and learning in focus. The Croatian initiative was also highly evaluated for its effectiveness despite financial and time constraints (Ledan, 2019).

The project coordinating body is CARNET, with AVETAE as one of the project partners and the Ministry of science and education as the responsible government authority. The pilot project value is over 40 million Euros, with 85% of the budget co-funded by the European Social Fund (ESF) and the European Regional Development Fund (ERDF). Based on the results of the e-Schools pilot project, full-scale implementation is underway from 2019-22, which proposes to encompass all Croatian primary and secondary schools (⁷).

Also operated by CARNET, Nikola Tesla national portal for distance learning currently comprises digital learning contents in mathematics, physics, biology, chemistry and English language for secondary schools, e-courses in computer programming, ECDL modules for certification in ICT literacy, tools for developing internet-based services and digital teaching materials (⁸).

3.2. VET regional centres of competence

In VET, the Ministry of science and education chose 25 VET schools to become the first regional competence centres in Croatia in 2018, based on the quality of VET provision, the number of students in sectors, regional distribution of schools

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⁷ Project website: https://www.e-skole.hr/en/

⁸ Nikola Tesla national portal for distance learning: https://tesla.carnet.hr/
and balanced geographical representation of the future centres. In the short-term, the centres will be established in five priority areas: tourism and hospitality sector, mechanical engineering, electrical engineering and ICT, health care and agriculture. As hubs of excellence, they will offer VET programs to students, professional guidance and training for professionals, VET teachers and workplace mentors. Central features of the centres include innovative learning opportunities, teaching excellence and intensive cooperation with local enterprises. Over 130 million Euros from the European structural and investment funds will be invested in the state-of-the-art equipment for the future centres, boarding room for VET students and expanded opportunities for work-based learning in line with the latest technological advancements in sector industries. The centres will also promote successful transition of VET graduates to the labour market. The future network of regional competence centres thus represents a unique opportunity to introduce the latest technology in Croatian schools and foster Industry 4.0 skills of VET students.

3.3. Promotion of early access to technology through digital innovation

As another flagship public initiative for early access to technology, the Ministry of Science and Education, CARNET and the Institute for development and youth innovation (IRIM) [Institut za razvoj i inovativnost mladih] launched the PROMikro project in 2017. The project aimed to improve digital literacy, programming, algorithmic thinking and problem-solving skills by using microcomputers in different teaching subjects and extracurricular activities. In 2017, 85% of primary schools applied to participate in the project. Students were equipped with micro:bit computers with the aim to improve their digital competencies, encourage creativity, innovation and interdisciplinary ICT use. 2 000 teachers were also trained to introduce microcomputers in all school subjects. Workshop evaluation revealed that 80% of participants were motivated to include microcomputers in education, including 50% of teachers with no prior experience or training in programming.

The ProMikro project belongs to the larger initiative Croatian makers (⁹), launched by the aforementioned civil society organisation IRIM. Croatian makers aim to advance STEM, Industry 4.0 and key competencies, social skills, as well as digital and scientific literacy through extracurricular activities in schools and local communities. IRIM equipped the first 1 000 Croatian schools with 25 000 micro:bit computers, as well as 100 libraries, after a highly successful crowdfunding campaign STEM Revolution in 2017, which mobilised high-profile contributors and raised broad public support. The micro:bit was developed by the Micro:bit Educational Foundation (¹⁰), with members including BBC, Microsoft, Samsung

⁹ Croatia makers website: https://croatianmakers.hr/en/home/
¹⁰ Micro:bit Educational Foundation website: https://microbit.org/
and Amazon, for its mass application in STEM and cross-curricular education in primary schools. The micro:bit is a handheld, programmable micro-computer that can be used for various student creations, from robots to musical instruments. Its central advantages are wireless connection, numerous sensors, and wide applicability across different subjects and levels of digital proficiency. In teacher training, IRIM used the original training materials of the Micro:bit educational foundation and developed a platform with open educational resources for independent use.

Further Croatian makers initiatives include the introduction of IoT technologies in 100 primary and secondary schools through equipment and training for teachers and around 1 000 students. Finally, STEM car brings digital literacy workshops in robotics and programming to primary school students in geographically underserved parts of Croatia. In 2018, IRIM launched another project, Digital Citizen, which aims to advance digital skills in local communities through transformation of public libraries in innovation and knowledge hubs. Supported by Google, Digital Citizen will equip over 120 libraries in Croatia and the region with micro:bit and mi:node do-it-yourself kits, which will be available to borrow or use in workshops at libraries. In addition, some libraries will receive 3D printers and librarians will go through train-the-trainer education.

From 2017, IRIM also holds WER Open Croatia, an advanced national-level competition in robotics and programming for participation in the World education robotics (WER). Primary schools in the Croatian Makers league and secondary schools in the STEM revolution initiative are invited to participate in the competition. The Croatian makers league represents a platform for competition in robotics, automation and programming for primary schools' students. Participating students use educational robot mBot to compete in quarterly regional and online competitions. At present, the Croatian Makers league involves over 550 schools, libraries and associations in Croatia with over 11 000 students and 3 000 donated robots.

3.4. Digitalisation in education governance

The responsible public institutions in education and training have equally invested significant digitisation efforts in upgrading online tools and data systems for the purposes of more effective data management and policy-making, as well as broader access to information for the interested public. For example, the Ministry of Science and Education developed a number of digital tools and databases, including e-matica, a centralised database with information on teachers and students in primary and secondary education in education. The application is updated directly by the school staff and it provides the Ministry with easy access to up-to-date information on the education system.
In 2018, the Ministry of science and education launched ŠeR (11), school data mining application, which presented large sets of aggregated data on students in primary and secondary education from the e-matica database. The open, real-time data continues to represent a valuable resource for policy development and analysis. The Ministry of science and education also initiated the development of two central application systems for enrolment in Croatian secondary schools (NISpuSŠ) (12) and higher education institutions (NISpVU) (13). The application systems offer a broader access to information for students and parents on the available programs and career choices, facilitate enrolment management for education institutions and allow the Ministry officials to extract current information on enrolment trends in education. Furthermore, AVETAE developed a number of online tools which support the development of VET policies and facilitate data collection and management, as well as access to information for target beneficiaries, in particular VET schools. For example, e-Kvaliteta (14) [eQuality] represents an online tool that facilitates VET school reporting and monitoring of the self-assessment process in VET. Next, the application Pikaso (15) is designed to support individuals in the process of international qualification recognition in Croatia. The online database e-Kvalifikacije (16) [e-Qualifications] supports VET qualification development and facilitates the work of expert groups in the development of occupational standards, qualification standards and VET curricula. Finally, in 2017 AVETAE launched a major ESF-funded project, the modernisation of the continuing professional development system for VET school teachers. The project is dedicated to developing an innovative, open and flexible model of continuing professional development (CPD) based on identified needs, relevant content, state-of-the-art training delivery methods, advanced ICT tools and a broad network of experts. The CPD delivery will rely on the web platform and teacher training materials developed through the project, with a focus on innovative and interactive training approaches, including e-learning and webinars. The project will thus increase the number of VET teachers participating in CPD and raise the quality, availability and relevance of teacher training.

(11) ŠeR, Školski e-Rudnik [School data mining], is available at: https://mzo.gov.hr/vijesti/ser-skolski-e-rudnik/2034
(12) NISpuSŠ, Nacionalni informacijski sustav prijava i upisa u srednje škole [National information system for application and enrolment in secondary schools], is available at: https://www.upisi.hr/upisi/
(13) NISpVU, Nacionalni informacijski sustav prijava na visoka učilista [National information system for application to higher education institutions], is available at: https://www.postani-student.hr/Ucilista/Default.aspx
(14) e-Kvaliteta: http://e-kvaliteta.asoo.hr
(15) Pikaso: http://pikaso.asoo.hr/
(16) e-Kvalifikacije: http://e-kvalifikacije.asoo.hr/
CHAPTER 4.
Using 4.0. intelligence for VET

4.1. Public initiatives on labour market intelligence

As a part of its efforts to associate data from different public databases, the Ministry of labour and pension system produced the Croatian qualifications framework (CROQF) web portal (17) as the central portal with labour market and education indicators. The CROQF portal serves as the central tool for labour market monitoring and the main evidence base for the development of sector profiles and occupational standards as the key mechanisms of CROQF. The portal offers data visualisation, statistics and analyses by CROQF sectors. In particular, it integrates data on employment, unemployment, enrolment in secondary and higher education programmes, key economic activities and corresponding employment rates, and distribution of different occupations in sectors in relation to economic activities. For example, the data on employment includes indicators such as the share of a specific sector in the total workforce, the number of occupations per sector and the distribution of workforce by age, sex and occupation.

In the upcoming period, further upgrades to the CROQF portal are foreseen, including a competence-based matching system, which would advance professional guidance and job placement activities of the employment services, career development monitoring and offer detailed labour market information to the public, including career choice guidance for prospective students. Target beneficiaries of the CROQF portal would include students enrolling in secondary or higher education programmes, unemployed job seekers, professionals changing careers, employers, as well as education, public and government institutions. The portal associates data on unemployment from the Croatian employment service (HZZ), data on employment from the Croatian pension insurance institute, enrolment in secondary and higher education programmes from the Ministry of science and education and the relevant statistical indicators from the Croatian bureau of statistics. The application uses aggregated data only in compliance with the General Data Protection Regulation (GDPR). The NET Framework application and Oracle cloud system are used for data storage and management.

In early 2019, the Ministry of labour launched a major initiative for further development of occupational standards in Croatia, funded through the ESF (18).

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(17) CROQF: http://hko.mrms.hr/
The initiative proposes progressive digital solutions for labour market monitoring based on advanced data management and exchange platforms. The development of 200 occupational standards for vocational occupations and adult education is underway. Working groups for the preparation of occupational standards actively use the CROQF portal, upgraded in 2019 within this initiative. The next step involves the development of a new platform for advanced education and labour market monitoring, supported by the Shared services centre (19). The Ministry of labour initiative also proposes to update the national classification of occupations, reference it to the classification of European Skills, Competences, Qualifications and Occupations (ESCO) and introduce a registry of regulated professions, based on advanced digital applications and data integration solutions. In the implementation of the initiative, prominent data scientists and ICT specialists provide their expertise to the Ministry of labour and HZZ, including the team that had developed the EU jobs and skills explorer described in 3.2. Moreover, one of the key developers of the EU jobs and skills explorer is appointed as a member of the ESCO maintenance committee of the European Commission, also with the support of the Ministry of labour.

4.2. EU jobs and skills explorer

In 2017, Croatian data scientists and ICT specialists developed EU jobs and skills explorer, an application which used the results of statistical surveys and big data to analyse the EU labour market in order to offer insight into skills gaps between job-seekers’ skills and skills demands in job vacancies in the EU. Furthermore, it offered forecasts of skill demands of the future labour markets at the regional level in the EU. The cloud application used databases with over 245 gigabytes of data and custom applications with more than one billion records. It relied on data from millions of job ads from the Cedefop database, as well as job listings and 4.7 million job seekers’ resumes from the European job mobility portal (EURES). In addition, the application tapped into different surveys including the Labour Force Survey (LFS) and the Program for the International Assessment of Adult Competencies (PIAAC), as well as Eurostat regional data sets. The data was standardised by using the European Skills, Competences, Qualifications and Occupations register (ESCO), which allowed easy data integration and comparability at the EU level.

(19) The Shared services centre was established in late 2019 at the Information system and information technologies support agency (APIS IT), with the support of the Ministry of public administration and the Central state office for the development of digital society. As the flagship initiative for digitalisation of public administration in Croatia, the Shared services centre represents a cloud-based solution that will integrate databases from a large number of public administration bodies. The centre would thus ensure higher effectiveness of public services for citizens and savings to the State budget.
Finally, the application used Cedefop European skills and jobs survey (ESJS) which, along with the macroeconomic data, offered comparisons at a lower, territorial level of the EU countries. The application supported user-interaction and intelligent data visualisation. The EU jobs and skills explorer was created during the first European big data hackathon, a competition organised by Eurostat and the European Commission, which asked participants to develop solutions that combined different data sources in addressing social challenges in the area of skills, education and lifelong learning. The Croatian team, comprised of experts from the IT company IN2data and Algebra university college, a private higher VET provider in Croatia, and coordinated by the Croatian bureau of statistics, won the first place in the competition in 2017 (20).

(20) Press release: https://www.dzs.hr/hrv/important/presscorner/Hrvatski%20tim%20pobijedio%20na%20Big%20Data%20Hackathonu.pdf
CHAPTER 5.
VET 4.0. learning practices

On the provider level, VET schools show significant interest in introducing the latest technologies and modernising curricula in order to teach Industry 4.0 skills to their students. For example, in higher VET, the Polytechnic of Zagreb runs specialist graduate professional studies in digital economy and the private provider Algebra University College offers programs in data science (including big data) and digital marketing (including courses on digital transformation of the economy, disruptive technologies, gamification and machine learning). Moreover, Algebra LAB - Open innovation lab supports entrepreneurship, innovation and digital transformation of businesses based on 4.0. technologies.

On the secondary education level, VET schools are eager to engage in international projects that introduce 4.0 technologies to their students. For example, Croatian VET schools participate in a number of Erasmus+ projects for integration of 3D technologies in IVET and CVET (21), building innovation (22), as well as digitalisation in the automotive industry (23). The Erasmus+ project upraising VET skills for innovation in European electro technical sector (24) focuses on sensorial technology as key communication technology in context of IoT and Industry 4.0. The institute for development and international relations from Croatia leads the Erasmus+ project boosting a novel and innovative training approach of key enabling technologies (25), which proposes to transfer key enabling technologies (KETs) to VET through the development of open educational


(22) Smart development of HVET for highly skilled and mobile workforce: https://ec.europa.eu/programmes/erasmus-plus/projects/eplus-project-details/#project/597862-EPP-1-2018-1-HR-EPPKA3-VET-JQ


resources. VET providers in Croatia also use international projects to foster student awareness of future skill needs through digital and Industry 4.0 technologies. The Erasmus+ project *making and designing a toy drone* through multidisciplinary collaborative work (26) aims to steer students to STEM careers by involving students in development of toy drones. The Erasmus+ project *robots boosts skills* (27) introduce robots in teaching and learning, as well as another Erasmus+ good practice example *cybernetic advanced technology* (28). In fact, a number of primary and secondary schools introduce robotics in learning and Croatian students have recently been quite successful in international competitions in robotics (European Commission, 2019).

Finally, adult education providers, including VET providers, are continuously increasing their offer of training opportunities for adults, ranging from basic digital literacy skills to advanced training in system and network administration, programming and web design, etc. In order to offer the courses free of charge, education providers use the European Social Fund (ESF) and apply to CES tenders for training providers as a part of Active labour market policy (ALMP) interventions.


CHAPTER 6.
Adapting to AI and automation

6.1. National strategy for artificial intelligence and digitalisation

In 2018, Croatia signed the *Declaration of cooperation on artificial intelligence*. Coordinated by the Ministry of economy, the preparation of the national strategic framework for AI and digital transformation of the economy is underway, in line with the *Coordinated plan on artificial intelligence* from 2018 and the *National reform programme 2019*. The future strategic framework should be aligned to the upcoming *National development strategy* for the period up to 2030 and address skills development. Digital economy belongs to the economic priorities of the Croatian presidency of the Council of the EU in 2020.

6.2. National training programmes for adults

The skills development and matching efforts of the Croatian employment service (HZZ) have thus far been largely directed at the unemployed through professional guidance and training interventions. Contrasted with several more popular ALMP interventions, training for the unemployed noted a moderate uptake by 8,474 participants in 2018 (HZZ, 2019). The available education opportunities for the unemployed included short training, re-training or professional development programmes approved by the Ministry of science and education. Their main purpose was to raise the employment perspective of the unemployed, especially through training for top shortage occupations, including for occupations in ICT, as well as training in transversal competences (digital skills, EU project management, language learning, etc.). As unemployment has been steadily declining since 2014, and on account of technological progress and its repercussions on the labour market, HZZ has been shifting its focus from the unemployed to the employed, in particular those at risk of losing their jobs, unqualified workers or workers who require advanced training in their occupation. Accordingly, HZZ expanded ALMP interventions and target groups to support both the employed and the unemployed in adjustment to new labour market demands in view of technological progress.

In 2019, the relevant ALMP interventions included (HZZ, 2018a):

a) Professional development training, among other, targeted at:
   (i) The employed for raising their competitiveness in the labour market;
   (ii) The employed at risk of losing jobs due to disruption in the production process and introduction of new technologies or higher standards.
b) Workplace training in companies, entrepreneurship hubs or development agencies, among other, targeted at:

(i) The unemployed trained for advanced technology, complex tasks at higher level of qualification or new jobs, for which corresponding programmes do not yet exist in the education system.

c) Job preservation in manufacturing industries (in particular, textile, garment, footwear, leather and wood processing industries) at companies that experience business difficulties, reduced competitiveness and disruption in business operations due to advanced technologies, offshoring of the manufacturing process to countries and regions with lower cost of labour, insufficient investment in technology or innovation, as well as low workforce competitiveness.

The job preservation intervention (c) targets older workers and workers with low or medium education levels (up to ISCED 3) directly involved in the manufacturing process. The intervention involves financial support to remuneration, training or professional development of workers. Although the uptake of new, expanded interventions remains modest in 2019, and generally comparable to 2018, the uptake of (a) professional development interventions somewhat increased (958), as well as the uptake of (c) the job preservation intervention (1,824), with a moderate uptake of (b) workplace training (286).

6.3. Employers’ perspective on artificial intelligence

In 2019, the coordinator of the National coalition for digital skills and jobs in Croatia, the Croatian employers’ association, published a position paper on the Potential of artificial intelligence in Croatia (HUP, 2019). First, the employers found that it was important to promote synergies between science, business and the public sector in defining priorities and investment framework for the proliferation of AI technologies in traditional and new industries. The assessment identified best practice examples and further potential for Croatia in the industry of smart vehicles and transportation, smart cities, tourism and cyber security. In the public sector, progress was observed in health care, justice and early detection of forest fires. Secondly, the assessment also advocated for the development of digital skills through education and lifelong learning, skills for the application of AI solutions in start-ups, business accelerators, R&D in traditional industry and the public sector, as well as the establishment of centres of excellence in AI. Thirdly, further progress in data management, sharing, transparency and integrity, based on advanced digital solutions, should support technology development in the business sector.
Among the existing initiatives in the public sector, initial steps have already been made by the Open data portal (29) and the Shared services centre. From the employers’ standpoint, the public sector was also encouraged to propose guidelines for ethical and responsible application of AI, as well as a legal framework that would foster investment, innovation and greater application of AI technologies by the business sector. Finally, Croatia was urged to take advantage of the funding opportunities of the Digital Europe Programme for the period 2021-27 (HUP, 2019).

(29) Open data portal: https://data.gov.hr/
CHAPTER 7.
Conclusion

According to the *Smart specialisation strategy*, well-educated secondary school graduates, a low level of early leaving and a high permeability represent the strengths of the Croatian education system. On the other hand, weaknesses consist of low shares of higher education students in STEM, a discrepancy of education profiles and skills of graduates with the labour market demands, an excessive focus on theoretical knowledge and lack of practical skills training, low shares of highly educated workers, inadequate skills profiles in R&D sector and inefficient tertiary education with a high leaving rate (Republic of Croatia, 2016). Consistent with low shares of STEM graduates, labour market data confirms pronounced shortages in STEM-related occupations (HZZ, 2017). In response, policy recommendations for enrolment in secondary and tertiary education advocate for increased enrolment in STEM programmes (HZZ, 2018b).

Based on its SWOT analysis, the final external evaluation and the research study of the impact of the e-Schools project, the strategy for the digital maturity of schools in Croatia identifies a number of challenges for comprehensive digital transformation of Croatian schools. Overall, the strategy underscores the complexity of ICT integration in education and pronounced digital divide in access to technology among schools. In terms of infrastructure, Croatian schools are significantly lagging behind digital single market targets for 2025. The quality of equipment at Croatian schools is often inadequate and unreliable which discourages teachers and disrupts their teaching plans. Moreover, the physical space for teaching and learning does not support innovative teaching methods.

The strategy finds that school leadership is generally not ready to face the challenges of digital transformation. In general, school autonomy in strategic planning, introducing and financing ICT solutions is minimal, in addition to restrictions in time, motivation, competence and leadership styles. Teachers and administrative staff are unevenly motivated, digitally competent and committed to reforms. The availability of initial and continuing training in digital skills is the key challenge for advancing digital competencies of teachers. School staff is generally not adequately informed of data protection procedures. The Strategy further underscores the inadequate methodological tools for ICT integration in teaching and learning. Teachers are still quite hesitant to experiment with ICT and innovative teaching methods. Digital education contents are not available for all subjects and technology is seldom used to include students with disabilities.

In the assessment of stakeholder attitudes, the strategy finds that the readiness for change and innovation largely varies among schools. Parents' support ranges from cooperative to disruptive attitudes and unrealistic demands. Although they sometimes motivate teachers to engage with ICT, students
sometimes give out a false perception of digital maturity, get overwhelmed by digital learning contents, whereas senior students even show disinterest in ICT. Overall, most schools struggle with funding and time constraints, in-school or system support for school projects.

Strengths for digital transformation of schools are observed in intergenerational cooperation, sound methodological competencies and growing interest in lifelong learning among teachers. Teacher innovation depends on their readiness to embrace reforms, motivation and professional attitudes as well as digital competency, available time and support. Schools stress the benefits of participation in e-Schools and international projects as opportunities for capacity-building and infrastructural investments. The opportunities for more successful digital transformation of schools are observed in international mobility, informal learning and best-practice exchange. In particular, gamification and artificial intelligence are seen as opportunities for the advancement of teaching and learning. Digital educational contents exist in STEM and their quality and scope are expected to increase with their proliferation.

Croatian policy makers recognise teachers as the staple of successful integration of ICT in education. In fact, competent leadership, motivated teachers, school readiness and a supportive environment are key to a successful digital transformation of schools. On the teacher level, key factors involve digital competencies and confidence, perceptions and attitudes, gender and experience in introducing ICT in teaching and learning. On the school level, the most important factors are infrastructure, technical support, teacher training, as well as institutional support, vision and organisational culture. On the system level, supportive and open structure for unhindered development is central to successful ICT integration in education (Commission for the development of a proposal of the strategy for the digital maturity and close team of the Commission, 2018).

DESI 2019 identified the following priorities for Croatia: improving digital skills, increasing the number of ICT specialists and focusing on re-skilling and up-skilling (European Commission, 2019). Given the digital economy and labour market indicators, as well as the challenges and the opportunities in the education sector, Croatia will continue improving digital infrastructure in schools, purposefully integrate ICT in teaching and learning and develop digital competencies of teachers, students and professionals. VET should strongly rely on technical and soft skills development. Moreover, investments in quality, excellence and innovation in VET are paramount. Croatia should make further efforts to improve education system performance in STEM, modernise VET in line with the present and the future skills needs and update curricula in view of skills forecasts for the Industry 4.0 and the digital economy.

Finally, Croatia would benefit from a wide-ranging reskilling strategy for education and labour, as well as a digitalisation strategy for the economy. Tools for skills anticipation and labour market forecasting, based on education and labour market indicators, would contribute to this goal. Professional guidance services
should be tuned to long-term skills forecasts based on economic and labour market indicators. Policies should encourage targeted reskilling for at-risk workforce and greater participation in lifelong learning.
Abbreviations and acronyms

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AVETAE</td>
<td>Vocational Education and Training and Adult Education</td>
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<td>CARNET</td>
<td>Croatian Academic and Research Network</td>
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<td>Cedefop</td>
<td>European Centre for the Development of Vocational Training</td>
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<td>CPD</td>
<td>continuing professional development</td>
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<td>CROQF</td>
<td>Croatian qualification framework</td>
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<td>DESI</td>
<td>Digital economy and society index</td>
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<td>EMA</td>
<td>education management application</td>
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<td>ERDF</td>
<td>European Regional Development Fund</td>
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<td>ESCO</td>
<td>European skills, competences, qualifications and occupations</td>
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<td>ESF</td>
<td>European Social Fund</td>
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<td>ETTA</td>
<td>Education and Teacher Training Agency</td>
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<td>GDP</td>
<td>Gross domestic product</td>
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<td>GDPR</td>
<td>General Data Protection Regulation</td>
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<td>HUP</td>
<td>Hrvatska udruga poslodavaca [Croatian employers’ association]</td>
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<td>HZZ</td>
<td>Hrvatski zavod za zapošljavanje [Croatian employment service]</td>
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<td>ICT</td>
<td>information and communication technology</td>
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<tr>
<td>IRIM</td>
<td>Institut za razvoj i inovativnost mladih [Institute for Development and Youth Innovation]</td>
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<td>KET</td>
<td>key enabling technologies</td>
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<td>LFS</td>
<td>Labour Force Survey</td>
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<td>NISpuSŠ</td>
<td>Nacionalni informacijski sustav prijava i upisa u srednje škole [National information system for application and enrolment in secondary schools]</td>
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<tr>
<td>NISpVU</td>
<td>Nacionalni informacijski sustav prijava na visoka učilista [National information system for application to higher education institutions]</td>
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<td>PIAAC</td>
<td>programme for the international assessment of adult competencies</td>
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<td>R&amp;D</td>
<td>research and development</td>
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<td>SEST</td>
<td>Strategy for education, science and technology</td>
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<td>STEAM</td>
<td>science, technology, engineering, arts and mathematics</td>
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<tr>
<td>STEM</td>
<td>science, technology, engineering and mathematics</td>
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<td>ŠER</td>
<td>ŠeR - Školski e-Rudnik [School data mining]</td>
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<tr>
<td>VET</td>
<td>vocational education and training</td>
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<td>WER</td>
<td>World Education Robotics</td>
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